MathsMadeEasy

GCSE Mathematics

Non Calculator
Higher Tier
Free Practice Set 3
1 hour 45 minutes

ANSWERS

Marks shown in brackets for each question (2)

A*	A	B	C	D	E
88	75	60	45	25	15

Legend used in answers

Green Box - Working out

5b means five times b
b = – 3 so 5 × – 3 = –15

Red Box and ✓ - Answer

48 % ✓

Authors Note

Every possible effort has been made to ensure that everything in this paper is accurate and the author cannot accept responsibility for any errors.

1. What is

a) $8 \times 6 - 4 \div 2$

REMEMBER

Do x **and** ÷ **before** –

$8 \times 6 - 4 \div 2$
$= 48 - 2 = 46$

46

……………………………………………
(1)

3 is a factor of 3 and 18

b) $\dfrac{18^{6\ 3} \times 7}{3_1 \times 4_2} = \dfrac{3 \times 7}{2} = \dfrac{21}{2} = 10\tfrac{1}{2}$

2 is a factor of 6 and 4

REMEMBER

Cancel with factors that go into top and bottom : 3 & 2

10.5

……………………………………………
(1)

c) Estimate $\dfrac{14.9 \times 99}{0.52}$

Round up to 15

Round up to 100

Round down to 0.5

We get $\dfrac{15 \times 100}{0.5} = \dfrac{1500}{0.5}$ or $\dfrac{1500}{½}$

Be CAREFUL this is not 750.

$\dfrac{1}{½}$ = 2 because there are two halves in 1

There are 3000 ½ 's in 1500

When you have anything divided by 0.5 just double it!

3000

……………………………………………
(3)

d) 243 ÷ 9

Lay out your division like this	$9\overline{)2\;4\;3}$
Will 9 go into 2? - NO	$9\overline{)2\;4\;3}$
Try the next two digits Will 9 go into 24? YES	$9\overline{)2\;4\;3}$
How many times will 9 go into 24? Twice: 2 x 9 = 18 Put 2 at the top.	$\begin{array}{l}\;\;\;2\\ 9\overline{)2\;4\;3}\end{array}$
Is there a remainder YES : 24 – 18 = 6. Put 6 before the 3	$\begin{array}{l}\;\;\;2\\ 9\overline{)2\;4^{6}3}\end{array}$
Will 9 go into 63 YES: seven times 7 x 9 = 63 Put 7 at the top	$\begin{array}{l}\;\;\;2\;7\\ 9\overline{)2\;4^{6}3}\end{array}$
Is there a remainder Yes : No	$\begin{array}{l}\;\;\;2\;7\\ 9\overline{)2\;4^{6}3}\end{array}$

…………………....... **27** ✓

(1)

2. The formula $v^2 = u^2 + 2as$ gives the final velocity of an object

a) Find the value of v when $u = 6$, $a = 8$ and $s = 4$

Replace the letters with the values given..

So	v^2	$= u^2 + 2as$
	v^2	$= 6^2 + 2 \times 8 \times 4$
	v^2	$= 36 + 64$
	v^2	$= 100$
(√ both sides)	v	$= \sqrt{100} = 10$ (strictly ± 10)

10 ✓

(2)

b) If $v = 12$, $u = 8$ and $a = 8$ find s

Replace the letters with the values given..

So	v^2	$= u^2 + 2as$
	12^2	$= 8^2 + 2 \times 8 \times s$
	144	$= 64 + 16s$
(–64 both sides)	80	$= 16s$
(÷ 16 both sides)	$\frac{80}{16}$	$= s = 5$

5 ✓

(2)

3. What is:

a) $3\frac{1}{3} + 2\frac{4}{5}$

denominators

Put aside the 3 + 2 = 5 for now. Add the fractions

REMEMBER when we add fractions the **denominators** have to be the **same**

Find a denominator by multiplying 3 x 5 = 15

$$\frac{1}{3} + \frac{4}{5} = \frac{?}{15} + \frac{?}{15}$$

To get the ? we ask what we multiplied the bottom of the fraction by to get 15

The bottom 3 was multiplied by 5 so we have to multiply the top 1 by 5 = 5
The bottom 5 was multiplied by 3 so we have to multiply the top 4 by 3 = 12

$$\frac{1}{3} + \frac{4}{5} = \frac{5}{15} + \frac{12}{15} = \frac{17}{15} \text{ or } 1\frac{2}{15}$$

