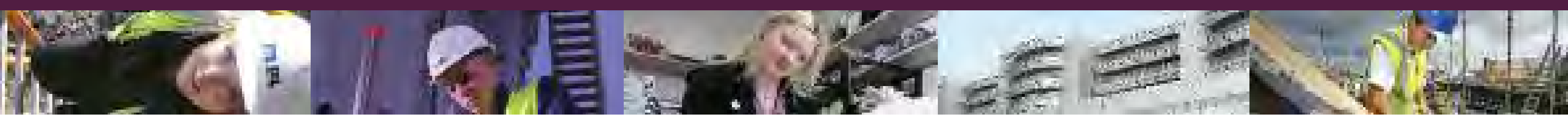
Essential Skills - Numeracy Level 2 for Experienced Construction Workers

ES LEVEL 2 RESOURCE FOR EXPERIENCED CONSTRUCTION WORKERS - JULY 2011



Acknowledgements
We would like to thank CITB-ConstructionSkills Northern Ireland who had this resource published. We also acknowledge our colleagues in the construction departments of South Eastern Regional College and South West College for their advice in our research prior to preparing this resource. We have also benefited from the expertise of many friends within the industry.

Aims
This resource should be used in the context of appropriately planned and structured Essential Skills programmes and should be used and adapted appropriately within that context.

Guidance for Using Resource
It is not intended that these materials should be used as a fixed programme of learning but as a resource which tutors can use to aid them in the planning and delivery of programmes suited to the needs of their particular groups of learners.

It is envisaged that tutors will bring their own ideas to these materials and extend and enhance them in order to keep activities refreshed and dynamic for learners.

Essential Skills tutors should ensure that they read and understand the following publication before they develop programmes: ESSENTIAL SKILLS GOOD PRACTICE: THE ASSESSMENT PROCESS. DEL NI, July 2007.

All information on this page is current and up to date at the time of printing (July 2011).

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Essential Skills Numeracy

This booklet will help you practice the skills you will need to achieve your level 2 in Numeracy.
When you see this symbol you may use a calculator to answer the question.

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MEASURE, SHAPE AND SPACE

HANDLING DATA

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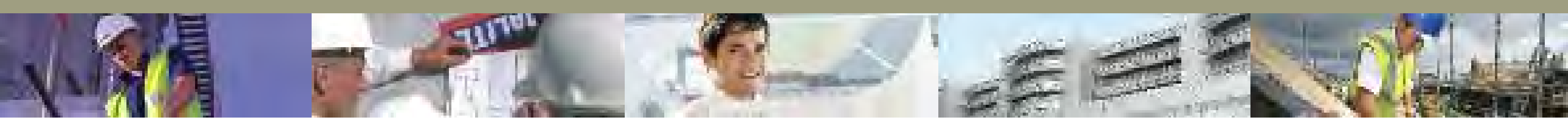
Tasks and Answers



NUMBER

TASK 1 - MONEY MATTERS

In this task we will explore some important points about borrowing money as this is very likely something you will have to do in the future in your career and/or personal life. You may well need to borrow money to purchase a vehicle, tools, equipment or property.

If you have ever heard or had a discussion on loans or borrowing you will be aware of the term “Interest” or “Interest rate”. Interest is a charge a lender makes to a borrower: it is the cost of borrowing or the price of money!

You may wish to purchase something but don’t have the cash available to do so. Some institutions (e.g. bank/building society/Credit Union) may lend you the money to make the purchase meaning you can have the goods immediately. You agree to pay the money back over a given period of time, usually months or years. The lender has taken a risk in giving you their money as something may happen that means you find it difficult to pay it back. In financial arrangements lenders expect some reward for taking this risk and the reward is that they will get back more than they gave you in the first place – that’s Interest!

For instance suppose you borrowed £500 for a certain period of time. A lender may choose an interest rate of 10%. This means that you have to pay back the original £500 plus the interest (10% of £500). The original £500 borrowed is usually referred to as Capital.

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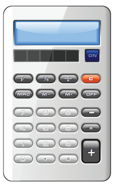
TASK 1 - MONEY MATTERS

1. What is the interest to be paid back on this loan?

2. What is the total amount to be paid back?

3. If the loan is to be paid back in 10 equal instalments how much will each instalment be?

4. What if you had agreed 12 equal instalments, how much would each instalment be?



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TASK 1 - MONEY MATTERS

Alternatively you may have agreed to pay back £35 each month for instance as that was the maximum you could afford.

5. In this case how long would it take you to repay the loan in full?

In practice interest is usually expressed as a per annum (yearly) percentage rate because loans normally run over a fixed number of years such as 3yrs or 5yrs (or maybe 10-15yrs for a commercial loan or 20-30yrs as in the case of a domestic mortgage).

For example, a bank may quote their lending rate as 10% p.a. To see what this means we will consider a real loan situation. Suppose Paul wants to borrow £2500 over three years (i.e. he will pay the money back gradually over three years normally in equal monthly instalments). The lender will calculate how much Paul has to pay in the following way.

Year 1:

Outstanding amount is £2500.

Interest for Yr 1 is 10% of £2500 = $2500 \div 100 \times 10 = £250$

The interest for the year is £250. You may now be tempted to simply multiply this amount by three to find out how much interest is to be paid over three years but it does not work like that in practice. Instead, lenders add on the interest for the first year when calculating interest for the second year.

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TASK 1 - MONEY MATTERS

6. To see how this works complete the calculation below?

Year 2:
Outstanding amount from Yr 1 is £2500 + £250 = £2750

Interest for Yr 2 is 10% of £2750 = £ ____

Year 3:
Outstanding amount from Yr 2 is £2750 + £ ____ = £ ____

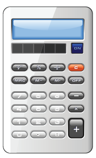
Interest for Yr 3 is 10% of £ ____ = ____ ÷ 100 × 10 = £ ____

Total to be repaid is £ ____ + £ ____ = £ ____

You can check your answer with the following statement, "if you borrow £2500 over three years at an interest rate of 10% pa you will pay back £3327.50 in total".

7. How many months are there in three years?

8. How much will each equal monthly instalment be?



Write down the display on your calculator including all digits

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TASK 1 - MONEY MATTERS

9. Round this off to an appropriate degree of accuracy.

When you are working with loans (or anything that involves percentages) it is very useful to be able to add on the interest in an efficient way. It will save time when you get used to it and can often make things easier. Here is what we mean by this…

In the example above we worked out 10% of £2500 (the interest) and then added that to the original £2500 (the capital) to get the total to be repaid for the first year of borrowing. These two steps can be done in a single multiplication which saves time. You will see how this works below but first….

You just need to brush-up on being able to write a percentage as a decimal fraction.

For example 50% = 0.5 and 25% = 0.25.

10. What is 10% as a decimal?

11. What is 75% as a decimal?

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TASK 1 - MONEY MATTERS

12. What is 100% as a decimal?

….and back to the loan calculation!

Original capital	+ interest for the year
= 100% of 2500	+ 10% of 2500
= 1.0 x 2500	+ 0.1 x 2500
= 1.1 x 2500 (or 2500 x 1.1)	= 2750

If you understood this you will now see that to increase a quantity by 10% we can multiply it by 1.1 (1.1 is the same as 110%).

In reality interest rates are not normally round figures such as 10%! Typical values might be 12.5%, 7.8%, 6.2% depending on the type of loan, etc.

13. Write each of the following percentage rates as decimals.
(some examples to start you off)

12.5% = 0.125	80% =	7.9% =
13.8% = 0.138	8% =	8.34% =
17.5% = 0.175	8.3% =	1.3% =
12.4% =	6.4% =	0.8% =

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TASK 1 - MONEY MATTERS

Now we can look at how to use this to add on interest or just increase (or decrease) things by a certain percentage. For instance, calculate the total capital and interest one year after borrowing £500 at an interest rate of 6.5%......

100% of 500 + 6.5% of 500

= 1.0 x 500 + 0.065 x 500

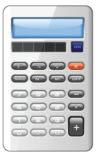
= (1.0 + 0.065) x 500

= 1.065 x 500

= £532.50

Try this one yourself!

14. Calculate the total capital and interest one year after borrowing £16500 at an interest rate of 8.4%?



In the previous calculation the number “1.084” is often called a growth factor and is very useful in percentage and interest calculations. To see how, let’s suppose the sum of money, £16,500, was borrowed over two years instead of one. The interest would have to be applied twice. We did something very similar to this in question 6 but did not use a growth factor.

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TASK 1 - MONEY MATTERS

Over two years the total capital and interest would be (to the nearest penny)

£16,500 x 1.084 x 1.084 = £16,500 x 1.084^2 = £19,388.42

Questions 15-19 are quite difficult so you can leave them out if you wish!

15. What would the total capital and interest be if this amount was borrowed over three years instead of two (interest rate is still 8.4%)?

Use '2 years' to help you: £16,500 x 1.084 x 1.084 = £16,500 x 1.084^2 = £19,388.42

John is a contractor who has just successfully tendered for a new development and needs to add to his existing fleet of diggers. He visits a website to see what his options are for borrowing £16,500 to finance the digger you see here.

He wants to consider a couple of important aspects of the loan: the interest rate and the loan repayment term (i.e. how long does he takes to pay the money back).

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TASK 1 - MONEY MATTERS

Obviously he wants to pay as low an interest rate as possible but it is not always as simple as that. For instance, sometimes to get a lower interest rate you may need to choose a shorter loan period and this then makes the monthly payment higher.

John has narrowed the loan options down to just two. One option is to borrow the money over 4 years at 8.4% p.a. (p.a. stands for per annum) and the other is to borrow it over 3 years at 7.5% p.a. John has also considered his financial circumstances and feels that the maximum monthly payment he could afford is £500. In the space below calculate the monthly repayment for John and help him decide which loan option to take.

16. John borrows £16,500 over 4 years @ 8.4% p.a.?

Use growth factors to help and don't forget there are 48 months in 4 years!

17. John borrows £16,500 over 3 years @ 7.5% p.a.?

Again use a growth factor to help…

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TASK 1 - MONEY MATTERS

18. Which loan option will John take based on the maximum monthly payment he can afford?

19. What is the main disadvantage for John in taking this loan option? In your answer give a reason and a number!

In the examples so far we have looked at interest on loans where the interest is applied each year. Often in practice it is applied each month. We can look at how a loan would be repaid over a one year period with the interest calculated each month. Breaking down a loan in this way is called 'amortising' by banks and it is useful to see how interest really works!

Peter is a self-employed joiner who borrowed £1000 to take advantage of an on-line sale on tools and equipment from a trade supplier.

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TASK 1 - MONEY MATTERS

Complete the loan breakdown below for his loan of £1000 charged at an interest rate of 1% per month. Read the information carefully before completing the table.

The balance in any given month is the difference between the balance and capital reduction from the previous month.

Monthly repayment is the repayment amount that will result in the loan being paid off after the agreed number of months. In this case it is fixed at £88.84

Interest is a fixed percentage (in this case 1%) of the balance each month.

Capital reduction is the difference between the monthly repayment and Interest.

20. The first half of the table has been completed for you. (You may consider completing this table by making use of spreadsheet software!)

** Look at how to calculate the interest for month 3. It is 1% of £841.53 which is £8.4153. When rounding this to 2 decimal places you would naturally end up with £8.42. However lenders cannot overcharge on interest which means they would have to round this down to £8.41.*

You can use this space for rough work!

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TASK 1 - MONEY MATTERS

Mth	Balance	Interest	Monthly repayment	Capital reduction
1	1000.00	10.00	88.84	78.84
2	921.16	9.21	88.84	79.63
3	841.53	8.41	88.84	80.43
4	761.11	7.61	88.84	81.23
5	679.87	6.79	88.84	82.05
6	597.82	5.97	88.84	82.87
7				
8				
9				
10				
11				
12				
13				

An extra row has been included in the table just in case you find that the capital reduction in month 12 does not exactly clear all the outstanding balance!

21. If you have needed to put an entry in for balance in Month 13 explain below why you think this is and what do you think will happen to this amount?

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TASK 1 - MONEY MATTERS

22. How much did Peter pay back in total?

23. What do you notice about the amount of interest each month as the loan progresses?

24. How would you explain capital reduction to someone who didn't know what it was?

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TASK 2 - NUTS AND BOLTS

James works for a large construction firm and one of his duties is to source structural steel components and fasteners (rivets, screws and bolts). His company has just won a contract for a very large development and he has set about sourcing the construction fasteners needed for the job.

Keeping costs to a minimum is very important and the lead civil engineer has asked James to investigate the possibility of sourcing these fasteners in the United States.

After some searching James has located a supplier who can provide the type of nuts and bolts required. Here is a table containing some data James has been given on a range of hex head bolts. As is often the case in US Imperial units have been used for length and diameter.

Code	Length (inches)	Diameter (inches)	Steel grade
A	3/4	½	10.9
B	1	¼	12.9
C	1 ½	3/8	11.9
D	1 ½	11/8	11.9
E	1 ½	5/16	12.9
F	2	9/16	10.9
G	2	7/16	11.9
H	2 ½	1 ¼	6.8
I	2 ½	3/4	7.9
J	4	17/16	10.9

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TASK 2 - NUTS AND BOLTS

1. Complete the table below for the selection of bolts above in terms of increasing shaft diameter. The first row is already completed?

Code	Diameter (inches)	Length (inches)	Steel grade
B	¼	1	12.9

2. What is the average (mean) length of the 10.9 grade fasteners?

Total length of 10.9 grade fasteners:

Mean length of 10.9 grade fasteners:

The Steel grade indicates the tensile strength of the steel used and is obviously of critical importance. Assume the grade numbers used (10.9, 11.9 etc) are direct measures of strength (in other words steel with a grade of 12.9 would be exactly twice as strong as steel with a grade of 6.45). A structural engineer has informed James that any fasteners of grade 6.8 and 7.9 are to be replaced by ones at least 40% stronger.

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TASK 2 - NUTS AND BOLTS

3. Which grades could be used to replace fasteners at the lower strength grades (6.8 and 7.9)?

You can tick more than one option if appropriate

6.8 grade fasteners: Replaced by:	7.9	10.9	11.9	12.9
7.9 grade fasteners: Replaced by:	10.9	11.9	12.9	

In order to compare these US fasteners with specifications provided by colleagues using metric measurements, James must convert the data for length and diameter into metric units. For the particular application in mind the precise diameter of these fasteners is critical. Accuracy in converting length is important but not critical. Therefore James has decided to adopt a different approach to making the conversion for diameter than for length.

4. To convert the lengths of the fasteners he decides to use the conversion 1 inch = 2 ½ cm. He doesn't use a calculator for this and not all Codes are used. Complete the table?

Code	Length (inches)	Length (cm)	
		Fraction	Decimal
	¼	¼ x 2 ½ = ¼ x 5/2 = 5/8	5/8 = 0.625
B			
C			
F			
H			

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TASK 2 - NUTS AND BOLTS

5. To convert the diameters he uses the conversion 1 inch = 25.4 mm as he needs to have this correct to the nearest ½ mm?

Code	Diameter (inches)	Diameter (metric)	
		mm	cm
A	½	½ = 0.5 0.5 x 25.4 = 12.7 = 12.5mm	12.5mm = 1.25cm
B	¼		
F	9/16		
H	1 ¼		
I	¾		

Following consultation with other construction professionals James concludes that almost 60000 fasteners will be required for this job. The job will require a mixture of Type A, B, C and J fasteners and the nature of the job indicates that they will be needed in the ratio 2:4:1:5.

6. Determine how many of each fastener is required?

Code	A	B	C	J
Ratio	**2**	**4**	**1**	**5**

Total number of fasteners = 60,000

Number of each type of fastener:

A = B = C = J =

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TASK 2 - NUTS AND BOLTS

7. Use the previous answer together with the original table (summarised below) to determine the ratio of fasteners ordered in terms of Steel grade?

Code	A	B	C	J
Grade	10.9	12.9	11.9	10.9

Find the Steel grade ratio **grade10.9:grade11.9:grade12.9** for the 60000 fasteners required.

Now that James has decided on the number of fasteners of each type required he needs to get a price for the order.

8. The supplier has the following table for pricing: use it to determine the cost of his order of 60,000 fasteners?

CODE	ORDER SIZE ($ PER 100)			
	<1000	*1000-4999*	*5000-19999*	*20000 or more*
A	N/A	8.95	7.50	6.95
B	10.50	9.95	8.50	7.95
C	12.50	11.95	10.50	9.95
J	24.50	22.95	20.50	18.95

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TASK 2 - NUTS AND BOLTS

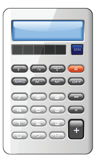
James now needs to determine the carriage cost for this order which will be determined by its weight. All fasteners come in boxes of 100 and the weight (mass) of each box is given in the table. Note the units used are lbs (pounds).

9. Determine the total weight of the order in lbs. Ignore the weight of any extra packaging as it will only be a tiny fraction of the total?

Code	A	B	C	J
Mass (lb)	4.3	6.5	9.2	10.5

James is going to use a courier located in the UK to bring the order home. On their website he needs to enter the weight of the order in kg.

10. Convert the previous answer to kg using 1kg = 2.2lb. Give your answer to the nearest kg?



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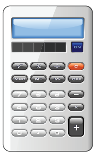
TASK 2 - NUTS AND BOLTS

The order will be loaded onto pallets for delivery from US to UK. The courier charges 25p per kg and there is a Customs administration charge of £47.50 placed on all orders.

11. In the space below calculate the carriage costs of the load using this courier?

12. Find out what the current $:£ exchange rate is and use it to price the entire order in Sterling (£) (remember the cost of the order is in $ but the carriage is in £)



Before completing the order one of the company directors asks James to double the size of the order as they have just won a second similar contract.

13. How will this impact on the cost of carriage? Will it also double? Answer this in the space below and explain your findings.

NUMBER

TASK 3 - LEVELS AND FORCES

The use of negative numbers in construction is generally related to temperature (see task called Temperature) and finances (see task called Bank Statement). They are also very useful when working with distance above or below certain levels in surveying or the direction of forces that act in beams, columns, frames etc.

In this task we will consider some situations where negative numbers are used in surveying levels and when working with forces.

Concrete hollow core floor units have a natural pre-camber when they are pre-stressed during manufacture.

A hollow core slab spanning 7.0m has a pre-camber of -4.5mm. When a certain dead load is applied in use the slab deflects downwards from the pre-stressed position by 5.3mm.

1. In the space below produce a sketch to describe the situation. Include a vertical number line and mark the before (unloaded) and after (loaded) positions.

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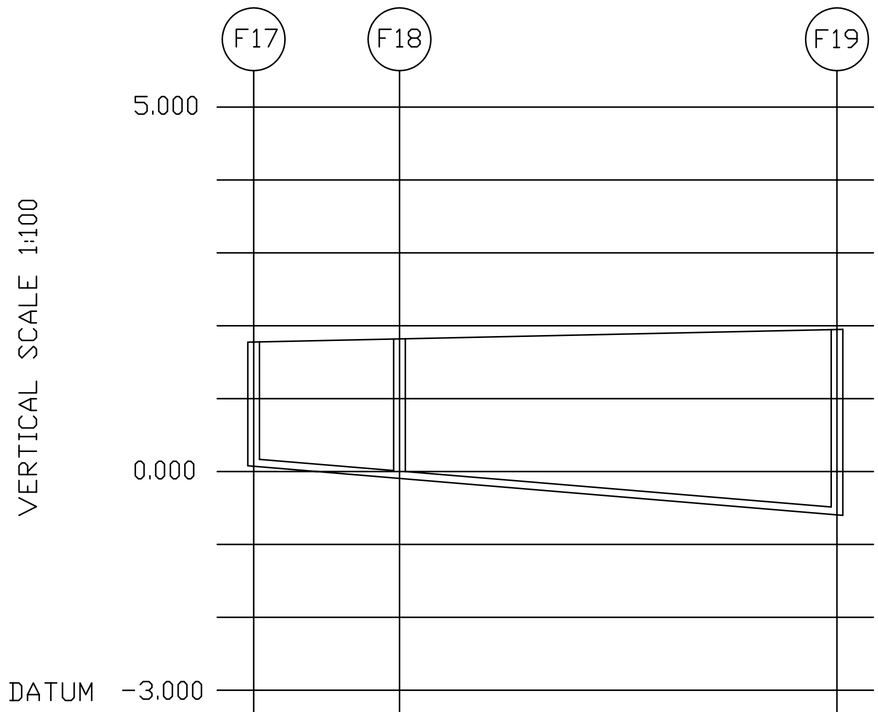
TASK 3 - LEVELS AND FORCES

The diagram below shows invert levels and cover levels of foul sewer through a site for a new leisure complex. Measurements have been taken between points F17, F18 and F19 on the site. All quoted levels are in metres and you do not need to take any scale measurements from the drawing, just use the values in the table.



	F17	F17–F18	F18	F18–F19	F19
FOULWATER COVER LEVEL	1.620		1.687		1.912
FOULWATER INVERT	0.099		-0.084		-0.681
FOULWATER DETAILS		Dia 150 Type uPVC 1 in 60		Dia 150 Type uPVC 1 in 60	
FOULWATER LENGTHS		10.964		35.742	

HORIZONTAL SCALE 1:500

LONGITUDINAL SECTION OF FOUL SEWER F17-F19

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TASK 3 - LEVELS AND FORCES

2. What is the difference in the invert level between grid F17 and F18?

3. What is the difference in depth between the foul water cover level and the foul water invert level at location F18?

4. What depth has the foul water invert level dropped between F18 and F19?

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TASK 3 - LEVELS AND FORCES

The internal ground floor level of a house has been set at 0.00m. External ground level is 0.15m below internal ground floor level. Internal basement level is 2.60m below internal ground floor level. The height of the eaves level is 5.20m above internal ground floor level. Mark on the diagram below the missing levels and calculate

5. The difference in height between external ground level and eaves level?

6. The total height from basement floor to eaves level?

7. How far is the basement floor level below external ground level?

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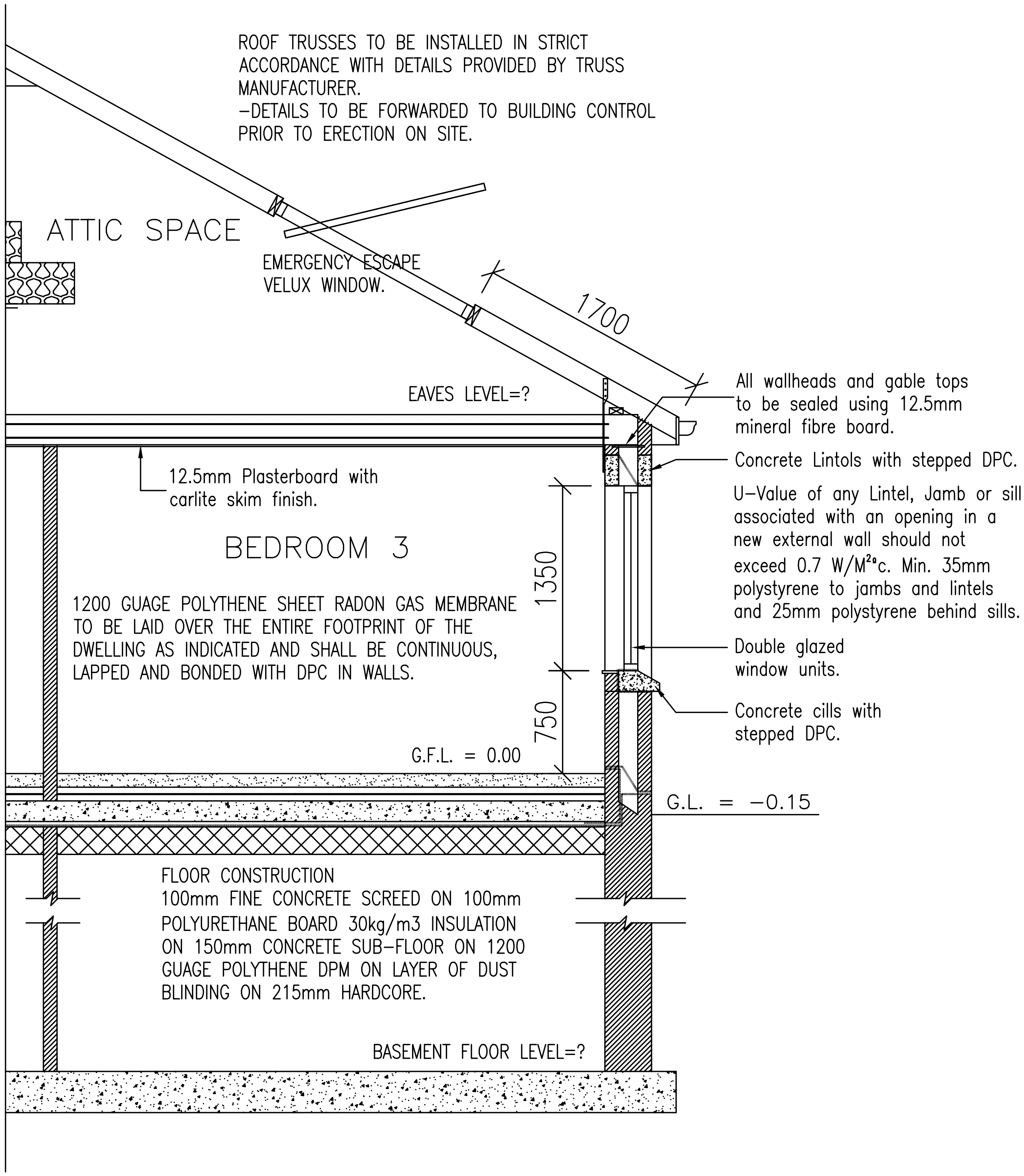
TASK 3 - LEVELS AND FORCES



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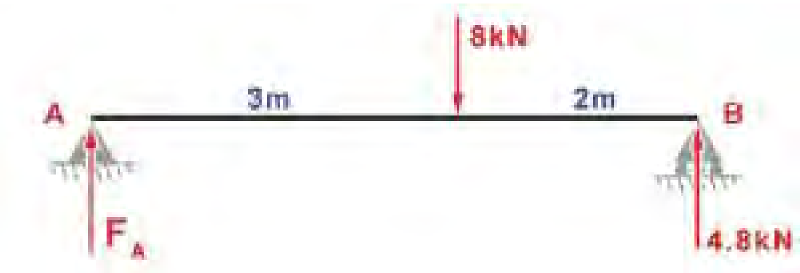
TASK 3 - LEVELS AND FORCES

The diagram below shows the forces present in a beam. A simply supported beam is supported at each end as shown and there are often forces (loads) acting on the beam itself between the supports. In the diagram there is a force of 8kN acting as shown. As a result there will be upwards forces acting at each of the support points A and B. The force at B is given as 4.8kN.



In order for this beam to be stable, certain conditions must hold. These are called equilibrium conditions and one condition is that the forces must all add up to zero! Forces are considered positive or negative depending on which direction they act. In this task we will take upwards forces as positive with downwards forces as negative.

For the beam in the diagram we can work out the unknown force FA as follows:

$F_A + 4.8 – 8 = 0$

$F_A - 3.2 = 0$

$F_A = 3.2$ kN

As a check we can sum positive forces and negative forces separately to see if the totals are equal.

For the beam above this would give:

Total positive forces = 3.2 + 4.8 = 8kN

Total negative forces = 8kN

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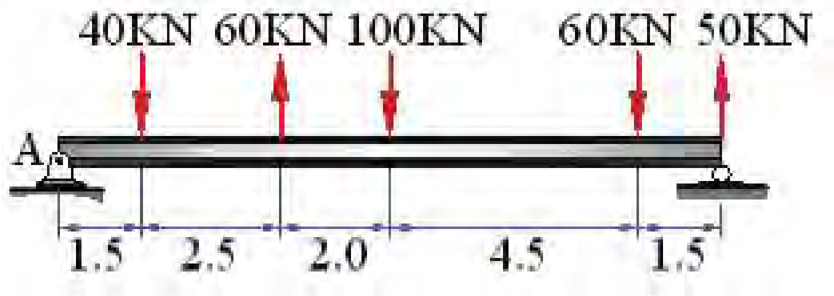
TASK 3 - LEVELS AND FORCES

Apply what you have learned in this example to the following problem (ignore the distances between the forces in the diagram).

8. Draw in the direction of the missing force at A



9. Use the method above of summing forces to equal zero to help you work out the size of the force at A?

10. Finally check your answer using the method of positive and negative totals?

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TASK 4 - BANK STATEMENT

Here is the bank statement for a local building contractor for the month of November. The contractor wants to take a detailed look at the statement and get an overview of his account. You can help with this by answering the following questions.

Mid-Ulster Bank **Statement of Account**

St. Swithin's Branch
Broad Street
Magherafelt
Co. Londonderry

Tel: 02886712345

Sort: 09-59-01
A/C 657362142
Date 12.12.10

A N Other, Main street, Belfast

Date	Details	Debits	Credits	Balance
01 Nov	Opening Balance			1836.51
02 Nov	Direct Debit 043121	2248.07		
03 Nov	Cheque 234174	2192.83		
05 Nov	Transfer a/c 61152309		1500.00	
09 Nov	Cheque 234017	5877.30		
10 Nov	Cheques paid in		4540.50	
10 Nov	Standing order 0021972	1466.45		
16 Nov	Cash paid in		8340.18	
20 Nov	Cheques for salary	7840.37		
25 Nov	JR Materials (refund)		2540.34	
27 Nov	Cheque paid in		12277.45	11409.96
29 Nov	Direct Debit	3480.32		7929.64
30 Nov	Closing Balance			

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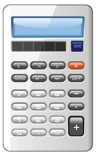
TASK 4 - BANK STATEMENT

1. Fill in the balance column as far as 29th November. The balance on 29th November should be £7929.64, allowing you to check your answer. Use the space below as well if you need to.



2. Use an alternative method to arrive at the balance on 29th November.

Hint: Total the Debit and Credit columns separately and then combine your answer with the figure for opening balance on 01 Nov.

3. On 2nd Nov Direct Debit 043121 was debited from the account leaving a balance that day of -£411.56 What does the negative sign mean?

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TASK 4 - BANK STATEMENT

4. On which day was the account at its lowest point and how much did he have in the bank on that date?

Date:

Amount owed:

The contractor has an agreed overdraft of £5000 on this account for which he pays £80 per month. The £80 is applied on the last day of the month and is applied if the account was 'in the red' for even one day in the month. He does not pay the fee for any month in which the account remained 'in the black' at all times.

5. Will he have to pay the £80 fee for the month of November?

The contractor also has an emergency reserve overdraft on the account of £2000. This means that if he exceeds his agreed overdraft of £5000 the bank will continue to honour any drawings on the account up to an extra £2000 (i.e. allowing a balance up to -£7000). However the bank has stipulated two conditions on this emergency reserve if it is used:

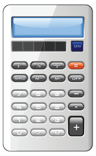
- A charge of 1.5% of the minimum balance will be applied at the end of the month
- The account needs to be brought back into the agreed overdraft limit immediately at the end of the month.

NUMBER

TASK 4 - BANK STATEMENT

6. Did he use his emergency reserve in November?

7. If he did use the emergency reserve determine the charge that will be applied for using it?



NB: if you need to round off a calculator display figure to the nearest penny remember a bank will have to round down so as not to overcharge!

There was no additional activity on the account on 29th and 30th November.

8. Complete the statement up to and including Nov 30th by applying any fees or charges due? Use the space below to do any additional calculation you need to.

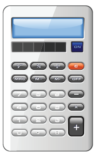
NUMBER

TASK 4 - BANK STATEMENT

The table below contains details on the account over the previous four months. In particular you will see the closing balance each month and the minimum balance for that month.

Month (2010)	Closing Balance Balance (before fees / charges)	Minimum Balance	Overdraft fee	Emergency reserve charge
July	3144.44	2469.46		
August	-6183.86	-6492.08		
September	1064.99	-2845.91		
October	1836.51	493.67		

9. Complete the table by entering an overdraft fee and an emergency reserve charge each month where appropriate. You may find it useful to read the instructions above again about how and why fees/charges are applied to this account. Use the space below for any working out you need to do?



At the end of one month the contractor had to lodge money into his account to bring the balance back to within the agreed overdraft limit (£5000).

10. Which month was that and how much did he have to lodge? Don't forget that the closing balance figure in the table above has NOT had any charges or fees applied. These will need to be added in before the final closing balance for the month is known.

NUMBER

TASK 5 - TEMPERATURE

Negative numbers are numbers to the left (or below) zero on a number line. The use of negative numbers in construction is generally related to temperature, finances (see task called Bank Statement), height above or below certain levels in surveying or the direction of forces and sense of moments (clockwise or anti-clockwise) that act in beams, columns, frames etc.

In this task we will look at some examples of how negative numbers can crop up when working with temperature.

There are two temperature scales you need to be aware of and indeed be able to convert temperatures from one scale to the other. Nowadays the Celsius temperature scale is more popular but Fahrenheit is still used quite frequently.

In the Celsius temperature scale 0˚C represents the freezing point of water. Be careful, it does not mean there is no heat energy present. It just means there isn't enough heat present for water to exist in liquid form so it freezes. A negative value on the Celsius scale indicates a temperature lower than 0˚C where there is less heat energy present and so it feels colder.

The boiling point of water is defined as 100°C on the Celsius scale but is 212°F on the Fahrenheit scale.

The picture below contains a dial from which you can read temperature in either scale.

NUMBER

TASK 5 - TEMPERATURE

1. What is the temperature according to the dial in °C to the nearest degree?

2. What is the dial reading in Fahrenheit (°F)? Try to estimate this to the nearest Fahrenheit degree and later you can use a formula to check.

In the text above you were told that two key points on the Celsius scale are 0°C and 100°C (this portion of the Celsius scale is sometimes referred to as the Centigrade scale because it has a range of 100 degrees). It was also stated above that the boiling point of water corresponds to 212°F.

3. What is the freezing point of water on the Fahrenheit scale? Use the dial and the information already given.

NUMBER

TASK 5 - TEMPERATURE

Two workers, Jake and Paul, are having a discussion about the usefulness of this dial.

Jake said, ***"This dial cannot be used to convert 60°C to Fahrenheit (°F)"***
Paul said, ***"Yes it can, you could just find out what 30°C converts to and double it!"***
This made Jake think as he wondered if Paul was correct. To reinforce his point Paul added,
"If someone is 1 metre tall then that makes them 3' 3" tall so if someone else is 2m tall they will be 6' 6" tall – you just double it"

4. Produce some evidence from the dial gauge above to settle the discussion one way or another?

5. In the space below to explain why Paul is correct when he says "If someone is 1 metre tall then that makes them 3' 3" tall so if someone else is 2m tall they will be 6' 6" tall" but he is wrong when he attempts to apply this argument to the temperature scales of Celsius and Fahrenheit?

You may wish to include the following words in your answer or use them to help structure your answer: "direct proportion", "one quantity is zero when the other is zero", "0°C is not 0°F", "doubling one temperature did not make the other temperature double", "if you increase one quantity by a certain percentage the other increases by the same percentage"

NUMBER

TASK 5 - TEMPERATURE

You will not always have access to a dial (or other device) to help you make a conversion from one temperature scale to another. Even if you had the dial above it could only help you with temperatures in the range shown as the above discussion has demonstrated.

For instance you could not use the dial to convert 60°C to °F! For this you could make use of a formula which works for all temperatures and conversion formula are very useful for this reason. We will consider two formulae in this section that can be used to convert from one temperature scale to the other depending on which direction conversion is needed.

Before doing this it will be helpful to recap on some number facts. Consider the two numbers 5/9 and 9/5.

6. One number is a proper fraction – which one is it? Give your answer in numbers and words.

7. Write the other number as a mixed number, again using numbers and words?

NUMBER

TASK 5 - TEMPERATURE

8. Convert each number (5/9 and 9/5) to a decimal fraction. Use your calculator and simply record the screen display in the space provided?

5/9:

9/5:

9. Now put each of the above answers into words?

Hint: for 0.45 you would write “zero point four five” or for 7.3636363636 you could write “seven point three six repeating”

NUMBER

TASK 5 - TEMPERATURE

When using temperature conversion formula you will need to use the above numbers (sometimes as fractions (5/9 or 9/5), sometimes as decimals (0.55 and 1.8)) in multiplications. This will be easy if you have a calculator but sometimes you may not and there are some useful properties of these numbers which may be helpful.

We can look at 1.8 first.

1.8 = 2 - 0.2 so multiplying a number by 1.8 is the same as multiplying the number by 2 and by 0.2 and then subtracting the two answers.

At first glance this may not seem to be much of an advantage but if you notice that

0.2 = 2 ÷ 10

then the advantage becomes clear as it is easy to divide by 10. Follow the examples below and then attempt the multiplications that follow.

Any multiplications involving negative numbers are optional!

eg 1: **45 x 1.8**
We can see that

45 x 2 = 90

and

45 x 0.2 = 9.0 (because 90 ÷ 10 = 9)

Which means…

45 x 1.8 = 90 – 9 = 81

eg 2: **6.4 x 1.8**

6.4 x 1.8

Again we can see that

6.4 x 2 = 12.8

and

6.4 x 0.2 = 1.28 (because 12.8 ÷ 10 = 1.28)

Which means…

6.4 x 1.8 = 12.8 – 1.28 = 11.52

NUMBER

TASK 5 - TEMPERATURE

10. In the space below complete the multiplications without using your calculator?

23 x 1.8	-37 x 1.8

Now we will look at how to work with **0.55.**

The first thing to note is

0.55 = 0.5 + 0.05

then make use of two simple number facts

- 0.5 is the decimal form of the fraction ½.
- 0.05 = 0.5 ÷ 10.

So, to multiply something by 0.55 you could

"first of all find one half of the number you are multiplying, then divide that number by 10, finally add these two answers together".

To make this clear we can look at an example

eg: **48 x 0.55**

- Half of 48 is 24
- One tenth of 24 id 2.4

So **48 x 0.55 = 24 + 2.4 = 26.4**

NUMBER

TASK 5 - TEMPERATURE

Sometimes you may need to multiply by 0.555 instead of 0.55 depending on how accurate you want your answer to be.

11. In the space below set out a method you could use as a convenient way to multiply by 0.555 without using a calculator or doing an actual multiplication sum?

Hint: 0.555 = 0.5 + 0.05 + 0.005!

12. Put your chosen method to use below?

48 x 0.555

13. Round the previous answer to 1 decimal place?

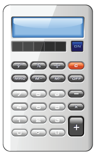
NUMBER

TASK 5 - TEMPERATURE

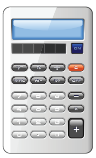
14. Compare your previous answer to the answer given above to 48 x 0.55. Which is closer to the exact answer to 48 x 5/9 and why?

Sometimes when multiplying by 5/9 it will actually be easier to do a fraction multiplication than firstly converting the fraction to a decimal. For instance consider the multiplication 36 x 5/9.

15. In the space below calculate the answer to this multiplication using fractions?



16. What property has the number 36 that made it easier to do the above calculation with 5/9 as a fraction instead of a decimal?



NUMBER

TASK 5 - TEMPERATURE

17. If instead the multiplication was 36 x 9/5 which approach would be easier – using 9/5 as a fraction or as a decimal? To help you decide do the multiplication both ways in the space below.

36 x 9/5:

36 x 1.8:

18. Without doing any calculations give a reason indicating which approach (fraction or decimal) you feel would be easier to do the multiplication 25 x 9/5?

NUMBER

TASK 5 - TEMPERATURE

We can now look at the actual temperature conversion formula. As mentioned earlier there are two formulae depending on whether you need to convert from Celsius (°C) to Fahrenheit (°F) or the other way around.

If you are converting temperature from Celsius (°C) to Fahrenheit (°F) then use this formula

$$C = \frac{5}{9}(F - 32)$$

C represents Celsius temperature and F represents Fahrenheit temperature.

19. Indicate which of the following statements correctly describes how to apply this formula?

A: multiply the Fahrenheit temperature by five ninths and then subtract thirty-two.

B: subtract thirty-two from the Fahrenheit temperature and then multiply by five ninths

NUMBER

TASK 5 - TEMPERATURE

If instead you need to convert from Fahrenheit (°F) to Celsius (°C)you should use this formula

$$F = \frac{9}{5}C + 32$$

again C represents the Celsius temperature and F represents the Fahrenheit temperature.

20. In the space below use words to describe how to correctly apply this formula?

Now we can look at an actual construction situation where you will have the opportunity to use these formulae and apply what you have learned earlier in the section.

During a cold spell temperature on site is monitored as freezing conditions can cause problems with materials and machinery. The health and safety of employees is also a top priority. In order to know whether certain precautions are necessary the temperature is recorded as shown in the table below.

Site temperature at 8am (1st to 14th November 2010)														
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Temp(°C)		4			-5		-10	-7	-3	4	1		4	
Temp (°F)	50	39	30					19	27	39	34			41

NUMBER

TASK 5 - TEMPERATURE

Each morning the temperature may be taken by a different individual with the result that on some mornings the temperature has been recorded in Celsius, some mornings in Fahrenheit and some mornings it has been recorded it in both formats.

On 1st, 3rd and 14th November temperature has been recorded in Fahrenheit degrees.

21. Use the appropriate formula to convert these temperatures to Celsius and record the answers in the table. Round to the nearest °C if necessary?

Before each calculation decide whether it is easier to use five ninths in fraction format (5/9) or in decimal format (0.55)!
1st:
3rd:
14th:

NUMBER

TASK 5 - TEMPERATURE

On 5th, 7th and 13th temperature has been recorded in Celsius degrees.

22. Use the appropriate formula to convert these temperatures to Fahrenheit and record the answers in the table. Round to the nearest °F if necessary?

Before each calculation decide whether it is easier to use nine fifths in fraction format (9/5) or in decimal format (1.8)!

5th:

7th:

13th:

NUMBER

TASK 5 - TEMPERATURE

Temperatures for 4th, 6th and 12th are not shown in the table. The images below show the temperatures for these dates measured in Celsius.

23. Make each temperature reading and record the result in the table?

4th December **6th December** **12th December**

24. Use the conversion dial shown earlier to record the temperatures for 4th, 6th and 12th in Fahrenheit to the nearest degree. As an exercise you may wish to test how well you have used the dial by checking your answers with the conversion formula?

25. Now that the table is complete you should use the space below to determine the mean temperature over the two week period, firstly in Celsius and then in Fahrenheit?

Celsius:

	4			-5		-10	-7	-3	4	1		4	

Fahrenheit:

50	39	30					19	27	39	34			41

NUMBER

TASK 5 - TEMPERATURE

26. Without doing an actual calculation how might you perform a check on your previous answers?

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

In this task we will explore some important points about borrowing money as this is very likely something you will have to do in the future in your career and/or personal life. You may well need to borrow money to purchase a vehicle, tools, equipment or property.

If you have ever heard or had a discussion on loans or borrowing you will be aware of the term “Interest” or “Interest rate”. Interest is a charge a lender makes to a borrower: it is the cost of borrowing or the price of money!

You may wish to purchase something but don’t have the cash available to do so. Some institutions (e.g. bank/building society/Credit Union) may lend you the money to make the purchase meaning you can have the goods immediately. You agree to pay the money back over a given period of time, usually months or years. The lender has taken a risk in giving you their money as something may happen that means you find it difficult to pay it back. In financial arrangements lenders expect some reward for taking this risk and the reward is that they will get back more than they gave you in the first place – that’s Interest!

For instance suppose you borrowed £500 for a certain period of time. A lender may choose an interest rate of 10%. This means that you have to pay back the original £500 plus the interest (10% of £500). The original £500 borrowed is usually referred to as Capital.

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

1. What is the interest to be paid back on this loan?

£50

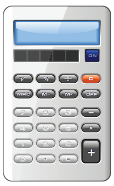
2. What is the total amount to be paid back?

£500 + £50 = £550

3. If the loan is to be paid back in 10 equal instalments how much will each instalment be?

£550 ÷ 10 = £55

4. What if you had agreed 12 equal instalments, how much would each instalment be?



£45.83

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

Alternatively you may have agreed to pay back £35 each month for instance as that was the maximum you could afford.

5. In this case how long would it take you to repay the loan in full?

(16 months): 15 payments of £35 followed by a single payment of £25

In practice interest is usually expressed as a per annum (yearly) percentage rate because loans normally run over a fixed number of years such as 3yrs or 5yrs (or maybe 10-15yrs for a commercial loan or 20-30yrs as in the case of a domestic mortgage).

For example, a bank may quote their lending rate as 10% p.a. To see what this means we will consider a real loan situation. Suppose Paul wants to borrow £2500 over three years (i.e. he will pay the money back gradually over three years normally in equal monthly instalments). The lender will calculate how much Paul has to pay in the following way.

Year 1:

Outstanding amount is £2500.

Interest for Yr 1 is 10% of £2500 = 2500 ÷ 100 × 10 = £250

The interest for the year is £250. You may now be tempted to simply multiply this amount by three to find out how much interest is to be paid over three years but it does not work like that in practice. Instead, lenders add on the interest for the first year when calculating interest for the second year.

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

6. To see how this works complete the calculation below?

Year 2:
Outstanding amount from Yr 1 is £2500 + £250 = £2750

Interest for Yr 2 is 10% of £2750 = £ **275**

Year 3:
Outstanding amount from Yr 2 is £2750 + £ **275** = £ **3025**

Interest for Yr 3 is 10% of £ **3025** = **3025** ÷ 100 × 10 = £ **302.50**

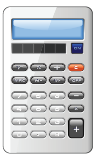
Total to be repaid is £ **3025** + £ **302.50** = £ **3327.50**

You can check your answer with the following statement, “if you borrow £2500 over three years at an interest rate of 10% pa you will pay back £3327.50 in total”.

7. How many months are there in three years?

12 × 3 = 36

8. How much will each equal monthly instalment be?



Write down the display on your calculator including all digits

3327.50 ÷ 36 = 92.43055556

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

9. Round this off to an appropriate degree of accuracy.

£92.43

When you are working with loans (or anything that involves percentages) it is very useful to be able to add on the interest in an efficient way. It will save time when you get used to it and can often make things easier. Here is what we mean by this…

In the example above we worked out 10% of £2500 (the interest) and then added that to the original £2500 (the capital) to get the total to be repaid for the first year of borrowing. These two steps can be done in a single multiplication which saves time. You will see how this works below but first….

You just need to brush-up on being able to write a percentage as a decimal fraction.

For example 50% = 0.5 and 25% = 0.25.

10. What is 10% as a decimal?

0.10

11. What is 75% as a decimal?

0.75

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

12. What is 100% as a decimal?

1.00

….and back to the loan calculation!

Original capital + interest for the year

= 100% of 2500 + 10% of 2500

= 1.0 x 2500 + 0.1 x 2500

= 1.1 x 2500 (or 2500 x 1.1) = 2750

If you understood this you will now see that to increase a quantity by 10% we can multiply it by 1.1 (1.1 is the same as 110%).

In reality interest rates are not normally round figures such as 10%! Typical values might be 12.5%, 7.8%, 6.2% depending on the type of loan, etc.

13. Write each of the following percentage rates as decimals. (some examples to start you off)

12.5% = 0.125	80% = **0.80**	7.9% = **0.079**
13.8% = 0.138	8% = **0.08**	8.34% = **0.0834**
17.5% = 0.175	8.3% = **0.083**	1.3% = **0.013**
12.4% = **0.124**	6.4% = **0.064**	0.8% = **0.008**

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

Now we can look at how to use this to add on interest or just increase (or decrease) things by a certain percentage. For instance, calculate the total capital and interest one year after borrowing £500 at an interest rate of 6.5%......

100% of 500 + 6.5% of 500

= 1.0 x 500 + 0.065 x 500

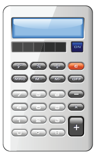
= (1.0 + 0.065) x 500

= 1.065 x 500

= £532.50

Try this one yourself!