Now we can add the fractions

$6\frac{2}{15}$

.... **(2)**

b) $1\frac{2}{3} \times 2\frac{3}{5}$

Convert each mixed fraction into an improper fraction

Convert $1\frac{2}{3}$ to 1/3rds: multiply 1 by 3 and add 2 = $\frac{5}{3}$

Convert $2\frac{3}{5}$ to 1/5ths: multiply 2 by 5 and add 3 = $\frac{13}{5}$

Now multiply denominators and numerators
But first CANCEL the 5 at top and the 5 at bottom

$$\frac{\cancel{5}}{3} \times \frac{13}{\cancel{5}} = \frac{13}{3}$$

$\frac{13}{3}$ or $4\frac{1}{3}$

.... **(2)**

4. Matthew bought some mp3 downloads
Each download costs 60 pence each
He spent £7.20.

a) How many downloads did he buy?

Divide 720 by 60 to get the answer in pence $= \frac{72\not{0}}{6\not{0}} = 12$

Or multiply 60 until you get to 720

The cost of 10 = 60 × 10 = 600 leaving 120 more needed
60 + 60 = 120 so we have another 2
In total he bought 10 + 2 = 12

12 ✓

....
(2)

b) Matthew found he could get 25% off the £7.20 he paid for his downloads.
How much would he pay with the 25% off?

Change £7.20 to pence by multiplying by 100 = 720

25% is ¼ so we need to find a quarter of 720.

If you half 720 and then half it again you get ¼ of 720

720 ÷ 2 = 360 360 ÷ 2 = 180

Now subtract 255 or 180 from 720

720 – 180 = 540 or £5.40

£.... **5.40** ✓
(2)

c) Matthew bought an IPod-touch for £210
VAT on the IPod-touch is 15 %

How much does the IPod-touch cost including VAT?

Use the fact that 15% = 10% + 5%

10% of £210 = £21.00
5% is half this = £10.50
So 15% = £31.50

Total cost = £ 31.50 (VAT)
+ £210.00
£ 241.50

£.... **241.50** ✓
(2)

5. a) Simplify:

$8y \times 3y^2$

This is $8 \times y \times 3 \times y \times y = 24 \times y \times y \times y$
We write $y \times y \times y$ as y^3 . So we have $24y^3$

$24y^3$ ✓

....
(1)

b) Solve
$6x - 14 = 10$

Get rid of the 14 on the left side by adding 14 to both sides
$6x - 14 + 14 = 10 + 14$ so $6x = 24$
Divide both sides by 6 so we only have x on the left. $x = 24 \div 6 = 4$

x = ...**4** ✓.......
(1)

c) Expand and simplify:

$3(x + 4y) + 2(5x - 3y)$

Expand means multiply out the brackets:

$3(x + 4y)$	$= 3x + 12y$
$2(5x - 3y)$	$= 10x - 6y$

Simplify by putting same types together
$3x + 12y + 10x - 6y = 13x + 6y$

$13x + 6y$ ✓

....
(2)

d) Solve
$9(x + 2) = 7x + 23$

Expand the left side first:	$9x + 18$	$= 7x + 23$
(–18 from both sides)	$9x$	$= 7x + 5$
(– 7x from both sides)	$2x$	$= 5$
(÷ 2)	x	$= 5 \div 2 = 2\frac{1}{2}$

x = ...**2 ½** ✓.......
(2)

e) $-3 < x \leq 2$

A ≤ B means B is greater than A or equal to A
B < C means B is less than C

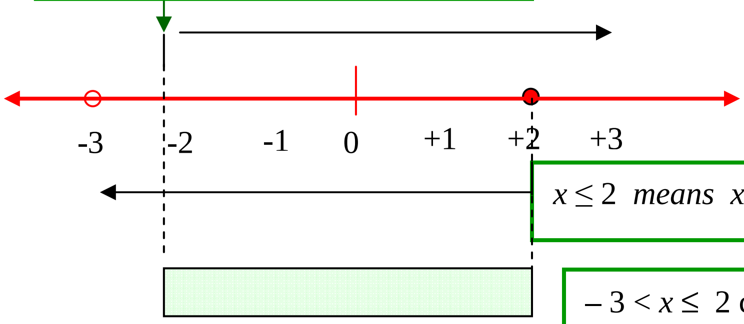
x is an integer.

Write down all the possible values of x.