14. Calculate the total capital and interest one year after borrowing £16500 at an interest rate of 8.4%?



1.0 x 16,500 + 0.084 x 16,500

(1.0 + 0.084) x 16,500

1.084 x 16,500

= £17,886

In the previous calculation the number “1.084” is often called a growth factor and is very useful in percentage and interest calculations. To see how, let’s suppose the sum of money, £16,500, was borrowed over two years instead of one. The interest would have to be applied twice. We did something very similar to this in question 6 but did not use a growth factor.

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

Over two years the total capital and interest would be (to the nearest penny)

£16,500 x 1.084 x 1.084 = £16,500 x 1.084^2 = £19,388.42

Questions 15-19 are quite difficult so you can leave them out if you wish!

15. What would the total capital and interest be if this amount was borrowed over three years instead of two (interest rate is still 8.4%)?

Use '2 years' to help you: £16,500 x 1.084 x 1.084 = £16,500 x 1.084^2 = £19,388.42

£16,500 x 1.084 x 1.084 x 1.084 = £16,500 x 1.084^3 = £21,017.05

John is a contractor who has just successfully tendered for a new development and needs to add to his existing fleet of diggers. He visits a website to see what his options are for borrowing £16,500 to finance the digger you see here.

He wants to consider a couple of important aspects of the loan: the interest rate and the loan repayment term (i.e. how long does he takes to pay the money back).

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

Obviously he wants to pay as low an interest rate as possible but it is not always as simple as that. For instance, sometimes to get a lower interest rate you may need to choose a shorter loan period and this then makes the monthly payment higher.

John has narrowed the loan options down to just two. One option is to borrow the money over 4 years at 8.4% p.a. (p.a. stands for per annum) and the other is to borrow it over 3 years at 7.5% p.a. John has also considered his financial circumstances and feels that the maximum monthly payment he could afford is £500. In the space below calculate the monthly repayment for John and help him decide which loan option to take.

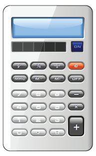
16. John borrows £16,500 over 4 years @ 8.4% p.a.?

Use growth factors to help and don’t forget there are 48 months in 4 years!

£16,500 x 1.084 x 1.084 x 1.084 x 1.084 = £16,500 x 1.084^4 = £22,782.48

£22,782.48 ÷ 48 = £474.63

17. John borrows £16,500 over 3 years @ 7.5% p.a.?



Again use a growth factor to help…

£16,500 x 1.075 x 1.075 x 1.075 = £16,500 x 1.075^3 = £20,497.89

£20,497.89 ÷ 36 = £569.38

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

18. Which loan option will John take based on the maximum monthly payment he can afford?

John will have to take the loan of £16,500 over 4 years @ 8.4% p.a.

19. What is the main disadvantage for John in taking this loan option? In your answer give a reason and a number!

By taking this loan John will have to make loan payments for 4 years instead of 3 years and will pay back an extra £2284.59 over the other loan.

In the examples so far we have looked at interest on loans where the interest is applied each year. Often in practice it is applied each month. We can look at how a loan would be repaid over a one year period with the interest calculated each month. Breaking down a loan in this way is called 'amortising' by banks and it is useful to see how interest really works!

Peter is a self-employed joiner who borrowed £1000 to take advantage of an on-line sale on tools and equipment from a trade supplier.

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

Complete the loan breakdown below for his loan of £1000 charged at an interest rate of 1% per month. Read the information carefully before completing the table.

The balance in any given month is the difference between the balance and capital reduction from the previous month.

Monthly repayment is the repayment amount that will result in the loan being paid off after the agreed number of months. In this case it is fixed at £88.84

Interest is a fixed percentage (in this case 1%) of the balance each month.

Capital reduction is the difference between the monthly repayment and Interest.

20. The first half of the table has been completed for you. (You may consider completing this table by making use of spreadsheet software!)

** Look at how to calculate the interest for month 3. It is 1% of £841.53 which is £8.4153. When rounding this to 2 decimal places you would naturally end up with £8.42. However lenders cannot overcharge on interest which means they would have to round this down to £8.41.*

You can use this space for rough work!

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

Mth	Balance	Interest	Monthly repayment	Capital reduction
1	1000.00	10.00	88.84	78.84
2	921.16	9.21	88.84	79.63
3	841.53	8.41	88.84	80.43
4	761.11	7.61	88.84	81.23
5	679.87	6.79	88.84	82.05
6	597.82	5.97	88.84	82.87
7	**514.95**	**5.14**	**88.84**	**83.70**
8	**431.25**	**4.31**	**88.84**	**84.53**
9	**346.72**	**3.46**	**88.84**	**85.38**
10	**261.34**	**2.61**	**88.84**	**86.23**
11	**175.11**	**1.75**	**88.84**	**87.09**
12	**88.02**	**0.88**	**88.84**	**87.96**
13	**0.06**			

An extra row has been included in the table just in case you find that the capital reduction in month 12 does not exactly clear all the outstanding balance!

21. If you have needed to put an entry in for balance in Month 13 explain below why you think this is and what do you think will happen to this amount?

Because of the rounding down during the loan breakdown not all the interest gets paid off. This 6p will be written off by the bank and will not have to be paid by Peter.

NUMBER

TASK 1 - MONEY MATTERS ANSWERS

22. How much did Peter pay back in total?

12 x £88.84 = £1066.08

23. What do you notice about the amount of interest each month as the loan progresses?

It decreases because the interest applied in any month depends on the balance (amount outstanding) at the beginning of that month. As this is decreasing the interest charged also decreases.

24. How would you explain capital reduction to someone who didn't know what it was?

Each month a loan payment is made. Some of this payment goes towards covering the interest for that month. The rest is used to reduce the amount owed to the bank (i.e. the balance). The amount by which the balance is reduced each month is the capital reduction.

NUMBER

TASK 2 - NUTS AND BOLTS ANSWERS

James works for a large construction firm and one of his duties is to source structural steel components and fasteners (rivets, screws and bolts). His company has just won a contract for a very large development and he has set about sourcing the construction fasteners needed for the job.

Keeping costs to a minimum is very important and the lead civil engineer has asked James to investigate the possibility of sourcing these fasteners in the United States.

After some searching James has located a supplier who can provide the type of nuts and bolts required. Here is a table containing some data James has been given on a range of hex head bolts. As is often the case in US Imperial units have been used for length and diameter.

Code	Length (inches)	Diameter (inches)	Steel grade
A	3/4	½	10.9
B	1	¼	12.9
C	1 ½	3/8	11.9
D	1 ½	11/8	11.9
E	1 ½	5/16	12.9
F	2	9/16	10.9
G	2	7/16	11.9
H	2 ½	1 ¼	6.8
I	2 ½	3/4	7.9
J	4	17/16	10.9

NUMBER

TASK 2 - NUTS AND BOLTS ANSWERS

1. Complete the table below for the selection of bolts above in terms of increasing shaft diameter. The first row is already completed?

Code	Diameter (inches)	Length (inches)	Steel grade
B	¼	1	12.9
E	**5/16**		
C	**3/8**		
G	**7/16**		
A	**½**		
F	**9/16**		
I	**¾**		
J	**1 1/16**		
H	**1 ¼**		
D	**1 3/8**		

2. What is the average (mean) length of the 10.9 grade fasteners?

Total length of 10.9 grade fasteners:

¾ + 2 + 4 = 6 ¾

Mean length of 10.9 grade fasteners:

6 ¾ ÷ 3 = 27/4 ÷ 3 = 9/4 = 2 ¼ or 6 ¾ ÷ 3 = 27/4 ×1/3 = 9/4 = 2 ¼

The Steel grade indicates the tensile strength of the steel used and is obviously of critical importance. Assume the grade numbers used (10.9, 11.9 etc) are direct measures of strength (in other words steel with a grade of 12.9 would be exactly twice as strong as steel with a grade of 6.45). A structural engineer has informed James that any fasteners of grade 6.8 and 7.9 are to be replaced by ones at least 40% stronger.

NUMBER

TASK 2 - NUTS AND BOLTS ANSWERS

3. Which grades could be used to replace fasteners at the lower strength grades (6.8 and 7.9)?

You can tick more than one option if appropriate				
6.8 grade fasteners: Replaced by:	7.9	**10.9**	**11.9**	**12.9**
7.9 grade fasteners: Replaced by:	10.9	**11.9**	**12.9**	

In order to compare these US fasteners with specifications provided by colleagues using metric measurements, James must convert the data for length and diameter into metric units. For the particular application in mind the precise diameter of these fasteners is critical. Accuracy in converting length is important but not critical. Therefore James has decided to adopt a different approach to making the conversion for diameter than for length.

4. To convert the lengths of the fasteners he decides to use the conversion 1 inch = 2 ½ cm. He doesn't use a calculator for this and not all Codes are used. Complete the table?

Code	Length (inches)	Length (cm)	
		Fraction	Decimal
–	¼	¼ x 2 ½ = ¼ x 5/2 = 5/8	5/8 = 0.625
B	**1**	**1 x 2 ½ = 2 ½**	**2 ½ = 2.5**
C	**1 ½**	**1 ½ x 2 ½ = 3 ¾**	**3 ¾ = 3.75**
F	**2**	**2 x 2 ½ = 5**	**5**
H	**2 ½**	**2 ½ x 2 ½ = 6 ¼**	**6 ¼ = 6.25**

NUMBER

TASK 2 - NUTS AND BOLTS ANSWERS

5. To convert the diameters he uses the conversion 1 inch = 25.4 mm as he needs to have this correct to the nearest ½ mm?

Code	Diameter (inches)	Diameter (metric)	
		mm	cm
A	½	½ = 0.5 0.5 x 25.4 = 12.7 = 12.5mm	12.5mm = 1.25cm
B	¼	**¼ = 0.25 0.25 x 25.4 = 6.35 = 6.5mm**	**6.5mm = 0.65cm**
F	9/16	**9/16 = 0.5625 0.5625 x 25.4 = 14.3 = 14.5mm**	**14.5mm = 1.45cm**
H	1 ¼	**1¼ x 25.4 = 31.75 = 31.5 or 32.0**	**31.5mm = 3.15cm 32.0mm = 3.20cm**
I	¾	**¾ x 25.4 = 19.05 = 19.0**	**19.0mm = 1.90cm**

Following consultation with other construction professionals James concludes that almost 60000 fasteners will be required for this job. The job will require a mixture of Type A, B, C and J fasteners and the nature of the job indicates that they will be needed in the ratio 2:4:1:5.

6. Determine how many of each fastener is required?

Code	A	B	C	J
Ratio	2	4	1	5

Total number of fasteners = 60,000

2+4+1+5 = 12 parts. 60000 ÷ 12 = 5000. 1 part = 5000 fasteners

Number of each type of fastener:

A = **2 x 5000 = 10000** B = **4 x 5000 = 20000** C = **1 x 5000 = 5000** J = **5 x 5000 = 25000**

NUMBER

TASK 2 - NUTS AND BOLTS ANSWERS

7. Use the previous answer together with the original table (summarised below) to determine the ratio of fasteners ordered in terms of Steel grade?

Code	A	B	C	J
Grade	10.9	12.9	11.9	10.9

Find the Steel grade ratio **grade10.9:grade11.9:grade12.9** for the 60000 fasteners required.

Method 1
grade10.9 (A+J=10000+25000= 35000)
grade11.9 (C=5000)
grade12.9 (B=20000)

35000:5000:20000 = 7:1:4

Method 2 (from table in question 6)

A&J:C:B = (2+5):1:4 = 7:1:4

Now that James has decided on the number of fasteners of each type required he needs to get a price for the order.

8. The supplier has the following table for pricing: use it to determine the cost of his order of 60,000 fasteners?

CODE	ORDER SIZE ($ PER 100)			
	<1000	*1000-4999*	*5000-19999*	*20000 or more*
A	N/A	8.95	7.50	6.95
B	10.50	9.95	8.50	7.95
C	12.50	11.95	10.50	9.95
J	24.50	22.95	20.50	18.95

Code A: 10000 fasteners. This means $7.50 per 100 = 7.50 x 100 = $750
Code B: 20000 fasteners. This means $7.95 per 100 = 7.95 x 200 = $1590
Code C: 5000 fasteners. This means $10.50 per 100 = 10.5 x 50 = $525
Code J: 25000 fasteners. This means $18.95 per 100 = 18.95 x 250 = $4737.50

Total = 750 + 1590 + 525 + 4737.50 = $7602.50

NUMBER

TASK 2 - NUTS AND BOLTS ANSWERS

James now needs to determine the carriage cost for this order which will be determined by its weight. All fasteners come in boxes of 100 and the weight (mass) of each box is given in the table. Note the units used are lbs (pounds).

9. Determine the total weight of the order in lbs. Ignore the weight of any extra packaging as it will only be a tiny fraction of the total?

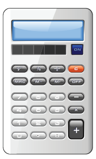
Code	A	B	C	J
Mass (lb)	4.3	6.5	9.2	10.5

Code A: 4.3 x 100 = 430 lb
Code B: 6.5 x 200 = 1300 lb
Code C: 9.2 x 50 = 460 lb
Code J: 10.5 x 250 = 2625 lb

Total = 430 + 1300 + 460 + 2625 = 4815 lb

James is going to use a courier located in the UK to bring the order home. On their website he needs to enter the weight of the order in kg.

10. Convert the previous answer to kg using 1kg = 2.2lb. Give your answer to the nearest kg?



4815 ÷ 2.2 = 2189 kg (to nearest kg)

NUMBER

TASK 2 - NUTS AND BOLTS ANSWERS

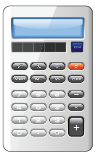
The order will be loaded onto pallets for delivery from US to UK. The courier charges 25p per kg and there is a Customs administration charge of £47.50 placed on all orders.

11. In the space below calculate the carriage costs of the load using this courier?

Pallet cost = 2,189 kg x 25 p/kg = 54,725 p = £547.25

Carriage cost = Pallet cost + Customs charge = £547.25 + £47.50 = £594.75

12. Find out what the current $:£ exchange rate is and use it to price the entire order in Sterling (£) (remember the cost of the order is in $ but the carriage is in £)



depends on exchange rate

Before completing the order one of the company directors asks James to double the size of the order as they have just won a second similar contract.

13. How will this impact on the cost of carriage? Will it also double? Answer this in the space below and explain your findings.

Doubling order means it weighs 4,378kg instead of 2,189kg

Pallet cost = 4,378 kg x 25 p/kg = 109,450 p = £1,094.50
Carriage cost = Pallet cost + Customs charge = £1,094.50 + £47.50 = £1,142

The carriage cost has not exactly doubled. This is because of the customs charge which does not depend on the weight of the order. The presence of the customs charge means the relationship between carriage cost and weight are not in direct proportion. You will probably have noticed that the pallet cost doubled as this cost is in direct proportion to the weight of the order.

NUMBER

TASK 3 - LEVELS AND FORCES ANSWERS

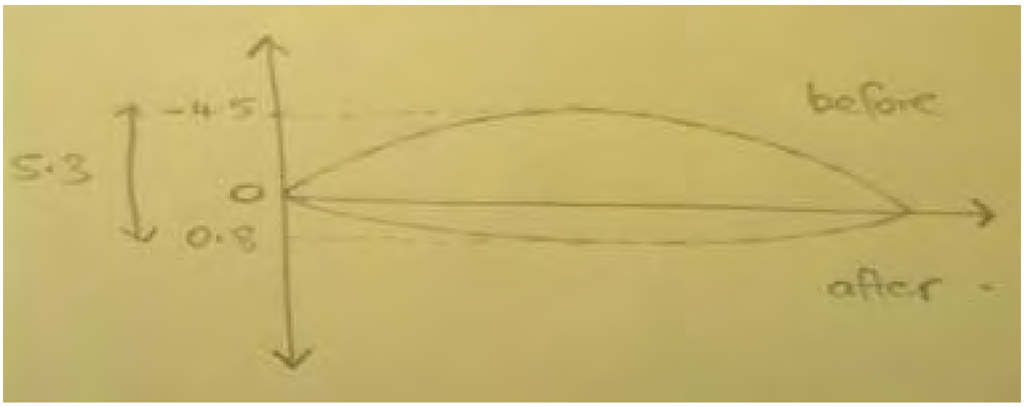
The use of negative numbers in construction is generally related to temperature (see task called Temperature) and finances (see task called Bank Statement). They are also very useful when working with distance above or below certain levels in surveying or the direction of forces that act in beams, columns, frames etc.

In this task we will consider some situations where negative numbers are used in surveying levels and when working with forces.

Concrete hollow core floor units have a natural pre-camber when they are pre-stressed during manufacture.

A hollow core slab spanning 7.0m has a pre-camber of -4.5mm. When a certain dead load is applied in use the slab deflects downwards from the pre-stressed position by 5.3mm.

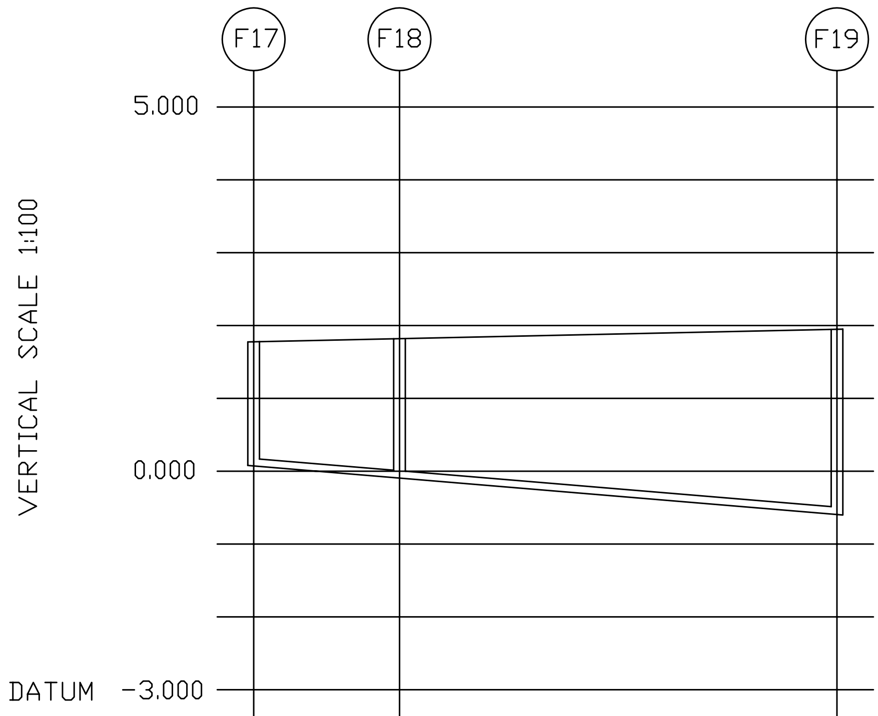
1. In the space below produce a sketch to describe the situation. Include a vertical number line and mark the before (unloaded) and after (loaded) positions.



NUMBER

TASK 3 - LEVELS AND FORCES ANSWERS

The diagram below shows invert levels and cover levels of foul sewer through a site for a new leisure complex. Measurements have been taken between points F17, F18 and F19 on the site. All quoted levels are in metres and you do not need to take any scale measurements from the drawing, just use the values in the table.



FOULWATER COVER LEVEL	1.620		1.687		1.912
FOULWATER INVERT	0.099		-0.084		-0.681
FOULWATER DETAILS		Dia 150 Type uPVC 1 in 60		Dia 150 Type uPVC 1 in 60	
FOULWATER LENGTHS		10.964		35.742	

HORIZONTAL SCALE 1:500

LONGITUDINAL SECTION OF FOUL SEWER F17-F19

NUMBER

TASK 3 - LEVELS AND FORCES ANSWERS

2. What is the difference in the invert level between grid F17 and F18?

The difference is the distance along the number line from one number to the other. Since the values here are 0.099 and -0.084 (one positive and one negative) the difference will be 0.099 + 0.084 = 0.183m (183mm)

3. What is the difference in depth between the foul water cover level and the foul water invert level at location F18?

Again one negative value and one positive value so the difference is

0.084 + 1.687 = 1.771m (1771mm)

4. What depth has the foul water invert level dropped between F18 and F19?

As these are both negative values the difference between -0.084 and -0.681 is equal to the difference between 0.084 and 0.681 which is 0.681 – 0.084 = 0.597m (597mm)

NUMBER

TASK 3 - LEVELS AND FORCES ANSWERS

The internal ground floor level of a house has been set at 0.00m. External ground level is 0.15m below internal ground floor level. Internal basement level is 2.60m below internal ground floor level. The height of the eaves level is 5.20m above internal ground floor level. Mark on the diagram below the missing levels and calculate

5. The difference in height between external ground level and eaves level?

5.20 + 0.15 = 5.35m (5350mm)

6. The total height from basement floor to eaves level?

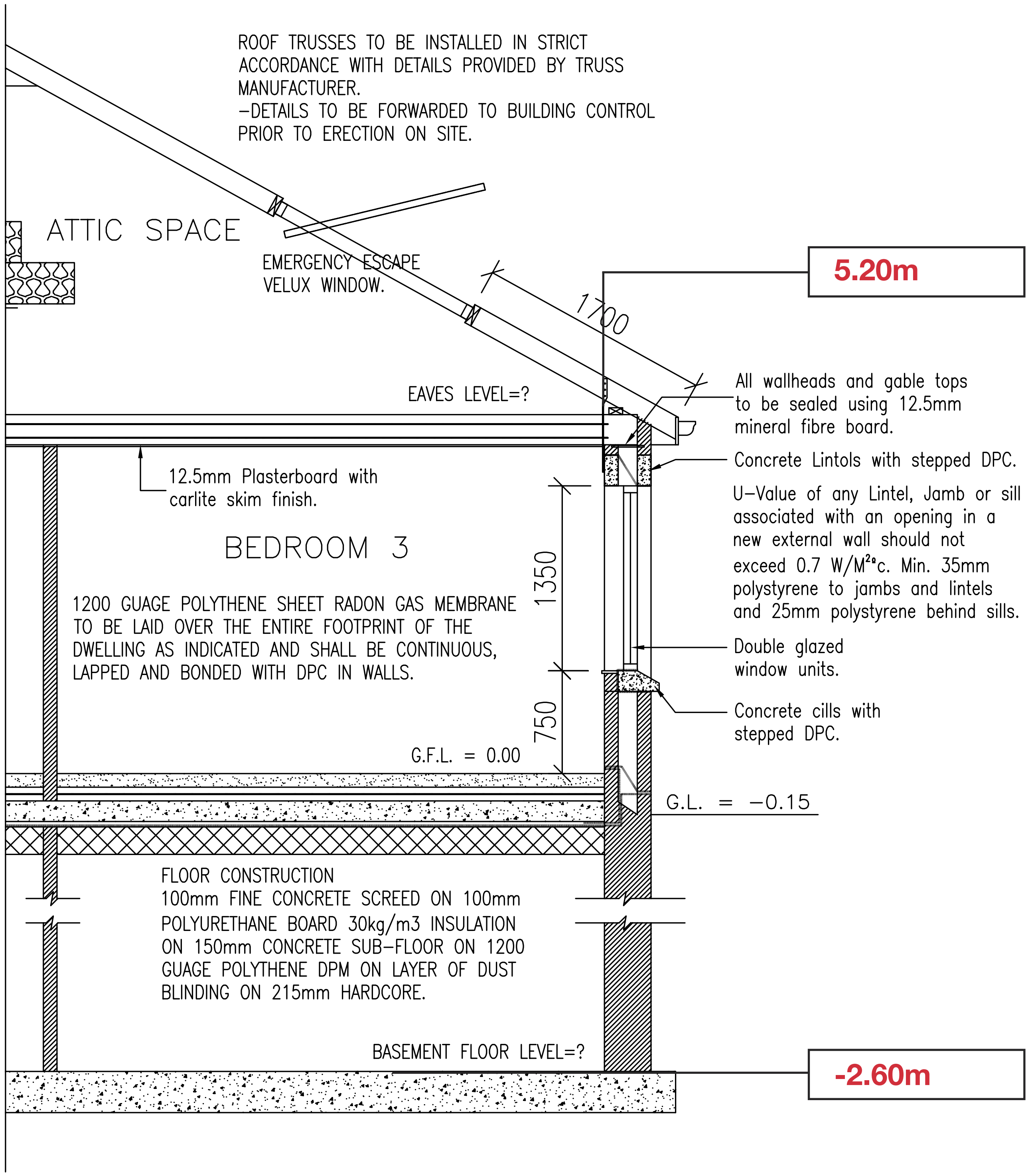
5.20 + 2.60 = 7.80m (7800mm)

7. How far is the basement floor level below external ground level?

Difference between two negative numbers -0.15 and -2.60 is equal to the difference between 2.60 and 0.15 which equals 2.60 – 0.15 = 2.45m (2450mm)

NUMBER

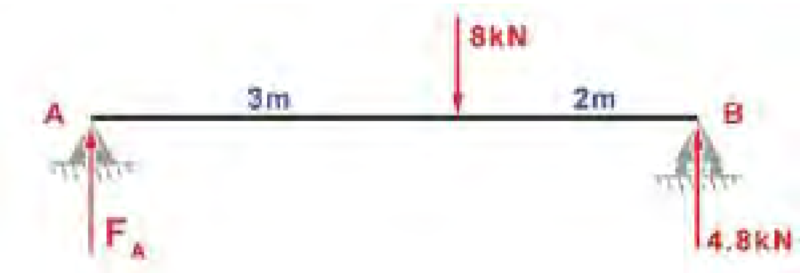
TASK 3 - LEVELS AND FORCES ANSWERS



NUMBER

TASK 3 - LEVELS AND FORCES ANSWERS

The diagram below shows the forces present in a beam. A simply supported beam is supported at each end as shown and there are often forces (loads) acting on the beam itself between the supports. In the diagram there is a force of 8kN acting as shown. As a result there will be upwards forces acting at each of the support points A and B. The force at B is given as 4.8kN.



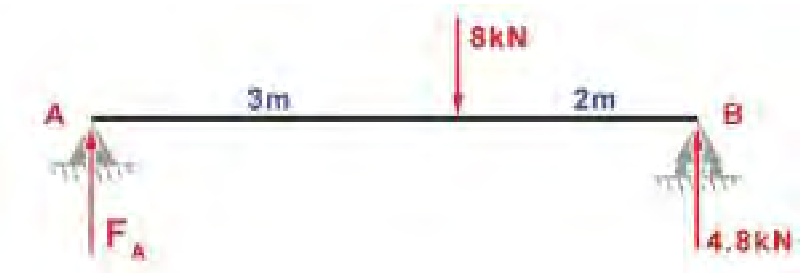
In order for this beam to be stable, certain conditions must hold. These are called equilibrium conditions and one condition is that the forces must all add up to zero! Forces are considered positive or negative depending on which direction they act. In this task we will take upwards forces as positive with downwards forces as negative.

For the beam in the diagram we can work out the unknown force FA as follows:

$F_A + 4.8 - 8 = 0$

$F_A - 3.2 = 0$

$F_A = 3.2$ kN



As a check we can sum positive forces and negative forces separately to see if the totals are equal.

For the beam above this would give:

Total positive forces = 3.2 + 4.8 = 8kN

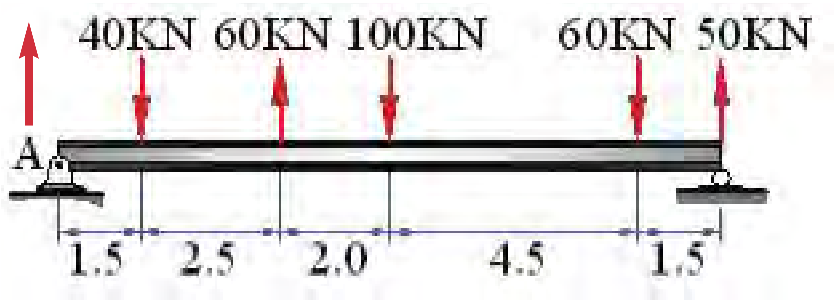
Total negative forces = 8kN

NUMBER

TASK 3 - LEVELS AND FORCES ANSWERS

Apply what you have learned in this example to the following problem (ignore the distances between the forces in the diagram).

8. Draw in the direction of the missing force at A



9. Use the method above of summing forces to equal zero to help you work out the size of the force at A?

F +60 + 50 – 40 – 100 – 60 = 0

F + 110 – 200 = 0

F -90 = 0 so F = 90kN

10. Finally check your answer using the method of positive and negative totals?

Total Positive forces = 90 +60 + 50= 200kN

Total Negative forces = 40 + 100 + 60 = 200kN

NUMBER

TASK 4 - BANK STATEMENT ANSWERS

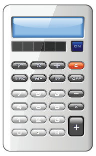
Here is the bank statement for a local building contractor for the month of November. The contractor wants to take a detailed look at the statement and get an overview of his account. You can help with this by answering the following questions.

Mid-Ulster Bank	**Statement of Account**			
St. Swithin's Branch Broad Street Londonderry Tel: 02886712345	A/C 657362142 Magherafelt			Sort: 09-59-01 Date 12.12.10 Co.
A N Other, Main street, Belfast				
Date	**Details**	**Debits**	**Credits**	**Balance**
01 Nov	Opening Balance			1836.51
02 Nov	Direct Debit 043121	2248.07		**-411.56**
03 Nov	Cheque 234174	2192.83		**-2604.39**
05 Nov	Transfer a/c 61152309		1500.00	**-1104.39**
09 Nov	Cheque 234017	5877.30		**-6981.69**
10 Nov	Cheques paid in		4540.50	**-2441.19**
10 Nov	Standing order 0021972	1466.45		**-3907.64**
16 Nov	Cash paid in		8340.18	4432.54
20 Nov	Cheques for salary	7840.37		**-3407.83**
25 Nov	JR Materials (refund)		2540.34	**-867.49**
27 Nov	Cheque paid in		12277.45	11409.96
29 Nov	Direct Debit	3480.32		7929.64
30 Nov	**Overdraft fee**	**80.00**		7849.64
30 Nov	**Emergency reserve**	**104.72**		7744.92
30 Nov	Closing Balance			7744.92

NUMBER

TASK 4 - BANK STATEMENT ANSWERS

1. Fill in the balance column as far as 29th November. The balance on 29th November should be £7929.64, allowing you to check your answer. Use the space below as well if you need to.



2. Use an alternative method to arrive at the balance on 29th November.

Hint: Total the Debit and Credit columns separately and then combine your answer with the figure for opening balance on 01 Nov.

Debit total = £23,105.34

Credit total = £29,198.47

Credit – Debit = £6,093.13

balance = opening balance + Credit – Debit

= £1,836.51 + £6,093.13 = £7,929.64

3. On 2nd Nov Direct Debit 043121 was debited from the account leaving a balance that day of -£411.56 What does the negative sign mean?

It means the account holder owes the bank money, £411.56 to be exact.

NUMBER

TASK 4 - BANK STATEMENT ANSWERS

4. On which day was the account at its lowest point and how much did he have in the bank on that date?

Date: **9th November**

Amount owed: **£6,981.69**

The contractor has an agreed overdraft of £5000 on this account for which he pays £80 per month. The £80 is applied on the last day of the month and is applied if the account was 'in the red' for even one day in the month. He does not pay the fee for any month in which the account remained 'in the black' at all times.

5. Will he have to pay the £80 fee for the month of November?

Yes

The contractor also has an emergency reserve overdraft on the account of £2000. This means that if he exceeds his agreed overdraft of £5000 the bank will continue to honour any drawings on the account up to an extra £2000 (i.e. allowing a balance up to -£7000). However the bank has stipulated two conditions on this emergency reserve if it is used:

- A charge of 1.5% of the minimum balance will be applied at the end of the month
- The account needs to be brought back into the agreed overdraft limit immediately at the end of the month.

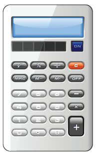
NUMBER

TASK 4 - BANK STATEMENT ANSWERS

6. Did he use his emergency reserve in November?

Yes

7. If he did use the emergency reserve determine the charge that will be applied for using it?



NB: if you need to round off a calculator display figure to the nearest penny remember a bank will have to round down so as not to overcharge!

1.5% of £6,981.69 = 0.015 x 6981.69 = 104.72535 = £104.72

There was no additional activity on the account on 29th and 30th November.

8. Complete the statement up to and including Nov 30th by applying any fees or charges due? Use the space below to do any additional calculation you need to.

Overdraft fee of £80 plus emergency reserve charge of £104.72

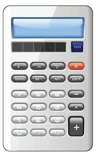
NUMBER

TASK 4 - BANK STATEMENT ANSWERS

The table below contains details on the account over the previous four months. In particular you will see the closing balance each month and the minimum balance for that month.

Month (2010)	Closing Balance Balance (before fees / charges)	Minimum Balance	Overdraft fee	Emergency reserve charge
July	3144.44	2469.46	**N / A**	**N / A**
August	-6183.86	-6492.08	**80.00**	**97.38**
September	1064.99	-2845.91	**80.00**	**N / A**
October	1836.51	493.67	**N / A**	**N / A**

9. Complete the table by entering an overdraft fee and an emergency reserve charge each month where appropriate. You may find it useful to read the instructions above again about how and why fees/charges are applied to this account. Use the space below for any working out you need to do?



At the end of one month the contractor had to lodge money into his account to bring the balance back to within the agreed overdraft limit (£5000).

10. Which month was that and how much did he have to lodge? Don't forget that the closing balance figure in the table above has NOT had any charges or fees applied. These will need to be added in before the final closing balance for the month is known.

Month: **August**

Closing balance (after fees/charges applied):

-6,183.36 – 80.00 – 97.38 = £6,361.24

Amount to be lodged to restore account:

6,361.24 – 5,000 = £1,361.24

NUMBER

TASK 5 - TEMPERATURE ANSWERS

Negative numbers are numbers to the left (or below) zero on a number line. The use of negative numbers in construction is generally related to temperature, finances (see task called Bank Statement), height above or below certain levels in surveying or the direction of forces and sense of moments (clockwise or anti-clockwise) that act in beams, columns, frames etc.

In this task we will look at some examples of how negative numbers can crop up when working with temperature.

There are two temperature scales you need to be aware of and indeed be able to convert temperatures from one scale to the other. Nowadays the Celsius temperature scale is more popular but Fahrenheit is still used quite frequently.

In the Celsius temperature scale 0˚C represents the freezing point of water. Be careful, it does not mean there is no heat energy present. It just means there isn't enough heat present for water to exist in liquid form so it freezes. A negative value on the Celsius scale indicates a temperature lower than 0˚C where there is less heat energy present and so it feels colder.

The boiling point of water is defined as 100°C on the Celsius scale but is 212°F on the Fahrenheit scale.

The picture below contains a dial from which you can read temperature in either scale.

NUMBER

TASK 5 - TEMPERATURE ANSWERS

1. What is the temperature according to the dial in °C to the nearest degree?

22°C

2. What is the dial reading in Fahrenheit (°F)? Try to estimate this to the nearest Fahrenheit degree and later you can use a formula to check.

72°F

In the text above you were told that two key points on the Celsius scale are 0°C and 100°C (this portion of the Celsius scale is sometimes referred to as the Centigrade scale because it has a range of 100 degrees). It was also stated above that the boiling point of water corresponds to 212°F.

3. What is the freezing point of water on the Fahrenheit scale? Use the dial and the information already given.

32°F

NUMBER

TASK 5 - TEMPERATURE ANSWERS

Two workers, Jake and Paul, are having a discussion about the usefulness of this dial.

Jake said, ***"This dial cannot be used to convert 60°C to Fahrenheit (°F)"***
Paul said, ***"Yes it can, you could just find out what 30°C converts to and double it!"***
This made Jake think as he wondered if Paul was correct. To reinforce his point Paul added, ***"If someone is 1 metre tall then that makes them 3' 3" tall so if someone else is 2m tall they will be 6' 6" tall – you just double it"***

4. Produce some evidence from the dial gauge above to settle the discussion one way or another?

22°C = 72°F but 44°C ≠ 144°F 0°C = 32°F

5. In the space below to explain why Paul is correct when he says "If someone is 1 metre tall then that makes them 3' 3" tall so if someone else is 2m tall they will be 6' 6" tall" but he is wrong when he attempts to apply this argument to the temperature scales of Celsius and Fahrenheit?

You may wish to include the following words in your answer or use them to help structure your answer: "direct proportion", "one quantity is zero when the other is zero", "0°C is not 0°F", "doubling one temperature did not make the other temperature double", "if you increase one quantity by a certain percentage the other increases by the same percentage"

The units of measure for height (metres and feet) are in direct proportion – when one is zero the other is zero, for instance a distance of 0m is also 0ft. Also the relation 1m = 3.25ft means if you double a length in metres you also double it in ft.

For two quantities to be in direct proportion one should be zero when the other is zero and if you double one the other should double as well. This is true for length (in metres and feet) as just discussed but it is not true for converting temperature from Celsius to Fahrenheit as the answer to the previous question shows.

NUMBER

TASK 5 - TEMPERATURE ANSWERS

You will not always have access to a dial (or other device) to help you make a conversion from one temperature scale to another. Even if you had the dial above it could only help you with temperatures in the range shown as the above discussion has demonstrated.

For instance you could not use the dial to convert 60°C to °F! For this you could make use of a formula which works for all temperatures and conversion formula are very useful for this reason. We will consider two formulae in this section that can be used to convert from one temperature scale to the other depending on which direction conversion is needed.

Before doing this it will be helpful to recap on some number facts. Consider the two numbers 5/9 and 9/5.

6. One number is a proper fraction – which one is it? Give your answer in numbers and words.

5/9 (five ninths)

7. Write the other number as a mixed number, again using numbers and words?

9/5 = 1 4/5 (one and four fifths)

NUMBER

TASK 5 - TEMPERATURE ANSWERS

8. Convert each number (5/9 and 9/5) to a decimal fraction. Use your calculator and simply record the screen display in the space provided?

5/9: **0.555555555**

9/5: **1.8**

9. Now put each of the above answers into words?

Hint: for 0.45 you would write “zero point four five” or for 7.3636363636 you could write “seven point three six repeating”

zero point five repeating or zero point five recurring for 0.555555555

one point eight for 1.8

NUMBER

TASK 5 - TEMPERATURE ANSWERS

When using temperature conversion formula you will need to use the above numbers (sometimes as fractions (5/9 or 9/5), sometimes as decimals (0.55 and 1.8)) in multiplications. This will be easy if you have a calculator but sometimes you may not and there are some useful properties of these numbers which may be helpful.

We can look at 1.8 first.

1.8 = 2 - 0.2 so multiplying a number by 1.8 is the same as multiplying the number by 2 and by 0.2 and then subtracting the two answers.

At first glance this may not seem to be much of an advantage but if you notice that

0.2 = 2 ÷ 10

then the advantage becomes clear as it is easy to divide by 10. Follow the examples below and then attempt the multiplications that follow.

Any multiplications involving negative numbers are optional!

eg 1: **45 x 1.8**
We can see that

45 x 2 = 90

and

45 x 0.2 = 9.0 (because 90 ÷ 10 = 9)

Which means…

45 x 1.8 = 90 – 9 = 81

eg 2: **6.4 x 1.8**

6.4 x 1.8

Again we can see that

6.4 x 2 = 12.8

and

6.4 x 0.2 = 1.28 (because 12.8 ÷ 10 = 1.28)

Which means…

6.4 x 1.8 = 12.8 – 1.28 = 11.52

NUMBER

TASK 5 - TEMPERATURE ANSWERS

10. In the space below complete the multiplications without using your calculator?

23 x 1.8

23 x 2 = 46 and

23 x 0.2 = 4.6 (because 46÷ 10 = 4.6)

which means…

23 x 1.8 = 46 – 4.6 = 41.4

-3.7 x 1.8

3.7 x 1.8 (ignore minus for now)

3.7 x 2 = 7.4 and

3.7 x 0.2 = 0.74 (because 7.4÷ 10 = 0.74)

which means…

3.7 x 1.8 = 7.4 – 0.74 = 6.66

now replace minus to give - 6.66

Now we will look at how to work with **0.55.**

The first thing to note is

0.55 = 0.5 + 0.05

then make use of two simple number facts

- 0.5 is the decimal form of the fraction ½.
- 0.05 = 0.5 ÷ 10.

So, to multiply something by 0.55 you could

"first of all find one half of the number you are multiplying, then divide that number by 10, finally add these two answers together".

To make this clear we can look at an example

eg: **48 x 0.55**

- Half of 48 is 24
- One tenth of 24 id 2.4

So **48 x 0.55 = 24 + 2.4 = 26.4**

NUMBER

TASK 5 - TEMPERATURE ANSWERS

Sometimes you may need to multiply by 0.555 instead of 0.55 depending on how accurate you want your answer to be.

11. In the space below set out a method you could use as a convenient way to multiply by 0.555 without using a calculator or doing an actual multiplication sum?

Hint: 0.555 = 0.5 + 0.05 + 0.005!

"first of all find one half of the number you are multiplying, then divide that number by 10, then divide that number by 10 also, finally add the three answers together".

12. Put your chosen method to use below?

48 x 0.555

(0.5) 1/2 of 48 = 24

(0.05) 24 ÷ 10 = 2.4

(0.05) 2.4 ÷ 10 = 0.24

48 x 0.555 = 24 + 2.4 + 0.24 = 26.64

13. Round the previous answer to 1 decimal place?

26.64 = 26.6 (to 1 decimal place)

NUMBER

TASK 5 - TEMPERATURE ANSWERS

14. Compare your previous answer to the answer given above to 48 x 0.55. Which is closer to the exact answer to 48 x 5/9 and why?

48 x 0.55 = 26.4

48 x 0.555 = 26.6

The exact answer to 48 x 5/9 is 26 2/3 which is 26.7 (to 1 decimal place). This shows that 48 x 0.555 is closer to the exact answer than 48 x 0.55 and the reason is that 0.555 is a better approximation to 5/9 than 0.55.

Sometimes when multiplying by 5/9 it will actually be easier to do a fraction multiplication than firstly converting the fraction to a decimal. For instance consider the multiplication 36 x 5/9.

15. In the space below calculate the answer to this multiplication using fractions?

36 x 5/9 = 36/1 x 5/9 = 4/1 x 5/1 (cancel 9 and 36) = 20/1 = 20

16. What property has the number 36 that made it easier to do the above calculation with 5/9 as a fraction instead of a decimal?

36 is a multiple of 9

NUMBER

TASK 5 - TEMPERATURE ANSWERS

17. If instead the multiplication was 36 x 9/5 which approach would be easier – using 9/5 as a fraction or as a decimal? To help you decide do the multiplication both ways in the space below.

36 x 9/5:

36 x 9/5 = 36/1 x 9/5 = 324/5
(as no common factors to cancel) = 64 4/5 = 64.8

36 x 1.8:

36 x 1.8 = 72 – 7.2 = 64.8 (this was less work!)

18. Without doing any calculations give a reason indicating which approach (fraction or decimal) you feel would be easier to do the multiplication 25 x 9/5?

As 5 is a factor of 25 it would definitely be easier to use fractions here

NUMBER

TASK 5 - TEMPERATURE ANSWERS

We can now look at the actual temperature conversion formula. As mentioned earlier there are two formulae depending on whether you need to convert from Celsius (°C) to Fahrenheit (°F) or the other way around.

If you are converting temperature from Celsius (°C) to Fahrenheit (°F) then use this formula

$$C = \frac{5}{9}(F - 32)$$

C represents Celsius temperature and F represents Fahrenheit temperature.

19. Indicate which of the following statements correctly describes how to apply this formula?

A: multiply the Fahrenheit temperature by five ninths and then subtract thirty-two.

B: subtract thirty-two from the Fahrenheit temperature and then multiply by five ninths

NUMBER

TASK 5 - TEMPERATURE ANSWERS

If instead you need to convert from Fahrenheit (°F) to Celsius (°C)you should use this formula

$$F = \frac{9}{5}C + 32$$

again C represents the Celsius temperature and F represents the Fahrenheit temperature.

20. In the space below use words to describe how to correctly apply this formula?

Multiply the Celsius temperature by nine fifths and then add thirty-two

Now we can look at an actual construction situation where you will have the opportunity to use these formulae and apply what you have learned earlier in the section.

During a cold spell temperature on site is monitored as freezing conditions can cause problems with materials and machinery. The health and safety of employees is also a top priority. In order to know whether certain precautions are necessary the temperature is recorded as shown in the table below.

Site temperature at 8am (1st to 14th November 2010)														
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Temp(°C)	10	4	-1	-2	-5	-6	-10	-7	-3	4	1	0	4	5
Temp (°F)	50	39	30	28	23	21	14	19	27	39	34	32	39	41

NUMBER

TASK 5 - TEMPERATURE ANSWERS

Each morning the temperature may be taken by a different individual with the result that on some mornings the temperature has been recorded in Celsius, some mornings in Fahrenheit and some mornings it has been recorded it in both formats.

On 1st, 3rd and 14th November temperature has been recorded in Fahrenheit degrees.

21. Use the appropriate formula to convert these temperatures to Celsius and record the answers in the table. Round to the nearest °C if necessary?

Before each calculation decide whether it is easier to use five ninths in fraction format (5/9) or in decimal format (0.55)!

1st: **F-32 = 50-32 = 18. As 18 is a multiple of 9 it will be easier to use five ninths in fraction format.**

C = 5/9 x 18 = 5/9 x 18/1 = 5/1 x 2/1 = 10

3rd: **F-32 = 30-32 = -2. As 2 is not a factor of 9 it will be easier to use five ninths in decimal format.**

C = 0.55 x 2 =1 +0.1 = 1.1 = 1 to nearest degree. Now put the minus sign back to give -1.

14th: **F – 32 = 41 – 32 = 9. Obviously easier to use fraction form of five ninths**

C = 5/9 x 9 = 5/9 x 9/1 = 5/1 = 5

NUMBER

TASK 5 - TEMPERATURE ANSWERS

On 5th, 7th and 13th temperature has been recorded in Celsius degrees.

22. Use the appropriate formula to convert these temperatures to Fahrenheit and record the answers in the table. Round to the nearest °F if necessary?

Before each calculation decide whether it is easier to use nine fifths in fraction format (9/5) or in decimal format (1.8)!

5th: **As C = -5 it will be easier to use five ninths in fraction format.**
9/5 x -5 = 9/5 x -5/1 = -9/1 = - 9. And -9 + 32 = 23

7th: **As above = 9/5 x -10 = 9/5 x -10/1 = -9/1 x 2/1 = -18/1 = -18.**
And -18 +32 = 14.

13th: **As 4 is not a factor of 5 it will be easier to use decimal format 1.8. 4 x 1.8 = 8 – 0.8 = 7.2. And 7.2 + 32 = 39.2 = 39 to nearest degree.**

NUMBER

TASK 5 - TEMPERATURE ANSWERS

Temperatures for 4th, 6th and 12th are not shown in the table. The images below show the temperatures for these dates measured in Celsius.

23. Make each temperature reading and record the result in the table?

4th December **6th December** **12th December**

24. Use the conversion dial shown earlier to record the temperatures for 4th, 6th and 12th in Fahrenheit to the nearest degree. As an exercise you may wish to test how well you have used the dial by checking your answers with the conversion formula?

25. Now that the table is complete you should use the space below to determine the mean temperature over the two week period, firstly in Celsius and then in Fahrenheit?

Celsius:

10	4	-1	-2	-5	-6	-10	-7	-3	4	1	0	4	5

10 + 4 + (-1) + (-2) + (-5) + (-6) + (-10) + (-7) + (-3) + 4 + 1 + 0 + 4 + 5 = -6 -6 ÷ 14 = -0.43°C

Fahrenheit:

50	39	30	28	23	21	14	19	27	39	34	32	39	41

50 + 39 + 30 + 28 + 23 + 21 + 14 + 1 + 27 + 39 + 34 + 32 + 39 + 41 = 436 436 ÷ 14 = 31.1°F

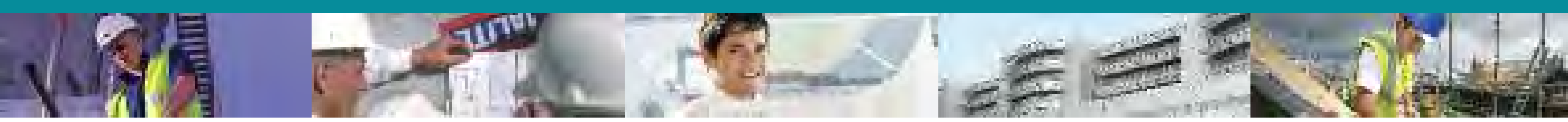
NUMBER

TASK 5 - TEMPERATURE ANSWERS

26. Without doing an actual calculation how might you perform a check on your previous answers?

Use the conversion formula on one of the answers to see if it converts to match the other one! Bear in mind though that any rounding off when completing the table may result in the conversion not being exact. However it should be close enough to make you feel sure your calculations for the mean have been correct.