–2, –1, 0, 1, 2

.... **(2)**

$-3 < x$ *means x is greater than –3*



$x \leq 2$ *means x is less than or equal to 2*

$-3 < x \leq 2$ combines both and the possible range is shown by the box

f) Factorise $4y^2 - 16$

This is a Difference Of Two Squares: $(a + b)(a - b) = a^2 - b^2$ (DOTS)
Common ones:
$y^2 - 4 = (y - 2)(y + 2)$
$y^2 - 9 = (y - 3)(y + 3)$

The + and – signs make sure that the x terms disappear.

Rewrite $4y^2 - 16 = (2y - 4)(2y + 4)$

(2y – 4)(2y + 4)

.... **(1)**

g) Simplify $\dfrac{2x^2 - 7x + 3}{x^2 + x - 12}$

Factorise the top and bottom quadratics and look for terms to cancel

First Factorise the top term $2x^2 - 7x + 3$

Multiply 1st and last numbers, a × c = **2 x 3 = 6**

1. Find two numbers which multiply to make 6 → and also makes the *middle x value* –7 by adding or subtracting → 6 = – 6 × –1 and –7 = – 6 + – 1

$2x^2 - 7x + 3$

2. Rewrite $-7x$ as $(-x - 6x)$ in the equation

$2x^2 - 7x + 3 = 2x^2 - x - 6x + 3$

Notice : we put $-6x$ next to the 3 and $-x$ next to the $2x^2$. We use it for factorisation in the next step

3. Factorise each pair of terms:

$2x^2 - x \quad - 6x + 3$

→ $x(2x - 1) - 3(2x - 1)$

– × – = +

4. Simplify: we have (2x – 1) in both terms so we can take out as a factor

$x(2x - 1) - 3(2x - 1) = (2x - 1)(x - 3)$ so $2x^2 - 7x + 3 = (2x - 1)(x - 3)$

Now Factorise the bottom term

$x^2 + 1x - 12$

1. Start with: $(x \quad A)(x \quad B)$
2. To find A and B look at the quadratic
3. A and B are two numbers which → make 1 by adding or subtracting → and multiply to make –12

The two values are –3 and +4 because: –12 = –3 × + 4 and 1 = –3 + 4

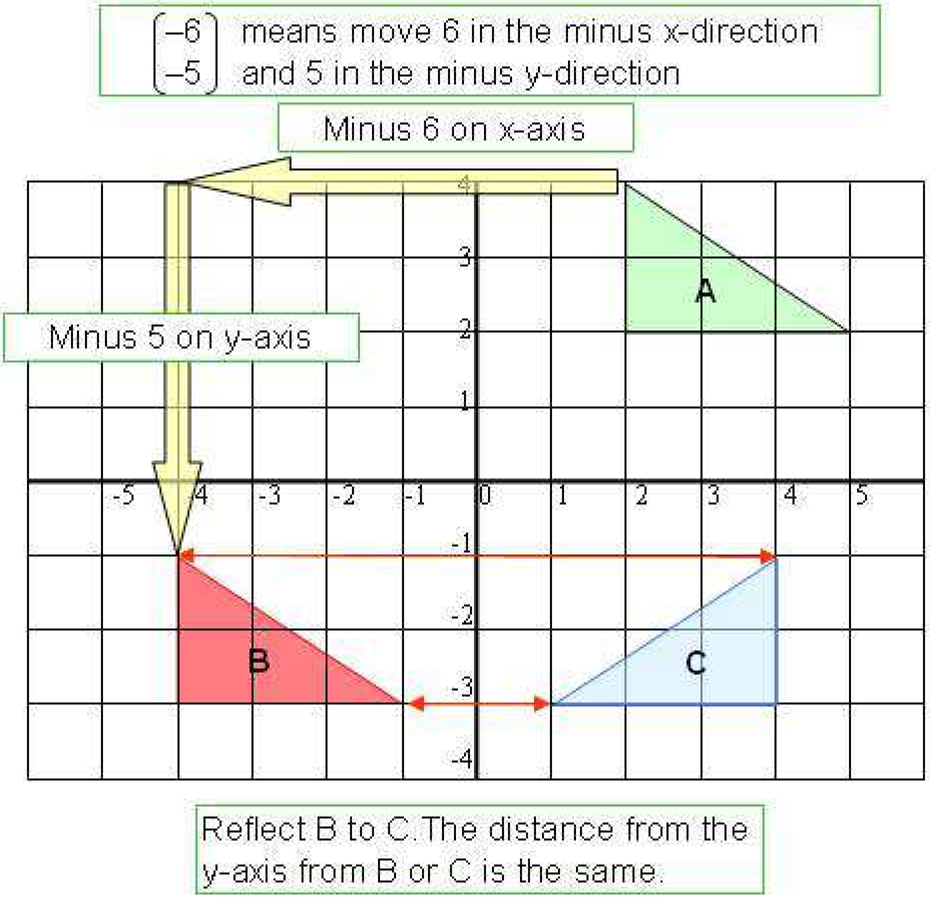
Rewriting the quadratic using –12 and 1 we get: $x^2 + x - 12 = (x - 3)(x + 4)$

Rewriting $\dfrac{2x^2 - 7x + 3}{x^2 + x - 12} = \dfrac{(2x - 1)\cancel{(x - 3)}}{\cancel{(x - 3)}(x + 4)} = \dfrac{2x - 1}{x + 4}$

$\dfrac{\mathbf{2x - 1}}{\mathbf{x + 4}}$ ✓ …

(4)

6.



Triangle A is shown above.

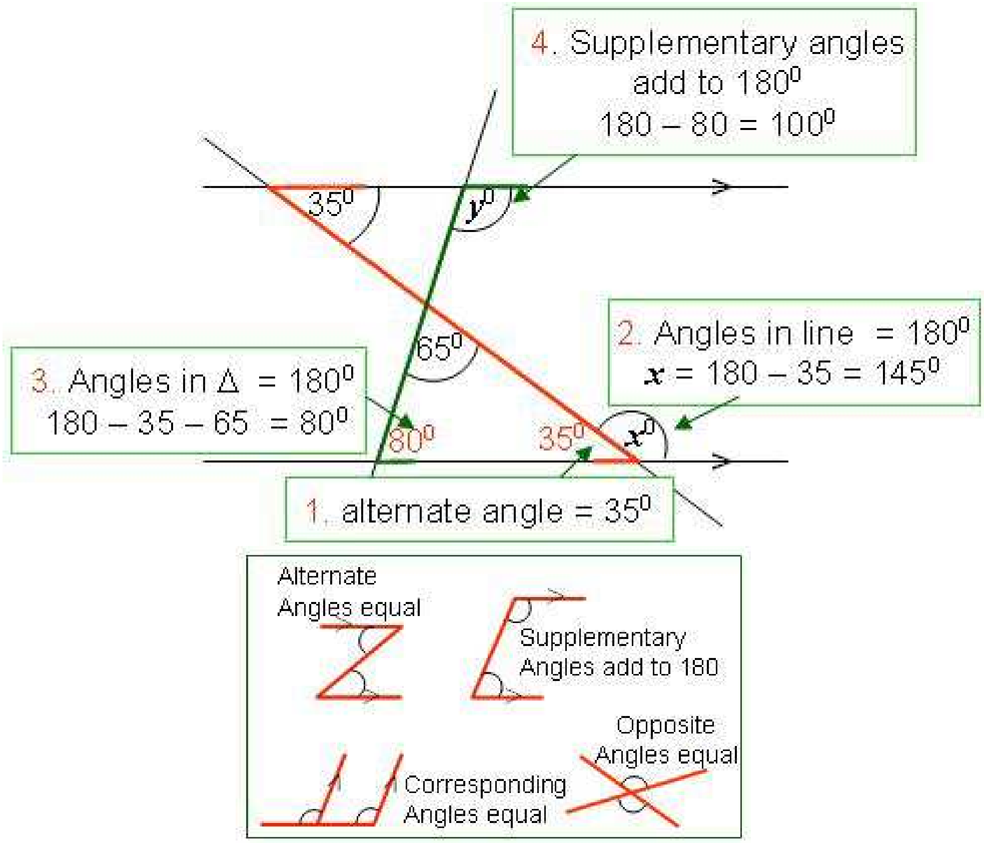
a) Translate the triangle A by $\begin{pmatrix}-5\\-6\end{pmatrix}$ Label the new triangle B

(1)

b) Reflect the triangle B in the y-axis
Label the triangle C

(1)

7. The diagram shows two parallel lines and two other lines which intersect



a) Work out the size of angle x

x = **145** °

(1)

b) Explain how you got your answer

1. Alternate angle = 35, 2. x = 180 (straight line) – 35 = 145

(1)

c) Work out the size of angle y

y = **100** °

(1)

d) Explain how you got your answer

3. Angles in Δ = 180, angle = 80,
4. Supplementary angle y = 180 – 80 = 100

(1)