MEASURE, SHAPE AND SPACE
Tasks and Answers



MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB

In construction time is money. It is important to manage your time effectively and when estimating the time to complete a job, to do so as accurately as possible. Calculations involving time must be accurate as you know there will be cost implications if the job is not completed on schedule and it will impact on the reputation of your company.

When you are costing a job, keeping to a schedule will be important to ensure that all trades are able to come to site and work on site productively.

Time

Units of time

Remember:

1 minute = 60 seconds
1 hour = 60 minutes
1 day = 24 hours
1 week = 7 days
1 year = 12 months
1 year = 52 weeks
1 year = 365 days (366 days in a leap year)
1 century = 100 years
1 millennium = 1000 years

Adding and subtracting time in hours, minutes and seconds.

It took a decorator 1 ¾ hours to paint a cupboard. 40 minutes of that time was spent sanding and preparing the wood in the cupboard. How long was actually spent in painting the cupboard?

To calculate this we need to change the times to the same units:

1 ¾ hours	**1 hour**	**¾ hour**	**60 minutes**	**45 minutes**	**105 minutes**

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB

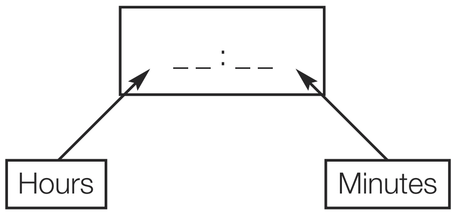
Now subtract the times:

105 minutes – 40 minutes = 65 minutes

So the time spent by the decorator actually painting the cupboard was 65 minutes = 1 hour 5 minutes

Reading times
Each day is split into two halves, am and pm.

24 hour clock is used in digital clocks, timers and timetables. The hours are numbered up to 24 instead of using am and pm, starting at 00:00 for midnight.
4 digits are used when writing times in 24 hour clock:



Example:

- twenty five minutes to two in the morning
- 1:35am is the time as 12 hour clock
- 01:35 is the time as 24 hour clock

- Quarter past four in the afternoon
- 4:15pm
- 16:15

- Add 12 hours to pm times.
- Subtract 12 hours to find the pm time.

Finding the difference between times

Example
If you start work at 08:15 and stop for lunch at 12:40, how long have you worked for?

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB

- Find the number of minutes to the next hour i.e.

  8:15 to 9:00 => **45 minutes**

- Then find the number of hours and minutes to the final time:

  9:00 to 12:40 => **3 hours and 40 minutes**

- Total the hours and the minutes separately:

  3 hours + 40 minutes + 45 minutes = 3 hours and 85 minutes = **4 hours and 25 minutes**

  85 minutes = 60 mins + 25 mins
  = 1 hour and 25 minutes

Painting a room

When it comes to painting a room there are a number of steps you will need to follow.
For each step you must estimate the time required so you can schedule your time effectively.

In a recent job painter James Bloggs is working on a site in Castledawson. He has estimated the times it would take for him to paint a dining room.

STEP 1: Clear out the room to ensure you have clear space to work.

30 minutes

STEP 2: Prepare the ceiling and walls – fill and rub down.

1 ¾ hours

STEP 3: Remove / mask any hardware.

20 minutes

STEP 4: Clear away any dust from rubbing down walls and ceiling.

15 minutes

STEP 5: Paint ceiling

30 minutes

STEP 6: Paint walls

1 hour 45 minutes

STEP 7: Remove masking tape

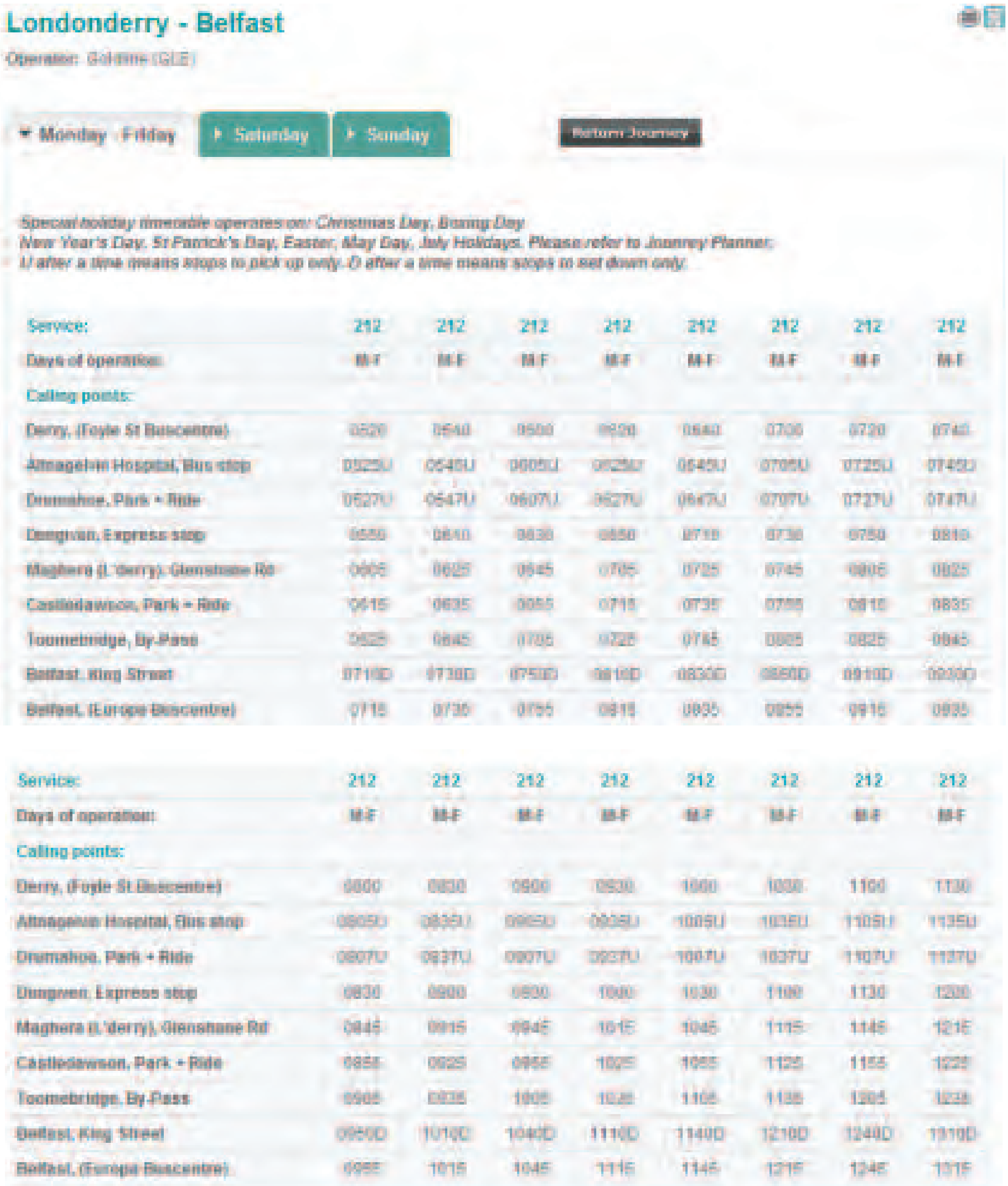
10 minutes

1. James must be on site by ten to nine in the morning. Write this in 24 hour clock format.

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB

2. James has to get the bus from Drumahoe in order to get to work. The site he is working on is a ten minute walk from the bus stop in Castledawson. Using the timetable below work out what time he will need to catch the bus in Drumahoe in order to make it to work on time.


Londonderry - Belfast

Operator: Goldline (GLE)

Monday - Friday | Saturday | Sunday | Return Journey

Special holiday timetable operates on: Christmas Day, Boxing Day
New Year's Day, St Patrick's Day, Easter, May Day, July Holidays. Please refer to Journey Planner.
U after a time means stops to pick up only. D after a time means stops to set down only.

Service:	212	212	212	212	212	212	212	212
Days of operation:	M-F	M-F	M-F	M-F	M-F	M-F	M-F	M-F
Calling points:								
Derry, (Foyle St Buscentre)	0520	0540	0600	0620	0640	0700	0720	0740
Altnagelvin Hospital, Bus stop	0525U	0545U	0605U	0625U	0645U	0705U	0725U	0745U
Drumahoe, Park + Ride	0527U	0547U	0607U	0627U	0647U	0707U	0727U	0747U
Dungiven, Express stop	0555	0610	0630	0650	0710	0730	0750	0810
Maghera (L'derry), Glenshane Rd	0605	0625	0645	0705	0725	0745	0805	0825
Castledawson, Park + Ride	0615	0635	0655	0715	0735	0755	0815	0835
Toomebridge, By-Pass	0625	0645	0705	0725	0745	0805	0825	0845
Belfast, King Street	0710D	0730D	0750D	0810D	0830D	0850D	0910D	0930D
Belfast, (Europa Buscentre)	0715	0735	0755	0815	0835	0855	0915	0935

Service:	212	212	212	212	212	212	212	212
Days of operation:	M-F	M-F	M-F	M-F	M-F	M-F	M-F	M-F
Calling points:								
Derry, (Foyle St Buscentre)	0800	0830	0900	0930	1000	1030	1100	1130
Altnagelvin Hospital, Bus stop	0805U	0835U	0905U	0935U	1005U	1035U	1105U	1135U
Drumahoe, Park + Ride	0807U	0837U	0907U	0937U	1007U	1037U	1107U	1137U
Dungiven, Express stop	0830	0900	0930	1000	1030	1100	1130	1200
Maghera (L'derry), Glenshane Rd	0845	0915	0945	1015	1045	1115	1145	1215
Castledawson, Park + Ride	0855	0925	0955	1025	1055	1125	1155	1225
Toomebridge, By-Pass	0905	0935	1005	1035	1105	1135	1205	1235
Belfast, King Street	0950D	1010D	1040D	1110D	1140D	1210D	1240D	1310D
Belfast, (Europa Buscentre)	0955	1015	1045	1115	1145	1215	1245	1315

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB

3. If the bus is on time, what is the time in words that James will arrive at the Castledawson Park and ride?

4. How long would it take for the bus to get to Castledawson from Drumahoe?

5. As there can be delays in Dungiven, James thinks that it would be better to catch an earlier bus. He decides to get the 07:27 bus from Drumahoe. What time will he get to Castledawson if there are no delays?

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB

6. Following the steps that James has listed below to help find the time it will take to paint the dining room, work out the total estimated time for James to complete the room assuming he takes no breaks?

STEP 1: Clear out the room to ensure you have clear space to work.

30 minutes

STEP 2: Prepare the ceiling and walls – fill and rub down.

1 ¾ hours

STEP 3: Remove / mask any hardware.

20 minutes

STEP 4: Clear away any dust from rubbing down walls and ceiling.

15 minutes

STEP 5: Paint ceiling

30 minutes

STEP 6: Paint walls

1 hour 45 minutes

STEP 7: Remove masking tape

10 minutes

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB

7. If James was to work without breaks, what time would he finish the job?

**8. James takes a 15 minute break in the morning and 40 minute break for lunch.
How long it will be before he completes painting the room including his breaks?**

9. What time will he finish the job, taking into account the breaks he has?

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB

10. The foreman on the site records when the site operatives arrive and leave at the start and end of the day. The times are recorded below:

Using the times he has recorded work out how long each operative has worked that day – assume each has had breaks totalling 45mins.

Employee	Start Time	End Time	
Peter Johnston	08:35	16:20	
Gerry Quigg	08:30	Twenty-five to five in the afternoon	
Marie Tosh	08:50	Quarter to five in the afternoon	
Peter Curran	8:45	5:00pm	
Jonny Slade	08:15	16:30	

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA

In construction you often have to work with area so you need to understand the basic concepts and be familiar with a variety of methods of determining area. In this task we will focus on some important basics.

Some construction workers were asked to define area, here are two replies,

James: "Area is an amount of space"

Michael: "Area is an amount of surface"

1. Which of these would you accept as the better definition of area? Why?

2. Here is a selection of units used to measure physical quantities. Circle the units you think could be used to represent area?

Litres	**pints**	**acres**	**sq. yards**
metres	**mm^2**	**mm^3**	**cubic feet**
m^2	**gallons**	**sq. inch**	**degrees**
hectareskm^2	**yards**	**cm^2**	**kg**
cm			

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA

3. Have the units you selected anything in common? And were there any exceptions?

4. Use the space below to define any units you considered exceptions?

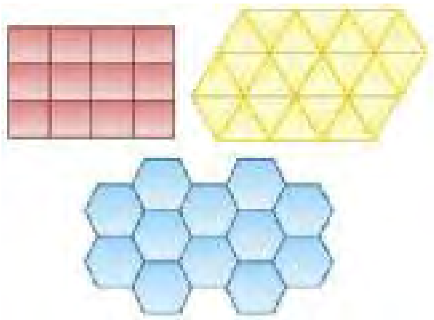
You will have noticed by now that area is always measured in ‘squares’. You should use a suitable square object (called a template or unit square) to measure the area of something in the classroom. For instance you could cut out a square piece of card and use it to measure the area of your desk or a table.

5. In the space below give a brief description of how you went about actually measuring the area with your square template?

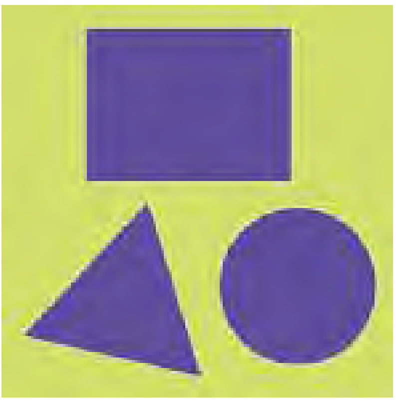
MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA

6. By considering the picture below give one property that any template used to measure area must have?



7. Based on your answer to the previous question which of the following common shapes could not be used to measure area? Choose only one and write its name in the space provide.?



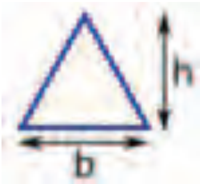
As all rectangles and all triangles tessellate we could use either of these shapes as templates to measure area. However, the square has a clear advantage!

For instance, once someone decides on the 'size' of template to be used use to measure an area (e.g. to measure the area of something approximately the size of an A4 page you might choose a template approximately the size of a postage stamp)there is only one possible square of that 'size' but there could be lots of different rectangles and triangles the same 'size' but different shapes – this could be confusing. Thus to keep things simple area is always measured in squares!

If you want to determine an area which is in the form of a simple shape then there are some formulae which can be used to speed the calculation up. Here is a selection of simple shapes which often appear in construction and it is important you are familiar with finding the areas of these shapes and using the formulae provided. In the following few examples it is assumed you are familiar with length and perimeter.

MEASURE, SHAPE AND SPACE

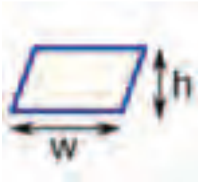
TASK 2 - KNOW YOUR AREA



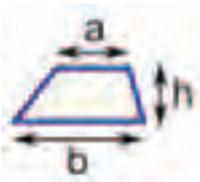
Triangle
Area = ½ b × h
b = base
h = vertical height

Square
Area = a^2
a = length of side

Rectangle
Area = w × h
w = width
h = height



Parallelogram
Area = w × h
w = width
h = height



Trapezium
Area = ½(a+b) × h
h = vertical height

Circle
Area = πr^2
Circumference=$2\pi r$
r = radius

8. Using the appropriate formula above determine the area of a square whose side is 1.2m long?

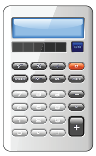
9. Find the area of a triangle whose base is 2.3m and height is 1.8m?

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA

10. Would it be possible to have a square whose perimeter is 16m and whose area is $20m^2$? Use a sketch and formula to help explain your answer.

11. Determine the area of a circle whose diameter is 4.2cm? Take $\pi = 3.14$ and give your answer to 1 decimal place.



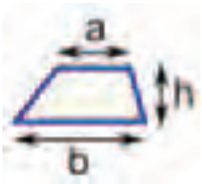
12. Would it be possible to determine the area of a rectangle if the only information you had was the perimeter? Explain your answer.

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA

We will take a look at one of the shapes above in a little more detail as it is used surprisingly often in construction where determining area is concerned.

13. Use the space below to provide a definition of the shape in question. Include the words quadrilateral and parallel in your answer and try to make it as simple as you can.



At a glance the trapezium probably does not appear very useful because it is not a regular shape like a square or rectangle. However it is very useful when determining composite and irregular areas in construction. We will consider the formula for the area of a trapezium and where it comes from. It will be useful to understand the term perpendicular distance in what follows.

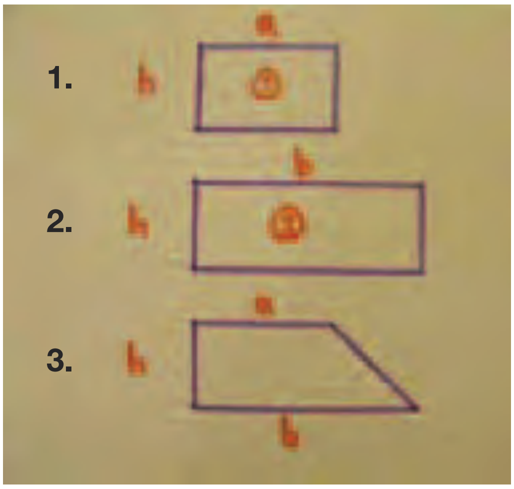
14. Use the space below to make a note of what this means? You may find it helpful to include a sketch in your answer.

Perpendicular distance…

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA

Consider the following diagram



You will hopefully be able to see that the trapezium is something of a compromise between two rectangles and that its area will be 'in between' the area of the two rectangles shown. In fact you will soon be able to show that the area of the trapezium is the mean of the area of two rectangles.

15. Write down a formula for the area of Rectangle 1?

16. Write down a formula for the area of Rectangle 2?

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA

17. Now choose a formula (or formulae) which would allow you to find the mean area of these two rectangles?

(a) Area = (ah + bh)/2 **(b) Area = ah + bh/2** **(c) Area = 0.5(ah + bh)**

18. In the space below show that both formulae shown will give the same answer? Use a =2, b= 3, h = 4. Don't worry about units in this question but show any working out!

Area = 0.5(ah+bh)

Area = 0.5h(a+b)

The area of a trapezium is often described as being

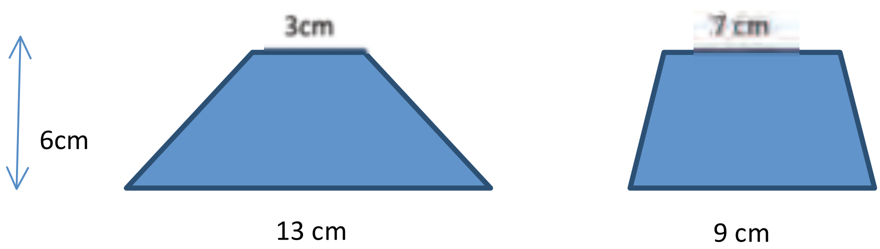
"half the sum of the parallel sides, times the perpendicular distance between them".

19. Even though both formulae in the previous question mean the same thing, which of the two do you think would be worded in this way?

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA

20. Without doing any calculation what can you say about the area of the following trapezia and why?



Comment:

MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY

In construction you often have to work with volume and capacity so you need to understand the basic concepts and be very familiar with calculating quantities. In this task we will focus on some important examples.

To begin with we will consider what is meant by volume and capacity. These terms are sometimes used to refer to the same thing but they are not exactly the same.

When we use the terms volume and capacity we are referring to an amount of space – that is what these terms have in common. How they differ is in the way we think of the space.

"Volume is the amount of space occupied by an object"

e.g. how much space a solid object such as a brick takes up.

"Capacity is the amount of space contained by an object"

e.g. how much space there is inside a container.

MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY

This is why we tend to use capacity when referring to vessels (tanks, bottles, jars, swimming pools, dams, reservoirs, etc) which are normally designed to contain liquids or gases. We tend to use volume when we think of solid objects such as bricks, blocks, beams, concrete, rock, etc.

Sometimes, however, we may refer to both the volume and capacity of an object. For example look at this picture of a sand hopper.

We could ask questions such as **"What is the capacity of this hopper?"** or **"What is the volume of this hopper?"** What are we actually trying to find out with each of these questions?

1. **For each of the statements below put circle around V or C to indicate whether Volume or Capacity is being referred to?You will find that you cannot do that for one of the statements so please circle both V and C on that occasion and explain why you had to in the space below.**

a) The amount of sand the hopper can hold	**V**	**C**
b) The amount of metal used to make the hopper	**V**	**C**
c) The increase in water level if the hopper was fully immersed in water with the lid and exit valve shut (assume it is water tight)	**V**	**C**
d) The amount of water it would take to fill the hopper	**V**	**C**
e) The increase in water level if the empty hopper was fully immersed in water with its lid open	**V**	**C**

Which statement could you not circle V or C for and why?

MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY

2. Here is a selection of units used to represent physical quantities. Circle the units you feel could be used to measure volume or capacity?

litres	pints	sq. inches
metres	mm^2	cm^2
m^3	gallons	sq. mile
hectares	yards	cubic inches
km^2	acres	degrees
cm	mm^3	kg

3. Draw a line to link the picture of the object with the correct formula for its volume?

$V = l^3$	$V = lwd$	$V = \pi r^2 h$

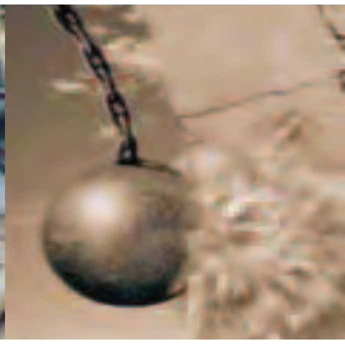
MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY

4. In the space below evaluate each of these formulae using the measurements given and name the shape to which that formula applies? State your answers in appropriate units.

$V = l^3$	($l = 1.6$m)
$V = lwd$	(l=258mm,w=65mm,h=110mm)
$V = \pi r^2 h$	(π=3.14,d=14.5cm,h=5.2m)

The shapes you have just named have an important property in common and this will prove useful later in this task. To help you decide what this property is look at the pictures below of some solid objects which don't have this property!


5. What is the property?

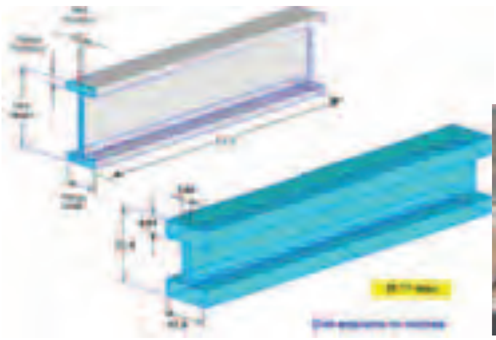
Hint: If you cannot see the answer from the pictures think of the word cross-section.

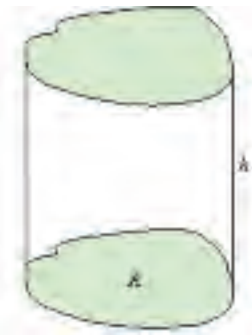
MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY

From your previous answer you will now be aware of a family of 3-D objects called prisms. All prisms have something in common and this is what you have just found out – they have a constant cross-section. The main advantage of being able to identify an object as a prism is that it can provide a convenient way to determine a volume or a capacity.

Indeed sometimes the information available will be such that using the prism property of an object will be the only way you can calculate (or estimate) a volume or capacity. Even though all prisms have a common property they can look very different indeed. Here are some examples of objects which at first glance may not appear to be prisms





6. For each of the objects above identify which face represents the constant cross-section and draw it in the space below? A free hand sketch will be fine!

MEASURE, SHAPE AND SPACE

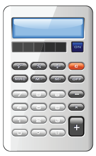
TASK 3 - VOLUME AND CAPACITY

If you need to calculate an amount of space in the form of a prism you first need to identify the face that is the common cross-section. Then you can work out the volume or capacity using the formula

Volume (or Capacity) = Cross-section Area x Length

Here are a couple of examples for you to try!

7. The picture below shows some hydraulic hose. The larger gauge hose has an outer diameter of 54mm and a wall thickness of 10.5mm. Calculate the capacity (in litres) of a 1 metre length of this hose. In other words how much hydraulic fluid could this hose hold per metre?

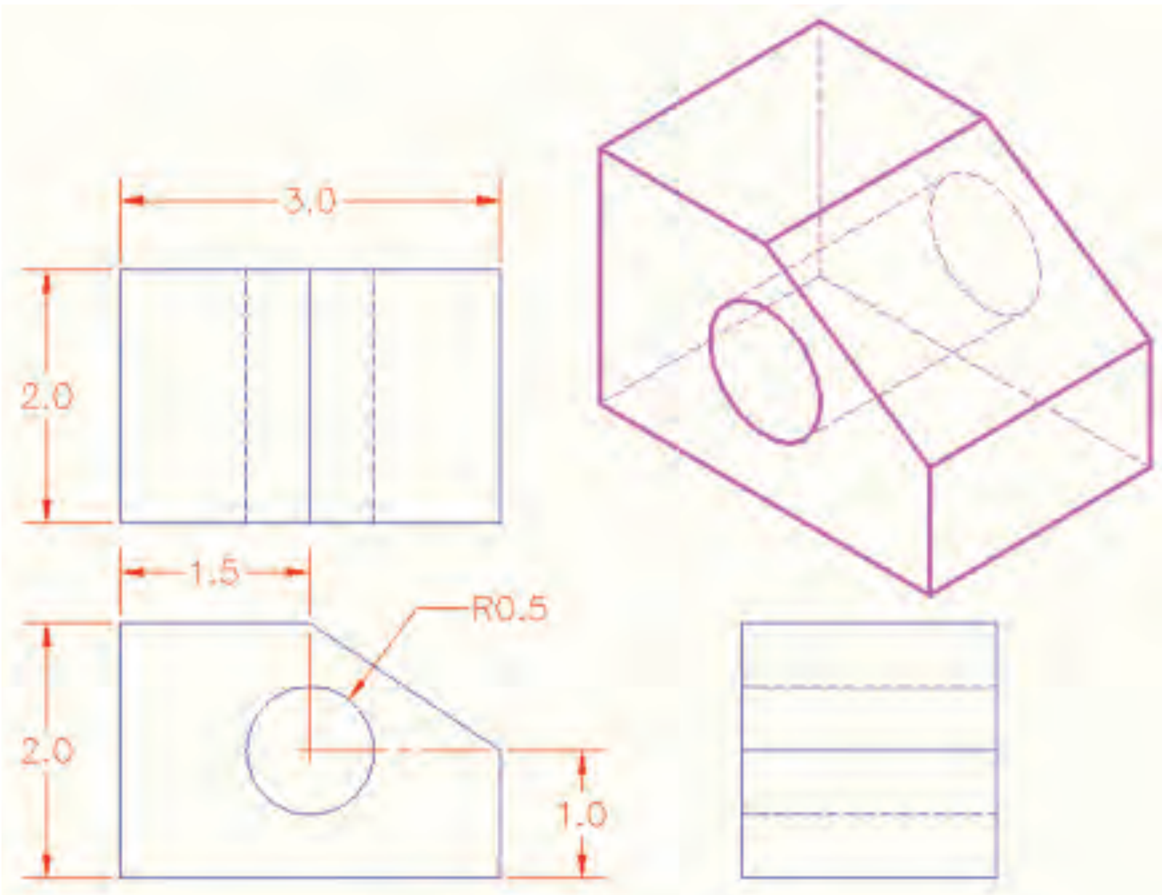


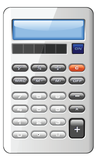
Hints:
- identify the 3-D shape of the fluid-filled part of the hose and find its cross-section.
- Find volume using V = cross-section area x length
- Work in cm for all lengths as you can most easily give your answer in litres (1 litre = 1000 cm^3)

MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY

8. The drawing below shows some views of a spacer component designed to fit between two corner sections in a portal frame. Use what you have learned in this task to find the volume (in cm³) of steel material used in the manufacture of one of these spacers. Measurements are given in cm.





Hint: when calculating the cross-section area it may be helpful to think of a rectangle with a triangle and a circle removed! Use π = 3.14.

MEASURE, SHAPE AND SPACE

TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE

Many trades associated with the construction industry rely on accurate measurements being taken. Where inaccuracies occur this may lead to loss in profit, time or even compromise safety on site. Working on site you need to be able to use different units of measurement and be able to choose the appropriate unit for the job you are doing.

Normally on site you work with metric units such as millimetres and metres. You have probably also come across imperial units of measurement such as feet, inches and gallons on site.

In Northern Ireland road distances are measured in miles. You should be aware that:

Metric Units

	Abbreviation	Full Name	Equivalent
Measurement of length	mm	millimetre	10 mm = 1 cm 1 000 mm = 1 m
	cm	centimetre	100 cm = 1 m
	m	metre	1 000 m = 1 km
	km	kilometre	1 000 m = 1 km
Measurement of weight	g	gram	1000g = 1kg
	kg	kilogram	1kg = 1000g
	t	tonne	1t = 1000kg
Measurement of capacity	ml	millilitre	1l = 1000ml
	l	litre	1l = 1000ml

MEASURE, SHAPE AND SPACE

TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE

Spindles on a staircase must be less than 100mm to meet building regulations.
100mm is 0.1m. This is found by:

There are two methods you could use:

Use 1000mm = 1m

100mm ÷ 1000 = 0.1m

Use 10mm = 1cm

100mm ÷ 10 = 10cm

Use 100cm = 1m

10 ÷ 100 = 0.1m

Imperial Units

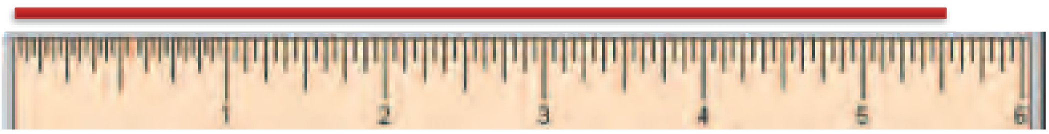
Some tools you come across on site have metric and imperial measurements marked.

	Abbreviation	Full Name	Equivalent
Measurement of length	in	inches	1 foot = 12 inches
	ft	feet	
	yd	yard	1 yd = 3 ft
	mile	mile	1 mile = 1760 yds
Measurement of weight	oz	ounce	1lb = 16 ounces
	lb	pound	
	st	stone	1st = 14 lbs
Measurement of capacity	pt	pint	1gal = 8 pts
	gal	gallon	

MEASURE, SHAPE AND SPACE

TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE

For example a tape measure will have inches as well as centimetres marked.
The length of the line below is 5 ½ inches.



Usually you will find that the rule has each inch divided into 16 parts called $\frac{1}{16}$ths.

1 inch is approximately 2 ½ centimetres.
This should help you if you need to convert from inches to centimetres.

Screws and nails are sometimes measured in inches.

You may also have come across 4 by 2 stud work.
This describes stud work that is 4 inches wide by 2 inches thick.

Converting imperial lengths use:

12 inches = 1 foot

3 feet = 1 yard

1760 yards = 1 mile

1 gallon = 8 pints

1 stone = 14 pounds

1 pound = 16 ounces

MEASURE, SHAPE AND SPACE

TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE

1. If a gorilla tub holds 10 gallons, how many pints is this?

Converting between metric and imperial lengths use:

1 inch ≈ 25 mm

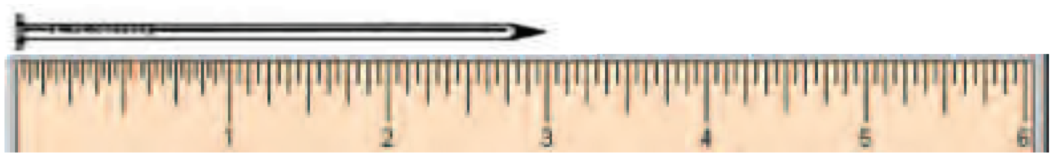
1 foot ≈ 300 mm

≈ means approx. equally to

1 gallon ≈ 4.55 litres

5 miles ≈ 8 km

2. What is the length of the nail below?

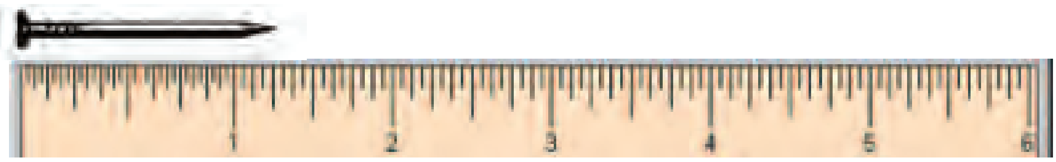


3. Using **1 inch ≈ 25 mm** **calculate the length of the nail in question 2?**

MEASURE, SHAPE AND SPACE

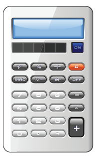
TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE

4. What is the length of the nail below?



5. Use a calculator to calculate the length of the nail in question 4 in mm.

Remember: **1 inch ≈ 25 mm**



6. Peter works in Belfast but lives in Limavady. The distance from Limavady to Belfast is 65 miles. What is this distance in km?

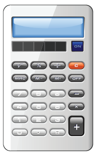
5 miles ≈ 8 km

MEASURE, SHAPE AND SPACE

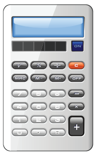
TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE

7. Peter has worked out that in 1 round trip to work he used approximately 15 litres of diesel. To work out how many miles per gallon he is getting from his car Peter needs to convert the number of litres of fuel to gallons. How many gallons is this?

1 gallon ≈ 4.55 litres

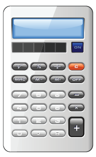


8. Using the answer to question 7, calculate the miles per gallon that Peter's car is achieving.



9. Peter knows that at the weekend when he is making shorter trips he is only achieving 35mpg (miles per gallon). Over 1 month he would do around 300 miles in total at the weekend. How many litres of fuel would this use?

1 gallon ≈ 4.55 litres



MEASURE, SHAPE AND SPACE

TASK 5 - COMMON MEASUREMENT INSTRUMENTS

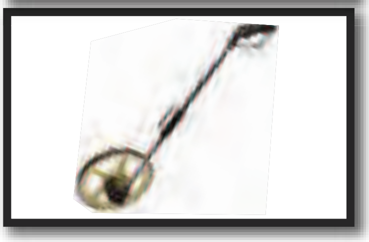
On site you will measure using various instruments.

1. Consider what each of these devices measure and match them to the associated units.









Millimetres

Inches

Degrees

Kilometres

Centimetres

Gallons

Celsius

Metres

Litres

Yards

MEASURE, SHAPE AND SPACE

TASK 5 - COMMON MEASUREMENT INSTRUMENTS

2. In construction we mainly use metric units for measuring. Where have you come across the metric and imperial units below at work? Fill in examples of where you have come across that unit in work. Some suggested answers below:

Units	Used in
Millimetres	Site plans, widths and depths of joists…
Inches	
Degrees	
Kilometres	
Centimetres	
Gallons	
Celsius	
Metres	
Litres	
Yards	

MEASURE, SHAPE AND SPACE

TASK 5 - COMMON MEASUREMENT INSTRUMENTS

3. Match each item with a likely measurement:

Safety lanyard and scafford hook

CO_2 Extinguisher

Water Extinguisher

85 litres

1.75 m

4 m

20 litres

9 litres

365 metres

10 gallons

2 kg

1 tonne

MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS

Drawings are an important part of construction work. Understanding how drawings provide each trade with the necessary information to do their job is an important skill. The scale on the plan tells you the relationship between the lengths on the plan and the real distances.

Example:

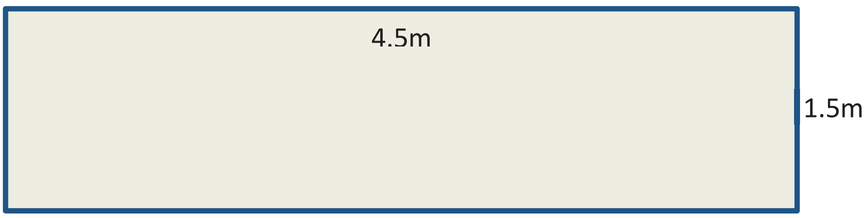
Below is a sketch of a hallway drawn to a scale of 1:50. When you measure the room below you should find that it is 90mm by 30mm. Check and see this is correct.

The scale 1:50 means that every 1 unit on the plan represents 50 units in real life i.e. for a scale of 1:50 the real distance is 50 times the length of 1 unit on the map or drawing.

To work out the actual dimensions of the hallway we need to use the scale and the measurements on the plan as shown:

1:50 means that the actual dimensions are 50 times the size of the measurements on the plan.

Measurement on the plan	Scale	Actual measurement
90mm 30mm	1:50 1:50	90 ×50 = 4500mm = 4.5m 30 ×50 =1500mm = 1.5m



MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS

1. The cards below contain a mixture of units. Cut out the cards and match each scale card with a measurement on plan card and an actual measurement card. The way they are currently matched is incorrect.

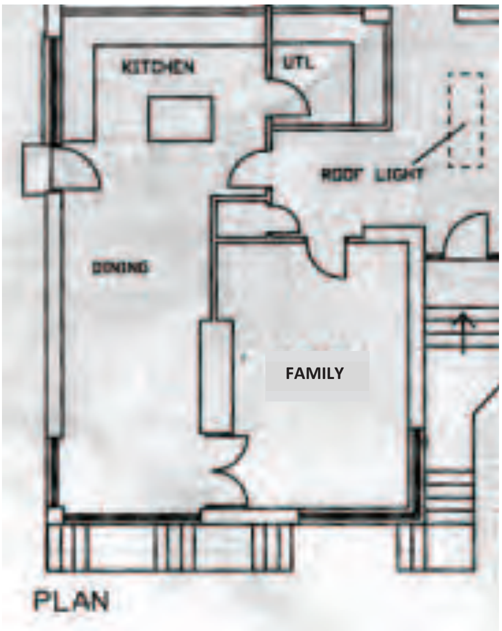
For example: A measurement on a plan of 20mm matches with a scale of 1:25 to give an actual measurement of 500mm = 0.5m

Measurement on plan	Scale	Actual Measurement
2mm	1:2	0.3m
10mm	1:5	100mm
60mm	1:10	60m
3000mm	1:20	3m
10mm	1:50	1m
60mm	1:100	600mm
300mm	1:5000	10mm

MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS

2. Using the plan below, what would the front elevation of the house look like?



View from front

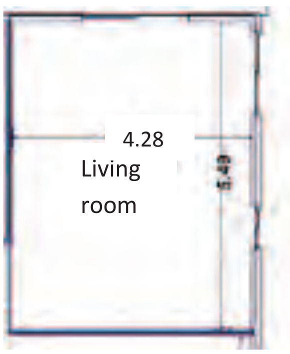
MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS

3. Sketch the elevation of the house from the view shown.

View from this point

**4. The plan of a living room shows the room dimensions in metres.
Usually measurements on a plan are given in mm. Convert the lengths to millimetres.**



MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS

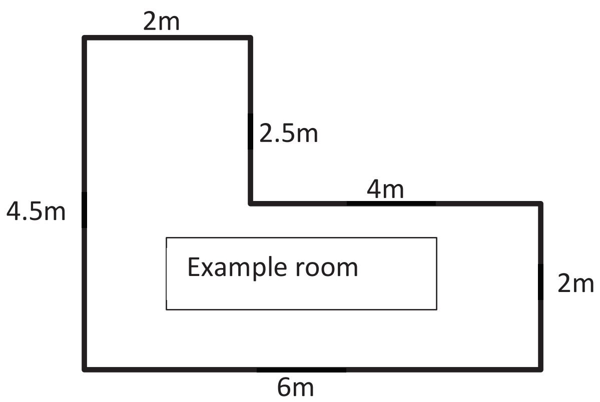
Remember:

PERIMETER

The distance around a shape is the perimeter.

- Make sure you have all the side measurements
- Make sure all units are the same

Example: the room below has a perimeter of:



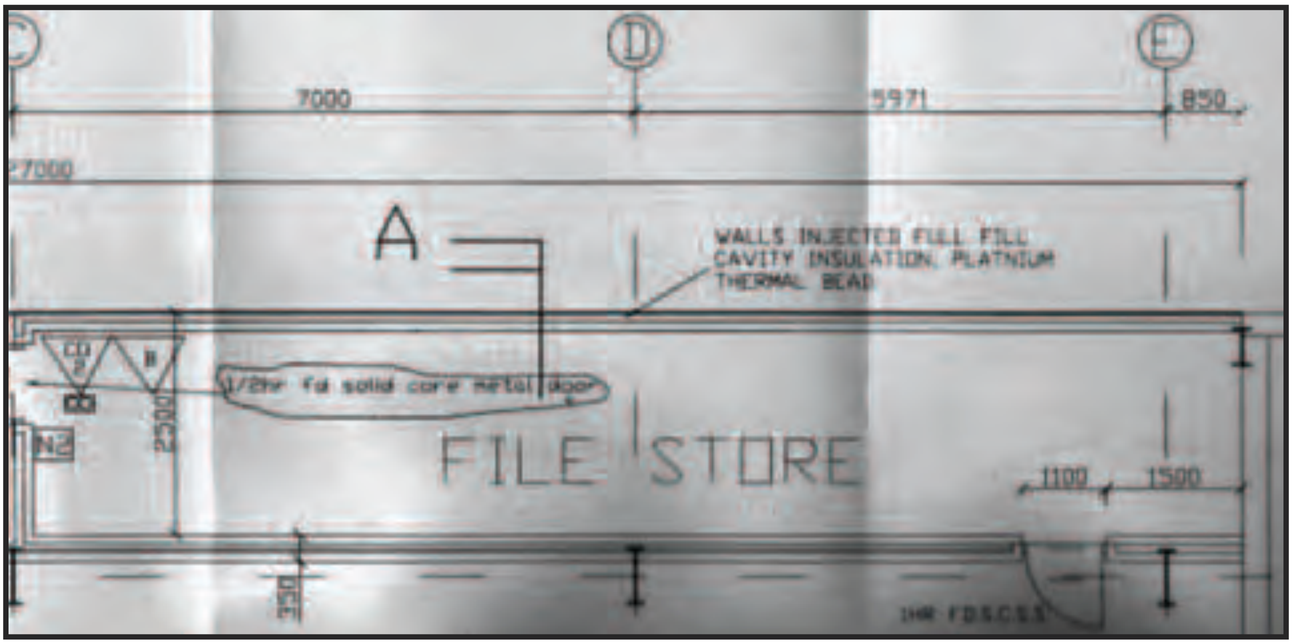
2 + 2.5 + 4 + 2 + 6 + 4.5 = 21m

5. A builder wants to work out how much coving is needed to go round the room in question 4.

MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS

6. The floor of the file store shown in the plan needs to be tiled. What is the area of the floor in metres squared?

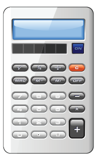


Remember area

length

Area = length × width

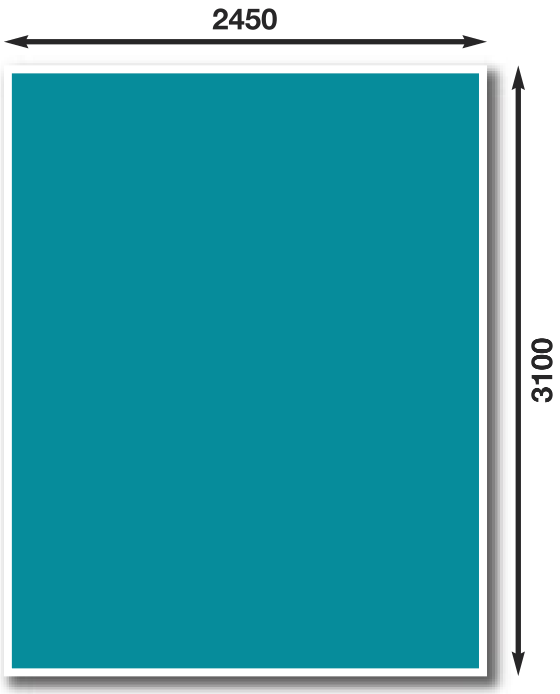
width



MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS

7. Below is a sketch of the utility room in the new build. The dimensions are shown in mm. Sketch a scale drawing of the utility room using an appropriate scale.



MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS

Every building loses heat. In a typical home, around one-third of the heat produced by a central heating system is rapidly lost through the roof, ceiling and walls. This means that for a poorly insulated property up to £1 out of every £3 spent on heating is being wasted.

Heat loss will typically occur:

- through the roof
- through the walls
- through doors/windows and floors

To calculate heat loss, ambient temperature readings inside and outside the building need to be taken and compared.

Drawing a number line can help us to calculate temperature differences. For example, if the overnight temperature fell to –3°C, and by midday it had risen to 9°C, then, counting from –3 up to 9 on the number line.

Using the number line you can see that the temperature has gone up by 12°C.

Extremes in temperature can have a negative impact on a building. High temperatures can reduce the moisture content in a room and cause shrinkage. Temperatures below -7 °C can cause concrete fractures. Understanding the impact of temperature changes during construction allows a builder to choose the appropriate materials to offset possible problems.

RJM Construction has been asked to look at thermal loss and light pollution in Central High School. The drawings need to be reviewed to advise the school on reveals, windows, insulation, roof lights etc. The base surveyor has looked at the design and has found that to keep a constant temperature of 23°C in the building there would be an expected loss of 30% out of the windows and 25% through the roof.

1. The temperature inside an unheated building is usually around 2.78°C higher than the outside air temperature, so when the outside air temperature is at 15.6°C what will the inside temperature be?

MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS

Inside and outside the building the readings over the course of two weeks are shown below:

Day	1	2	3	4	5	6	7	8	9	10
Inside temperature	18.5°C	19°C	17°C	21°C	20.5°C	19.5°C	18°C	18.5°C	21°C	20.5°C
Outside temperature	3°C	1°C	-1°C	0°C	5°C	1.5°C	2°C	-2.5°C	4°C	6°C

2. Which day had the smallest difference in temperature between the inside and outside? What was the temperature difference that day?

3. Which day had the largest difference in temperature between the inside and outside? What was the temperature difference that day?