8. A shop recorded the types of drinks bought by 90 customers for Christmas

Drink	Frequency	Angle
Wine	30	120
Beer	35	**140** ✓
Spirits	**10** ✓	40
Champagne	15	**60** ✓

1 customers = 4^0.
35 is $35 \times 4^0 = 140^0$

1 customers = 4^0.
40^0 is $40^0 \div 4^0 = 10$

1 customers = 4^0.
15 is $15 \times 4^0 = 60^0$

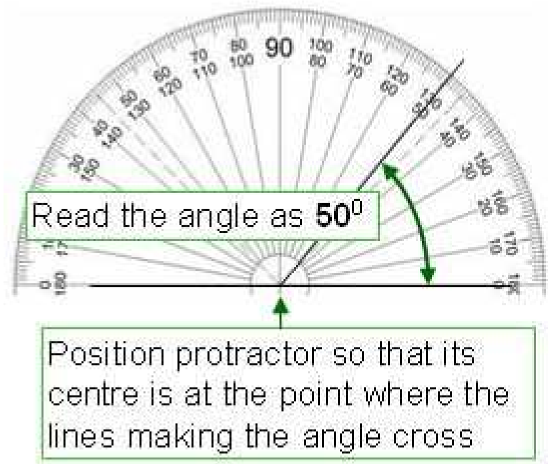
a) Complete the table above

To get how much 1 customer is in degrees, divide 360^0 by 90 customers = 4^0.
Frequency is the number of customers.
For Beer we have 35 customers $= 35 \times 4^0 = 140^0$
For champagne we have 15 customers $= 15 \times 4^0 = 60^0$

For spirits we have 40^0. To convert to frequency divide this by $4^0 = 10$

(2)

b) Draw an accurate pie chart to show this information. The first drink has been done for you.



How to use a protractor

(2)

c) Hosanna counted the number of sweets in 30 sweet packets. She got the following results.

14	18	25	26	33	43	28	12
41	42	48	27	38	45	23	13
8	11	14	20	43	19	33	
32	32	36	36	8	9	27	

Draw a stem and leaf diagram to show these results with this Key: 4 | 1 = 41

Arrange them is sequence smallest first

8 8 9 11 12 13 14 14 18 19 20 23 25 26 27 27 28
32 32 33 33 36 36 38 41 42 43 43 45 48

Now put into stem and leaf

This column is first part of the number

Each entry is the number of sweets in a packet. This one has 0 | 9 or 9 sweets

0	8	8	9				
1	1	2	3	4	4	8	9
2	0	3	5	6	7	7	8
3	2	2	3	3	6	6	8
4	1	2	3	3	5	8	

The Key tells you how to read the diagram

Key 4 | 1 stands for 41 letters

0	**8**	**8**	**9**				
1	**1**	**2**	**3**	**4**	**4**	**8**	**9**
2	**0**	**3**	**5**	**6**	**7**	**7**	**8**
3	**2**	**2**	**3**	**3**	**6**	**6**	**8**
4	**1**	**2**	**3**	**3**	**5**	**8**	

✓

(2)

9. a) What is the gradient of the straight line equation $y = 4x + 6$

A straight line has an equation y = mx + c where

m is the gradient and c is where the line crosses the vertical y-axis

y = 4x + 6 so the gradient is 4 and cuts the y-axis at 6

.... **4** ....

(1)

b) What is the gradient of the *perpendicular* line to $y = 4x + 6$

If a line has a gradient of m
then the line perpendicular to this has gradient $\frac{-1}{m}$

Flip the gradient over and change the sign

$-\frac{1}{4}$

....

(1)

c) What are the co-ordinates of point P where $y = 4x + 6$ cuts the **x-axis**

To work out where it crosses the x-axis put y = 0 in the equation:

y = 4x + 6
0 = 4x + 6
(–6 from both sides) –6 = 4x
(÷ 4) $x = -\frac{6}{4} = -1\frac{1}{2}$

(.. **– 1½ , 0** ..)

(1)

10. A survey of 40 children was made to see how long they spent revising for their GCSE Maths exam in the month before the exam.

The table below shows how long in hours the children spent.

Time (t hours)	Frequency
$0 \le t < 4$	2
$4 \le t < 8$	6
$8 \le t < 12$	18
$12 \le t < 16$	9
$16 \le t < 20$	4
$20 \le t < 24$	1

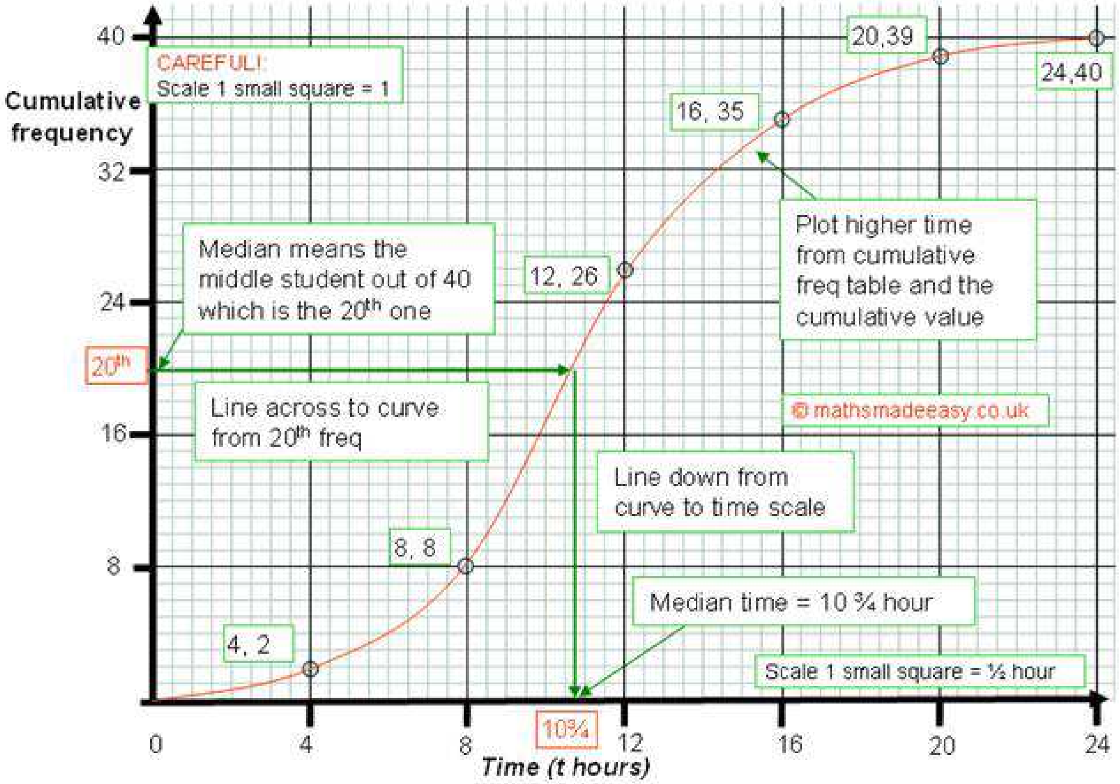
a) Complete the cumulative frequency table

(1)

Time (t hours)	Cumulative Frequency
$0 \le t < 4$	2
$0 \le t < 8$	**8** ✓
$0 \le t < 12$	**26** ✓
$0 \le t < 16$	**35** ✓
$0 \le t < 20$	**39** ✓
$0 \le t < 24$	**40** ✓

b) Using your completed table draw a cumulative frequency graph on the grid

(2)



c) Using the completed graph estimate the median time

10¾ hrs ✓
……………………….