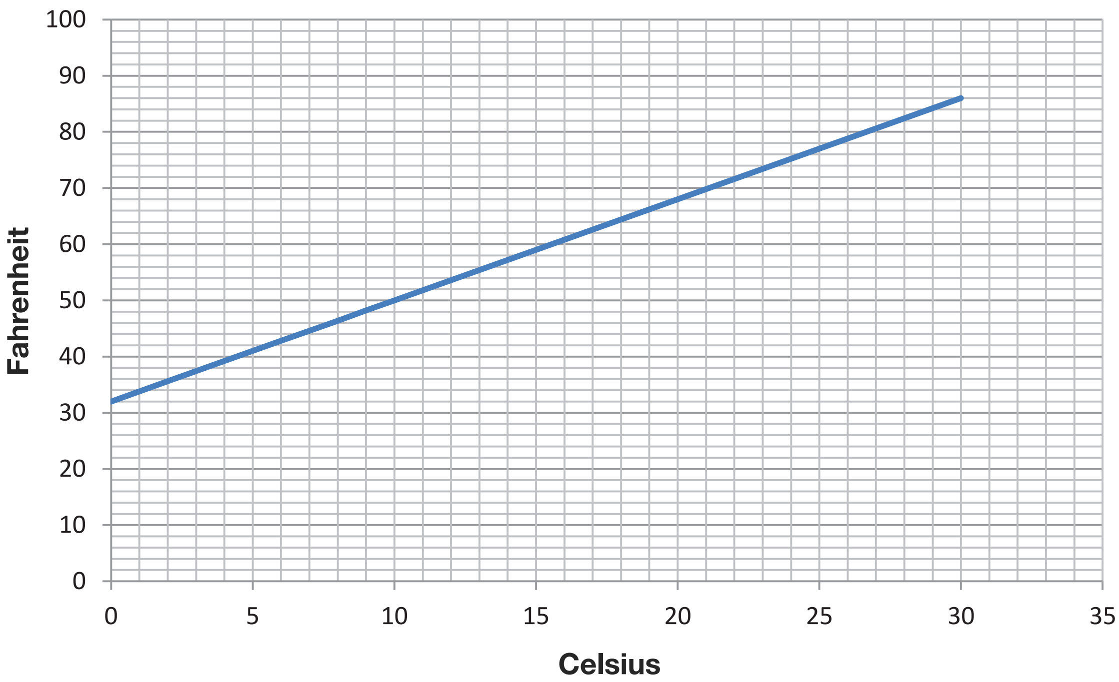
The surveyor has been working abroad and compares the temperature readings he has gathered from the site with readings he had on a similar project in the US.

In America temperature is measured in degrees Fahrenheit and in order to compare values these need to be converted to degrees Celsius. The conversion graph below allows the temperature to be compared.

MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS

Conversion Graph: Degrees Fahrenheit - Degrees Celsius



4. From the conversion graph – which temperature is higher 30 °C or 30 °F?

5. The ambient temperature inside the building on day 11 is 23 °C. What is this temperature in Fahrenheit?

MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS

6. It is possible to check the accuracy of this reading by using the formula below to convert between Celsius and Fahrenheit. Use the formula and check if the answer you got to question 5 is accurate.

$$F = \frac{9C}{5} + 32$$

C is the temperature in degrees Celsius and F is the temperature in degrees Fahrenheit.

If you wanted a precise reading of thermal heat loss then you would need to have a lot of information based upon temperature differences internally and externally.

A U value is a measure of heat loss. It is expressed in W/m^2K, and shows the amount of heat lost in watts (W) per square metre of material (for example wall, roof, glazing, and so on) when the temperature (K) is one degree lower outside.

The lower the U value, the better the insulation provided by the material.

The amount of heat loss through a section of the structure such as a wall is obtained from the equation below;

Heat Loss (in Watts) **= area** (in m^2) **x temp difference** (in °C) **x U value** (units W/m^2K)

Calculations are made for one wall of the building. The room has an external wall 5.5m x 3m. It has a 280mm brick wall with an unventilated cavity, and it faces east.

MEASURE, SHAPE AND SPACE

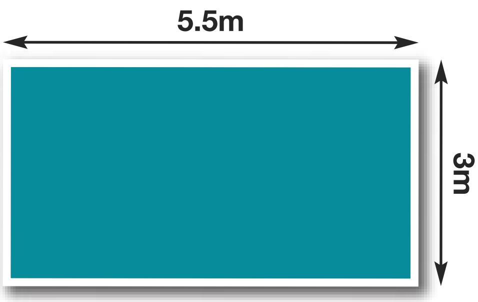
TASK 7 - THERMAL HEAT LOSS

7. Calculate the temperature difference between the outside and inside of the building.

Outside temperature: -2 °C

Inside temperature: 21 °C

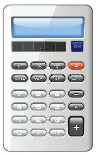
8. What is the area of the wall?



MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS

9. Using the formula below calculate the heat loss.

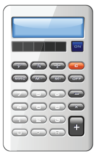


Heat Loss (in Watts) = area (in m^2) x temp difference (in °C) x U value (units W/m^2K)

The U value is $1.8W/m^2K$.

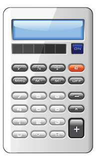
10. A one metre squared standard single glazed window has a U Value of 5.6. If the temperature outside is -1.5 °C and the inside temperature is 19 °C, calculate the heat loss.

Heat Loss (in Watts) = area (in m^2) x temp difference (in °C) x U value (units W/m^2K)



11. A one metre squared double glazed window will be significantly better with a U Value of 2.8, i.e. only transmitting 2.8 watts of energy in similar conditions. Calculate the heat loss if the inside and outside temperatures remain the same.

Heat Loss (in Watts) = area (in m^2) x temp difference (in °C) x U value (units W/m^2K)



MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS

12. Building regulations now specify that U Values must be 2.0 W/m^2K or lower. This means that any new window will need to comply with these regulations. What is the difference in the heat loss between the single and double glazed windows?

Claims by the glazing company state that:

"Double-glazing can halve heat loss through windows."

Do you agree? Why?

MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES

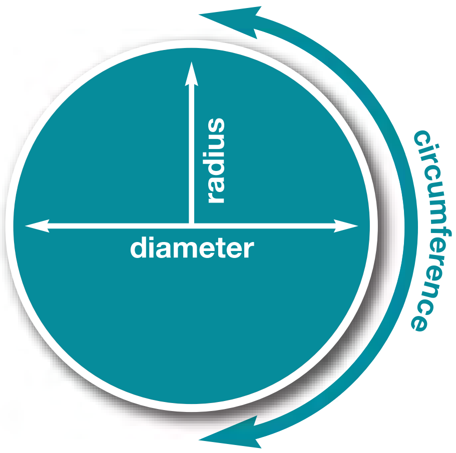
Very large floors can have low U-values without all-over insulation. Unlike components above ground, heat transfer through floors varies over the area of the floor, being greatest at the edge of the floor and least in the middle. The U-value for floors depends on the exposed perimeter and the area of the floor.

PERIMETER

The distance around a shape is the perimeter.

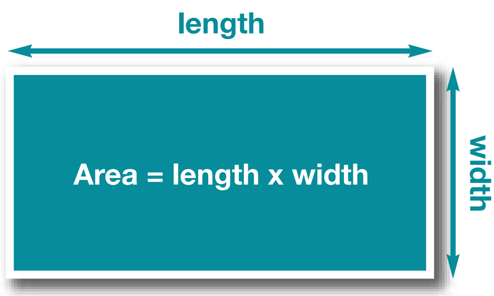
- Make sure you have all the side measurements
- Make sure all units are the same

The perimeter of a circle is called the circumference.



When the circumference of a circle is divided by the diameter the answer is a number called **pi** and is written as π. Your calculator will have a **π** button. When you press the **π** button on your calculator you will get a number 3.14159…

Circumference = **π × d** = π × diameter

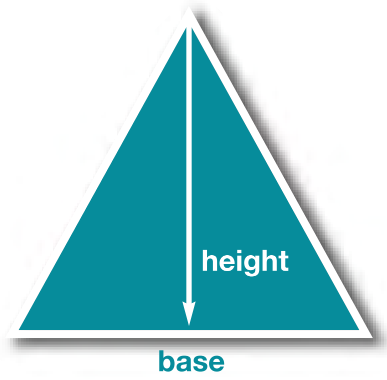


AREA

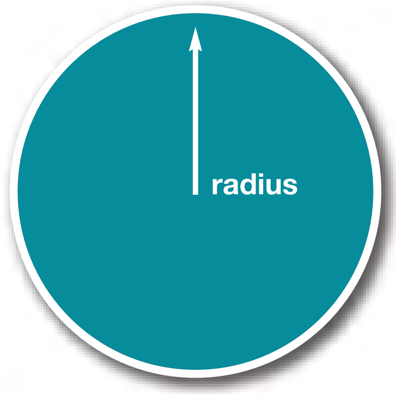
Area of rectangle

MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES



Area of a triangle = ½ base × height

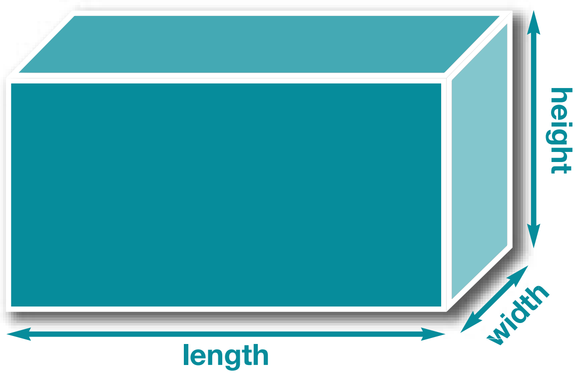


Area of a circle = $\pi \times r^2$

r^2 means $r \times r$

VOLUME

To order material such as stones for a path or concrete for a driveway or foundations, you need to calculate the volume. Volumes are normally measured in **units cubed** such as metres cubed.

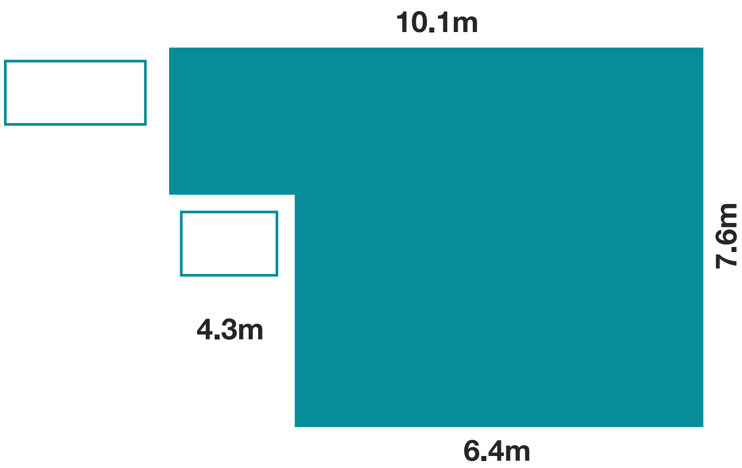


Volume = length × width × height

MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES

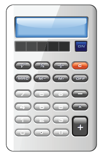
1. The dimensions of a proposed dwelling are shown below. Two of the lengths are missing. Fill in the missing lengths in the boxes provided – show your methods in the box below.

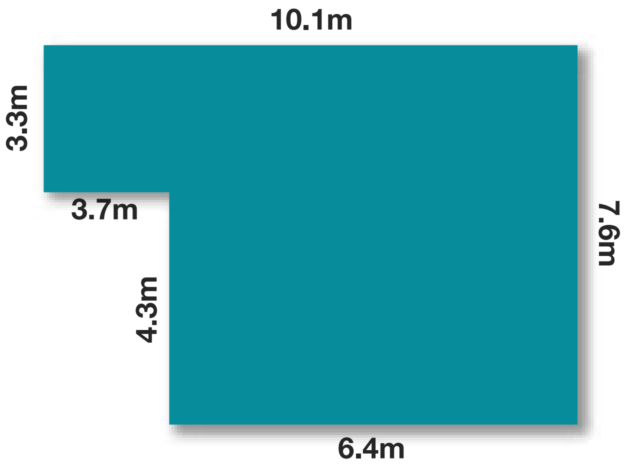


MEASURE, SHAPE AND SPACE

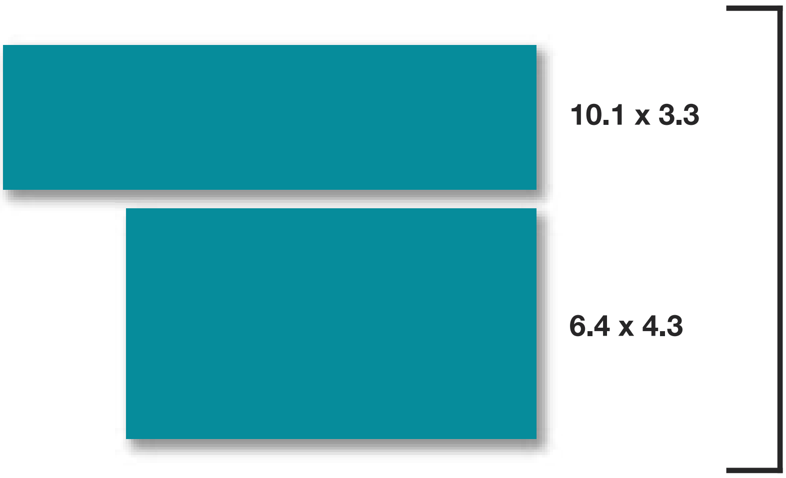
TASK 8 – THERMAL PROPERTIES

2. Three site operatives calculate the ground floor area. Their methods are below. Who has calculated the ground floor area correctly and why is the method correct? Who has calculated the ground floor area incorrectly and why?





Jay calculated the ground floor area. He divided L shape into two rectangles:



Jay then totalled the two areas together to get 60.85m^2

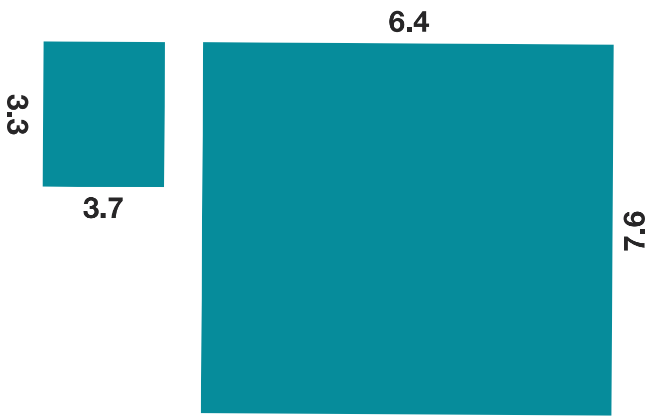
MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES

Chris's method is shown below:

10.1 × 10.1 – 3.7 × 4.3 = 102.01 - 15.91 = 86.1m²

Mark's method is below



3.3 x 3.7 = 12.21

10.1 x 7.6 = 76.76

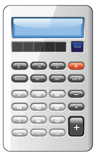
76.76 + 12.21 = 88.97m²

MEASURE, SHAPE AND SPACE

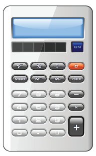
TASK 8 – THERMAL PROPERTIES

3. The floor construction consists of a 150 mm concrete slab, 75 mm of rigid insulation (thermal conductivity 0.04 W/mK) and a 65 mm screed. Use the formula below to find the volume of concrete needed to construct the concrete slab.

Volume = area of base × height



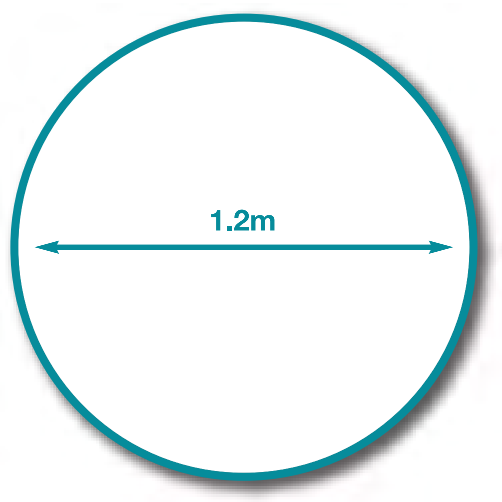
4. Calculate the perimeter of the concrete base and divide the perimeter by the area to find the U value for the floor.



MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES

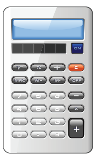
Heat loss for a circular window in the dwelling is related to the area of the window. The dimension of the window is shown below:



5. Find the area of the glass in the window. Use the formula below:

Area of a circle = $\pi \times r^2$

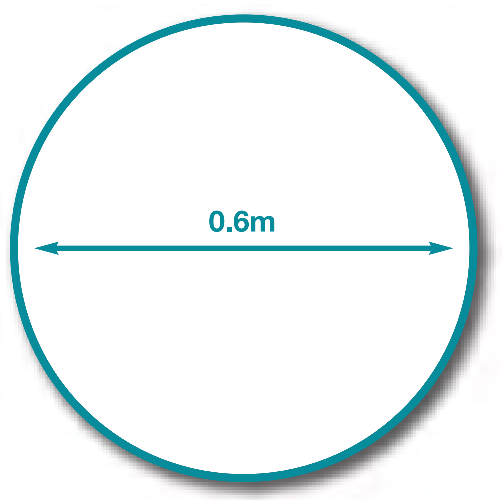
Use the π button on your calculator.



MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES

6. The window manufacturer claims that if the diameter of the window is reduced by half, then the heat loss will be reduced by half. By calculating the area of the smaller window, state whether you agree or disagree and why.



MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

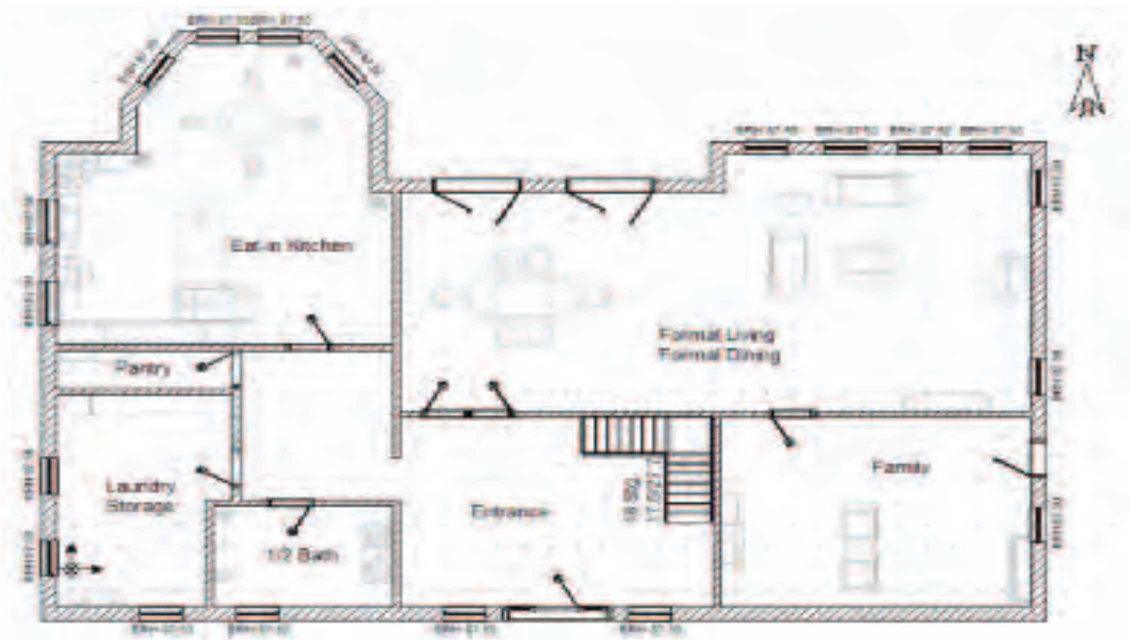
More often than not in construction we are required to calculate an area which will not be in the form of a regular basic shape such as a square, rectangle, triangle, circle etc., so a little more work and understanding will be required in order to find such areas. In this task we will look at two general scenarios (You should complete *Know Your Area* task before attempting this one).

We will consider composite shapes where the area cannot be calculated using a simple formula. However the area that can be broken down into smaller regular areas each of which can be determined, using a formula you are familiar with, and then summed to get an answer. When working with composite area it is usually possible to get an exact answer.

The second scenario involves trying to determine an irregular area which cannot usually be broken down into simple shapes in an exact way. It can be modelled as something very close to a composite shape but an exact answer is not usually possible (or at least not practical). However as you will see in this task numerical methods have been developed which can be used to get an answer to whatever level of accuracy is required. The level of accuracy will depend on the amount of information available or the number of measurements taken.

Composite area

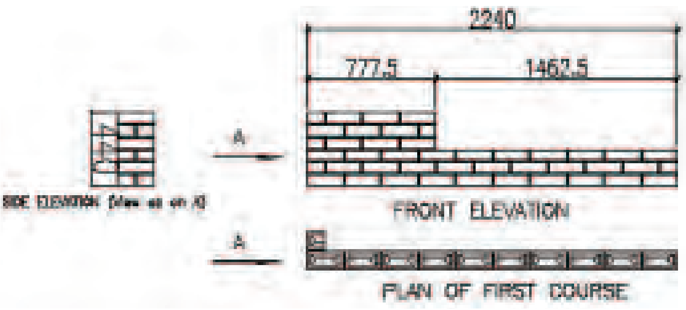
1. Take a look at the floor plan below and edit the plan using pen and ruler to show how you would break up the interior of the Eat-in Kitchen to set about calculating its area. You don't actually need to calculate it, just try to break it into as few smaller bits as possible but write on the diagram the kinds of shapes you use?



MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

The walls in this building will be constructed as shown below. Take a good look at the drawing and photograph provided and then use them to help answer the questions which follow



2. By concentrating on the Front Elevation drawing and the measurements given determine the metric dimensions of the brick used to build the wall. All mortar joints are 10mm?

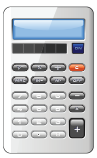
MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

3. By firstly rounding off your answers to the previous question (to the nearest 50mm) write down a ratio for length:width:height for the brick which is a standard UK brick?

4. Use the space below to produce a "3-D" sketch of the brick using the simple ratio you have just calculated. Your drawing does not have to be to any particular scale but try to get the proportions correct (for example if the length of the brick is twice the width of then make sure your drawing conveys that fact)?

5. Calculate the area of wall built so far (again consider only the front elevation). Don't forget to account for the mortar joints in your calculation and give your answer in mm²?



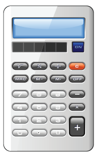
MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

6. Calculate all three cross-sectional areas of a single brick using dimensions in mm?

7. Now use whichever of these cross-sections you consider necessary to determine the area of the wall which actually is brick (i.e. not mortar)?

8. Using some of your previous answers calculate the percentage of the wall which actually is composed of mortar. Round it off to the nearest 1%?



9. Suppose someone asked you what the 'typical' ratio of brick to mortar is for a brick wall. If you decided to use the wall in the drawing as a basis for your answer, which one of the following simple ratios is closest to the truth for the area ratio of brick to mortar?

brick:mortar	**brick:mortar**	**brick:mortar**
7:1	**6:1**	**5:1**

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

Irregular area

In many cases the area you need to calculate will not be in the form of a regular shape. In particular you will often have irregular boundaries which means the area inside cannot be calculated exactly. There are different ways to work with such areas depending on how accurate the answer needs to be. In most cases it will involve replacing a curved line with a straight line as you will see.

The map below is a detailed Ordinance survey map of a region north of Draperstown, where an area of land has been identified as being suitable to site a wind farm.The land owner and a local contractor are considering various aspects of this potential development. The area is bounded by some local roads and a stretch of the river Moyola and one of its tributaries. This region is highlighted on the map below.

For valuation purposes it is necessary to calculate the area of land inside the boundary and you will probably agree this would be quite a difficult thing to do.

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

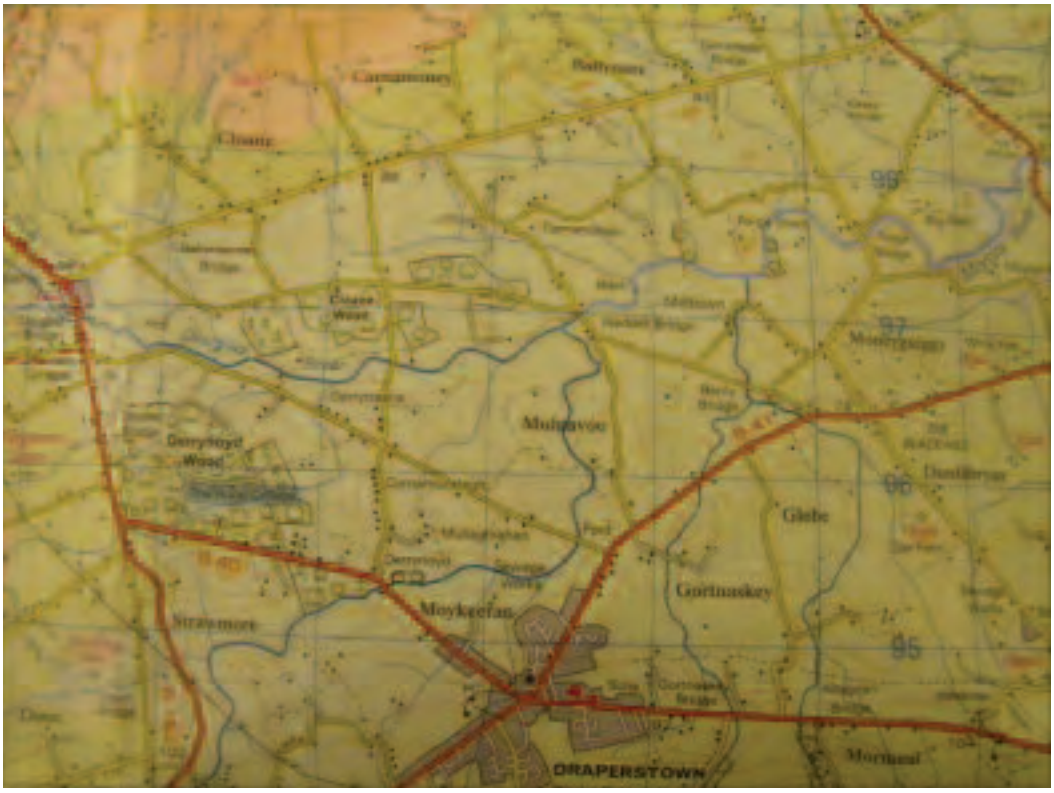
10. On the map below you are asked to redraw the boundary in a way that will make it possible to calculate this area, at least approximately?

Here are a few pointers to help with the process

a. Use an irregular pentagon to replace the boundary

b. The river stretch will be covered by 2 sides of the pentagon

c. Your pentagon should have two internal right angles.



MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

You now need to split the shape you have drawn (which is considered a composite area) up into smaller shapes whose area you can calculate using formula. Two shapes will be sufficient.

11. Use the space below to lay out your calculation beginning with a sketch of the composite shape and the smaller shapes together with the appropriate measurements for the lengths of sides?

In order to determine the lengths of the sides you will need to use the scale 2cm:1km

Composite area (sketch):

List the two smaller shapes and the formula used to determine their area:

Use scale on map 2cm:1km to take whatever length measurements you require (with your ruler work to the nearest mm on the map):

Resulting area calculation:

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

In practice the method used is not very different to the calculation you have just done. However, many more measurements would be taken resulting in a very accurate answer. Suppose this has been done for the land in question and you are told that the answer (correct to the nearest 100m^2) is 5,835,700m^2.

12. Use the space below to determine the percentage error in the approach you were asked to use above to get an approximate answer.

Percentage error = (actual area – approximate area) ÷ actual area x 100.

Land area is normally stated in units of acres or hectares.

13. Convert the exact area answer (5,835,700m^2) to the nearest acre and the nearest hectare.

1 acre = 4047m^2 **1 hectare = 10000m^2**

Your answers will have involved some rounding to the nearest whole number for each of the two units used.

14. Which of your answers (acre and hectare) is most accurate and why?

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

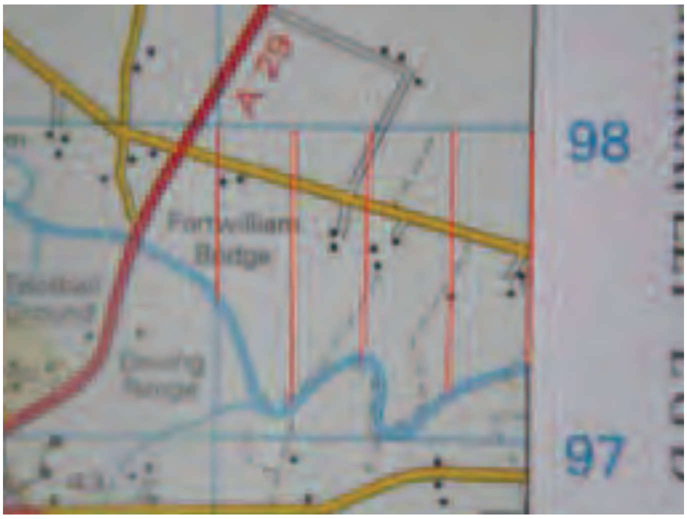
We will now take a look at the method used to get a more accurate answer. To do this we will focus on an individual grid square (pale blue lines on map) and consider an irregular area within this grid square. This is what would happen in practice. Look the region outlined in the picture where some land is bounded by a stretch of river and three of the sides of the square.

There is one very useful advantage in using three sides of the grid square. It means we can make use of a formula which engineers have developed. Don't forget, we will still be using a composite area to approximate an irregular area but there is a formula to use meaning we don't have to calculate lots of smaller individual areas and add the answers up!

In order to use this formula we need to take some distance measurements from the base of the square to the river. These are often referred to as off-sets in construction. The off-sets need to be evenly spaced across the base of the square as indicated in the picture below. Here the red lines indicate the measurements which need to be taken. The more off-sets used the more accurate the answer. For this example we will use five off-set measurements.

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA



15. Use the scale 1cm:250m to calculate each of the distances marked in red and note the distance along the base line between each off-set (normally called the strip width) is 250m?

Take distance measurements from the map to the nearest millimetre 'tick-mark' on your ruler

When you have determined these measurements you will be ready to use the formula below to calculate the area that was outlined in the earlier picture.

16. Label the five off-sets 1st, 2nd, 3rd, 4th and 5th and make sure you state the lengths in metres?

1st:	**2nd:**	**3rd:**	**4th:**	**5th:**

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

The formula is

Area = d(2S-t)

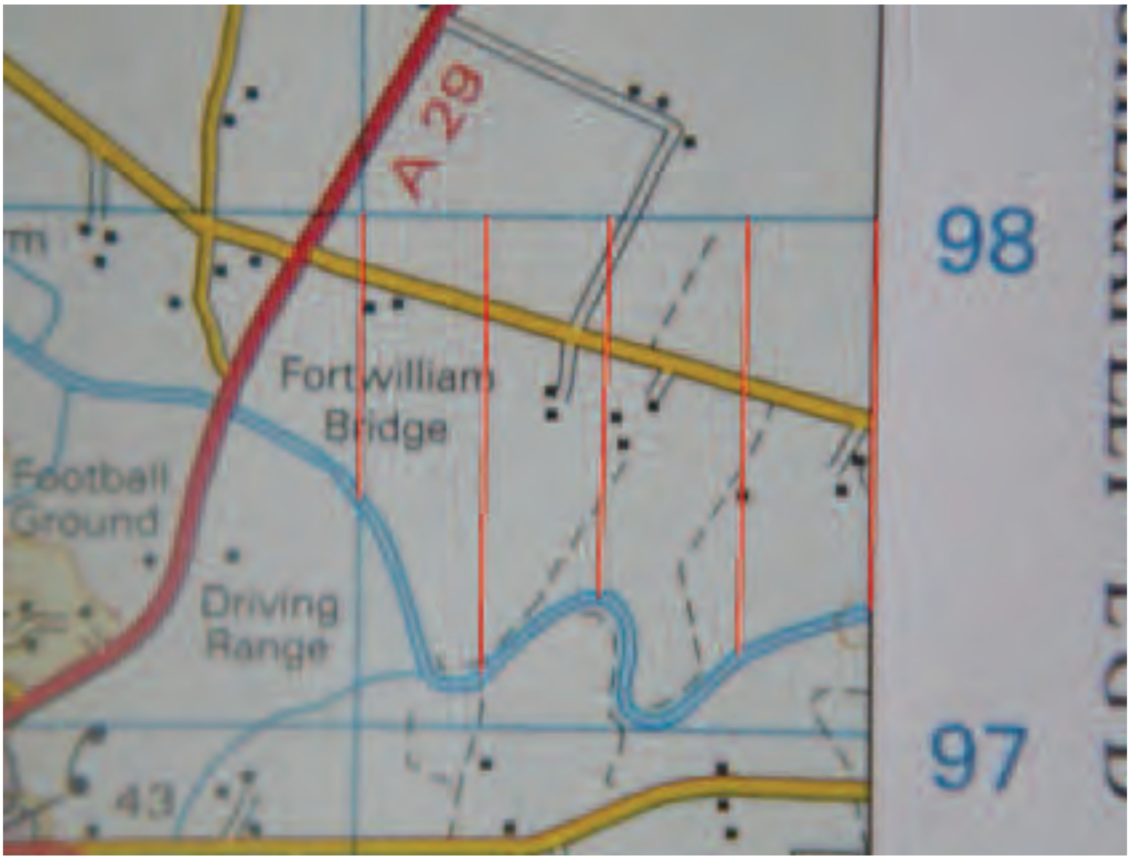
Where **S** is the sum of all the off-sets, **t** is the sum of the 1st and last off-set and **d** is the strip width.

17. Use the space below and this formula to calculate the area.

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

18. In order to see the actual area you have calculated using this formula you need to join up the tops of the off-sets with straight lines. You can do this in the figure below and when you have it done the area should resemble four trapezia sitting next to each other.



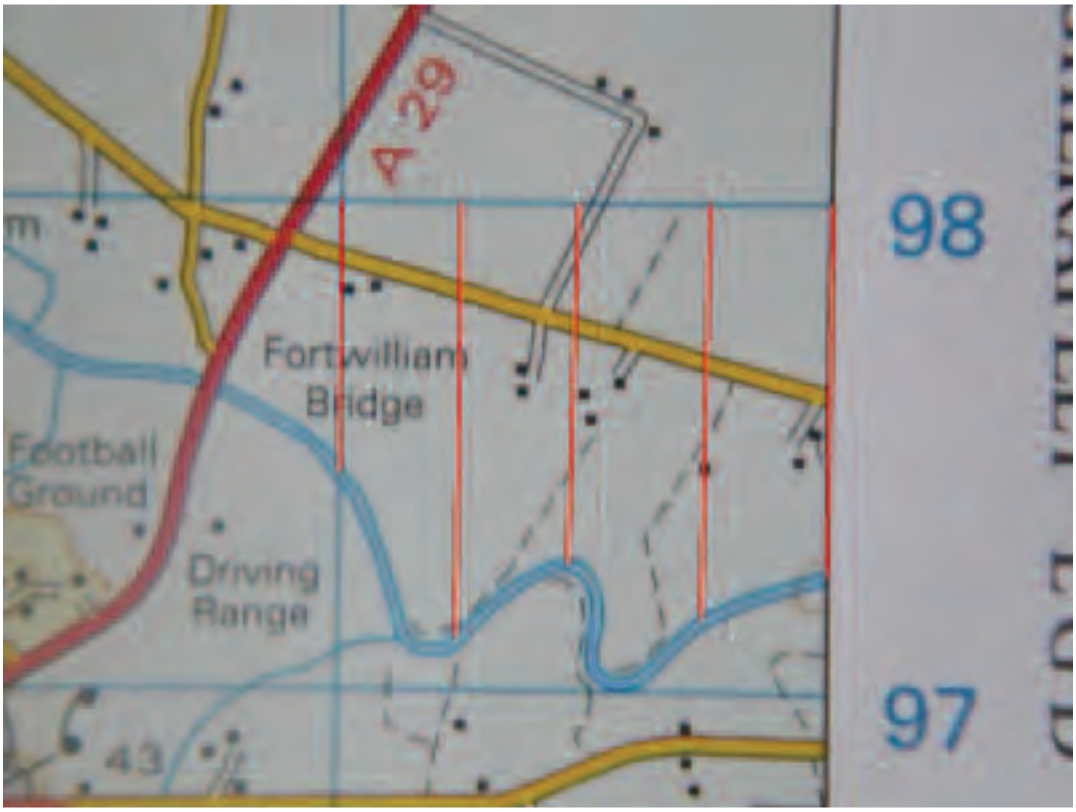
19. On the same picture shade in two small irregular areas which could be described as 'error 'in this calculation.

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA

In practice a large number of off-sets would be used giving a very accurate answer. You can use the figure below to demonstrate how increasing the number of off-setsgives an improved answer.

20. Add in 4 more off-sets, each one equally spaced in between the off-sets already drawn in the figure below and then join the tops of them with straight lines. Indicate the 'error' region with shading.

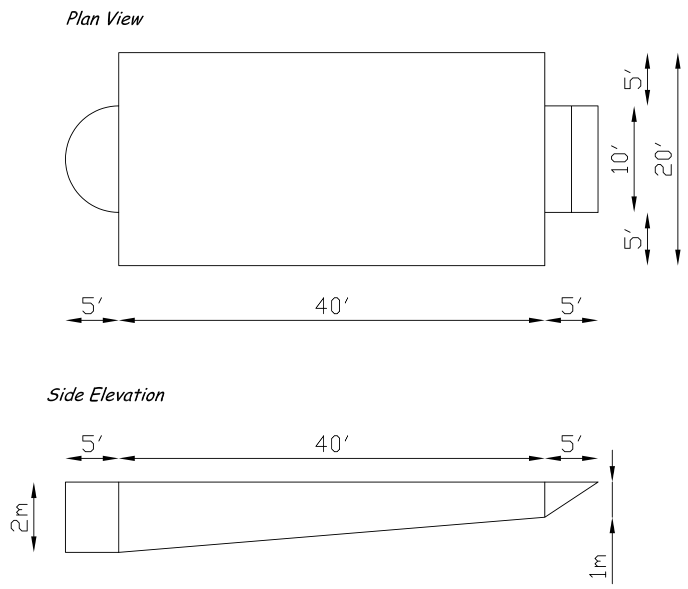


21. In the space below indicate why you think using 9 off-sets instead of 5 will give a better (i.e. more accurate) answer?

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL

Now that you are familiar with calculating the volume or capacity of an object which has been identified as a prism (you may wish to complete task *Volume and Capacity* before this one) we are going to look at an example of how this can be useful in practice. A contractor has been approached by a local spa centre to build a second swimming pool on site. Here are some initial plans they have drawn up for the pool.



Notice how some measurements are in feet (e.g. 5' which means 5 ft) whereas other measurements are in metres.

1. Before going any further it will be useful to convert all length measurements to cm?

Use the conversion factors 1ft = 0.305m and 1m = 100cm to convert 5', 10', 20', 40', 2m and 1m to cm. See if you can use factors or multiples to spot some short-cuts !

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL

2. In the space below produce some sketches indicating how you would break the swimming pool up into 3 parts (each of which is a prism) that would help you calculate the capacity of the pool. Don't worry about writing in dimensions at this stage?

For each prism lightly shade the face which is the common cross-section!

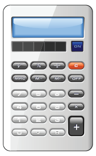
3. Consider each of the prisms in turn and in the space below sketch the cross-sections and write the appropriate dimensions on each sketch?

Remember to work in cm!

MEASURE, SHAPE AND SPACE

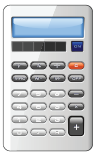
TASK 10 – EXCAVATION FOR A SWIMMING POOL

4. Write down and use formulae you have met before (see task Know your Area for a list of formulae if you need to) to help you calculate the area of each of the faces above. Also name each of the shapes you are working with?



Give each area in cm^2:

5. Now use the property Volume = Cross-section Area x length to calculate the volume of each of these 3 prisms giving your answer in cm^3?



Volume = Cross-section Area x length

6. Use some of your previous answers and what you have learned to help you write down a formula for the volume of each of the prisms you have been working with?

e.g. for a cylinder the area of cross section is $\mathbf{A = \pi r^2}$ where r is the radius. If the cylinder had a length l then the volume of the cylinder would be…

$$V = A \times l = \pi r^2\, l = \pi r^2\, l$$

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL

7. If 1litre = $1000cm^3$ what is the total capacity of the pool in litres?

The contractor needs to excavate some earth so he can set the pool structure into the space created. The diagram below gives an outline of the cross section of the excavation when complete.

It is important to get a good estimate of the volume of earth excavated. When the pool structure is put in place the space around it will need to be in-filled with concrete so it is necessary to know how much concrete to order.

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL

You will need to 'model' the excavation as a prism. In other words you will assume the cross-section shown above is constant along the entire length of the excavation so it can be considered a prism.

8. If you knew this cross-section area, which property of a prism would allow you to calculate the volume. Use a formula to answer this?

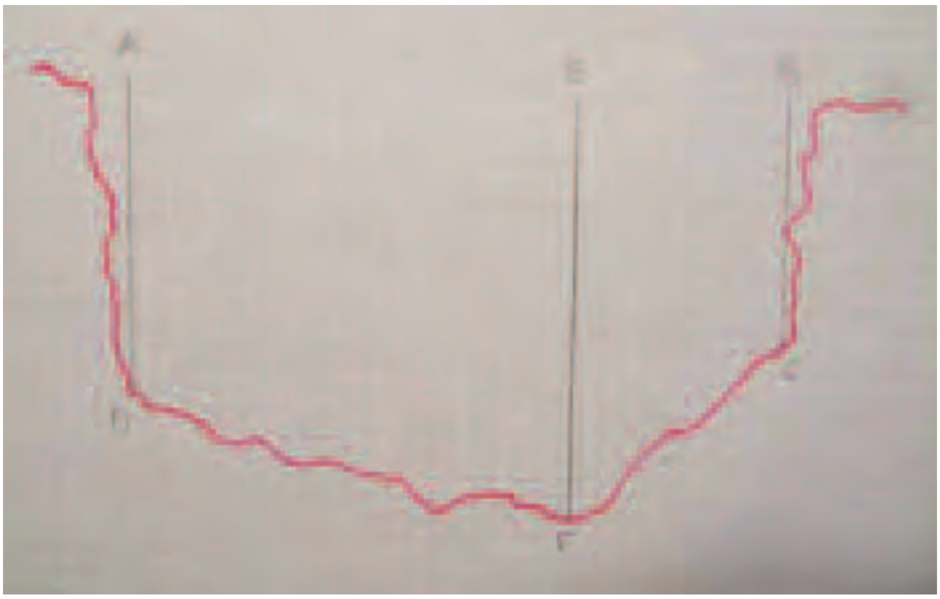
First, however, you need to calculate the cross-section area! As you can see the cross-section is an irregular area so you cannot calculate it exactly. Hopefully you will remember from a previous task Composite and Irregular Area that you can approximate this irregular area using a composite area. In the figure below you are shown where two depth measurements have been taken, one at each side of the excavation.

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL

9. Complete the drawing below to indicate which common shape you could use to approximate the cross-section area using only these two depth measurements and the width?

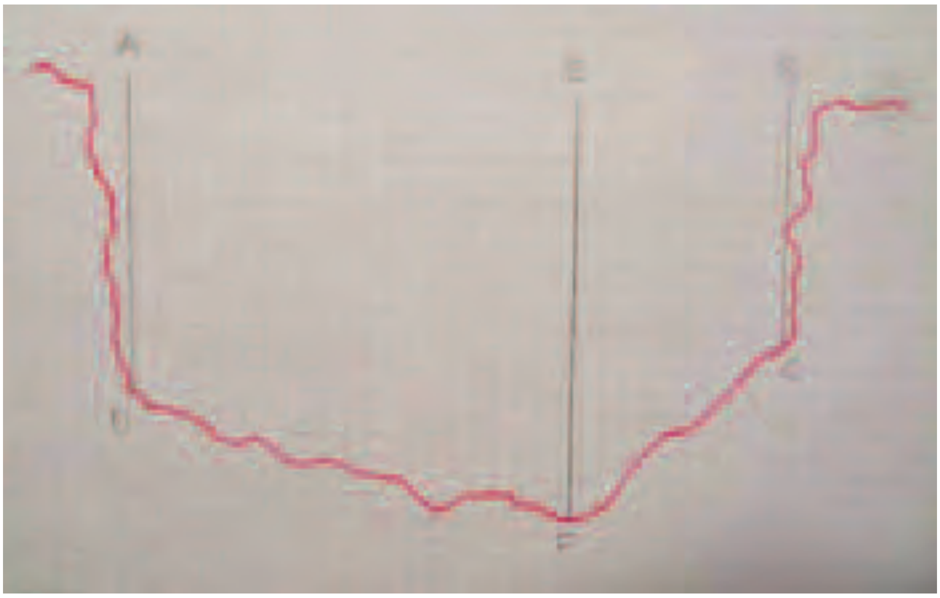
In the figure below you will see that an extra depth measurement has been taken at the deepest part of the excavation.



MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL

10. Now complete this diagram to indicate how you would approximate the cross-section area given this additional information?

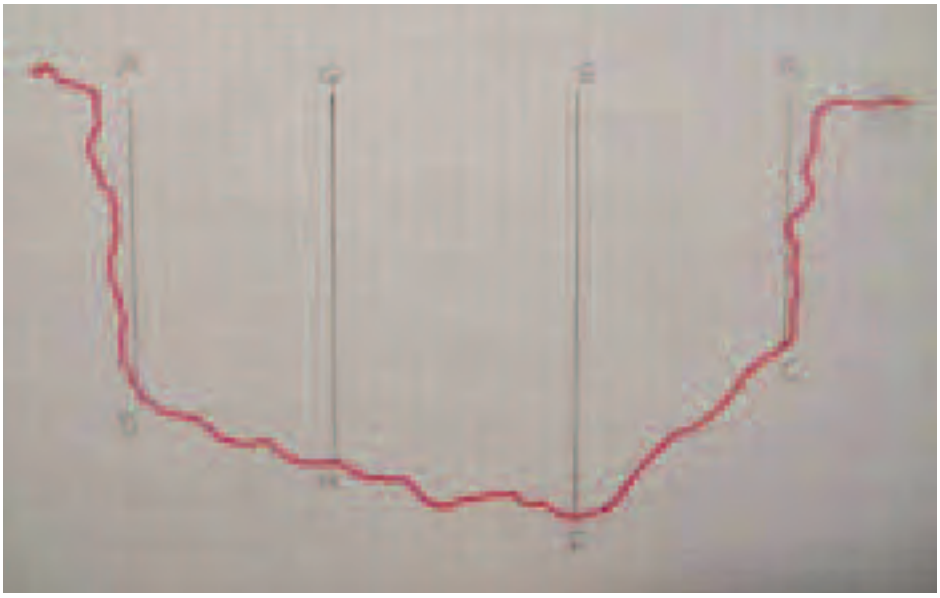


11. Which of the two approaches would give a more accurate answer to the cross-section area and why?

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL

Finally, in the diagram below you can see that four equally spaced depth measurements have been taken along the cross-section. The width of the excavation (distance AB in the diagram) is 8.1m. The depth measurements are from left to right: AD =2.65 m, GH =2.73 m, EF = 2.90m, BC = 2.44m.



12. Use these measurements and the formula given below to get an approximate answer to this area in m^2?

Off-sets (from left to right): 1st 2nd 3rd 4th

d = strip width (gap between off-sets) =

S = sum of all four off-sets, t = sum of first and last off-set

Area = d(2S-t)

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL

13. Use your answer for the cross-section area above together with what you know about prisms to estimate the volume of the excavation given it is 18m long?

Give your answer in m^3

14. How much concrete (m^3) will be needed to support the pool structure?

Use $1m^3$ = 1000 litres

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB ANSWERS

In construction time is money. It is important to manage your time effectively and when estimating the time to complete a job, to do so as accurately as possible. Calculations involving time must be accurate as you know there will be cost implications if the job is not completed on schedule and it will impact on the reputation of your company.

When you are costing a job, keeping to a schedule will be important to ensure that all trades are able to come to site and work on site productively.

Time

Units of time

Remember:

1 minute = 60 seconds
1 hour = 60 minutes
1 day = 24 hours
1 week = 7 days
1 year = 12 months
1 year = 52 weeks
1 year = 365 days (366 days in a leap year)
1 century = 100 years
1 millennium = 1000 years

Adding and subtracting time in hours, minutes and seconds.

It took a decorator 1 ¾ hours to paint a cupboard. 40 minutes of that time was spent sanding and preparing the wood in the cupboard. How long was actually spent in painting the cupboard?