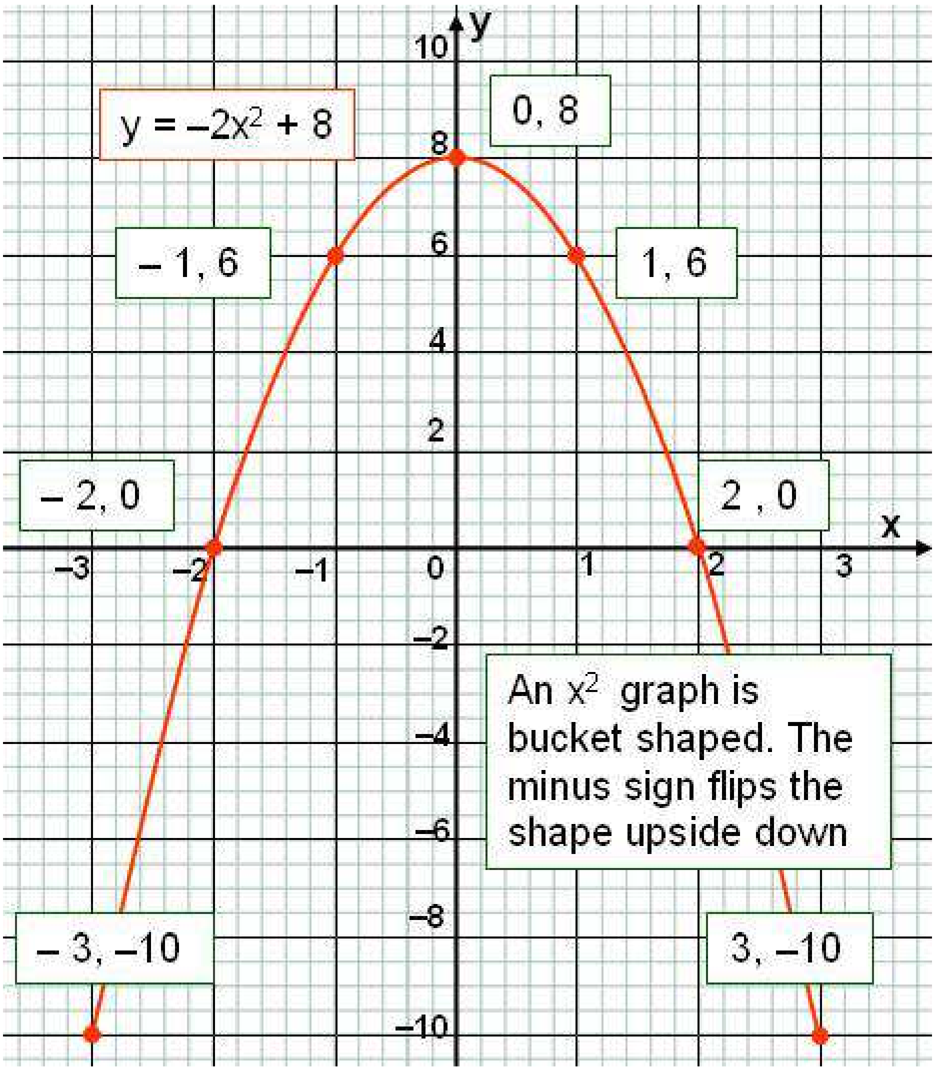
(1)

11. a) Complete the table of values for $y = -2x^2 + 8$ below.
Some of the working out has been done for you

x	–3	–2	–1	0	1	2	3
$-2x^2$	$-2(-3)^2$ -2×9	$-2(-2)^2$ $= -2 \times 4$	$-2(-1)^2$ $= -2 \times 1$	$-2(0)^2$ $= -2 \times 0$	$-2(1)^2$ $= -2 \times 1$	$-2(2)^2$ $= -2 \times 4$	$-2(3)^2$ $= -2 \times 9$
+8	+8	+8	+8	+8	+8	+8	+8
= y	– 10	0 ✓	6 ✓	8 ✓	6 ✓	0 ✓	–10 ✓

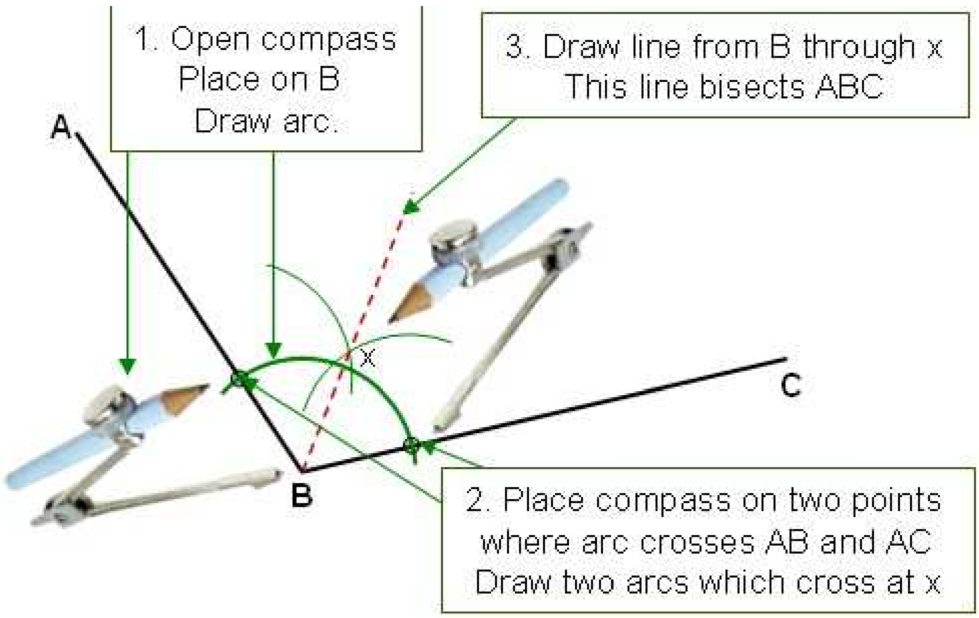
(2)