To calculate this we need to change the times to the same units:

1 ¾ hours	**1 hour**	**¾ hour**	**60 minutes**	**45 minutes**	**105 minutes**

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB ANSWERS

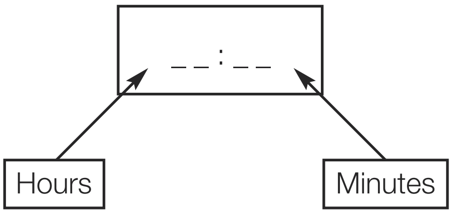
Now subtract the times:

105 minutes – 40 minutes = 65 minutes

So the time spent by the decorator actually painting the cupboard was 65 minutes = 1 hour 5 minutes

Reading times
Each day is split into two halves, am and pm.

24 hour clock is used in digital clocks, timers and timetables. The hours are numbered up to 24 instead of using am and pm, starting at 00:00 for midnight.
4 digits are used when writing times in 24 hour clock:



Example:

- twenty five minutes to two in the morning
- 1:35am is the time as 12 hour clock
- 01:35 is the time as 24 hour clock

- Quarter past four in the afternoon
- 4:15pm
- 16:15

- Add 12 hours to pm times.
- Subtract 12 hours to find the pm time.

Finding the difference between times

Example
If you start work at 08:15 and stop for lunch at 12:40, how long have you worked for?

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB ANSWERS

- Find the number of minutes to the next hour i.e.

  8:15 to 9:00 => **45 minutes**

- Then find the number of hours and minutes to the final time:

  9:00 to 12:40 => **3 hours and 40 minutes**

- Total the hours and the minutes separately:

  3 hours + 40 minutes + 45 minutes = 3 hours and 85 minutes = **4 hours and 25 minutes**

  85 minutes = 60 mins + 25 mins
  = 1 hour and 25 minutes

Painting a room

When it comes to painting a room there are a number of steps you will need to follow. For each step you must estimate the time required so you can schedule your time effectively.

In a recent job painter James Bloggs is working on a site in Castledawson. He has estimated the times it would take for him to paint a dining room.

STEP 1: Clear out the room to ensure you have clear space to work.
30 minutes

STEP 2: Prepare the ceiling and walls – fill and rub down.
1 ¾ hours

STEP 3: Remove / mask any hardware.
20 minutes

STEP 4: Clear away any dust from rubbing down walls and ceiling.
15 minutes

STEP 5: Paint ceiling
30 minutes

STEP 6: Paint walls
1 hour 45 minutes

STEP 7: Remove masking tape
10 minutes

1. James must be on site by ten to nine in the morning. Write this in 24 hour clock format.

08:50

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB ANSWERS

2. James has to get the bus from Drumahoe in order to get to work. The site he is working on is a ten minute walk from the bus stop in Castledawson. Using the timetable below work out what time he will need to catch the bus in Drumahoe in order to make it to work on time.

Londonderry - Belfast

Operator: Goldline (GLE)

▾ Monday - Friday | ▸ Saturday | ▸ Sunday | Return Journey

Special holiday timetable operates on: Christmas Day, Boxing Day
New Year's Day, St Patrick's Day, Easter, May Day, July Holidays. Please refer to Journey Planner.
U after a time means stops to pick up only. D after a time means stops to set down only.

Service:	212	212	212	212	212	212	212	212
Days of operation:	M-F	M-F	M-F	M-F	M-F	M-F	M-F	M-F
Calling points:								
Derry, (Foyle St Buscentre)	0520	0540	0600	0620	0640	0700	0720	0740
Altnagelvin Hospital, Bus stop	0525U	0545U	0605U	0625U	0645U	0705U	0725U	0745U
Drumahoe, Park + Ride	0527U	0547U	0607U	0627U	0647U	0707U	0727U	0747U
Dungiven, Express stop	0550	0610	0630	0650	0710	0730	0750	0810
Maghera (L'derry), Glenshane Rd	0605	0625	0645	0705	0725	0745	0805	0825
Castledawson, Park + Ride	0615	0635	0655	0715	0735	0755	0815	0835
Toomebridge, By-Pass	0625	0645	0705	0725	0745	0805	0825	0845
Belfast, King Street	0710D	0730D	0750D	0810D	0830D	0850D	0910D	0930D
Belfast, (Europa Buscentre)	0715	0735	0755	0815	0835	0855	0915	0935

Service:	212	212	212	212	212	212	212	212
Days of operation:	M-F	M-F	M-F	M-F	M-F	M-F	M-F	M-F
Calling points:								
Derry, (Foyle St Buscentre)	0800	0830	0900	0930	1000	1030	1100	1130
Altnagelvin Hospital, Bus stop	0805U	0835U	0905U	0935U	1005U	1035U	1105U	1135U
Drumahoe, Park + Ride	0807U	0837U	0907U	0937U	1007U	1037U	1107U	1137U
Dungiven, Express stop	0830	0900	0930	1000	1030	1100	1130	1200
Maghera (L'derry), Glenshane Rd	0845	0915	0945	1015	1045	1115	1145	1215
Castledawson, Park + Ride	0855	0925	0955	1025	1055	1125	1155	1225
Toomebridge, By-Pass	0905	0935	1005	1035	1105	1135	1205	1235
Belfast, King Street	0950D	1010D	1040D	1110D	1140D	1210D	1240D	1310D
Belfast, (Europa Buscentre)	0955	1015	1045	1115	1145	1215	1245	1315

James will need to get to Castledawson by 08:40 to allow for the ten minute walk to site. This means he will need to get the 07:47 bus from Drumahoe in order to make it to Castledawson by 08:40.

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB ANSWERS

3. If the bus is on time, what is the time in words that James will arrive at the Castledawson Park and ride?

08:35 is twenty-five minutes to nine in the morning.

4. How long would it take for the bus to get to Castledawson from Drumahoe?

07:47 to 08:35

07:47 13 minutes 08:00 35 minutes 08:35

Total time = 13mins + 35mins = 48 mins

5. As there can be delays in Dungiven, James thinks that it would be better to catch an earlier bus. He decides to get the 07:27 bus from Drumahoe. What time will he get to Castledawson if there are no delays?

08:15

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB ANSWERS

6. Following the steps that James has listed below to help find the time it will take to paint the dining room, work out the total estimated time for James to complete the room assuming he takes no breaks?

STEP 1: Clear out the room to ensure you have clear space to work.

30 minutes

STEP 2: Prepare the ceiling and walls – fill and rub down.

1 ¾ hours

STEP 3: Remove / mask any hardware.

20 minutes

STEP 4: Clear away any dust from rubbing down walls and ceiling.

15 minutes

STEP 5: Paint ceiling

30 minutes

STEP 6: Paint walls

1 hour 45 minutes

STEP 7: Remove masking tape

10 minutes

Ensure all times are in the same units.

30mins + 105mins + 20mins + 15mins + 30mins +105mins +10mins = 315 mins

60 minutes = 1 hour
300 minutes = 5 hours

Hence: 315 minutes = 5 hours and 15 minutes

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB ANSWERS

7. If James was to work without breaks, what time would he finish the job?

James starts at 8:40am and works 5 hours and 15 mins

8:40 + 5 hours 13:40 + 15 mins 13:55

James should finish at five minutes to two in the afternoon
or 13:55 or 1:55pm

**8. James takes a 15 minute break in the morning and 40 minute break for lunch.
How long it will be before he completes painting the room including his breaks?**

5 hours 15 minutes to complete room + 15 min break + 40 min lunch

= 5 hours + (15 + 15 + 40 minutes)

= 5 hours + 70 minutes

= 5 hours + 1 hour + 10 minutes

6 hours 10 minutes

9. What time will he finish the job, taking into account the breaks he has?

8:40 +6 hours 14:40 +10 mins 14:50

James should finish at ten minutes to three in the afternoon
or 14:50 or 2:50pm

MEASURE, SHAPE AND SPACE

TASK 1 - COSTING A JOB ANSWERS

10. The foreman on the site records when the site operatives arrive and leave at the start and end of the day. The times are recorded below:

Using the times he has recorded work out how long each operative has worked that day – assume each has had breaks totalling 45mins.

Employee	Start Time	End Time	Working time
Peter Johnston	08:35	16:20	08:35 -> 09:00 => 25 mins 09:00 -> 16:20 => 7 hours 20 mins 7 hours 20 mins + 25 mins = 7 hours 45 mins **Subtract breaks 45 mins** 7 hours 45 mins – 45 mins = **7 hours**
Gerry Quigg	08:30	Twenty-five to five in the afternoon	08:30 -> 09:00 => 30 mins 09:00 -> 16:35 => 7 hours 35 mins 7 hours 35 mins + 30 mins = 7 hours 65 mins **Subtract breaks 45 mins** 7 hours 65 mins – 45 mins **= 7 hours 20 mins**
Marie Tosh	08:50	Quarter to five in the afternoon	08:50 -> 09:00 => 10 mins 09:00 -> 16:45 => 7 hours 45 mins 7 hours 45 mins + 10 mins = 7 hours 55 mins **Subtract breaks 45 mins** 7 hours 55 mins – 45 mins = **7 hours 10 mins**
Peter Curran	8:45	5:00pm	08:45 -> 09:00 => 15 mins 09:00 -> 17:00 => 8 hours 8 hours + 15 mins = 8 hours 15 mins **Subtract breaks 45 mins** 8 hours 15 mins – 45 mins = 8 hours 15 mins – 15 – 30 = 8hours -30mins **= 7 ½ hours**
Jonny Slade	08:15	16:30	08:15 -> 09:00 => 45 mins 09:00 -> 16:30 => 7 hours 30 mins 7 hours 30 mins + 45 mins = 7 hours 75 mins **Subtract breaks 45 mins** 7 hours 75 mins – 45 mins **= 7 hours 30 mins**

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA ANSWERS

In construction you often have to work with area so you need to understand the basic concepts and be familiar with a variety of methods of determining area. In this task we will focus on some important basics.

Some construction workers were asked to define area, here are two replies,

James: "Area is an amount of space"

Michael: "Area is an amount of surface"

1. Which of these would you accept as the better definition of area? Why?

Michael's is better because surface is 2-D (2-dimensional) whereas space is 3-D and cannot be used to describe area.

2. Here is a selection of units used to measure physical quantities. Circle the units you think could be used to represent area?

litres	**pints**	**acres**	**sq. yards**
metres	**mm^2**	**mm^3**	**cubic feet**
m^2	**gallons**	**sq. inch**	**degrees**
hectareskm^2	**yards**	**cm^2**	**kg**
cm			

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA ANSWERS

3. Have the units you selected anything in common? And were there any exceptions?

All involve something "squared" in the name.
Exceptions are acres and hectares.

4. Use the space below to define any units you considered exceptions?

Acre and hectare are both measures of area, generally used for land.

An acre is an area equal to 4,046.86 m^2.

An acre was originally understood as land sized at one furlong (660 ft) long and one chain (66 ft) wide; this may have also been considered the amount of land a man and one ox could plough in one day. As a unit of measure an acre has no prescribed shape; any perimeter enclosing 43,560 square feet is an acre in size.

A hectare is an area of 10000m^2.

You will have noticed by now that area is always measured in 'squares'. You should use a suitable square object (called a template or unit square) to measure the area of something in the classroom. For instance you could cut out a square piece of card and use it to measure the area of your desk or a table.

5. In the space below give a brief description of how you went about actually measuring the area with your square template?

I cut out two templates so I could carefully set them side by side and move one at a time as I placed them like tiles to cover the desk working from side to side in rows.

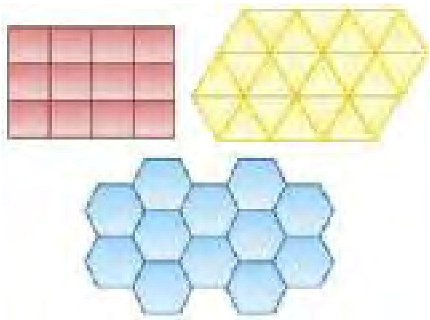
To begin with I just counted the number of complete templates needed to cover the desk. This gave me an approximate answer as there was some area left over at the end of each row which was smaller than the template.

Then for the "left over" area in each row I estimated what fraction this was of my template and recorded it (I used the fractions ¼,1/3, ½, 2/3, 3/4). At the end I added up the number of whole and fraction templates required to cover the desk to get a more accurate answer.

MEASURE, SHAPE AND SPACE

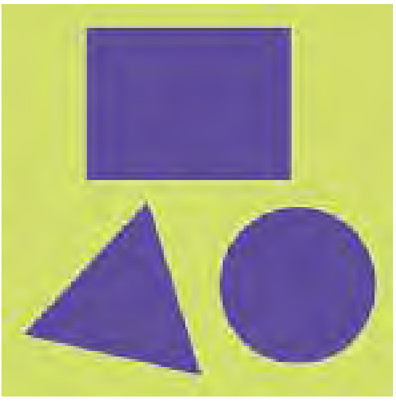
TASK 2 - KNOW YOUR AREA ANSWERS

6. By considering the picture below give one property that any template used to measure area must have?



It must tessellate!

7. Based on your answer to the previous question which of the following common shapes could not be used to measure area? Choose only one and write its name in the space provide.?



Circle

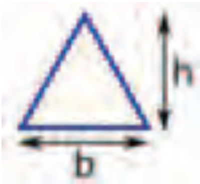
As all rectangles and all triangles tessellate we could use either of these shapes as templates to measure area. However, the square has a clear advantage!

For instance, once someone decides on the ‘size’ of template to be used use to measure an area (e.g. to measure the area of something approximately the size of an A4 page you might choose a template approximately the size of a postage stamp)there is only one possible square of that ‘size’ but there could be lots of different rectangles and triangles the same ‘size’ but different shapes – this could be confusing. Thus to keep things simple area is always measured in squares!

If you want to determine an area which is in the form of a simple shape then there are some formulae which can be used to speed the calculation up. Here is a selection of simple shapes which often appear in construction and it is important you are familiar with finding the areas of these shapes and using the formulae provided. In the following few examples it is assumed you are familiar with length and perimeter.

MEASURE, SHAPE AND SPACE

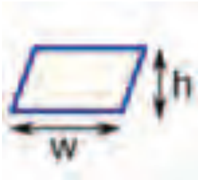
TASK 2 - KNOW YOUR AREA ANSWERS



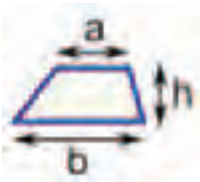
Triangle
Area = ½ b × h
b = base
h = vertical height

Square
Area = a^2
a = length of side

Rectangle
Area = w × h
w = width
h = height



Parallelogram
Area = w × h
w = width
h = height



Trapezium
Area = ½(a+b) × h
h = vertical height

Circle
Area = πr^2
Circumference=$2\pi r$
r = radius

8. Using the appropriate formula above determine the area of a square whose side is 1.2m long?

Area = a^2 = a x a = 1.2 x 1.2 = 1.44m^2

9. Find the area of a triangle whose base is 2.3m and height is 1.8m?

Area = ½ b x h = 0.5 x b x h = 0.5 x 2.3 x 1.8 = 0.5 x 1.8 x 2.3 = 0.9 x 2.3 = 2.07m^2

MEASURE, SHAPE AND SPACE

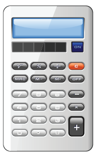
TASK 2 - KNOW YOUR AREA ANSWERS

10. Would it be possible to have a square whose perimeter is 16m and whose area is 20m²? Use a sketch and formula to help explain your answer.

Perimeter = 4a which means 16 = 4a, which means a = 4

therefore area cannot be $20m^2$.

11. Determine the area of a circle whose diameter is 4.2cm? Take π = 3.14 and give your answer to 1 decimal place.



Area = $\pi r^2 = \pi \times r \times r$ = 3.14 x 2.1 x 2.1 = 13.8474 = 13.8 m^2 (to 1 decimal place)

12. Would it be possible to determine the area of a rectangle if the only information you had was the perimeter? Explain your answer.

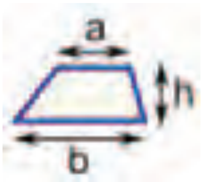
No, because knowing the perimeter only allows you to find out what the sides add up to and not what each sides actually is. You need to know each side to work out the area.

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA ANSWERS

We will take a look at one of the shapes above in a little more detail as it is used surprisingly often in construction where determining area is concerned.

13. Use the space below to provide a definition of the shape in question. Include the words quadrilateral and parallel in your answer and try to make it as simple as you can.



A quadrilateral with one pair of parallel sides

At a glance the trapezium probably does not appear very useful because it is not a regular shape like a square or rectangle. However it is very useful when determining composite and irregular areas in construction. We will consider the formula for the area of a trapezium and where it comes from. It will be useful to understand the term perpendicular distance in what follows.

14. Use the space below to make a note of what this means? You may find it helpful to include a sketch in your answer.

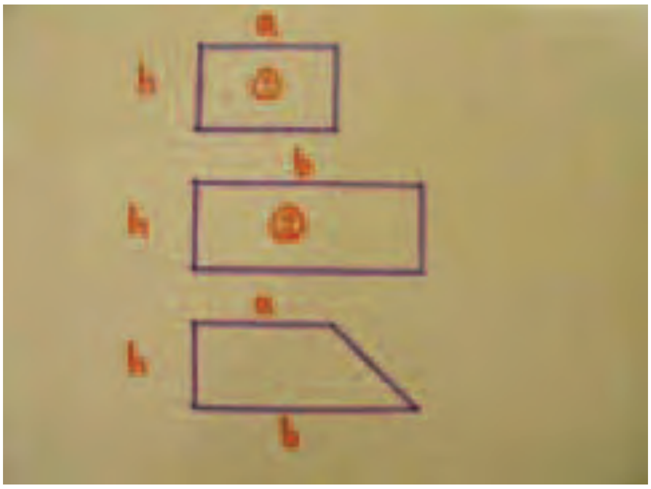
Perpendicular distance…

Perpendicular distance means the shortest distance!

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA ANSWERS

Consider the following diagram



You will hopefully be able to see that the trapezium is something of a compromise between two rectangles and that its area will be 'in between' the area of the two rectangles shown. In fact you will soon be able to show that the area of the trapezium is the mean of the area of two rectangles.

15. Write down a formula for the area of Rectangle 1?

Area = h x a = ha = ah (in formulae we often put variables in alphabetical order if we can)

16. Write down a formula for the area of Rectangle 2?

Area = h x b = hb = bh

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA ANSWERS

17. Now choose a formula (or formulae) which would allow you to find the mean area of these two rectangles?

(a) Area = (ah + bh)/2	**(b) Area = ah + bh/2**	**(c) Area = 0.5(ah + bh)**

18. In the space below show that both formulae shown will give the same answer? Use a =2, b= 3, h = 4. Don't worry about units in this question but show any working out!

Area = 0.5(ah+bh)

Area = 0.5(2x4 + 3x4) = 0.5(8 + 12) = 0.5 x 20 = 10

Area = 0.5h(a+b)

Area = 0.5x4(2 + 3) = 0.5 x4 x 5 = 0.5 x 20 = 10

The area of a trapezium is often described as being

"half the sum of the parallel sides, times the perpendicular distance between them".

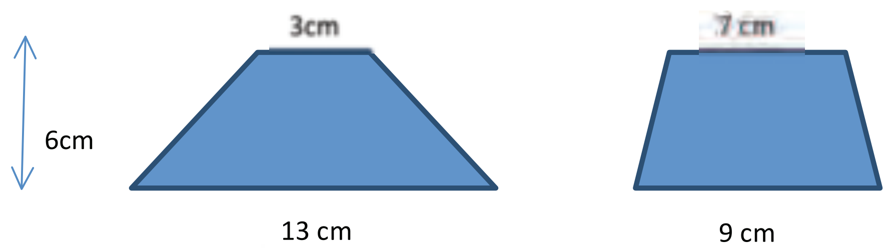
19. Even though both formulae in the previous question mean the same thing, which of the two do you think would be worded in this way?

Area = 0.5h (a+b)

MEASURE, SHAPE AND SPACE

TASK 2 - KNOW YOUR AREA ANSWERS

20. Without doing any calculation what can you say about the area of the following trapezia and why?



Comment:

parallel sides have the same mean length and perpendicular distance is the same for both trapezia therefore the area will be the same.

MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY ANSWERS

In construction you often have to work with volume and capacity so you need to understand the basic concepts and be very familiar with calculating quantities. In this task we will focus on some important examples.

To begin with we will consider what is meant by volume and capacity. These terms are sometimes used to refer to the same thing but they are not exactly the same.

When we use the terms volume and capacity we are referring to an amount of space – that is what these terms have in common. How they differ is in the way we think of the space.

“Volume is the amount of space occupied by an object”

e.g. how much space a solid object such as a brick takes up.

“Capacity is the amount of space contained by an object”

e.g. how much space there is inside a container.

MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY ANSWERS

This is why we tend to use capacity when referring to vessels (tanks, bottles, jars, swimming pools, dams, reservoirs, etc) which are normally designed to contain liquids or gases. We tend to use volume when we think of solid objects such as bricks, blocks, beams, concrete, rock, etc.

Sometimes, however, we may refer to both the volume and capacity of an object. For example look at this picture of a sand hopper.

We could ask questions such as **"What is the capacity of this hopper?"** or **"What is the volume of this hopper?"** What are we actually trying to find out with each of these questions?

1. For each of the statements below put circle around V or C to indicate whether Volume or Capacity is being referred to?You will find that you cannot do that for one of the statements so please circle both V and C on that occasion and explain why you had to in the space below.

a) The amount of sand the hopper can hold	V	C
b) The amount of metal used to make the hopper	V	C
c) The increase in water level if the hopper was fully immersed in water with the lid and exit valve shut (assume it is water tight)	V	C
d) The amount of water it would take to fill the hopper	V	C
e) The increase in water level if the empty hopper was fully immersed in water with its lid open	V	C

Which statement could you not circle V or C for and why?

Statement C The increase in water level will correspond to volume + capacity!

MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY ANSWERS

2. Here is a selection of units used to represent physical quantities. Circle the units you feel could be used to measure volume or capacity?

Litres	pints	sq. inches
metres	mm^2	cm^2
m^3	gallons	sq. mile
hectares	yards	cubic inches
km^2	acres	degrees
cm	mm^3	kg

3. Draw a line to link the picture of the object with the correct formula for its volume?

$V = l^3$	**$V = lwd$**	**$V = \pi r^2 h$**

MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY ANSWERS

4. In the space below evaluate each of these formulae using the measurements given and name the shape to which that formula applies? State your answers in appropriate units.

$V = l^3$ ($l = 1.6$m)

1.6 x 1.6 x 1.6 = 4.096m^3 (CUBE)

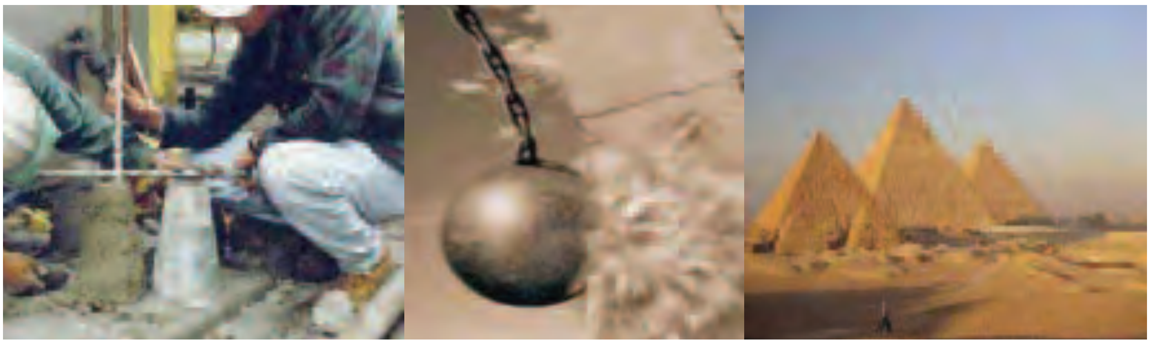
$V = lwd$ (l=258mm,w=65mm,h=110mm)

258 x 65 x 110 = 1844700mm^3 (CUBOID)

$V = \pi r^2 h$ (π=3.14,d=14.5cm,h=5.2m)

3.14 x 7.25 x 7.25 x 520 = 85824.05 (round to 85,824cm^3,approx 86 litres) (CYLINDER)

The shapes you have just named have an important property in common and this will prove useful later in this task. To help you decide what this property is look at the pictures below of some solid objects which don't have this property!



5. What is the property?

Hint: If you cannot see the answer from the pictures think of the word cross-section.

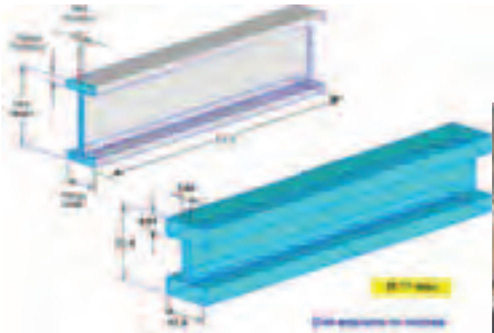
The earlier shapes are all examples of prisms: which are 3-D objects with a constant cross-section.

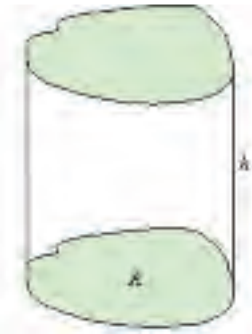
MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY ANSWERS

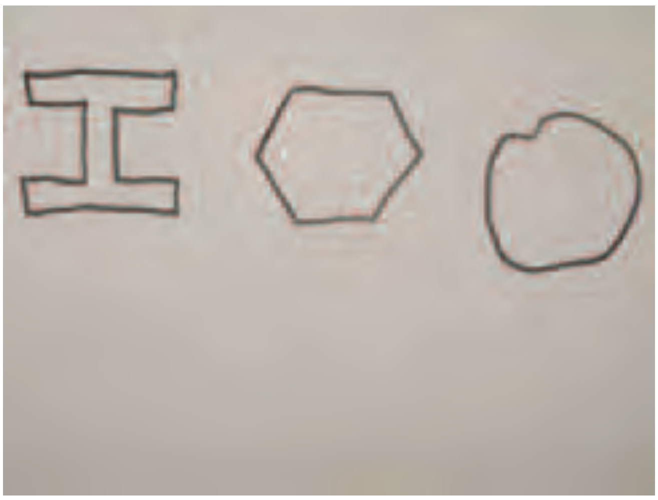
From your previous answer you will now be aware of a family of 3-D objects called prisms. All prisms have something in common and this is what you have just found out – they have a constant cross-section. The main advantage of being able to identify an object as a prism is that it can provide a convenient way to determine a volume or a capacity.

Indeed sometimes the information available will be such that using the prism property of an object will be the only way you can calculate (or estimate) a volume or capacity. Even though all prisms have a common property they can look very different indeed. Here are some examples of objects which at first glance may not appear to be prisms





6. For each of the objects above identify which face represents the constant cross-section and draw it in the space below? A free hand sketch will be fine!



MEASURE, SHAPE AND SPACE

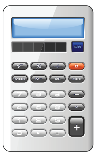
TASK 3 - VOLUME AND CAPACITY ANSWERS

If you need to calculate an amount of space in the form of a prism you first need to identify the face that is the common cross-section. Then you can work out the volume or capacity using the formula

Volume (or Capacity) = Cross-section Area x Length

Here are a couple of examples for you to try!

7. The picture below shows some hydraulic hose. The larger gauge hose has an outer diameter of 54mm and a wall thickness of 10.5mm. Calculate the capacity (in litres) of a 1 metre length of this hose. In other words how much hydraulic fluid could this hose hold per metre?



Hints:
- identify the 3-D shape of the fluid-filled part of the hose and find its cross-section.
- Find volume using V = cross-section area x length
- Work in cm for all lengths as you can most easily give your answer in litres (1 litre = 1000 cm^3)

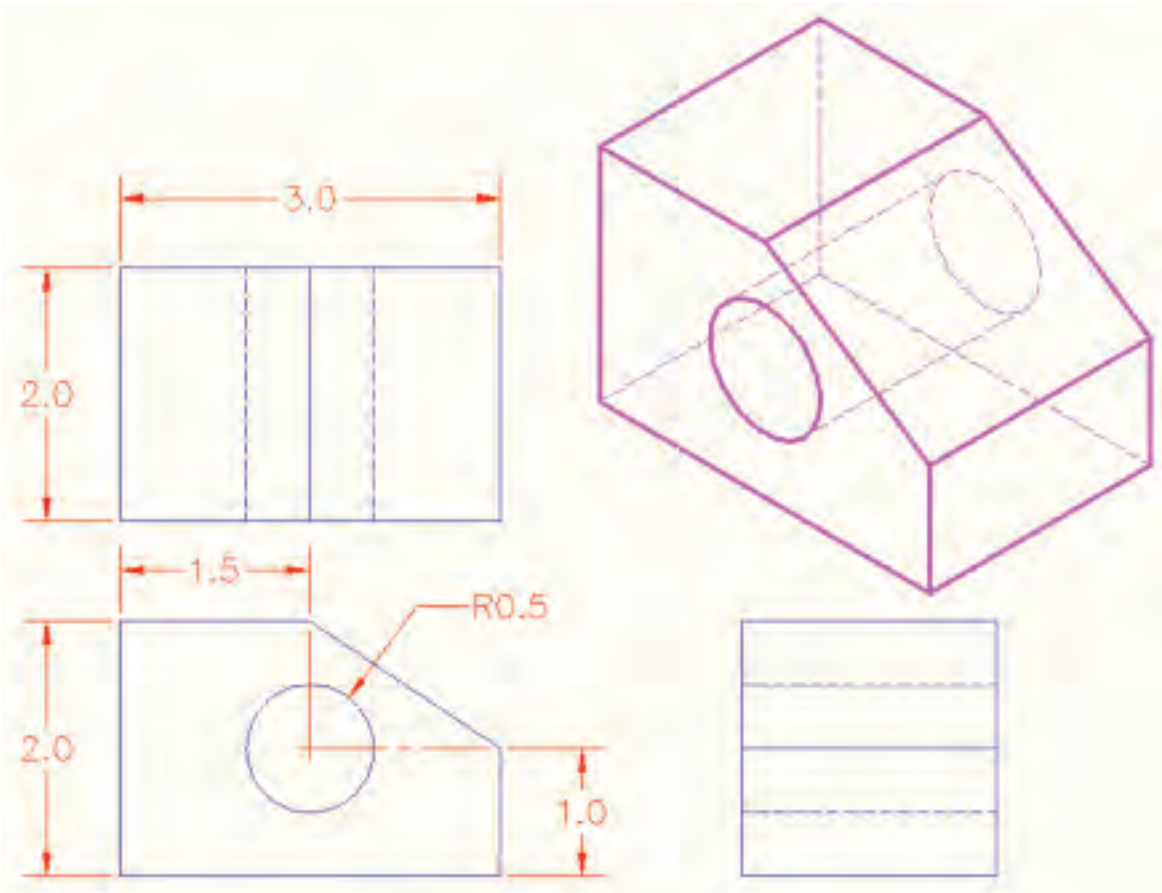
Cross- section area, A = 3.14 x $(0.5 \times 3.3)^2$ = 8.55cm^2.

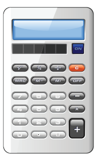
Capacity = A x length = 8.55 x 100 = 855cm^3 = 0.855 litres.

MEASURE, SHAPE AND SPACE

TASK 3 - VOLUME AND CAPACITY ANSWERS

8. The drawing below shows some views of a spacer component designed to fit between two corner sections in a portal frame. Use what you have learned in this task to find the volume (in cm^3) of steel material used in the manufacture of one of these spacers. Measurements are given in cm.





Hint: when calculating the cross-section area it may be helpful to think of a rectangle with a triangle and a circle removed! Use π = 3.14.

Cross section area, A = rectangle – triangle – circle

= (2.0 x 3.0) – (0.5 x 1.5 x 1.0) – (3.14 x 0.5^2) = 4.465cm^2

Volume = A x length = 4.465 x 2.0 = 8.93cm^3

MEASURE, SHAPE AND SPACE

TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE ANSWERS

Many trades associated with the construction industry rely on accurate measurements being taken. Where inaccuracies occur this may lead to loss in profit, time or even compromise safety on site. Working on site you need to be able to use different units of measurement and be able to choose the appropriate unit for the job you are doing.

Normally on site you work with metric units such as millimetres and metres. You have probably also come across imperial units of measurement such as feet, inches and gallons on site.

In Northern Ireland road distances are measured in miles. You should be aware that:

Metric Units

	Abbreviation	Full Name	Equivalent
Measurement of length	mm	millimetre	10 mm = 1 cm 1 000 mm = 1 m
	cm	centimetre	100 cm = 1 m
	m	metre	1 000 m = 1 km
	km	kilometre	1 000 m = 1 km
Measurement of weight	g	gram	1000g = 1kg
	kg	kilogram	1kg = 1000g
	t	tonne	1t = 1000kg
Measurement of capacity	ml	millilitre	1l = 1000ml
	l	litre	1l = 1000ml

MEASURE, SHAPE AND SPACE

TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE ANSWERS

Spindles on a staircase must be less than 100mm to meet building regulations.
100mm is 0.1m. This is found by:

There are two methods you could use:

Use 1000mm = 1m

100mm ÷ 1000 = 0.1m

Use 10mm = 1cm

100mm ÷ 10 = 10cm

Use 100cm = 1m

10 ÷ 100 = 0.1m

Imperial Units

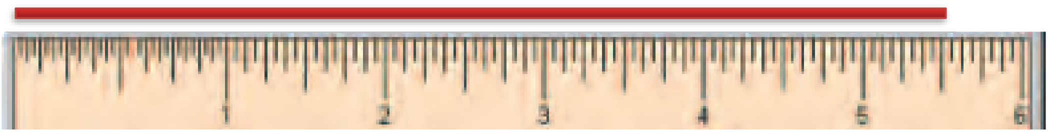
Some tools you come across on site have metric and imperial measurements marked.

	Abbreviation	Full Name	Equivalent
Measurement of length	in	inches	1 foot = 12 inches
	ft	feet	
	yd	yard	1 yd = 3 ft
	mile	mile	1 mile = 1760 yds
Measurement of weight	oz	ounce	1lb = 16 ounces
	lb	pound	
	st	stone	1st = 14 lbs
Measurement of capacity	pt	pint	1gal = 8 pts
	gal	gallon	

MEASURE, SHAPE AND SPACE

TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE ANSWERS

For example a tape measure will have inches as well as centimetres marked.
The length of the line below is 5 ½ inches.



Usually you will find that the rule has each inch divided into 16 parts called $\frac{1}{16}$ ths.

1 inch is approximately 2 ½ centimetres. This should help you if you need to convert from inches to centimetres.

Screws and nails are sometimes measured in inches.

You may also have come across 4 by 2 stud work.
This describes stud work that is 4 inches wide by 2 inches thick.

Converting imperial lengths use:

12 inches = 1 foot	**3 feet = 1 yard**	**1760 yards = 1 mile**
1 gallon = 8 pints	**1 stone = 14 pounds**	**1 pound = 16 ounces**

MEASURE, SHAPE AND SPACE

TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE ANSWERS

1. If a gorilla tub holds 10 gallons, how many pints is this?

1 gallon = 8 pints

10 x 8 = 80 pints

Converting between metric and imperial lengths use:

1 inch ≈ 25 mm

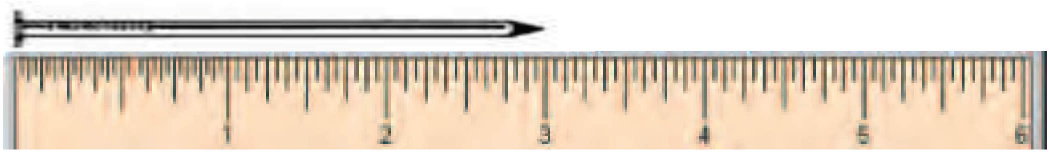
1 foot ≈ 300 mm

≈ means approx. equally to

1 gallon ≈ 4.55 litres

5 miles ≈ 8 km

2. What is the length of the nail below?



3 inches

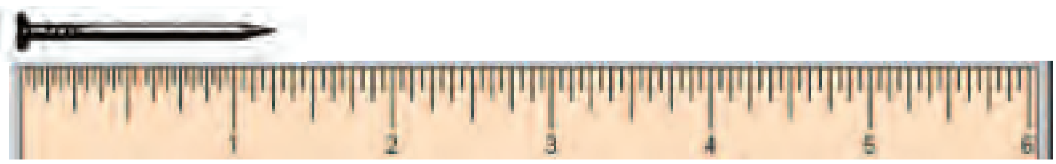
3. Using **1 inch ≈ 25 mm** **calculate the length of the nail in question 2?**

3 x 25 = 75 mm

MEASURE, SHAPE AND SPACE

TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE ANSWERS

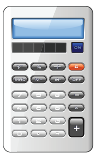
4. What is the length of the nail below?



1 ¼ inches

5. Use a calculator to calculate the length of the nail in question 4 in mm.

Remember: 1 inch ≈ 25 mm



1 ¼ inches = 1.25 inches

$1.25 \times 25 = 31.25$ mm

6. Peter works in Belfast but lives in Limavady. The distance from Limavady to Belfast is 65 miles. What is this distance in km?

5 miles ≈ 8 km

$65 \div 5 \times 8 = 104$ km

MEASURE, SHAPE AND SPACE

TASK 4 - CONVERTING BETWEEN UNITS OF MEASURE ANSWERS

7. Peter has worked out that in 1 round trip to work he used approximately 15 litres of diesel. To work out how many miles per gallon he is getting from his car Peter needs to convert the number of litres of fuel to gallons. How many gallons is this?

1 gallon ≈ 4.55 litres

15 ÷ 4.55 litres = 3.2967… gallons

This is approximately 3.30 gallons

8. Using the answer to question 7, calculate the miles per gallon that Peter's car is achieving.

1 round trip = 2 × 65 miles = 130 miles

130 ÷ 3.30 = 39.39…miles per gallon

9. Peter knows that at the weekend when he is making shorter trips he is only achieving 35mpg (miles per gallon). Over 1 month he would do around 300 miles in total at the weekend. How many litres of fuel would this use?

1 gallon ≈ 4.55 litres

300 ÷ 35 = 8.5714… gallons

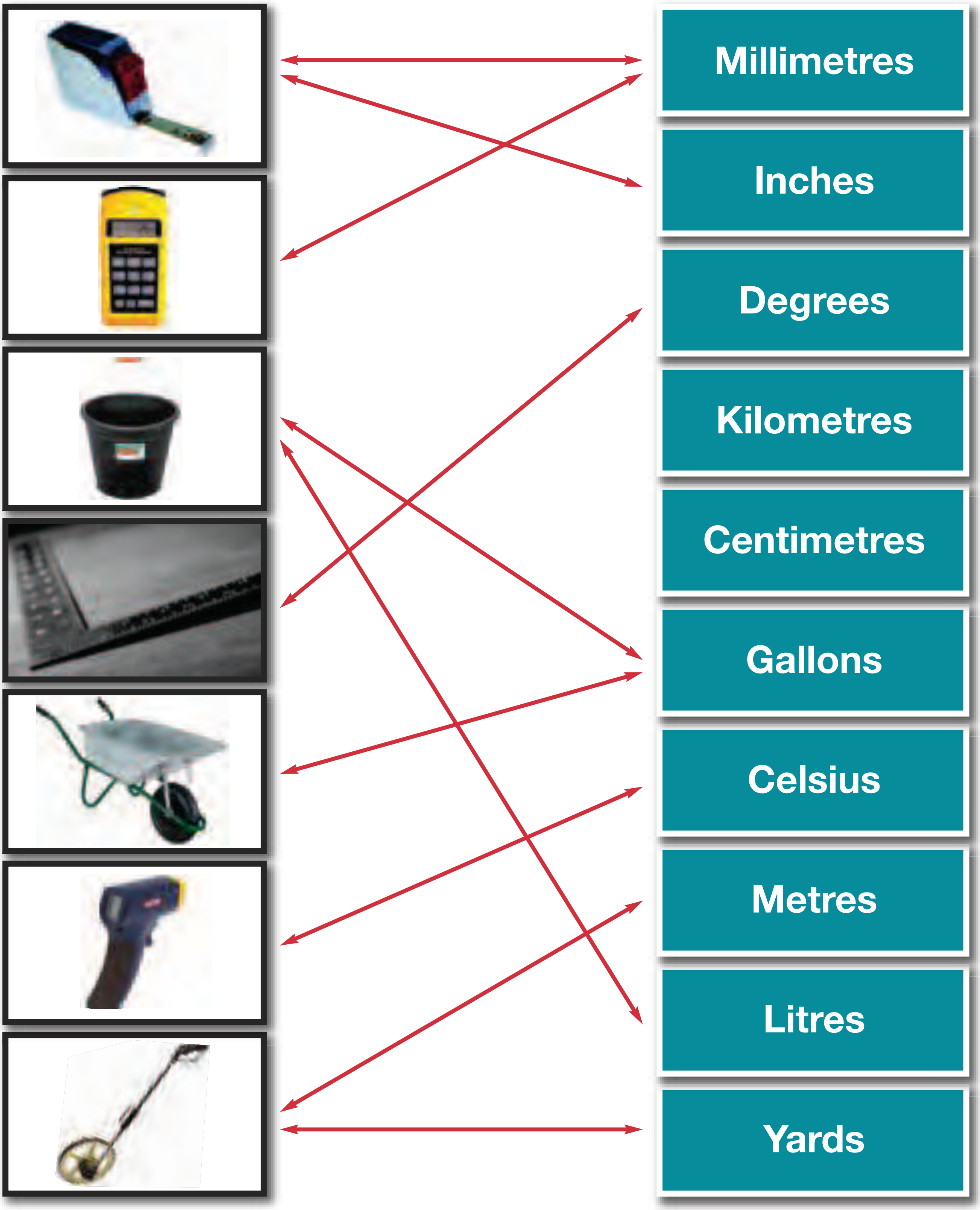
8.5714 × 4.55 = 39 litres

MEASURE, SHAPE AND SPACE

TASK 5 - COMMON MEASUREMENT INSTRUMENTS ANSWERS

On site you will measure using various instruments.

1. Consider what each of these devices measure and match them to the associated units.



MEASURE, SHAPE AND SPACE

TASK 5 - COMMON MEASUREMENT INSTRUMENTS ANSWERS

2. In construction we mainly use metric units for measuring. Where have you come across the metric and imperial units below at work? Fill in examples of where you have come across that unit in work. Some suggested answers below:

Units	Used in
Millimetres	Site plans, widths and depths of joists…
Inches	**Wood, nails…**
Degrees	**Slope of a roof…**
Kilometres	**Road construction…**
Centimetres	**Tape measure**
Gallons	**Equipment fuel**
Celsius	**Heat loss calculations**
Metres	**Slope of a roof…**
Litres	**Drainage pipe**
Yards	**Water storage tank**

MEASURE, SHAPE AND SPACE

TASK 5 - COMMON MEASUREMENT INSTRUMENTS ANSWERS

3. Match each item with a likely measurement:

Safety lanyard and scafford hook

CO_2 Extinguisher

Water Extinguisher

85 litres

1.75 m

4 m

20 litres

9 litres

365 metres

10 gallons

2 kg

1 tonne

MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS ANSWERS

Drawings are an important part of construction work. Understanding how drawings provide each trade with the necessary information to do their job is an important skill. The scale on the plan tells you the relationship between the lengths on the plan and the real distances.

Example:

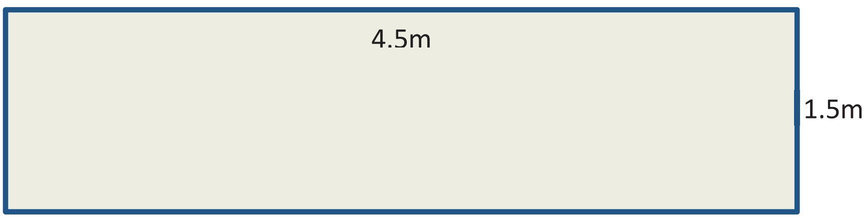
Below is a sketch of a hallway drawn to a scale of 1:50. When you measure the room below you should find that it is 90mm by 30mm. Check and see this is correct.

The scale 1:50 means that every 1 unit on the plan represents 50 units in real life i.e. for a scale of 1:50 the real distance is 50 times the length of 1 unit on the map or drawing.

To work out the actual dimensions of the hallway we need to use the scale and the measurements on the plan as shown:

1:50 means that the actual dimensions are 50 times the size of the measurements on the plan.

Measurement on the plan	Scale	Actual measurement
90mm 30mm	1:50 1:50	90 ×50 = 4500mm = 4.5m 30 ×50 =1500mm = 1.5m



MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS ANSWERS

1. The cards below contain a mixture of units. Cut out the cards and match each scale card with a measurement on plan card and an actual measurement card. The way they are currently matched is incorrect.

For example: A measurement on a plan of 20mm matches with a scale of 1:25 to give an actual measurement of 500mm = 0.5m

Measurement on plan	Scale	Actual Measurement
2mm	1:2	0.3m
10mm	1:5	100mm
60mm	1:10	60m
3000mm	1:20	3m
10mm	1:50	1m
60mm	1:100	600mm
300mm	1:5000	10mm

MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS ANSWERS

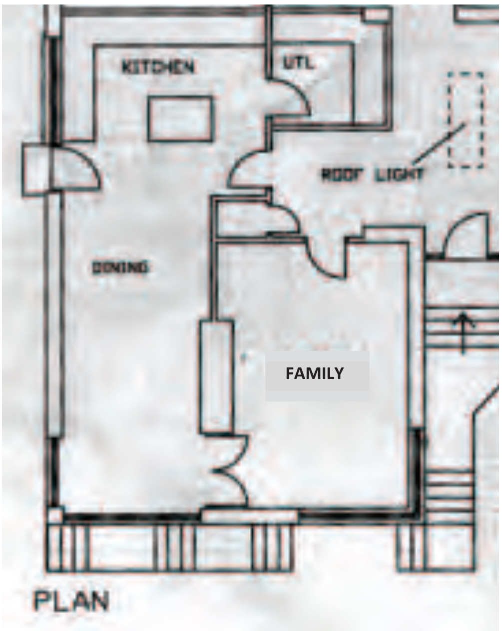
The answer should be:

Measurement on plan	Scale	Actual Measurement
300mm	1:2	600mm
60mm	1:5	0.3m
10mm	1:10	100mm
3000mm	1:20	60m
60mm	1:50	3m
10mm	1:100	1m
2mm	1:5000	10mm

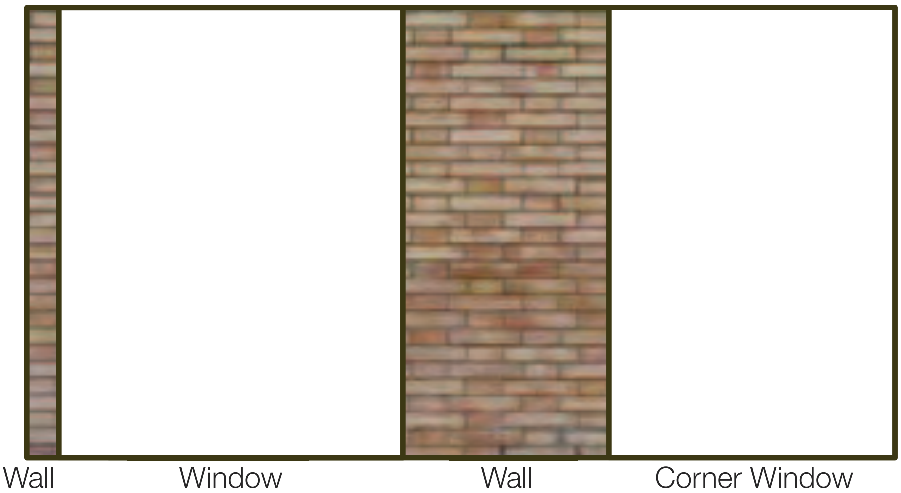
MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS ANSWERS

2. Using the plan below, what would the front elevation of the house look like?



View from front

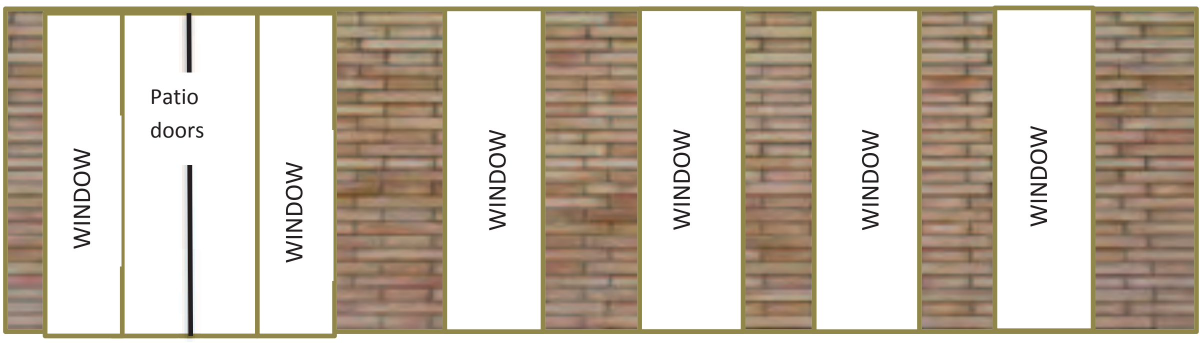


MEASURE, SHAPE AND SPACE

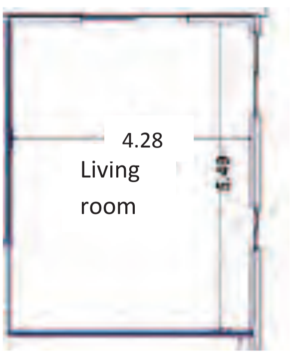
TASK 6 - WORKING WITH PLANS ANSWERS

3. Sketch the elevation of the house from the view shown.

View from this point



**4. The plan of a living room shows the room dimensions in metres.
Usually measurements on a plan are given in mm. Convert the lengths to millimetres.**



Multiply each length by 1000

4280mm by 5490mm

MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS ANSWERS

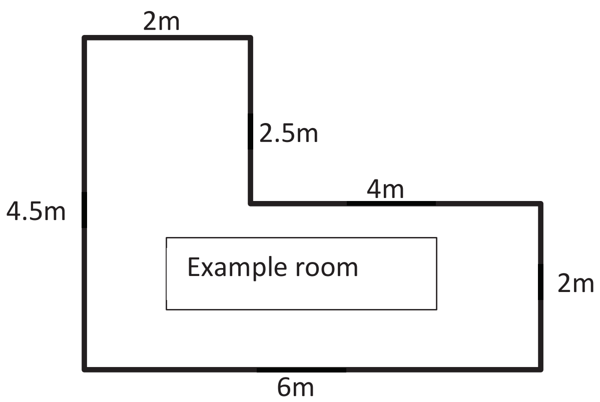
Remember:

PERIMETER

The distance around a shape is the perimeter.

- Make sure you have all the side measurements
- Make sure all units are the same

Example: the room below has a perimeter of:



2 + 2.5 + 4 + 2 + 6 + 4.5 = 21m

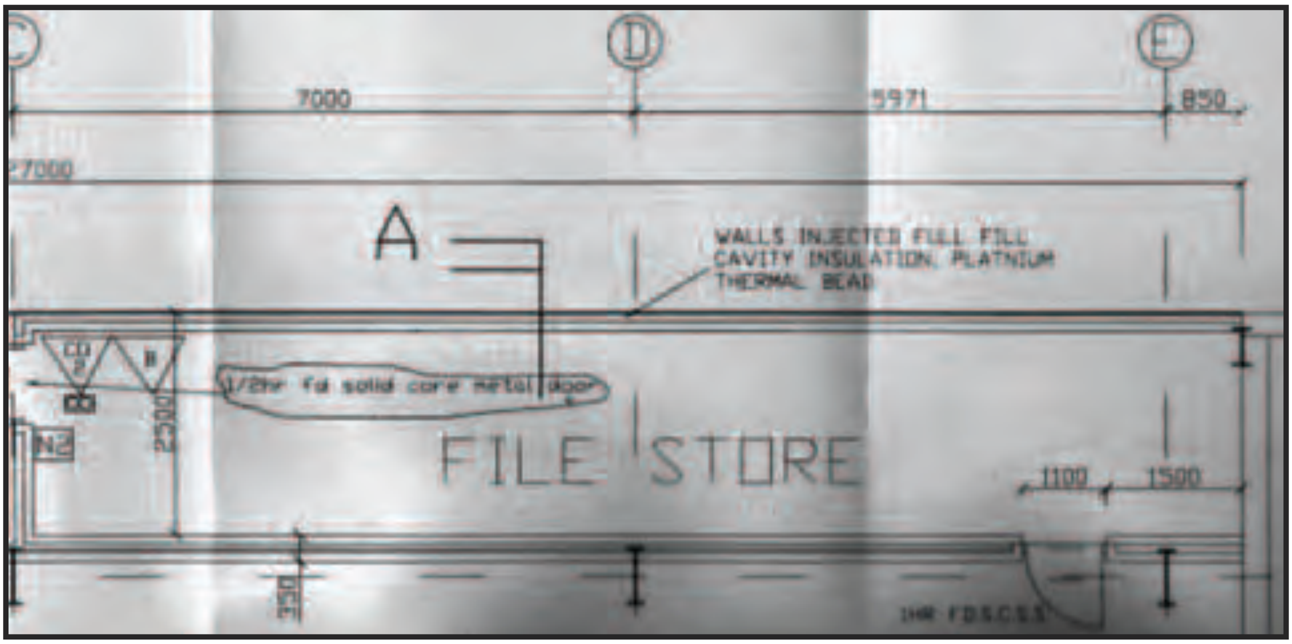
5. A builder wants to work out how much coving is needed to go round the room in question 4.

4280mm + 5490mm + 4280mm + 5490mm = 19 540mm

MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS ANSWERS

6. The floor of the file store shown in the plan needs to be tiled. What is the area of the floor in metres squared?



Remember area

length

Area = length × width

width

Length = 7000mm + 5971mm + 850mm = 13821mm

13821 ÷ 1000 = 13.821m

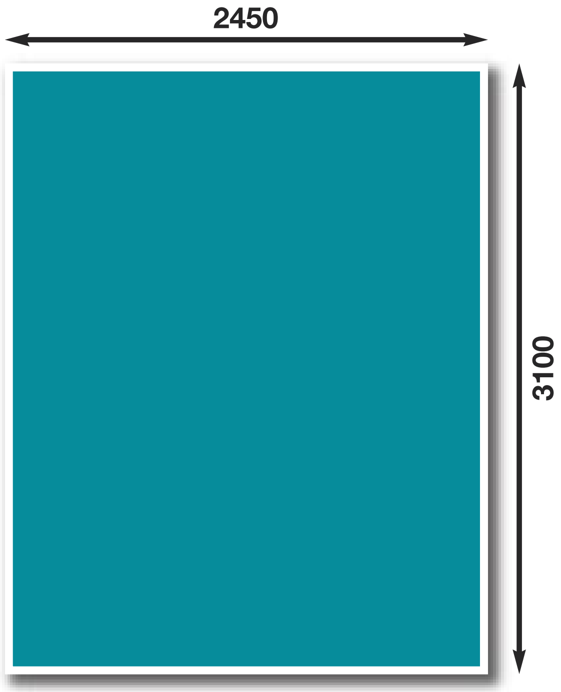
Width = 2500mm = 2500 ÷ 1000 = 2.5m

Area = length × width = 13.821 × 2.5 = 34.5525m^2

MEASURE, SHAPE AND SPACE

TASK 6 - WORKING WITH PLANS ANSWERS

7. Below is a sketch of the utility room in the new build. The dimensions are shown in mm. Sketch a scale drawing of the utility room using an appropriate scale.



MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS ANSWERS

Every building loses heat. In a typical home, around one-third of the heat produced by a central heating system is rapidly lost through the roof, ceiling and walls. This means that for a poorly insulated property up to £1 out of every £3 spent on heating is being wasted.

Heat loss will typically occur:

- through the roof
- through the walls
- through doors/windows and floors

To calculate heat loss, ambient temperature readings inside and outside the building need to be taken and compared.

Drawing a number line can help us to calculate temperature differences. For example, if the overnight temperature fell to –3°C, and by midday it had risen to 9°C, then, counting from –3 up to 9 on the number line.

Using the number line you can see that the temperature has gone up by 12°C.

Extremes in temperature can have a negative impact on a building. High temperatures can reduce the moisture content in a room and cause shrinkage. Temperatures below -7 °C can cause concrete fractures. Understanding the impact of temperature changes during construction allows a builder to choose the appropriate materials to offset possible problems.

RJM Construction has been asked to look at thermal loss and light pollution in Central High School. The drawings need to be reviewed to advise the school on reveals, windows, insulation, roof lights etc. The base surveyor has looked at the design and has found that to keep a constant temperature of 23°C in the building there would be an expected loss of 30% out of the windows and 25% through the roof.

1. The temperature inside an unheated building is usually around 2.78°C higher than the outside air temperature, so when the outside air temperature is at 15.6°C what will the inside temperature be?

15.6 + 2.78 = 18.38 °C

MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS ANSWERS

Inside and outside the building the readings over the course of two weeks are shown below:

Day	1	2	3	4	5	6	7	8	9	10
Inside temperature	18.5°C	19°C	17°C	21°C	20.5°C	19.5°C	18°C	18.5°C	21°C	20.5°C
Outside temperature	3°C	1°C	-1°C	0°C	5°C	1.5°C	2°C	-2.5°C	4°C	6°C

2. Which day had the smallest difference in temperature between the inside and outside? What was the temperature difference that day?

Day 10

20.5°C - 6°C = 14.5°C

3. Which day had the largest difference in temperature between the inside and outside? What was the temperature difference that day?

Day 8

2.5°C + 18.5°C = 21°C

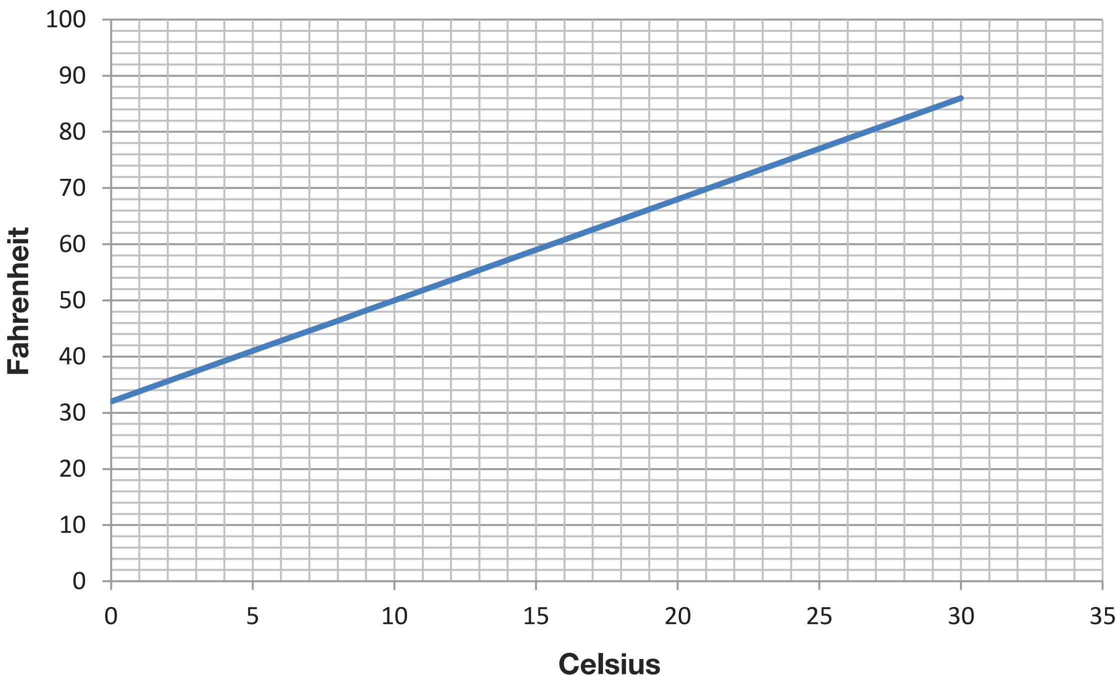
The surveyor has been working abroad and compares the temperature readings he has gathered from the site with readings he had on a similar project in the US.

In America temperature is measured in degrees Fahrenheit and in order to compare values these need to be converted to degrees Celsius. The conversion graph below allows the temperature to be compared.

MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS ANSWERS

Conversion Graph: Degrees Fahrenheit - Degrees Celsius



4. From the conversion graph – which temperature is higher 30 °C or 30 °F?

30 °C

5. The ambient temperature inside the building on day 11 is 23 °C. What is this temperature in Fahrenheit?

Approximately 74 °F

MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS ANSWERS

6. It is possible to check the accuracy of this reading by using the formula below to convert between Celsius and Fahrenheit. Use the formula and check if the answer you got to question 5 is accurate.

$$F = \frac{9C}{5} + 32$$

C is the temperature in degrees Celsius and F is the temperature in degrees Fahrenheit.

$$F = \frac{9C}{5} + 32 = \frac{9 \times 23}{5} + 32 = 73.4°F$$

If you wanted a precise reading of thermal heat loss then you would need to have a lot of information based upon temperature differences internally and externally.

A U value is a measure of heat loss. It is expressed in W/m^2K, and shows the amount of heat lost in watts (W) per square metre of material (for example wall, roof, glazing, and so on) when the temperature (K) is one degree lower outside.

The lower the U value, the better the insulation provided by the material.

The amount of heat loss through a section of the structure such as a wall is obtained from the equation below;

Heat Loss (in Watts) **= area** (in m^2) **x temp difference** (in °C) **x U value** (units W/m^2K)

Calculations are made for one wall of the building. The room has an external wall 5.5m x 3m. It has a 280mm brick wall with an unventilated cavity, and it faces east.

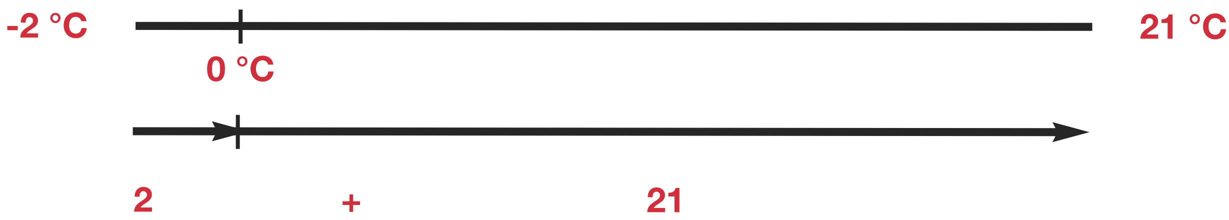
MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS ANSWERS

7. Calculate the temperature difference between the outside and inside of the building.

Outside temperature: -2 °C

Inside temperature: 21 °C



2 + 21 = 23°C

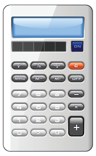
8. What is the area of the wall?

Area of wall is 5.5m x 3m = 16.5m^2

MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS ANSWERS

9. Using the formula below calculate the heat loss.



Heat Loss (in Watts) = area (in m^2) x temp difference (in °C) x U value (units W/m^2K)

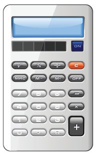
The U value is $1.8W/m^2K$.

Heat Loss (in Watts) = area (in m^2) x temp difference (in °C) x U value (units W/m^2K)

Heat Loss = 16.5 x 23 x 1.8 = 683.1 watts

10. A one metre squared standard single glazed window has a U Value of 5.6. If the temperature outside is -1.5 °C and the inside temperature is 19 °C, calculate the heat loss.

Heat Loss (in Watts) = area (in m^2) x temp difference (in °C) x U value (units W/m^2K)

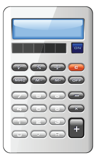


Heat Loss (in Watts) = area (in m^2) x temp difference (in °C) x U value (units W/m^2K)

Heat Loss = 1 x 20.5 x 5.6 = 114.8 watts

11. A one metre squared double glazed window will be significantly better with a U Value of 2.8, i.e. only transmitting 2.8 watts of energy in similar conditions. Calculate the heat loss if the inside and outside temperatures remain the same.

Heat Loss (in Watts) = area (in m^2) x temp difference (in °C) x U value (units W/m^2K)



Heat Loss (in Watts) = area (in m^2) x temp difference (in °C) x U value (units W/m^2K)

Heat Loss = 1 x 20.5 x 5.6 = 114.8 watts

MEASURE, SHAPE AND SPACE

TASK 7 - THERMAL HEAT LOSS ANSWERS

12. Building regulations now specify that U Values must be 2.0 W/m^{2}K or lower. This means that any new window will need to comply with these regulations. What is the difference in the heat loss between the single and double glazed windows?

Claims by the glazing company state that:

"Double-glazing can halve heat loss through windows."

Do you agree? Why?

114.8 watts - 57.4 watts = 57.4 watts.

$$\frac{57.4}{114.8} = \frac{1}{2}$$

The heat loss for the double glazed windows is ½ the heat loss through the single glazed windows.

MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES ANSWERS

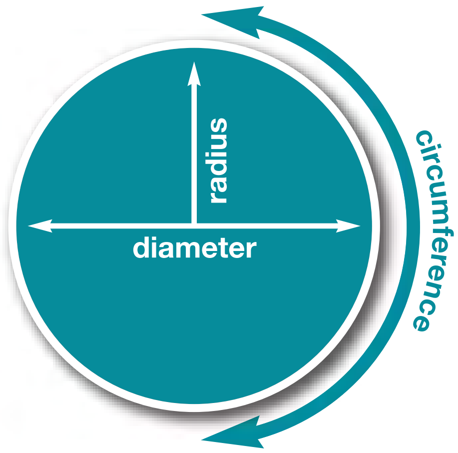
Very large floors can have low U-values without all-over insulation. Unlike components above ground, heat transfer through floors varies over the area of the floor, being greatest at the edge of the floor and least in the middle. The U-value for floors depends on the exposed perimeter and the area of the floor.

PERIMETER

The distance around a shape is the perimeter.

- Make sure you have all the side measurements
- Make sure all units are the same

The perimeter of a circle is called the circumference.

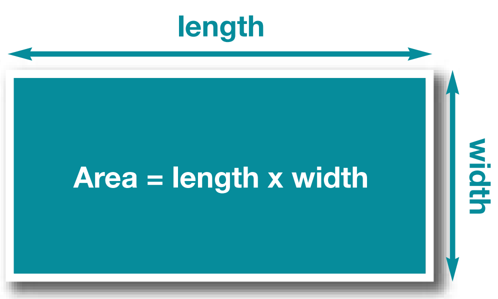


When the circumference of a circle is divided by the diameter the answer is a number called **pi** and is written as π. Your calculator will have a **π** button. When you press the **π** button on your calculator you will get a number 3.14159…

Circumference = **π × d** = π × diameter

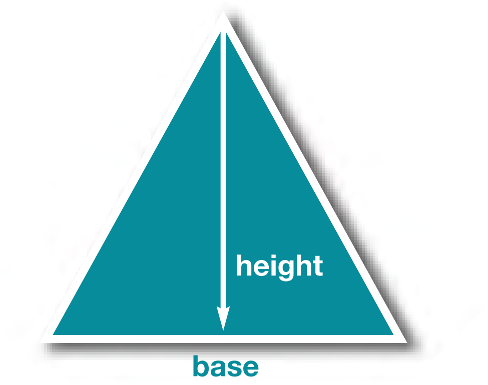
AREA

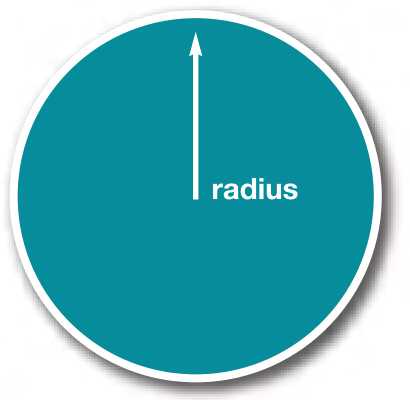
Area of rectangle



MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES ANSWERS





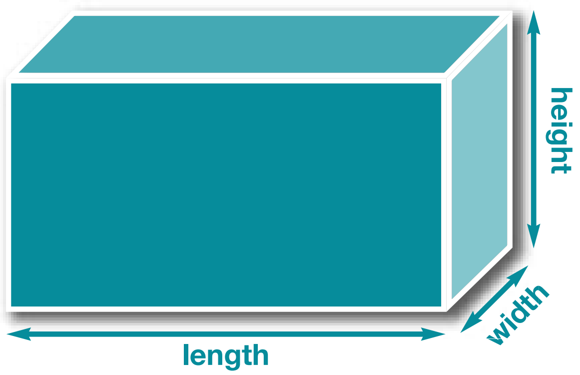
Area of a triangle = ½ base × height

Area of a circle = $\pi \times r^2$

r^2 means $r \times r$

VOLUME

To order material such as stones for a path or concrete for a driveway or foundations, you need to calculate the volume. Volumes are normally measured in **units cubed** such as metres cubed.

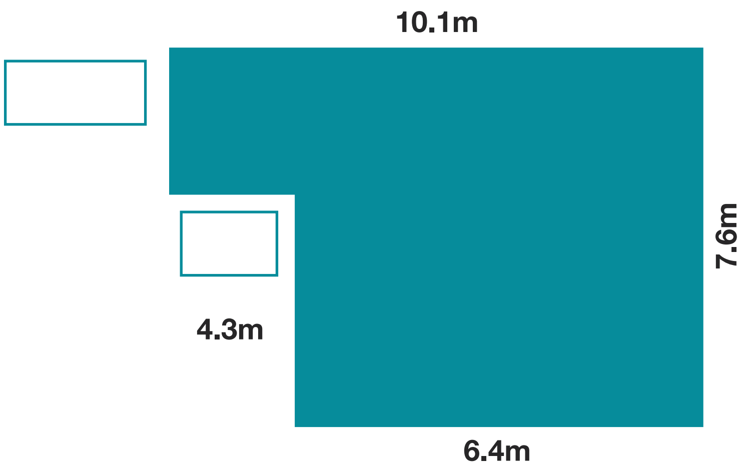


Volume = length × width × height

MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES ANSWERS

1. The dimensions of a proposed dwelling are shown below. Two of the lengths are missing. Fill in the missing lengths in the boxes provided – show your methods in the box below.



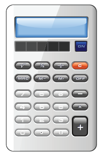
10.1m – 6.4m = 3.7m

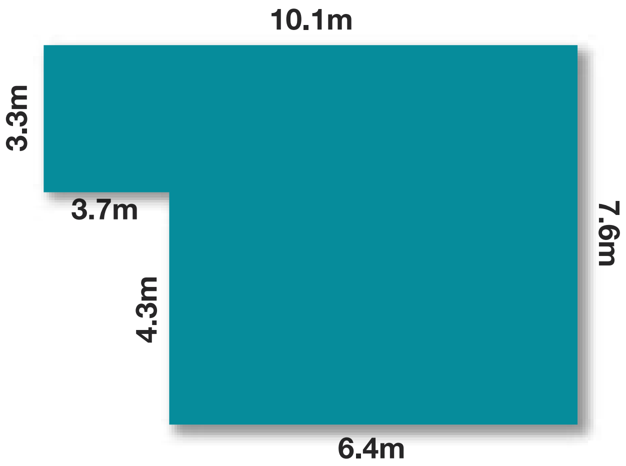
7.6m – 4.3m = 3.3m

MEASURE, SHAPE AND SPACE

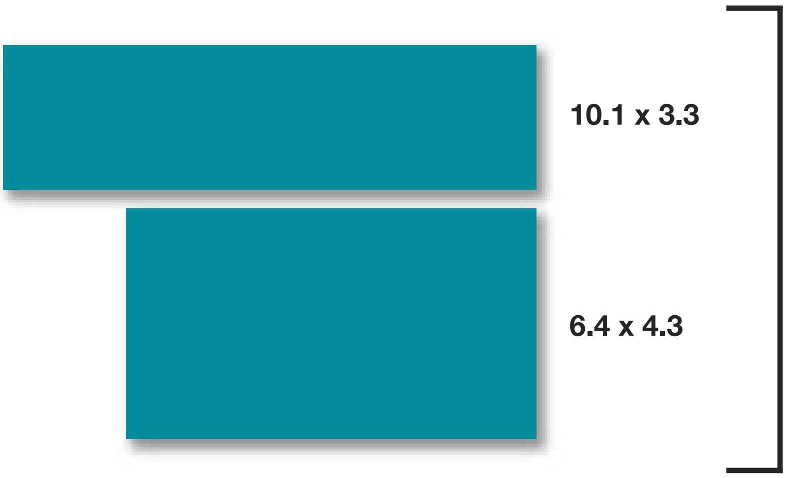
TASK 8 – THERMAL PROPERTIES ANSWERS

2. Three site operatives calculate the ground floor area. Their methods are below. Who has calculated the ground floor area correctly and why is the method correct? Who has calculated the ground floor area incorrectly and why?





Jay has correctly calculated the ground floor area. He divided L shape into two rectangles:

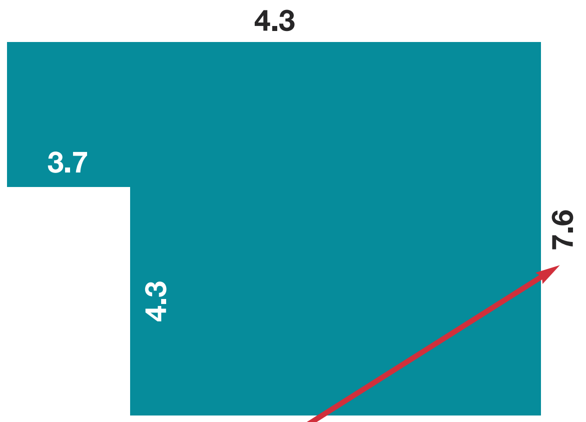


Jay then totalled the two areas together

MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES ANSWERS

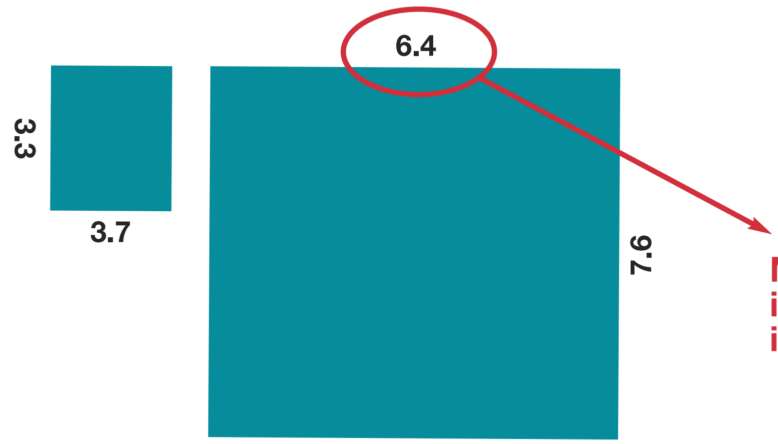
Chris's method is almost correct however he makes the mistake shown below:



10.1 × 10.1 – 3.7 × 4.3

This side length is 7.6 not 10.1.

Mark's method is almost correct but he too makes a mistake with one of the side lengths.



Mark uses 10.1 in his calculation instead of 6.4

MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES ANSWERS

3. The floor construction consists of a 150 mm concrete slab, 75 mm of rigid insulation (thermal conductivity 0.04 W/mK) and a 65 mm screed. Use the formula below to find the volume of concrete needed to construct the concrete slab.

Volume = area of base × height

Volume = area of base × height

area of base = 60.85m^2

height = 150mm

Different units therefore change 150mm to 0.15m

Volume = 60.85 × 0.15 = 9.1275m^3

4. Calculate the perimeter of the concrete base and divide the perimeter by the area to find the U value for the floor.

Perimeter = 10.1 +7.6 + 6.4 + 4.3 + 3.7 + 3.3 = 35.4m

Area = 60.85m^2

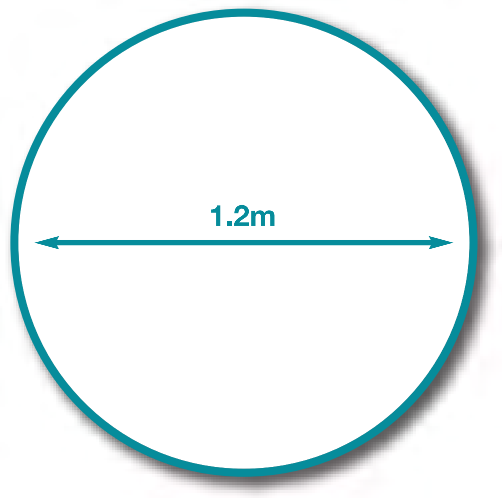
Perimeter ÷ area = 35.4 ÷ 60.85 = 0.5817777

The U value is 0.6 approximately

MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES ANSWERS

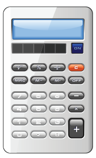
Heat loss for a circular window in the dwelling is related to the area of the window. The dimension of the window is shown below:



5. Find the area of the glass in the window. Use the formula below:

Area of a circle = $\pi \times r^2$

Use the π button on your calculator.



Area of a circle = $\pi \times r^2$

Diameter = 1.2m

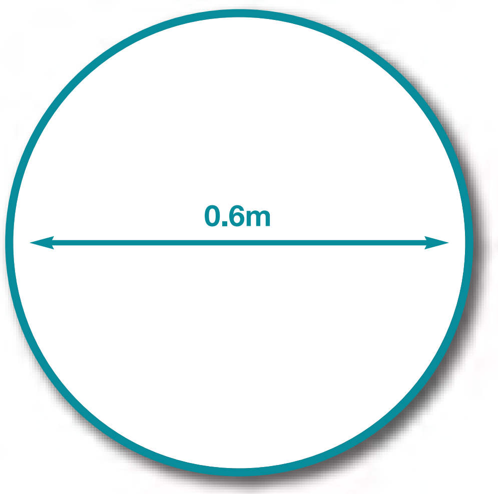
Radius = 0.6m

Area = $\pi \times 0.6^2 = \pi \times 0.6 \times 0.6 = 1.1309733....m^2$

MEASURE, SHAPE AND SPACE

TASK 8 – THERMAL PROPERTIES ANSWERS

6. The window manufacturer claims that if the diameter of the window is reduced by half, then the heat loss will be reduced by half. By calculating the area of the smaller window, state whether you agree or disagree and why.



Area of a circle = $\pi \times r^2$

Diameter = 0.6m

Radius = 0.3m

Area = $\pi \times 0.3^2 = = \pi \times 0.3 \times 0.3 = 0.2827433....m^2$

The area of the smaller window is 0.2827433 ÷ 1.1309733 = ¼ of the area of the larger window therefore the heat loss through the smaller window will be ¼ of the heat loss through the larger window.

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

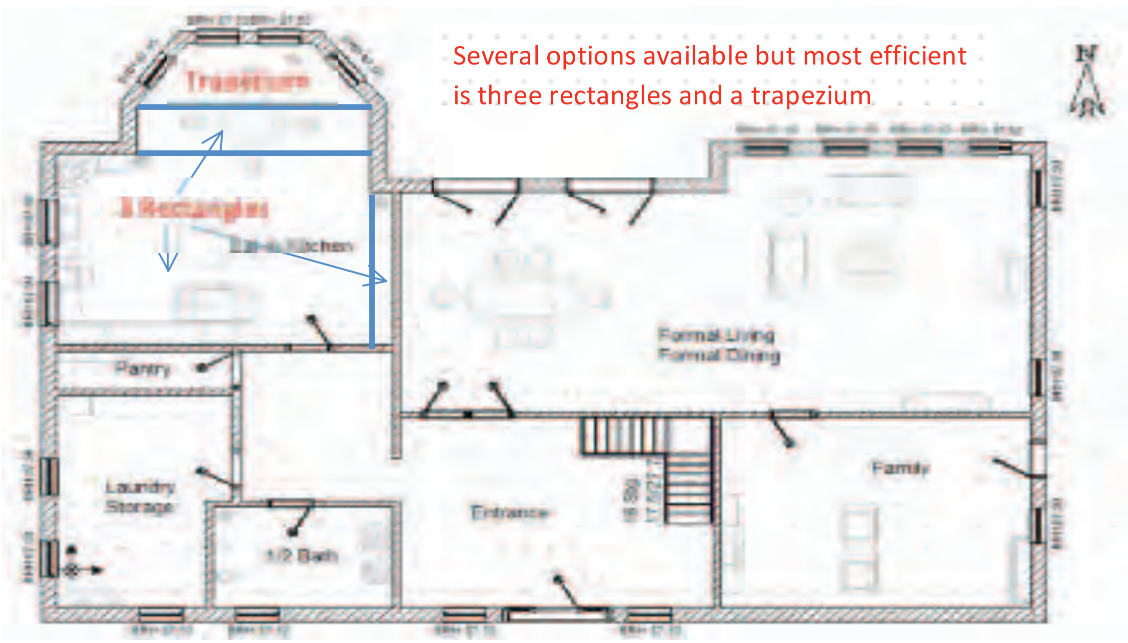
More often than not in construction we are required to calculate an area which will not be in the form of a regular basic shape such as a square, rectangle, triangle, circle etc., so a little more work and understanding will be required in order to find such areas. In this task we will look at two general scenarios (You should complete *Know Your Area* task before attempting this one).

We will consider composite shapes where the area cannot be calculated using a simple formula. However the area that can be broken down into smaller regular areas each of which can be determined, using a formula you are familiar with, and then summed to get an answer. When working with composite area it is usually possible to get an exact answer.

The second scenario involves trying to determine an irregular area which cannot usually be broken down into simple shapes in an exact way. It can be modelled as something very close to a composite shape but an exact answer is not usually possible (or at least not practical). However as you will see in this task numerical methods have been developed which can be used to get an answer to whatever level of accuracy is required. The level of accuracy will depend on the amount of information available or the number of measurements taken.

Composite area

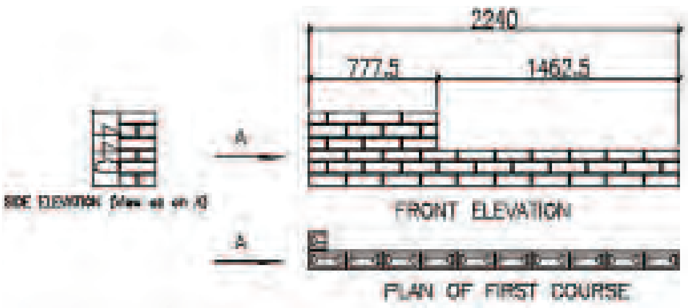
1. Take a look at the floor plan below and edit the plan using pen and ruler to show how you would break up the interior of the Eat-in Kitchen to set about calculating its area. You don't actually need to calculate it, just try to break it into as few smaller bits as possible but write on the diagram the kinds of shapes you use?



MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

The walls in this building will be constructed as shown below. Take a good look at the drawing and photograph provided and then use them to help answer the questions which follow



2. By concentrating on the Front Elevation drawing and the measurements given determine the metric dimensions of the brick used to build the wall. All mortar joints are 10mm?

Length:

look at the third course of brick, it is 10 bricks in length and 9 mortar joints

10 x length + 90 = 2240 so 10 x length = 2150 so length = 215mm

Width:

look at the uppermost course of brick, it is 3 bricks in length, one brick in width and 3 mortar joints

3 x length + width + 30 = 777.5 so width = 777.5 – 30 – 3 x 215 = 102.5mm

Height:

look at the height of the wall, it has 6 course of bricks and 5 mortar joints

6 x height + 50 = 440 so 6 x height = 390 so height = 65mm

MEASURE, SHAPE AND SPACE

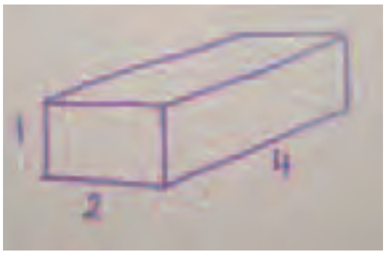
TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

3. By firstly rounding off your answers to the previous question (to the nearest 50mm) write down a ratio for length:width:height for the brick which is a standard UK brick?

Length = 215mm = 200mm (to nearest 50mm), width = 102.5mm = 100mm, height = 65mm = 50mm.

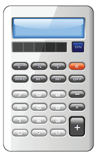
length:width:height = 200:100:50 = 4:2:1

4. Use the space below to produce a "3-D" sketch of the brick using the simple ratio you have just calculated. Your drawing does not have to be to any particular scale but try to get the proportions correct (for example if the length of the brick is twice the width of then make sure your drawing conveys that fact)?



A'3-D' sketch of a cuboid which conveys the approximate proportions from the previous question, for example…

5. Calculate the area of wall built so far (again consider only the front elevation). Don't forget to account for the mortar joints in your calculation and give your answer in mm²?



Two rectangles:

Rectangle 1, dimensions:
(3x65+3x10) by 777.5 = 225x777.5 = 174,937.5mm²

Rectangle 2, dimensions:
(3x65+2x10) by 2240 = 215 x 2240 = 481,600mm²

Total = 174,937.5 + 481,600 = 656,537.5 = 656,537 or 656,538 mm²
(depending on rounding)

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

6. Calculate all three cross-sectional areas of a single brick using dimensions in mm?

Face A = 102.5mm by 65mm = 6,662.5mm²

Face B = 215mm by 65mm = 13,975mm²

Face C = 215mm by 102.5mm = 22,037.5mm²

7. Now use whichever of these cross-sections you consider necessary to determine the area of the wall which actually is brick (i.e. not mortar)?

5 x Face A + 38 x Face B = 5 x 6,662.5 + 38 x 13,975 = 564,362.5mm²

8. Using some of your previous answers calculate the percentage of the wall which actually is composed of mortar. Round it off to the nearest 1%?

area of wall which is mortar = 656,537.5 – 564,362.5 = 92,175mm²

% of wall which is mortar = 92,175 ÷656,537.5 x 100 = 14.039

14% to nearest 1%.

9. Suppose someone asked you what the ‘typical’ ratio of brick to mortar is for a brick wall. If you decided to use the wall in the drawing as a basis for your answer, which one of the following simple ratios is closest to the truth for the area ratio of brick to mortar?

brick:mortar	brick:mortar	brick:mortar
7:1	6:1	5:1

86:14 = approximately 6:1

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

Irregular area

In many cases the area you need to calculate will not be in the form of a regular shape. In particular you will often have irregular boundaries which means the area inside cannot be calculated exactly. There are different ways to work with such areas depending on how accurate the answer needs to be. In most cases it will involve replacing a curved line with a straight line as you will see.

The map below is a detailed Ordinance survey map of a region north of Draperstown, where an area of land has been identified as being suitable to site a wind farm.The land owner and a local contractor are considering various aspects of this potential development. The area is bounded by some local roads and a stretch of the river Moyola and one of its tributaries. This region is highlighted on the map below.

For valuation purposes it is necessary to calculate the area of land inside the boundary and you will probably agree this would be quite a difficult thing to do.

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

10. On the map below you are asked to redraw the boundary in a way that will make it possible to calculate this area, at least approximately?

Here are a few pointers to help with the process

- **a.** Use an irregular pentagon to replace the boundary
- **b.** The river stretch will be covered by 2 sides of the pentagon
- **c.** Your pentagon should have two internal right angles.

MEASURE, SHAPE AND SPACE

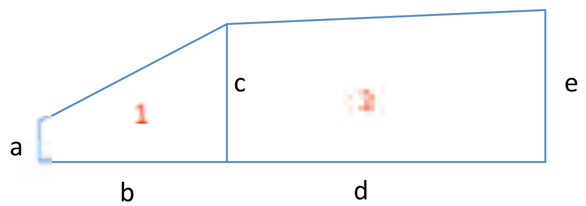
TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

You now need to split the shape you have drawn (which is considered a composite area) up into smaller shapes whose area you can calculate using formula. Two shapes will be sufficient.

11. Use the space below to lay out your calculation beginning with a sketch of the composite shape and the smaller shapes together with the appropriate measurements for the lengths of sides?

In order to determine the lengths of the sides you will need to use the scale 2cm:1km

Composite area (sketch):



List the two smaller shapes and the formula used to determine their area:

Trapezia, area = half the sum of the parallel sides times the height (perpendicular)

Use scale on map 2cm:1km to take whatever length measurements you require (with your ruler work to the nearest mm on the map):

2cm:1km = 20mm:1000m = 2mm:100m = 1mm:50m

The following are values for guidance only!

a = 6mm = 300m, b = 27mm = 1350m, c = 23mm = 1150m, d = 70mm = 3500m, e = 25mm = 1250m

Resulting area calculation:

Trapezium 1: area = 0.5x(300+1,150)x1,350 = 978,750m^2

Trapezium 2: area = 0.5x(1,150+1,250)x3,500 = 4,200,000m^2

Total = 978,750 + 4,200,000 = 5,178,750m^2

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

In practice the method used is not very different to the calculation you have just done. However, many more measurements would be taken resulting in a very accurate answer. Suppose this has been done for the land in question and you are told that the answer (correct to the nearest $100m^2$) is $5,835,700m^2$.

12. Use the space below to determine the percentage error in the approach you were asked to use above to get an approximate answer.

Percentage error = (actual area – approximate area) ÷ actual area x 100.

% error = (5,835,700 - 5,178,750) ÷ 5,835,700 x 100 = 11.3%

Land area is normally stated in units of acres or hectares.

13. Convert the exact area answer ($5,835,700m^2$) to the nearest acre and the nearest hectare.

1 acre = $4047m^2$ **1 hectare = $10000m^2$**

In acres: area is 1441.98 = 1442 acres,
(with rounding error of 0.02 acres = $81m^2$)

In hectares: area is 583.57 = 584 hectares,
(with rounding error of 0.43 hectares which is $4300m^2$)

Your answers will have involved some rounding to the nearest whole number for each of the two units used.

14. Which of your answers (acre and hectare) is most accurate and why?

This area rounded to the nearest acre is more accurate as the error is only $81m^2$ as opposed to $4300m^2$. Obviously a different starting figure might give a different outcome but in general rounding using a system of 'smaller' units will tend to have less error. So rounding an area in m^2 to the nearest acre will tend to be more accurate than rounding it to the nearest hectare.

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

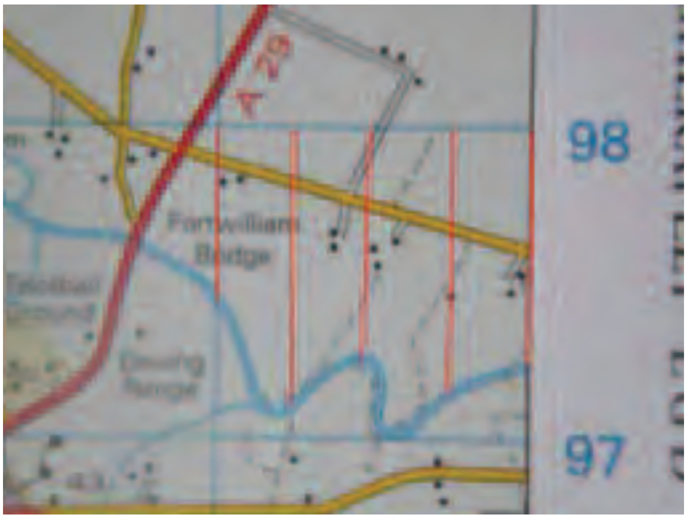
We will now take a look at the method used to get a more accurate answer. To do this we will focus on an individual grid square (pale blue lines on map) and consider an irregular area within this grid square. This is what would happen in practice. Look the region outlined in the picture where some land is bounded by a stretch of river and three of the sides of the square.

There is one very useful advantage in using three sides of the grid square. It means we can make use of a formula which engineers have developed. Don't forget, we will still be using a composite area to approximate an irregular area but there is a formula to use meaning we don't have to calculate lots of smaller individual areas and add the answers up!

In order to use this formula we need to take some distance measurements from the base of the square to the river. These are often referred to as off-sets in construction. The off-sets need to be evenly spaced across the base of the square as indicated in the picture below. Here the red lines indicate the measurements which need to be taken. The more off-sets used the more accurate the answer. For this example we will use five off-set measurements.

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS



15. Use the scale 1cm:250m to calculate each of the distances marked in red and note the distance along the base line between each off-set (normally called the strip width) is 250m?

Take distance measurements from the map to the nearest millimetre 'tick-mark' on your ruler

1cm:250m = 10mm:250m = 1mm:25m

30mm = 750m, 34mm = 850m, 30mm = 750m, 36mm = 900m, 22mm = 550m

When you have determined these measurements you will be ready to use the formula below to calculate the area that was outlined in the earlier picture.

16. Label the five off-sets 1st, 2nd, 3rd, 4th and 5th and make sure you state the lengths in metres?

1st: 750m **2nd**: 850m **3rd:** 750m **4th:** 900m **5th:** 550m

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

The formula is

Area = d(2S-t)

Where **S** is the sum of all the off-sets, **t** is the sum of the 1st and last off-set and **d** is the strip width.

17. Use the space below and this formula to calculate the area.

S = 750+850+750+900+550 = 3800m, **t = 750+550 = 1300m**

S = 3800 m **t = 1300 m** **d = 250 m**

Area (m^2) = **2S – t =2 x 3800 – 1300 = 6300**

d x (2S-t) = 250 x 6300 = 1,575,000

Area = 1,575,000m^2

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

18. In order to see the actual area you have calculated using this formula you need to join up the tops of the off-sets with straight lines. You can do this in the figure below and when you have it done the area should resemble four trapezia sitting next to each other.

19. On the same picture shade in two small irregular areas which could be described as 'error 'in this calculation.

MEASURE, SHAPE AND SPACE

TASK 9 – COMPOSITE AND IRREGULAR AREA ANSWERS

In practice a large number of off-sets would be used giving a very accurate answer. You can use the figure below to demonstrate how increasing the number of off-setsgives an improved answer.

20. Add in 4 more off-sets, each one equally spaced in between the off-sets already drawn in the figure below and then join the tops of them with straight lines. Indicate the 'error' region with shading.

21. In the space below indicate why you think using 9 off-sets instead of 5 will give a better (i.e. more accurate) answer?

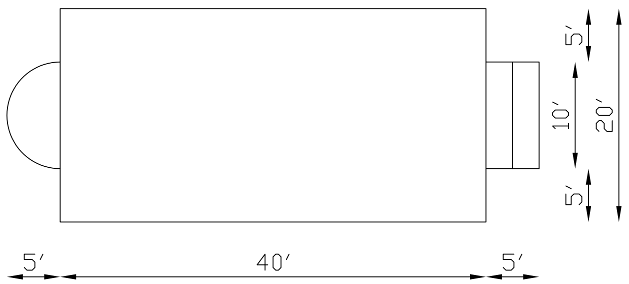
The error in the calculation will be smaller as shown by the solid red error regions.

MEASURE, SHAPE AND SPACE

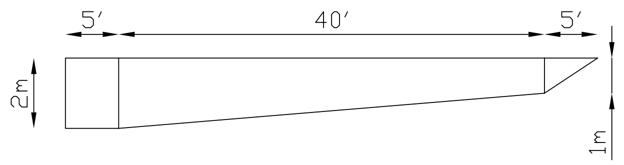
TASK 10 – EXCAVATION FOR A SWIMMING POOL ANSWERS

Now that you are familiar with calculating the volume or capacity of an object which has been identified as a prism (you may wish to complete task *Volume and Capacity* before this one) we are going to look at an example of how this can be useful in practice. A contractor has been approached by a local spa centre to build a second swimming pool on site. Here are some initial plans they have drawn up for the pool.

Plan View



Side Elevation



Notice how some measurements are in feet (e.g. 5' which means 5 ft) whereas other measurements are in metres.

1. Before going any further it will be useful to convert all length measurements to cm?

Use the conversion factors 1ft = 0.305m and 1m = 100cm to convert 5', 10', 20', 40', 2m and 1m to cm. See if you can use factors or multiples to spot some short-cuts !

5' = 5 x 0.305m = 1.525m = 152.5cm,

10' = 10 x 0.305m = 3.05m = 305cm,   20' = 2 x 10' = 610cm

40' = 2 x 20' = 1220cm

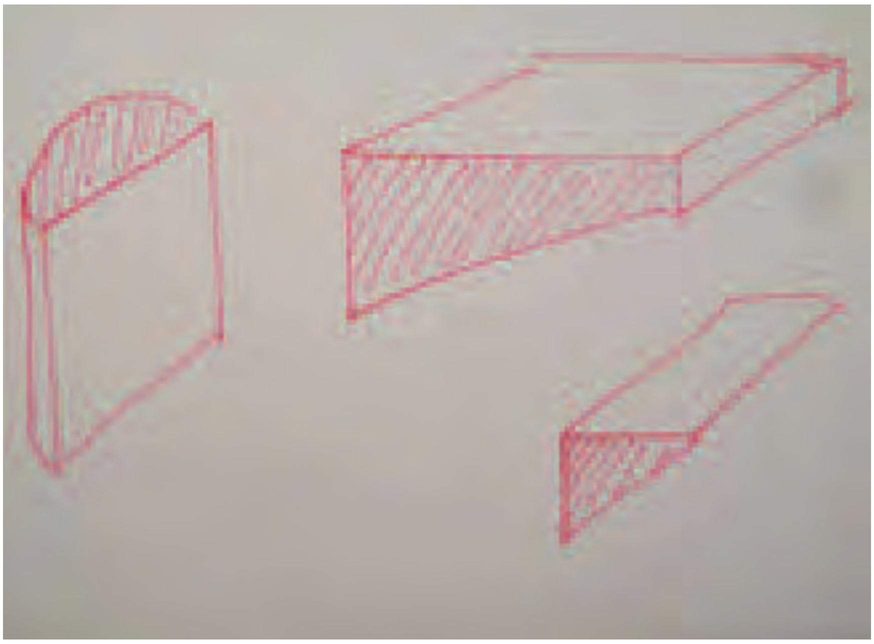
1m = 100cm, 2m = 200cm

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL ANSWERS

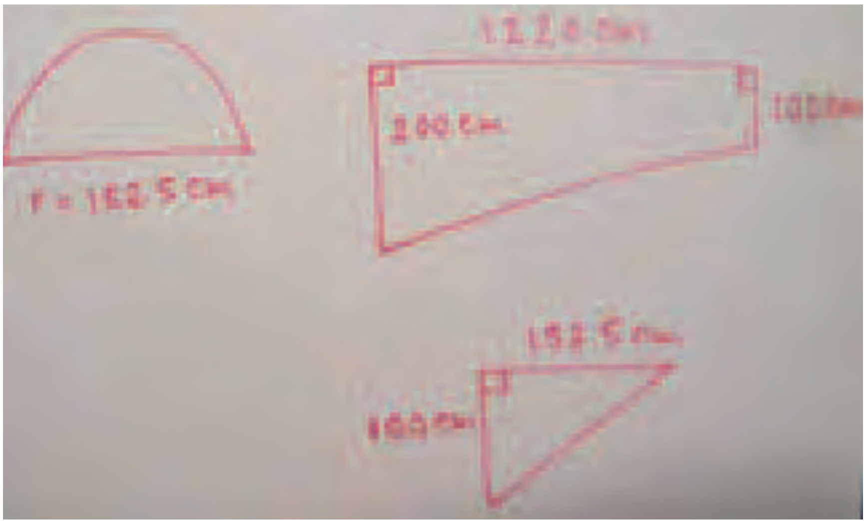
2. In the space below produce some sketches indicating how you would break the swimming pool up into 3 parts (each of which is a prism) that would help you calculate the capacity of the pool. Don't worry about writing in dimensions at this stage?

For each prism lightly shade the face which is the common cross-section!



3. Consider each of the prisms in turn and in the space below sketch the cross-sections and write the appropriate dimensions on each sketch?

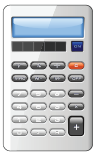
Remember to work in cm!



MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL ANSWERS

4. Write down and use formulae you have met before (see task Know your Area for a list of formulae if you need to) to help you calculate the area of each of the faces above. Also name each of the shapes you are working with?



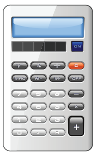
Give each area in cm^2:

Semi-circle, area =½ πr^2 = 0.5 x 3.14 x 152.5^2 = 36,512cm^2

Trapezium, area = ½(a+b)h = 0.5 x(200 + 100) x 1220 = 183,000cm^2

Triangle, area =½bh = 0.5 x 100 x 152.5 = 7,625cm^2

5. Now use the property Volume = Cross-section Area x length to calculate the volume of each of these 3 prisms giving your answer in cm^3?



Volume = Cross-section Area x length

**Semi-circular based prism (or half-cylinder),
Volume = 36,512 x 200 = 7,302,400cm^3**

Trapezoidal prism, Volume = 183,000 x 610 = 111,630,000cm^3

Triangular based prism, Volume = 7,625 x 305 = 2,325,625cm^3

6. Use some of your previous answers and what you have learned to help you write down a formula for the volume of each of the prisms you have been working with?

e.g. for a cylinder the area of cross section is **A = πr^2** where r is the radius. If the cylinder had a length l then the volume of the cylinder would be…

V = A x l = πr^2 l = πr^2 l

Half-cylinder: V = A x l = ½πr^2 x l = ½πr^2l

Trapezoidal prism: V = A x l = ½(a+b)h x l = ½(a+b)hl

Triangular based prism: V = A x l = ½bh x l = ½bhl

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL ANSWERS

7. If 1litre = 1000cm³ what is the total capacity of the pool in litres?

Volume of half-cylinder = 7,302,400cm³ = 7,302.4 l

Volume of Trapezoidal prism = 111,630,000cm³ = 111,630 l

Volume of Triangular based prism = 2,325,625cm³ = 2,326.625 l

Capacity of pool = 7,302.4 + 111,630 + 2,326.625 = 121,259.025 = 121,259 l (to the nearest litre)

The contractor needs to excavate some earth so he can set the pool structure into the space created. The diagram below gives an outline of the cross section of the excavation when complete.

It is important to get a good estimate of the volume of earth excavated. When the pool structure is put in place the space around it will need to be in-filled with concrete so it is necessary to know how much concrete to order.

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL ANSWERS

You will need to 'model' the excavation as a prism. In other words you will assume the cross-section shown above is constant along the entire length of the excavation so it can be considered a prism.

8. If you knew this cross-section area, which property of a prism would allow you to calculate the volume. Use a formula to answer this?

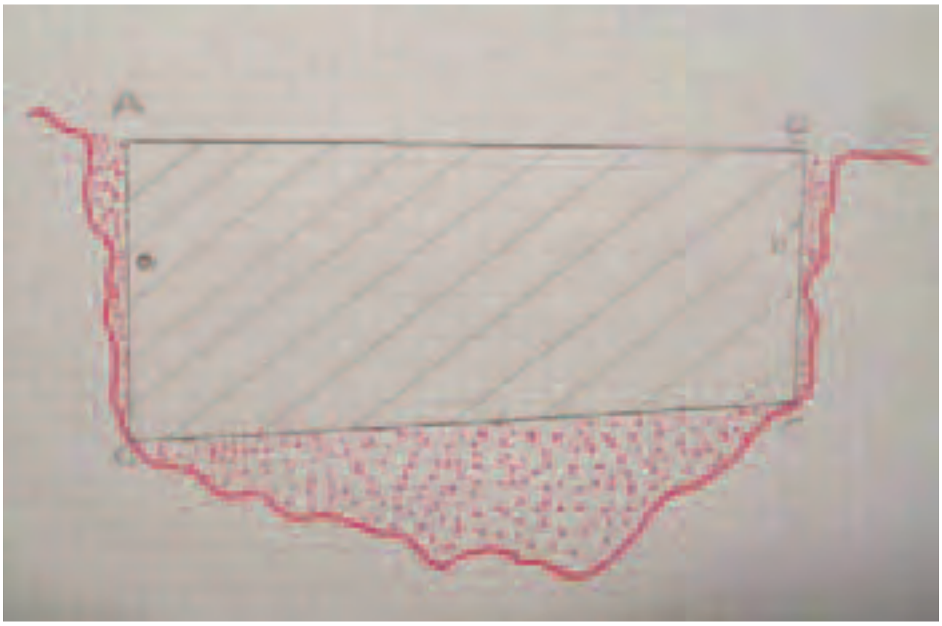
Volume = Cross-section area x length

First, however, you need to calculate the cross-section area! As you can see the cross-section is an irregular area so you cannot calculate it exactly. Hopefully you will remember from a previous task Composite and Irregular Area that you can approximate this irregular area using a composite area. In the figure below you are shown where two depth measurements have been taken, one at each side of the excavation.

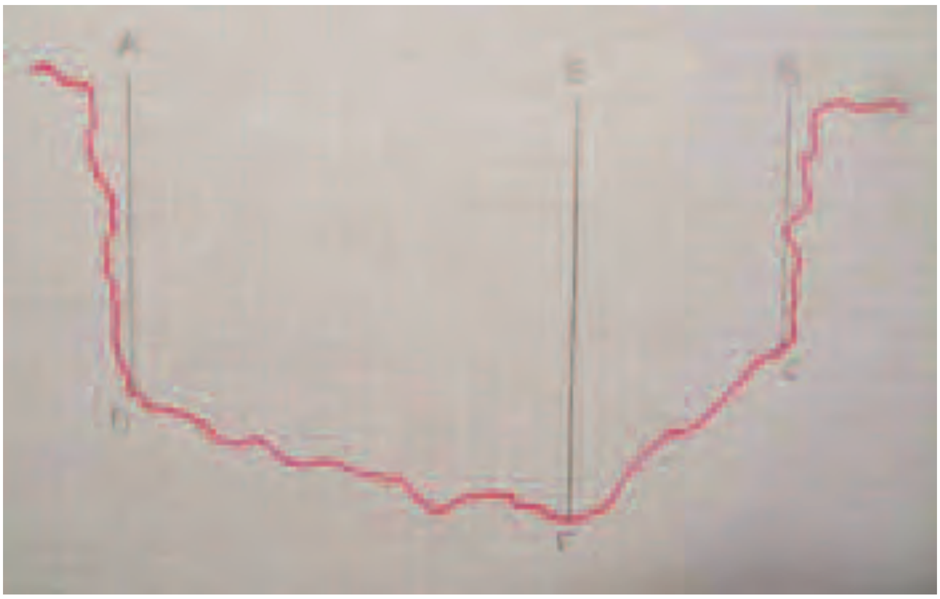
MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL ANSWERS

9. Complete the drawing below to indicate which common shape you could use to approximate the cross-section area using only these two depth measurements and the width?



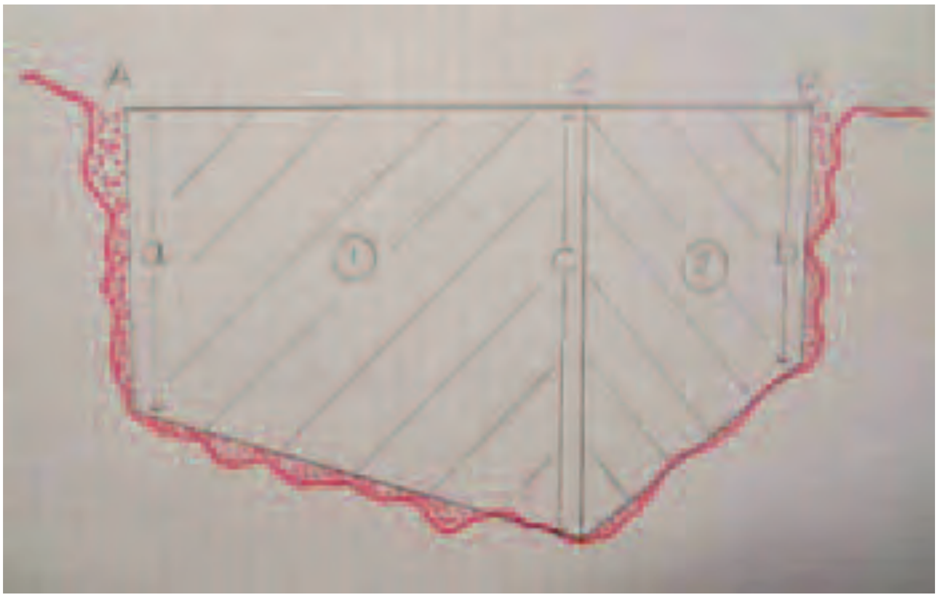
In the figure below you will see that an extra depth measurement has been taken at the deepest part of the excavation.



MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL ANSWERS

10. Now complete this diagram to indicate how you would approximate the cross-section area given this additional information?



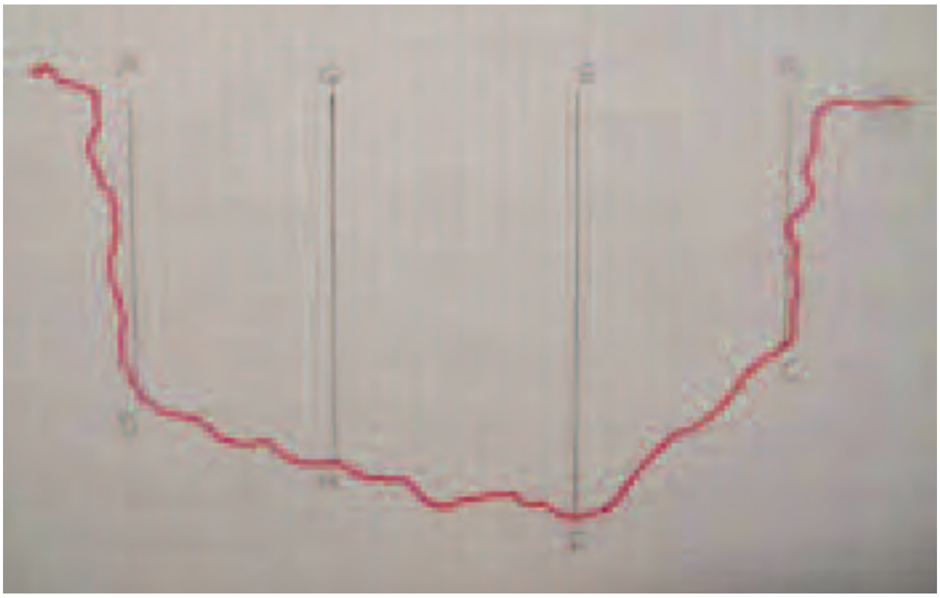
11. Which of the two approaches would give a more accurate answer to the cross-section area and why?

The error in the approximation is shown by the dotted region and it is very clearly smaller in the case where there are three measurements as opposed to only two.

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL ANSWERS

Finally, in the diagram below you can see that four equally spaced depth measurements have been taken along the cross-section. The width of the excavation (distance AB in the diagram) is 8.1m. The depth measurements are from left to right: AD =2.65 m, GH =2.73 m, EF = 2.90m, BC = 2.44m.



12. Use these measurements and the formula given below to get an approximate answer to this area in m^2?

Off-sets (from left to right): **1st** 2.65m **2nd** 2.73m **3rd** 2.90m **4th** 2.44m

d = strip width (gap between off-sets) = 8.1 ÷ 3 = 2.7m

S = sum of all four off-sets, t = sum of first and last off-set

Area = d(2S-t)

S =2.65 + 2.73 + 2.90 + 2.44 = 10.72m

t = 2.65 + 2.44 = 5.09m

2S-t = 2 x 10.72 – 5.09 = 16.35

Area = 2.7 x 16.35 = 44.145m^2

MEASURE, SHAPE AND SPACE

TASK 10 – EXCAVATION FOR A SWIMMING POOL ANSWERS

13. Use your answer for the cross-section area above together with what you know about prisms to estimate the volume of the excavation given it is 18m long?

Give your answer in m^3

Volume = Cross-section area x length = 44.145 x 18 = 794.61m^3

14. How much concrete (m^3) will be needed to support the pool structure?

Use $1m^3$ = 1000 litres

Capacity of pool in m^3: 121,259 litres ÷ 1000 = 121.259m^3

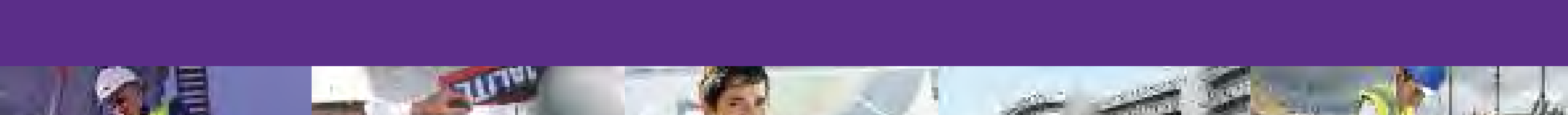
Volume of concrete required = Volume of excavation – capacity of pool

= 794.61 – 121.259

= 673.351

= 673m^3 (to nearest m^3)

HANDLING DATA
Tasks and Answers



HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE

Government legislation had required all commercial and residential properties; being sold, built or leased, to make available an energy performance certificate to prospective purchasers or tenants. This enabled people to make more informed decisions relating to the energy efficiency of a property and the on-going costs of fuel. Public buildings were also assessed for their efficiency.

Therefore it is important to be aware of the insulation values of various building materials.

By average insulation we mean the typical value. There is more than one type of average.

Example:

Look at the table below showing the sizes of various bricks.

	Length of brick (excluding joint)	Height of brick (excluding joint)
Metric	215mm	50mm
Metric	215mm	65mm
Imperial	225mm	67mm
Imperial	230mm	70mm
Imperial	230mm	73mm
Imperial	230mm	76mm
Imperial	230mm	80mm

Range = highest value – lowest value

The range in brick lengths is therefore 230 – 215 = 15mm

The range in heights of the brick = 80 – 50 = 30mm

Mean
This is the most commonly used average. The mean is calculated by adding up the numbers in the list and dividing that answer by how many numbers in the list. This is the only type of average that takes into account all the numbers in the sample.

It is easy to calculate: Just **add up** all the numbers, then **divide by how many** numbers there are.

e.g. $$\textbf{Mean} = \frac{\textbf{Total}}{\textbf{Number of values}}$$

$$\textbf{Mean} = \frac{50 + 65 + 67 + 70 + 73 + 76 + 80}{7} = \frac{481}{7}$$

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE

Mean brick height = 68.714…

Mean brick height = 68.7mm to 1 decimal place

Mode

The mode is another type of average. It describes the most common value in the set of numbers.

e.g. The modal length of brick is 230mm

Median

This type of average is the middle value and requires the numbers to be in order.

e.g. The median height of brick is

50, 65, 67, 70, 73, 76, 80

70mm

If there are two middle values, add them together and divide by 2.

e.g.

If the ages of apprentices on a site are: 23, 25, 18, 17, 35, 17 what is the median age?

Rewrite in ascending order

17, 17, 23, 25, 25, 35

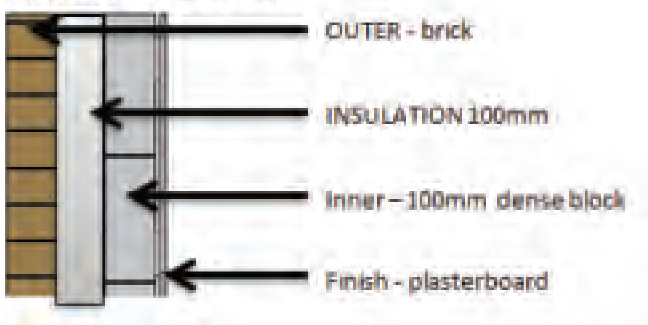
The middle values are 23 and 25, so the median age will be $\frac{23 + 25}{2} = 24$

HANDLING DATA

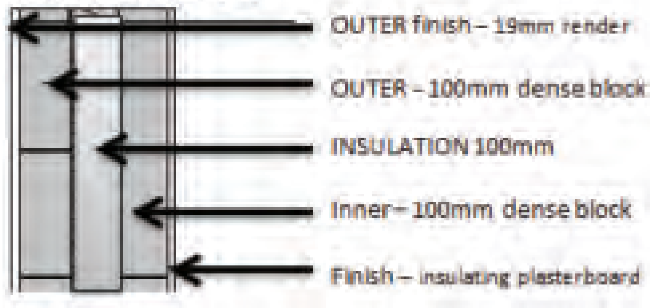
TASK 1 – ENERGY PERFORMANCE CERTIFICATE

Aggregate block solutions

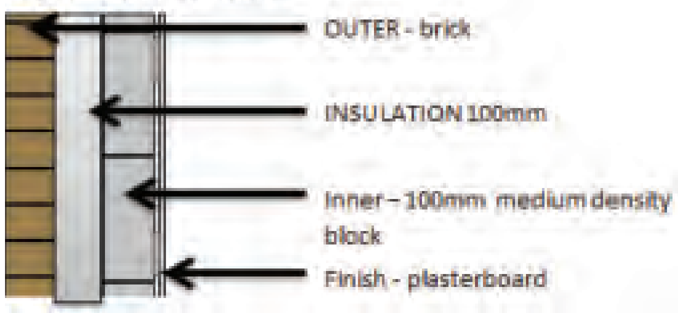
Option 1 U Value = 0.30



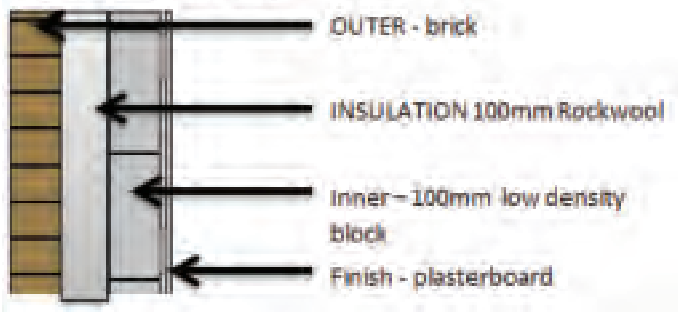
Option 2 U Value = 0.29



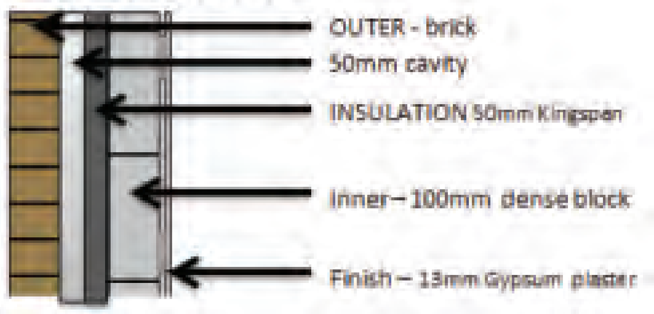
Option 3 U Value = 0.27



Option 4 U Value = 0.28



Option 5 U Value = 0.30



Option 6 U Value = 0.28

Option 7 U Value = 0.25

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE

Although the performance values of the building envelope will depend on factors such as fuel type and heating efficiency it is recommended that wall U values of around 0.30 W/m^{2}K are achieved. The above aggregate block solutions meet this level of performance and are applicable to any type of building.

1. What is the range of U values for the aggregate block solutions shown above?

2. Find the modal U value for the aggregate block solutions shown.

0.3	**0.29**	**0.27**	**0.28**	**0.3**	**0.28**	**0.25**

3. What is the median U value of the aggregate block solutions shown?

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE

4. What is the mean U value of the aggregate block solutions shown?

There is an enormous difference in the level of heat loss (called the U-value) of different types of windows related to the types of frame and glazing:

Window	**U-VALUE** (heat loss per square metre)
Single glazed, solid metal frame	5.6
Single glazed, wood frame	4.3
Double glazed, solid metal frame	3.9
Double glazed PVC / wood frame	2.5
Double glazed PVC / wood frame, argon and low-e glass	1.6
PVC Triple PVC / wood frame	1.5
PVC Triple PVC / wood frame, argon and low-e glass	1.3

5. What is the range of U values for the windows described in the table above?

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE

6. Which type of window frame has the median U value?

Building regulations that relate to energy efficiency have been revised several times in line with the need for increased energy efficiency, and to reduce the impact buildings have on global warming. This has meant significant changes to the thickness of insulation required for buildings. From May 2003, it became a legal requirement that thermal insulation products for buildings are tested to and comply with the Construction Products Regulations.

The best insulation materials should have the lowest thermal conductivity (thermal conductivity of a material describes how easily heat passes through it), in order to reduce heat loss. This means, less insulating material will be required.

Insulation Materials	Thermal conductivity W/mK
Extruded polystyrene (XPS) with CO2	0.035
Polyurethane (PU) with pentane	0.025
Foil-faced polyurethane (PU) with pentane	0.025
Polyurethane (PU) with CO2	0.02
Polyisocyanurate (PIR)	0.02
Mineral wool (glass) *≤ 160kg/m^3]	0.035
Sheep’s wool	0.045
Cellulose fibre (recycled)	0.04

7. What is the range of thermal conductivity values for the insulation materials listed?

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE

8. Which of the insulation materials listed would you recommend and why?

9. For an average semi-detached house it is estimated that you will need 33 rolls of eco-wool insulation. The price per roll from a range of suppliers is shown below.

Supplier	Cost
1	£16.99
2	£18.97
3	£15.98
4	£17.77
5	£16.99

What is the range of costs of the insulation for the semi-detached house?

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE

10. What is the median and modal cost of insulation?

Put the prices in order of size to find the median

11. What is the mean cost of insulation from the various suppliers? How does this differ from the median and modal price?

$$\textbf{Mean} = \frac{\textbf{sum of all values}}{\textbf{number of values}}$$

12. Using the cheapest supplier, calculate the cost of 33 rolls of insulation.

HANDLING DATA

TASK 2 – GLAZING

A local primary school is concerned that the large glass windows in the ground floor corridor are causing high temperatures in the rooms in summer term. They are investigating the option of heat efficient glass so that in the summer, infrared radiation from the sun is reflected away, keeping the rooms cooler and in winter, radiant heat from inside the room can be reflected back inside, thereby keeping heat inside in the winter.

Low Emissivity glass (Low E-Glass) can reflect 40% - 70% of the heat that is normally transmitted through the glass. It is now a standard requirement under Building Regulations for many homes in the UK.

The maximum and minimum temperature of each classroom during the course of the day is recorded and results are shown below.

Classroom	Maximum temperature	Minimum temperature
1	23	20
2	24	22
3	27	23
4	24	22
5	25	21
6	23	20
7	20	20
8	27	19
9	26	23
10	21	21

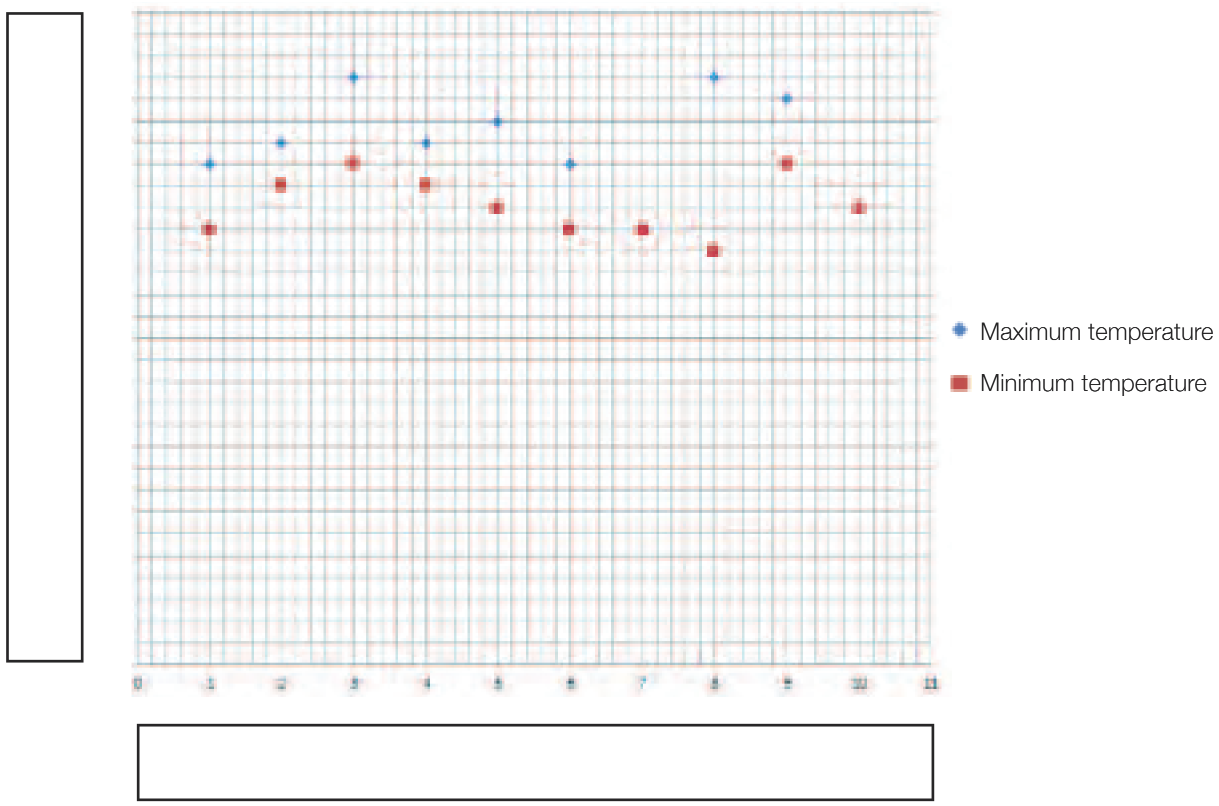
HANDLING DATA

TASK 2 – GLAZING

The extremes in temperature are causing expansion cracks in the plasterwork internally.

1. Label the axes below showing the maximum and minimum temperature in each classroom and decide what the scale on the vertical axis is.

Graph showing maximum and minimum temperatures



HANDLING DATA

TASK 2 – GLAZING

2. Using the table below, what is the mean maximum temperature for the classrooms?

Classroom	Maximum temperature	Minimum temperature
1	23	20
2	24	22
3	27	23
4	24	22
5	25	21
6	23	20
7	20	20
8	27	19
9	26	23
10	21	21

HANDLING DATA

TASK 2 – GLAZING

3. What is the mean minimum temperature for the classrooms?

4. How does the mean maximum temperature differ from the median maximum temperature?

HANDLING DATA

TASK 2 – GLAZING

5. Which classroom had the biggest range in temperature?

HANDLING DATA

TASK 2 – GLAZING

6. The recorded maximum temperature in classroom 1 was incorrect. When recalculated with this new value the mean maximum temperature for the classrooms becomes 23.9°C. What is the new maximum temperature of classroom 1?

HANDLING DATA

TASK 2 – GLAZING

7. The school decide to opt for aluminium double glazed Low-E glass windows. When fitted the maximum temperature in the classrooms on the ground floor are recorded over a 20 day period. The results are shown below.

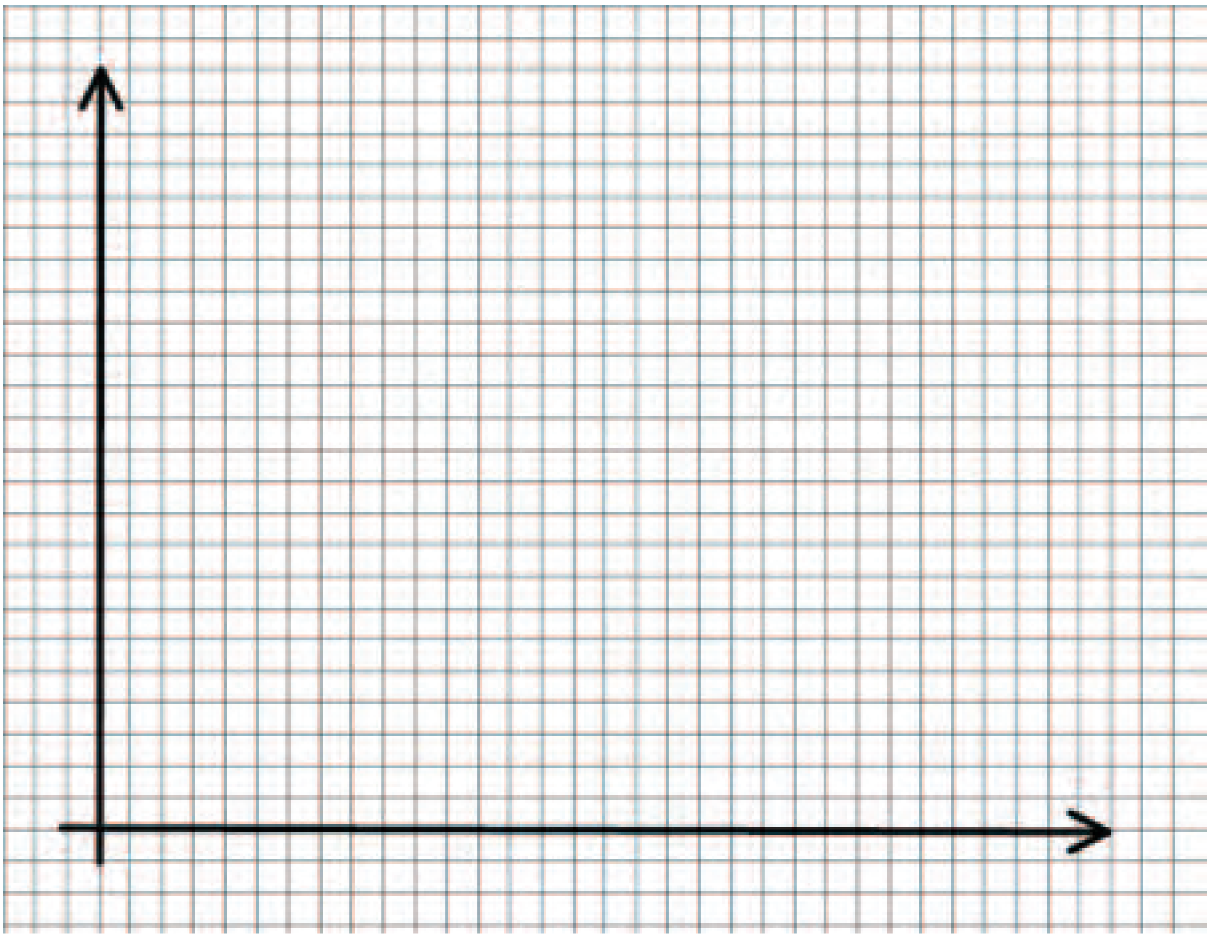
Maximum temperature	Frequency
17	2
18	5
19	4
20	6
21	2
22	1

What is the modal temperature? (To find the mode from a frequency table, look for the value with the highest frequency).

HANDLING DATA

TASK 2 – GLAZING

8. Draw a bar chart showing the temperatures in the classrooms now that the new windows have been fitted. Label your chart and choose an appropriate scale.



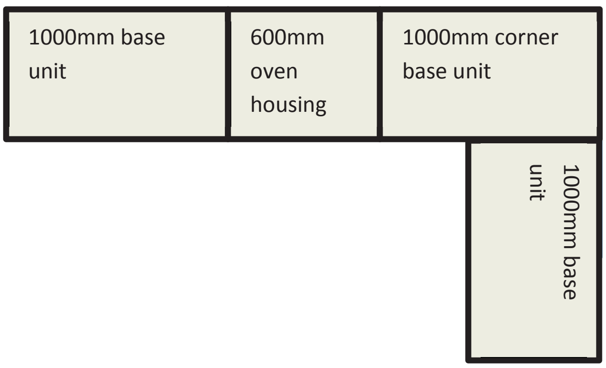
HANDLING DATA

TASK 3 - PLANNING A KITCHEN

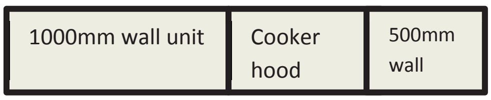
A customer has asked XYZ Joinery to price up a new kitchen. Having carried out measurements and with the client they have designed a layout that makes the best use of the space and meets the client's expectations. Based on the layout the units needed are:

- 2 x 1000mm base units
- 1 x 1000mm corner base unit
- 1 x 600mm built-under oven housing
- 1 x 1000mm wall unit
- 1 x integrated cooker hood door
- 1 x 500mm wall unit
- 2 x plinth
- 1 x 4.1m worktop

Base units



Wall units



HANDLING DATA

TASK 3 - PLANNING A KITCHEN

1. A local DIY store has a range of units that the client is considering. Complete the table below showing the prices for the kitchen the client has selected. Prices include door(s), handle(s), hinges and legs.

Slab style door in a cream high gloss finish

4.1m of Beech block worktop costs £125

Item	Price
2 x 1000mm base units	
1 x 1000mm corner base unit	
1 x 600mm built-under oven housing	
1 x 1000mm wall unit	
1 x integrated cooker hood door	
1 x 500mm wall unit	
2 x plinth	
1 x 4.1m worktop	
Total	

HANDLING DATA

TASK 3 - PLANNING A KITCHEN

2. As part of the quote you have allowed for the cost of the removal and disposal of the old kitchen, fitting of the new kitchen as well as the cost of appliances – integrated oven and hob as well as the sink and extractor-integrated hood. The breakdown of costs is shown below.

Removal of old kitchen	£200
Fitting of new Kitchen	£800
Integrated appliances	£459
Sink and taps	£183
Extractor – integrated hood	£63

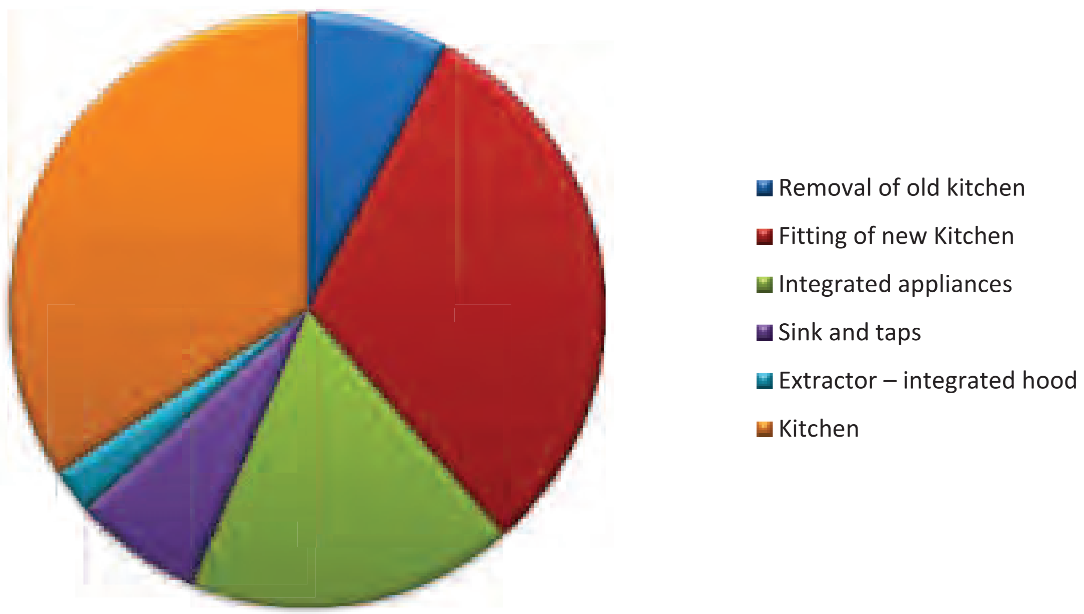
What is the total cost of the quote including the kitchen units (use your answer to question 1)?

HANDLING DATA

TASK 3 - PLANNING A KITCHEN

A pie chart shows how something is divided into parts.

**3. The pie chart below shows the costs above in the quote.
What does the pie chart show you?**



HANDLING DATA

TASK 3 - PLANNING A KITCHEN

To draw a pie chart, we need to represent each part of the data as a proportion of 360º, because there are 360º in a circle.

For example, if 1 out of 4 site operatives are under 25, we will represent this on the circle as a segment with an angle of: (1/4) x 360º = 90º

To draw a pie chart:

i. Find the total of the data
ii. To work out the angle of each segment, **work out the fraction of the total**
iii. There are 360° in a full turn, so to work out the angle, **multiply the fraction by 360º**
iv. Repeat this process to find the angle of the segments for the other segments
v. Check that the total angle sizes add up to 360º
vi. Once you have calculated the angles of the segments, construct the pie chart

4. The client has had a quote from another firm. The costs are below:

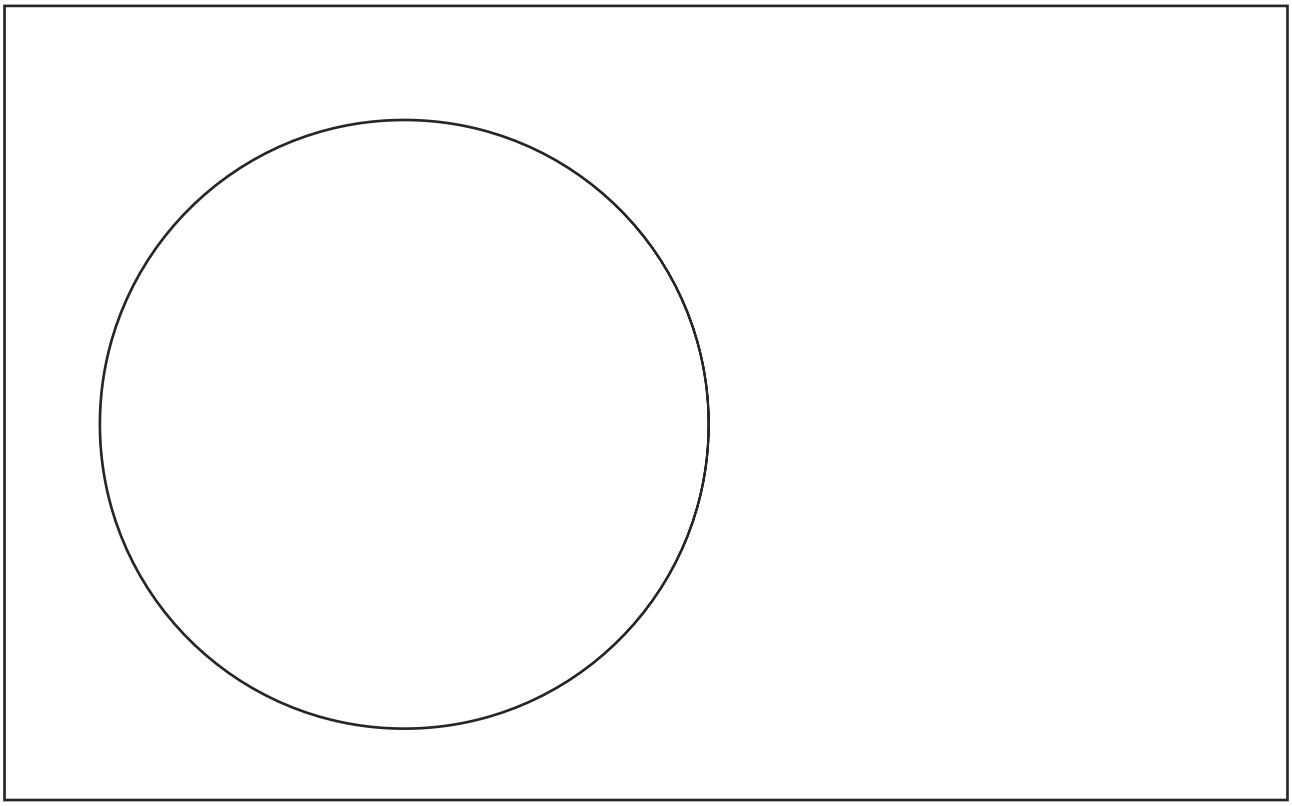
Removal of old kitchen	£180
Fitting of new Kitchen	£900
Integrated appliances	£720
Sink and taps	£230
Extractor – integrated hood	£90
Kitchen	£1,480

HANDLING DATA

TASK 3 - PLANNING A KITCHEN

Using this information draw a pie chart to represent the data. Don’t forget to give the pie chart a title.

A table to help you calculate the segment sizes has been started for you below.



		Fraction of total	Angle size
Removal of old kitchen	£180	180/3600	180/3600 x 360º = 10º
Fitting of new Kitchen	£900		
Integrated appliances	£720		
Sink and taps	£230		
Extractor – integrated hood	£90		
Kitchen	£1,480		
Total			

HANDLING DATA

TASK 3 - PLANNING A KITCHEN

5. What does the pie chart show you about the breakdown of costs from this firm compared to XYZ Joinery?

HANDLING DATA

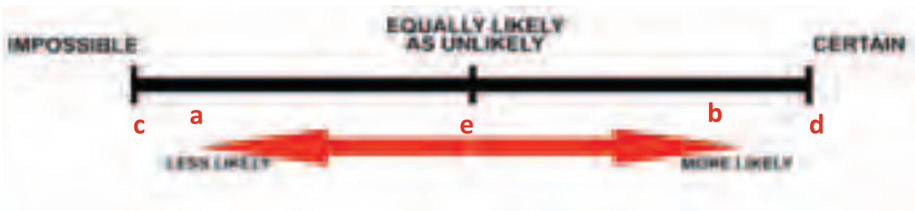
TASK 4 - MEASURING UNCERTAINTY

Probability is a branch of mathematics used to measure uncertainty. In life the outcome of many events is not predictable but it is possible to get an idea of how likely some things are to happen. Being able to tell how likely something is to happen is very important in construction especially when it comes to health and safety and deciding on how to price large or long-term projects.

A scale is used to represent probability with “Impossible” at one end and “Certain” at the other. All other outcomes can be placed somewhere on the scale between these two extremes. Things that are unlikely are placed near the Impossible end whilst things likely to happen are placed near the Certain end. We can use common sense to place some outcomes on the scale…

1. For example, place the following outcomes on the probability scale below

a. Someone chosen at random from a construction trade is a woman
b. Someone who does not follow any safety guidelines has an accident
c. A mortar mixture will harden if someone forgot to add cement
d. A warm but poorly insulated building will lose heat on a cold day
e. Someone chosen at random from the community is a man



HANDLING DATA

TASK 4 - MEASURING UNCERTAINTY

Sometimes we cannot just tell from common sense how likely an outcome is or whether one outcome is more likely than another. In order to tell if some outcomes are more likely than others we need to represent probabilities using fractions. The top of the fraction is the number of favourable outcomes and the bottom of the fraction is the number of possible outcomes.

$$\text{Probability} = \frac{\text{Number of favourable outcomes}}{\text{Number of possible outcomes}}$$

2. Complete the following table to help you practice working with different kinds of fractions and then you can try to answer some probability questions.

Fraction	Decimal	Percentage	Outcome description
0			Impossible
	0.08	8	
		25	Unlikely
1/2			Just as likely as not to happen
	0.75		
		95	Very likely
1			

Use the definition of probability given above to determine how probable the following events are to happen.

3. A local construction company has purchased 5 brand new diggers. Two of them have a telescopic jib. If a driver chooses a digger to use at random what is the probability it will have a telescopic jib?

HANDLING DATA

TASK 4 - MEASURING UNCERTAINTY

4. What is the probability it won't have telescopic jib?

5. If you have not already done so express your answers to the latter two questions in percentage form.

6. What do you notice about the answers when you add them together?

7. The probability of a digger breaking down in service is 0.065. Use what you have learned in the previous question to determine the probability that a digger will not break down in service.

HANDLING DATA

TASK 4 - MEASURING UNCERTAINTY

8. Write down a rule to help you find the probability of something not happening if you already know the probability of it happening.

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY

As mentioned in the previous task one important use of probability in construction is for considering aspects of health and safety. You can now try to apply what you have learned already to the following scenario:

A Safety at Work study (figures not official) has been carried out for the construction industry. It has been determined there is a 1.5% chance an operative (18-65 years old) will have an accident whilst driving machinery.

1. What is the probability that an operative will not have an accident whilst driving machinery?

2. If 1.5% of the 27000 operatives working in Northern Ireland have an accident when using machinery, how many would that be?

HANDLING DATA

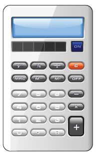
TASK 5 - EVERYDAY PROBABILITY

The study also looked at the safety of pneumatic drills and found that there is a 1 in 80 (that's 1.25%) chance an operative will have an accident whilst using one.

3. Which of the activities appears to be more accident prone, driving machinery or using a pneumatic drill?

Of the 27000 operatives referred to above, 1500 of them are over 50 years old.

4. What is the probability that an operative is 50 or under?



HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY

There are nine different tasks given to operatives in one company. Four involve driving machines, three involve using pneumatic drills and two involve the use of hand tools.

5. What is the probability an operative will be given a task involving a pneumatic drill?

6. What is the probability that the operative will NOT be given a task involving a pneumatic drill?

7. What is the probability that the operative will be given a task involving use of hand tool?

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY

So far in this task we have considered single events but sometimes in construction you will need to consider the probability of two events together (combined events) or perhaps the impact of one event on another event.

Peter works for a large construction company which has purchased a new fleet of vehicles. The fleet consists of ten vehicles and five of them have air-conditioning in the cab.

When drivers arrive for work in the morning they collect a key for the vehicle in the main office and keys are handed out randomly.

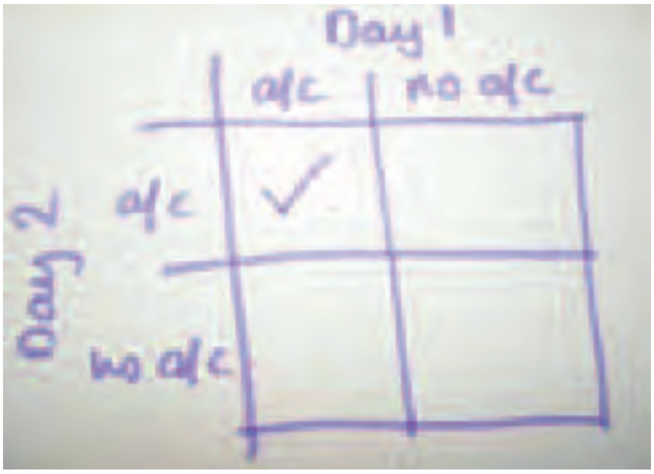
8. What does "handed out randomly" mean?

9. What is the probability that on any given morning a driver will get a vehicle with air conditioning?

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY

One driver was happy because he had got an air-conditioned vehicle two mornings in a row. Peter decided he would try to work out how likely it is for this to happen. The picture below shows the table Peter used to help him get an answer.



From the diagram Peter concluded that any driver has a 1 in 4 or (25%) chance of getting an air conditioned vehicle 2 days in a row.

Later in the week one of the vehicles (without air-con) broke down and went into the garage for repairs. During this time the fleet was reduced to nine vehicles. Peter instinctively felt that this should make it more likely for a driver to get an air-con vehicle on any given morning and also for two mornings in a row. He decided he would try to calculate what the probability for each of these would be.

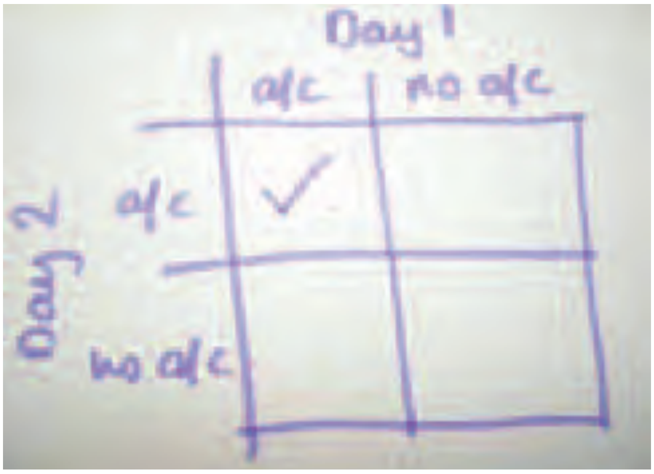
10. What do you think he got for the probability of getting an air-con vehicle on any given morning? Use the definition of probability below to help work this out!

$$\textbf{Probability} = \frac{\textbf{Number of favourable outcomes}}{\textbf{Number of possible outcomes}}$$

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY

When it came to working out the probability of getting a vehicle with air-con two mornings in a row he referred to the table he had constructed earlier. Here it is again.



Peter was confused when he looked at the table as it seemed to suggest the answer would be 1 in 4 as before. He knew this could not be correct but could not see why. Help explain what is wrong with Peter's approach to solving this problem.

You may want to begin by checking whether his original answer of 25% is correct. To help with this answer the following questions

11. How many possible outcomes are there for selecting a vehicle two days in row in terms of whether it will have air-con or not? List them in words or symbols!

List: Count:

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY

12. Are these outcomes equally likely? If so show why!

13. You should now be in a position to tell if his original answer of 25% is correct?

Is 25% correct?	Yes	No

14. Why did Peter's approach mislead him when he tried to repeat the calculation for the reduced fleet of 9 vehicles (5 with air-con and 4 without air-con)? Answer this in words!

Hint: consider the range of possible outcomes and whether or not they are equally likely.

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY

15. In the space below use a method (diagram) of your choice to outline the problem showing all possible outcomes?

Hint: In choosing a method, remember that a two-way table is better suited to problems where all possible outcomes are equally likely. For other combined situations it may be wiser to set the problem out using a tree diagram?

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE ANSWERS

Government legislation had required all commercial and residential properties; being sold, built or leased, to make available an energy performance certificate to prospective purchasers or tenants. This enabled people to make more informed decisions relating to the energy efficiency of a property and the on-going costs of fuel. Public buildings were also assessed for their efficiency.

Therefore it is important to be aware of the insulation values of various building materials.

By average insulation we mean the typical value. There is more than one type of average.

Example:

Look at the table below showing the sizes of various bricks.

	Length of brick (excluding joint)	Height of brick (excluding joint)
Metric	215mm	50mm
Metric	215mm	65mm
Imperial	225mm	67mm
Imperial	230mm	70mm
Imperial	230mm	73mm
Imperial	230mm	76mm
Imperial	230mm	80mm

Range = highest value – lowest value

The range in brick lengths is therefore 230 – 215 = 15mm

The range in heights of the brick = 80 – 50 = 30mm

Mean
This is the most commonly used average. The mean is calculated by adding up the numbers in the list and dividing that answer by how many numbers in the list. This is the only type of average that takes into account all the numbers in the sample.

It is easy to calculate: Just **add up** all the numbers, then **divide by how many** numbers there are.

e.g. $$\textbf{Mean} = \frac{\textbf{Total}}{\textbf{Number of values}}$$

$$\textbf{Mean} = \frac{50 + 65 + 67 + 70 + 73 + 76 + 80}{7} = \frac{481}{7}$$

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE ANSWERS

Mean brick height = 68.714…

Mean brick height = 68.7mm to 1 decimal place

Mode

The mode is another type of average. It describes the most common value in the set of numbers.

e.g. The modal length of brick is 230mm

Median

This type of average is the middle value and requires the numbers to be in order.

e.g. The median height of brick is

50, 65, 67, 70, 73, 76, 80

70mm

If there are two middle values, add them together and divide by 2.

e.g.

If the ages of apprentices on a site are: 23, 25, 18, 17, 35, 17 what is the median age?

Rewrite in ascending order

17, 17, 23, 25, 25, 35

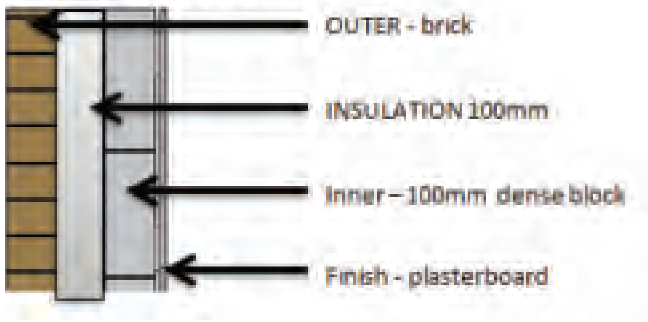
The middle values are 23 and 25, so the median age will be $\frac{\mathbf{23 + 25}}{\mathbf{2}}$ **= 24**

HANDLING DATA

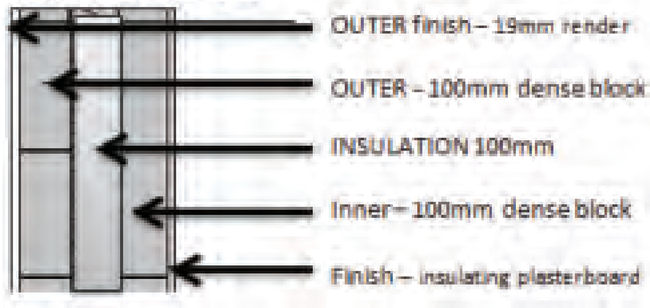
TASK 1 – ENERGY PERFORMANCE CERTIFICATE ANSWERS

Aggregate block solutions

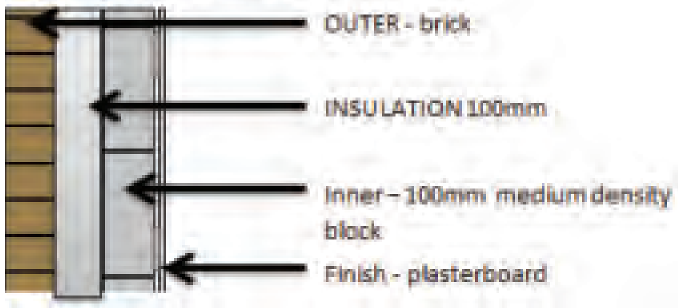
Option 1 U Value = 0.30



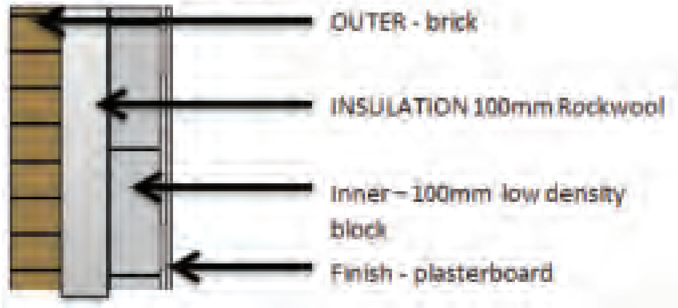
Option 2 U Value = 0.29



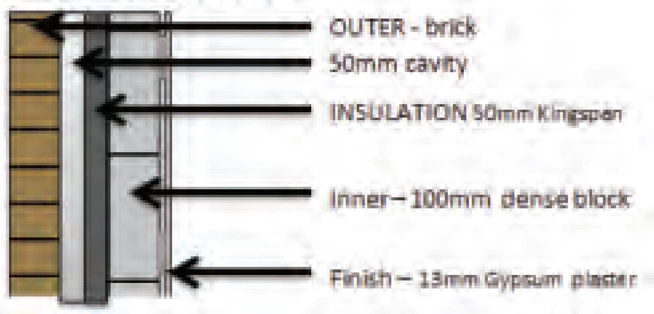
Option 3 U Value = 0.27



Option 4 U Value = 0.28



Option 5 U Value = 0.30



Option 6 U Value = 0.28

Option 7 U Value = 0.25

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE ANSWERS

Although the performance values of the building envelope will depend on factors such as fuel type and heating efficiency it is recommended that wall U values of around 0.30 W/m^{2}K are achieved. The above aggregate block solutions meet this level of performance and are applicable to any type of building.

1. What is the range of U values for the aggregate block solutions shown above?

0.3 – 0.25 = 0.05

2. Find the modal U value for the aggregate block solutions shown.

0.3	**0.29**	**0.27**	**0.28**	**0.3**	**0.28**	**0.25**

0.3 and 0.28 are the modal values

3. What is the median U value of the aggregate block solutions shown?

0.3	0.29	0.27	0.28	0.3	0.28	0.25

Write in ascending order

0.25	**0.27**	**0.28**	**0.28**	**0.29**	**0.3**	**0.3**
0.25	**0.27**	**0.28**	**0.28**	**0.29**	**0.3**	**0.3**

Find the middle value

0.28 W/m2K is the median value

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE ANSWERS

4. What is the mean U value of the aggregate block solutions shown?

$$\text{Mean} = \frac{\text{sum of all values}}{\text{number of values}}$$

0.25 + 0.27 + 0.28 + 0.28 + 0.29 + 0.3 + 0.3

$$\frac{1.97}{7} = 0.28142$$

The mean U value is 0.28142 W/m²K

There is an enormous difference in the level of heat loss (called the U-value) of different types of windows related to the types of frame and glazing:

Window	U-VALUE (heat loss per square metre)
Single glazed, solid metal frame	5.6
Single glazed, wood frame	4.3
Double glazed, solid metal frame	3.9
Double glazed PVC / wood frame	2.5
Double glazed PVC / wood frame, argon and low-e glass	1.6
PVC Triple PVC / wood frame	1.5
PVC Triple PVC / wood frame, argon and low-e glass	1.3

5. What is the range of U values for the windows described in the table above?

5.6 – 1.3 = 4.3 W/m²K

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE ANSWERS

6. Which type of window frame has the median U value?

Double glazed PVC / wood frame

Building regulations that relate to energy efficiency have been revised several times in line with the need for increased energy efficiency, and to reduce the impact buildings have on global warming. This has meant significant changes to the thickness of insulation required for buildings. From May 2003, it became a legal requirement that thermal insulation products for buildings are tested to and comply with the Construction Products Regulations.

The best insulation materials should have the lowest thermal conductivity (thermal conductivity of a material describes how easily heat passes through it), in order to reduce heat loss. This means, less insulating material will be required..

Insulation Materials	Thermal conductivity W/mK
Extruded polystyrene (XPS) with CO2	0.035
Polyurethane (PU) with pentane	0.025
Foil-faced polyurethane (PU) with pentane	0.025
Polyurethane (PU) with CO2	0.02
Polyisocyanurate (PIR)	0.02
Mineral wool (glass) *≤ 160kg/m^3]	0.035
Sheep’s wool	0.045
Cellulose fibre (recycled)	0.04

7. What is the range of thermal conductivity values for the insulation materials listed?

0.045-0.02=0.025 W/m^2K

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE ANSWERS

8. Which of the insulation materials listed would you recommend and why?

The type of insulation you would recommend will depend on what you want to use it for, budget and access issues.

9. For an average semi-detached house it is estimated that you will need 33 rolls of eco-wool insulation. The price per roll from a range of suppliers is shown below.

Supplier	Cost
1	£16.99
2	£18.97
3	£15.98
4	£17.77
5	£16.99

What is the range of costs of the insulation for the semi-detached house?

£18.97 - £15.98 = £2.99

HANDLING DATA

TASK 1 – ENERGY PERFORMANCE CERTIFICATE ANSWERS

10. What is the median and modal cost of insulation?

Put the prices in order of size to find the median

£15.98 £16.99 £16.99 £17.77 £18.97

Median price = £16.99

Modal price = £16.99

11. What is the mean cost of insulation from the various suppliers? How does this differ from the median and modal price?

$$\text{Mean} = \frac{\text{sum of all values}}{\text{number of values}}$$

Sum of all values = £15.98 + £16.99 + £16.99 + £17.77 + £18.97 = £86.68

$$\text{Mean} = \frac{£86.70}{5} = £17.34$$

The mean price is 35p more than the median and modal price

12. Using the cheapest supplier, calculate the cost of 33 rolls of insulation.

33 × £15.98 = £527.34

HANDLING DATA

TASK 2 – GLAZING ANSWERS

A local primary school is concerned that the large glass windows in the ground floor corridor are causing high temperatures in the rooms in summer term. They are investigating the option of heat efficient glass so that in the summer, infrared radiation from the sun is reflected away, keeping the rooms cooler and in winter, radiant heat from inside the room can be reflected back inside, thereby keeping heat inside in the winter.

Low Emissivity glass (Low E-Glass) can reflect 40% - 70% of the heat that is normally transmitted through the glass. It is now a standard requirement under Building Regulations for many homes in the UK.

The maximum and minimum temperature of each classroom during the course of the day is recorded and results are shown below.

Classroom	Maximum temperature	Minimum temperature
1	23	20
2	24	22
3	27	23
4	24	22
5	25	21
6	23	20
7	20	20
8	27	19
9	26	23
10	21	21

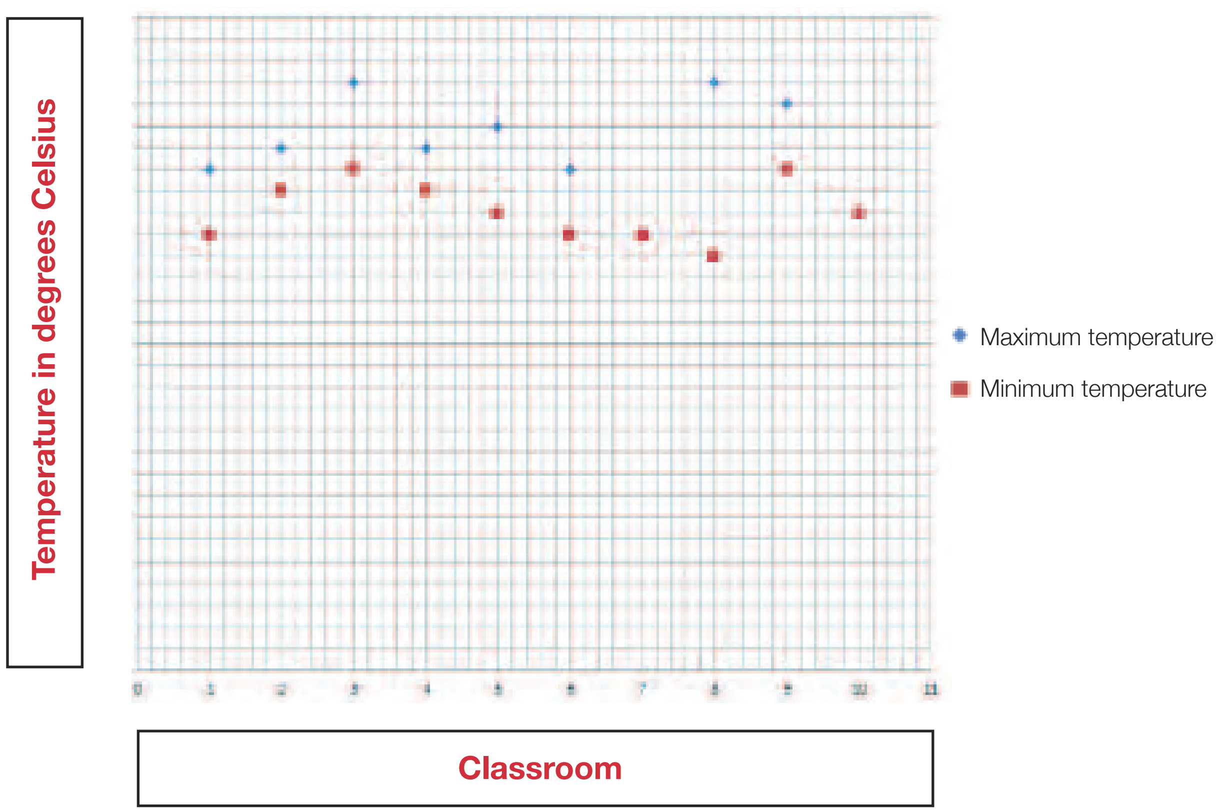
HANDLING DATA

TASK 2 – GLAZING ANSWERS

The extremes in temperature are causing expansion cracks in the plasterwork internally.

1. Label the axes below showing the maximum and minimum temperature in each classroom and decide what the scale on the vertical axis is.

Graph showing maximum and minimum temperatures



HANDLING DATA

TASK 2 – GLAZING ANSWERS

2. Using the table below, what is the mean maximum temperature for the classrooms?

Classroom	Maximum temperature	Minimum temperature
1	23	20
2	24	22
3	27	23
4	24	22
5	25	21
6	23	20
7	20	20
8	27	19
9	26	23
10	21	21

Total the maximum temperatures :

Classroom	Maximum temperature
1	23
2	24
3	27
4	24
5	25
6	23
7	20
8	27
9	26
10	21
Total	240

Then divide the total by the number of items. $\frac{240}{10} = 24°C$

HANDLING DATA

TASK 2 – GLAZING ANSWERS

3. What is the mean minimum temperature for the classrooms?

Total the maximum temperatures :

Classroom	Maximum temperature
1	20
2	22
3	23
4	22
5	21
6	20
7	20
8	19
9	23
10	21
Total	211

Then divide the total by the number of items. $\frac{211}{10}$ **= 21.1°C**

4. How does the mean maximum temperature differ from the median maximum temperature?

To find the Median – put the temperatures in ascending order.

20	21	23	23	**24**	**24**	25	26	27	27

When there are two middle values you take the average of the two. However in this case both values are the same so the median value is 24°C.

The mean and median temperatures are the same.

HANDLING DATA

TASK 2 – GLAZING ANSWERS

5. Which classroom had the biggest range in temperature?

Range = biggest – smallest value

Classroom	Maximum temperature	Minimum temperature	Range
1	23	20	**3**
2	24	22	**2**
3	27	23	**4**
4	24	22	**2**
5	25	21	**4**
6	23	20	**3**
7	20	20	**0**
8	27	19	**8**
9	26	23	**3**
10	21	21	**0**

The biggest range in temperature was in classroom 8.

HANDLING DATA

TASK 2 – GLAZING ANSWERS

6. The recorded maximum temperature in classroom 1 was incorrect. When recalculated with this new value the mean maximum temperature for the classrooms becomes 23.9°C. What is the new maximum temperature of classroom 1?

Classroom	Maximum temperature
1	
2	24
3	27
4	24
5	25
6	23
7	20
8	27
9	26
10	21
Total	

Mean = 23.9°C

$$\textbf{Mean} = \frac{\text{sum of all values}}{\text{number of values}} = 23.9 = \frac{\text{total}}{10}$$

Total = 23.9 × 10 = 239

239 – Temperatures in classrooms 2 to 9 = 21°C

Hence temperature in classroom 1 is 21°C

HANDLING DATA

TASK 2 – GLAZING ANSWERS

7. The school decide to opt for aluminium double glazed Low-E glass windows. When fitted the maximum temperature in the classrooms on the ground floor are recorded over a 20 day period. The results are shown below.

Maximum temperature	Frequency
17	2
18	5
19	4
20	6
21	2
22	1

What is the modal temperature? (To find the mode from a frequency table, look for the value with the highest frequency).

To find the mode from a frequency table, look for the value with the highest frequency.

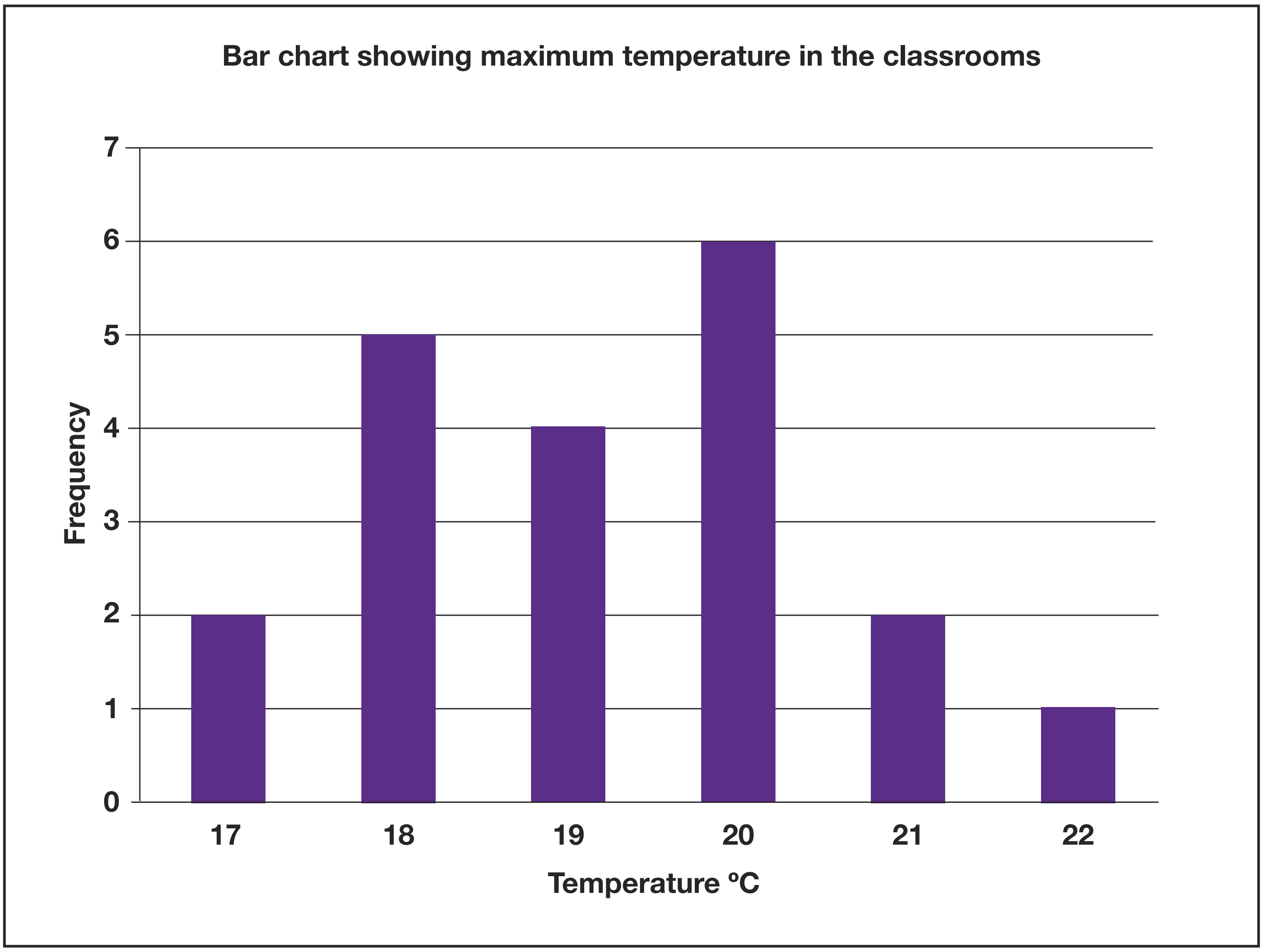
Maximum temperature	Frequency
17	2
18	5
19	**4**
20	6
21	2
22	1

The highest frequency temperature is 20ºC – this is the modal temperature.

HANDLING DATA

TASK 2 – GLAZING ANSWERS

8. Draw a bar chart showing the temperatures in the classrooms now that the new windows have been fitted. Label your chart and choose an appropriate scale.



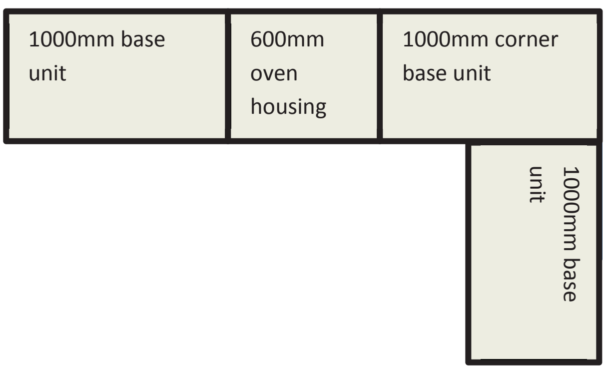
HANDLING DATA

TASK 3 - PLANNING A KITCHEN ANSWERS

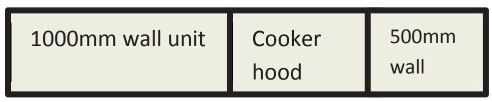
A customer has asked XYZ Joinery to price up a new kitchen. Having carried out measurements and with the client they have designed a layout that makes the best use of the space and meets the client's expectations. Based on the layout the units needed are:

- 2 x 1000mm base units
- 1 x 1000mm corner base unit
- 1 x 600mm built-under oven housing
- 1 x 1000mm wall unit
- 1 x integrated cooker hood door
- 1 x 500mm wall unit
- 2 x plinth
- 1 x 4.1m worktop

Base units



Wall units



HANDLING DATA

TASK 3 - PLANNING A KITCHEN ANSWERS

1. A local DIY store has a range of units that the client is considering. Complete the table below showing the prices for the kitchen the client has selected. Prices include door(s), handle(s), hinges and legs.

Slab style door in a cream high gloss finish

4.1m of Beech block worktop costs £125

Item	Price
2 x 1000mm base units	£256
1 x 1000mm corner base unit	£121
1 x 600mm built-under oven housing	£71
1 x 1000mm wall unit	£113
1 x integrated cooker hood door	£55
1 x 500mm wall unit	£91
2 x plinth	£54
1 x 4.1m worktop	£125
Total	£886

HANDLING DATA

TASK 3 - PLANNING A KITCHEN ANSWERS

2. As part of the quote you have allowed for the cost of the removal and disposal of the old kitchen, fitting of the new kitchen as well as the cost of appliances – integrated oven and hob as well as the sink and extractor-integrated hood. The breakdown of costs is shown below.

Removal of old kitchen	£200
Fitting of new Kitchen	£800
Integrated appliances	£459
Sink and taps	£183
Extractor – integrated hood	£63

What is the total cost of the quote including the kitchen units (use your answer to question 1)?

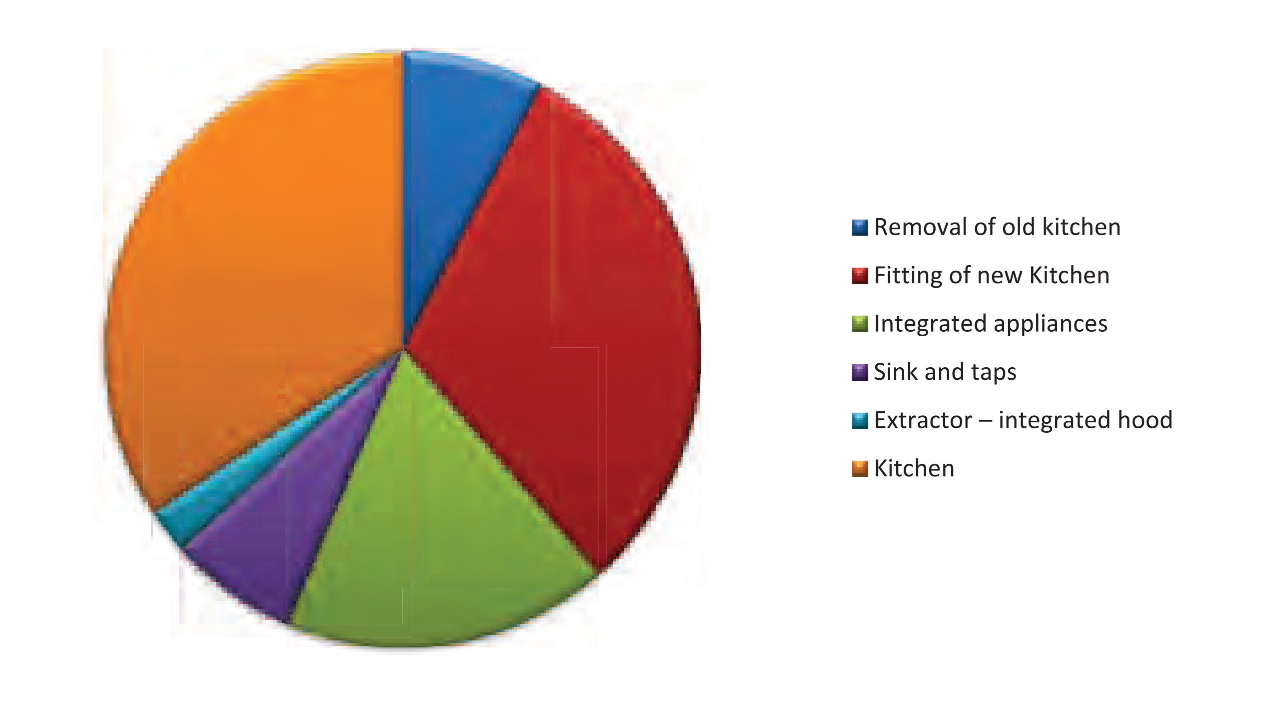
Removal of old kitchen	£200
Fitting of new Kitchen	£800
Integrated appliances	£459
Sink and taps	£183
Extractor – integrated hood	£63
Kitchen	£886
Total	£2,591

HANDLING DATA

TASK 3 - PLANNING A KITCHEN ANSWERS

A pie chart shows how something is divided into parts.

3. The pie chart below shows the costs above in the quote. What does the pie chart show you?



The main cost in the quote is the kitchen units. The cost of removing and disposing of the old kitchen is relatively small.

HANDLING DATA

TASK 3 - PLANNING A KITCHEN ANSWERS

To draw a pie chart, we need to represent each part of the data as a proportion of 360º, because there are 360º in a circle.

For example, if 1 out of 4 site operatives are under 25, we will represent this on the circle as a segment with an angle of: (1/4) x 360º = 90º

To draw a pie chart:

i. Find the total of the data
ii. To work out the angle of each segment, **work out the fraction of the total**
iii. There are 360° in a full turn, so to work out the angle, **multiply the fraction by 360º**
iv. Repeat this process to find the angle of the segments for the other segments
v. Check that the total angle sizes add up to 360º
vi. Once you have calculated the angles of the segments, construct the pie chart

4. The client has had a quote from another firm. The costs are below:

Removal of old kitchen	£180
Fitting of new Kitchen	£900
Integrated appliances	£720
Sink and taps	£230
Extractor – integrated hood	£90
Kitchen	£1,480

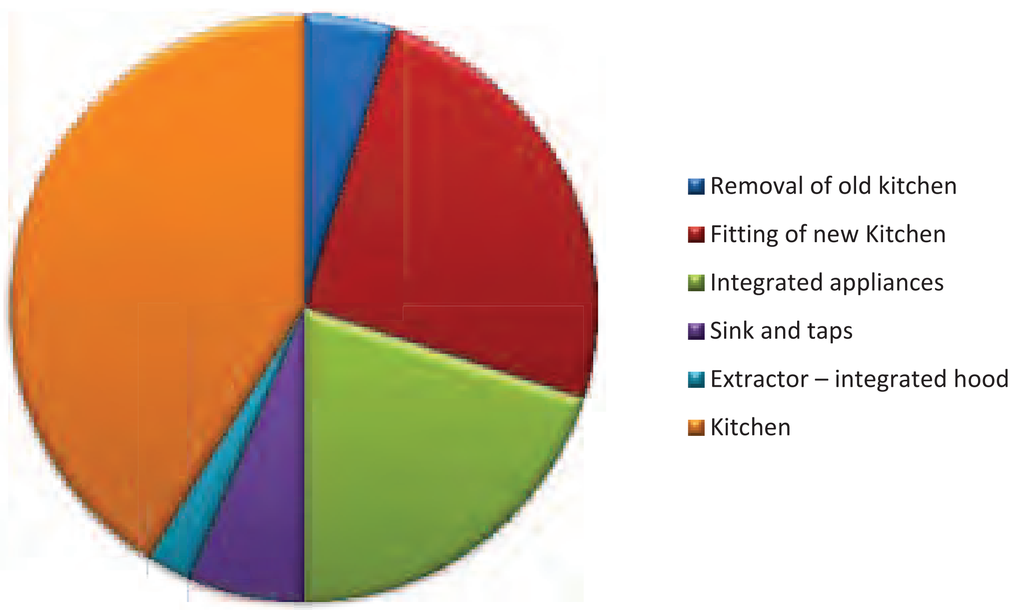
HANDLING DATA

TASK 3 - PLANNING A KITCHEN ANSWERS

Using this information draw a pie chart to represent the data. Don't forget to give the pie chart a title.

A table to help you calculate the segment sizes has been started for you below.

Pie chart showing breakdown of costs from the second firm



		Fraction of total	Angle size
Removal of old kitchen	£180	180/3600	180/3600 x 360° = 18°
Fitting of new Kitchen	£900	900/3600	900/3600 x 360° = 90°
Integrated appliances	£720	720/5600	720/5600 x 360° = 72°
Sink and taps	£230	250/5600	250/5600 x 360° = 23°
Extractor – integrated hood	£90	90/3600	1480/3600 x 360° = 9°
Kitchen	£1,480	1480/3600	1480/3600 x 360° = 148°
Total			360°

HANDLING DATA

TASK 3 - PLANNING A KITCHEN ANSWERS

5. What does the pie chart show you about the breakdown of costs from this firm compared to XYZ Joinery?

The proportion spent on each aspect of the job compared to the overall cost is approximately the same. But the overall cost is more.

HANDLING DATA

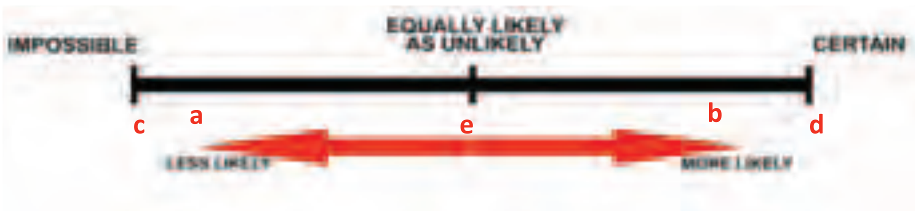
TASK 4 - MEASURING UNCERTAINTY ANSWERS

Probability is a branch of mathematics used to measure uncertainty. In life the outcome of many events is not predictable but it is possible to get an idea of how likely some things are to happen. Being able to tell how likely something is to happen is very important in construction especially when it comes to health and safety and deciding on how to price large or long-term projects.

A scale is used to represent probability with “Impossible” at one end and “Certain” at the other. All other outcomes can be placed somewhere on the scale between these two extremes. Things that are unlikely are placed near the Impossible end whilst things likely to happen are placed near the Certain end. We can use common sense to place some outcomes on the scale…

1. For example, place the following outcomes on the probability scale below

a. Someone chosen at random from a construction trade is a woman
b. Someone who does not follow any safety guidelines has an accident
c. A mortar mixture will harden if someone forgot to add cement
d. A warm but poorly insulated building will lose heat on a cold day
e. Someone chosen at random from the community is a man



a. unlikely so near the Impossible end.
b. likely but not certain, quite near Certain end
c. Impossible
d. Certain
e. equally likely as unlikely so in the middle of the scale

HANDLING DATA

TASK 4 - MEASURING UNCERTAINTY ANSWERS

Sometimes we cannot just tell from common sense how likely an outcome is or whether one outcome is more likely than another. In order to tell if some outcomes are more likely than others we need to represent probabilities using fractions. The top of the fraction is the number of favourable outcomes and the bottom of the fraction is the number of possible outcomes.

$$\text{Probability} = \frac{\text{Number of favourable outcomes}}{\text{Number of possible outcomes}}$$

2. Complete the following table to help you practice working with different kinds of fractions and then you can try to answer some probability questions.

Fraction	Decimal	Percentage	Outcome description
0	**0**	**0**	Impossible
2/25	0.08	8	**Very unlikely**
1/4	**0.25**	25	Unlikely
1/2	**0.5**	**50**	Just as likely as not to happen
3/4	0.75	**75**	**Likely**
19/20	**0.95**	95	Very likely
1	**1**	**100**	**Certain**

Use the definition of probability given above to determine how probable the following events are to happen.

3. A local construction company has purchased 5 brand new diggers. Two of them have a telescopic jib. If a driver chooses a digger to use at random what is the probability it will have a telescopic jib?

2/5

HANDLING DATA

TASK 4 - MEASURING UNCERTAINTY ANSWERS

4. What is the probability it won't have telescopic jib?

3/5

5. If you have not already done so express your answers to the latter two questions in percentage form.

40% and 60%

6. What do you notice about the answers when you add them together?

They add to 100%

7. The probability of a digger breaking down in service is 0.065. Use what you have learned in the previous question to determine the probability that a digger will not break down in service.

0.065= 6.5%

6.5% + 93.5% = 100%

So required probability is 93.5% or 0.935

HANDLING DATA

TASK 4 - MEASURING UNCERTAINTY ANSWERS

8. Write down a rule to help you find the probability of something not happening if you already know the probability of it happening.

probability of happening + probability of not happening = 100%

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY ANSWERS

As mentioned in the previous task one important use of probability in construction is for considering aspects of health and safety. You can now try to apply what you have learned already to the following scenario:

A Safety at Work study (figures not official) has been carried out for the construction industry. It has been determined there is a 1.5% chance an operative (18-65 years old) will have an accident whilst driving machinery.

1. What is the probability that an operative will not have an accident whilst driving machinery?

100 – 1.5 = 98.5%

or

1-0.015 = 0.985

2. If 1.5% of the 27000 operatives working in Northern Ireland have an accident when using machinery, how many would that be?

27000 ÷ 100 = 270 (i.e. 1%)
½ of 270 = 135 (i.e. 0.5% or half of 1%)

therefore 1.5% of 27000 = 270 + 135 = 405

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY ANSWERS

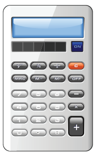
The study also looked at the safety of pneumatic drills and found that there is a 1 in 80 (that's 1.25%) chance an operative will have an accident whilst using one.

3. Which of the activities appears to be more accident prone, driving machinery or using a pneumatic drill?

1.5% is more than 1.25% so driving machinery is more accident prone based on this information.

Of the 27000 operatives referred to above, 1500 of them are over 50 years old.

4. What is the probability that an operative is 50 or under?



Directly
27000 – 1500 = 25500 so
25500/27000 = 255/270 = 17/18

Indirectly
1500/27000 = 15/270 = 1/18 so
1 – 1/18 = 17/18

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY ANSWERS

There are nine different tasks given to operatives in one company. Four involve driving machines, three involve using pneumatic drills and two involve the use of hand tools.

5. What is the probability an operative will be given a task involving a pneumatic drill?

3/9 = 1/3

6. What is the probability that the operative will NOT be given a task involving a pneumatic drill?

1 – 3/9 = 6/9 = 2/3

7. What is the probability that the operative will be given a task involving use of hand tool?

2/9

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY ANSWERS

So far in this task we have considered single events but sometimes in construction you will need to consider the probability of two events together (combined events) or perhaps the impact of one event on another event.

Peter works for a large construction company which has purchased a new fleet of vehicles. The fleet consists of ten vehicles and five of them have air-conditioning in the cab.

When drivers arrive for work in the morning they collect a key for the vehicle in the main office and keys are handed out randomly.

8. What does “handed out randomly” mean?

Handed out randomly means the keys are not selected with any plan or purpose. This means that all of the keys are equally likely to be selected.

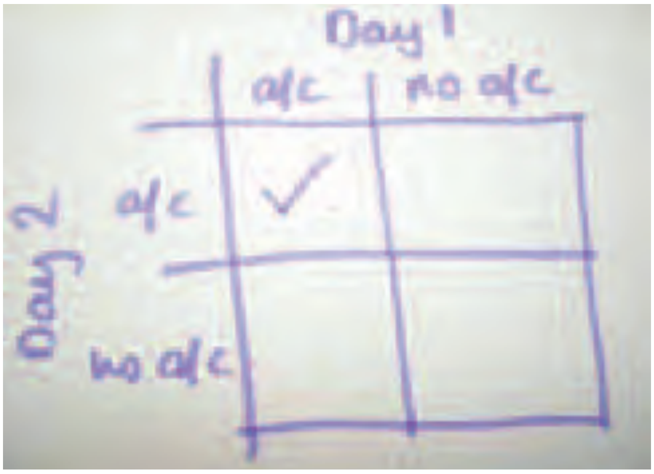
9. What is the probability that on any given morning a driver will get a vehicle with air conditioning?

5/10 = ½ or 50%

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY ANSWERS

One driver was happy because he had got an air-conditioned vehicle two mornings in a row. Peter decided he would try to work out how likely it is for this to happen. The picture below shows the table Peter used to help him get an answer.



From the diagram Peter concluded that any driver has a 1 in 4 or (25%) chance of getting an air conditioned vehicle 2 days in a row.

Later in the week one of the vehicles (without air-con) broke down and went into the garage for repairs. During this time the fleet was reduced to nine vehicles. Peter instinctively felt that this should make it more likely for a driver to get an air-con vehicle on any given morning and also for two mornings in a row. He decided he would try to calculate what the probability for each of these would be.

10. What do you think he got for the probability of getting an air-con vehicle on any given morning? Use the definition of probability below to help work this out!

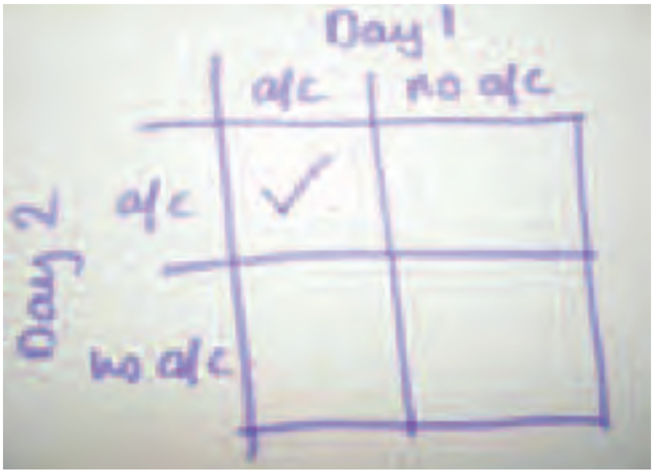
$$\textbf{Probability} = \frac{\textbf{Number of favourable outcomes}}{\textbf{Number of possible outcomes}}$$

5/9

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY ANSWERS

When it came to working out the probability of getting a vehicle with air-con two mornings in a row he referred to the table he had constructed earlier. Here it is again.



Peter was confused when he looked at the table as it seemed to suggest the answer would be 1 in 4 as before. He knew this could not be correct but could not see why. Help explain what is wrong with Peter's approach to solving this problem.

You may want to begin by checking whether his original answer of 25% is correct. To help with this answer the following questions

11. How many possible outcomes are there for selecting a vehicle two days in row in terms of whether it will have air-con or not? List them in words or symbols!

List:

(Day1 a/c & Day2 a/c)   (Day1 a/c & Day2 no a/c)

(Day1 no a/c & Day2 a/c) (Day1 no a/c & Day 2 no a/c)

Count:

4 possible outcomes

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY ANSWERS

12. Are these outcomes equally likely? If so show why!

Prob of Day1 a/c = Prob of Day1 no a/c = Prob of Day2 a/c =

Prob of Day2 no a/c = 0.5

Thus all four of the outcomes above are equally likely.

13. You should now be in a position to tell if his original answer of 25% is correct?

Is 25% correct? **Yes** No

14. Why did Peter's approach mislead him when he tried to repeat the calculation for the reduced fleet of 9 vehicles (5 with air-con and 4 without air-con)? Answer this in words!

Hint: consider the range of possible outcomes and whether or not they are equally likely.

The outcomes are not equally likely:

Prob of Day1 a/c = Prob of Day2 a/c = 5/9 BUT

Prob of Day1 no a/c = Prob of Day2 no a/c = 4/9

HANDLING DATA

TASK 5 - EVERYDAY PROBABILITY ANSWERS

15. In the space below use a method (diagram) of your choice to outline the problem showing all possible outcomes?

Hint: In choosing a method, remember that a two-way table is better suited to problems where all possible outcomes are equally likely. For other combined situations it may be wiser to set the problem out using a tree diagram?