b) Plot the graph for $y = -2x^2 + 8$



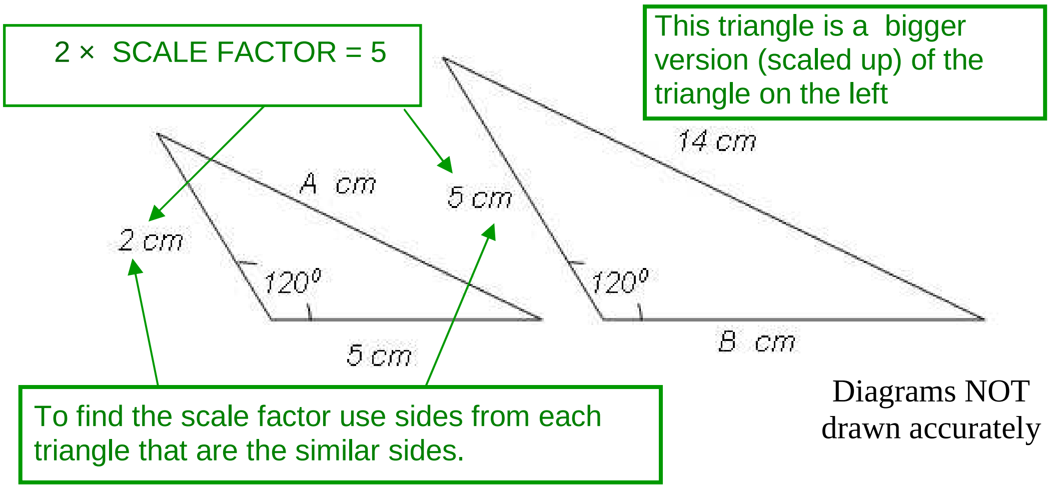
(2)

12. Construct a bisector of the angle ABC using a ruler and compasses.
Show all your construction lines



(2)

13.



Diagrams NOT drawn accurately

The two triangles are mathematically similar.

If two shapes are mathematically similar, one is an enlargement of the other with the same angles

a) What is the length of side B in the larger triangle

Scale factor = $\frac{\text{Big side}}{\text{Small side}} = \frac{5}{2}$

Side B can be found from the 5cm side in the left Δ by multiplying with the scale Factor

$B = 5 \times \frac{5}{2} = \frac{25}{2} = 12\frac{1}{2}$

12 ½ ✓

……………………….cm

(2)

b) What is the length of side A in the smaller triangle

Side A can be found from the 14cm side in the right Δ by dividing by the scale factor

$A = 14 \div \frac{5}{2}$

If we flip the scale over we can multiply

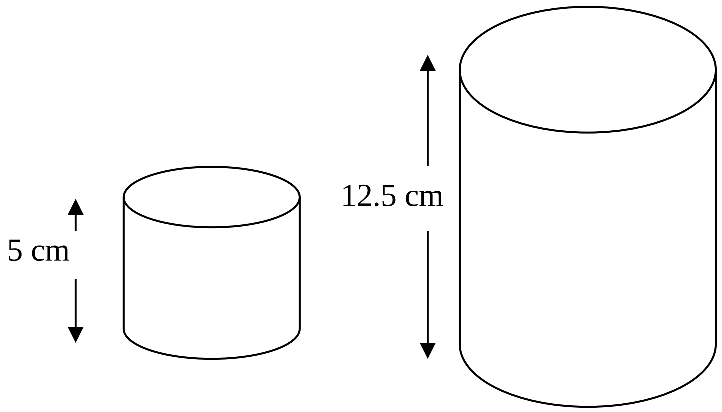
$A = 14 \times \frac{2}{5} = \frac{28}{5} = 5.6$

5.6 ✓

……………………….cm

(1)

c) Two mathematically similar cylinders are shown



Diagrams NOT drawn accurately

The surface area of the smaller cylinder is 40 cm^2
Calculate the surface area of the larger cylinder.

Since they are mathematically similar we can work out the scale factor for length

Scale factor (for length) $= \frac{\text{big side}}{\text{small side}} = \frac{12.5}{5} = \frac{5}{2}$

The scale factor for area = (scale factor for length)^2 = $\left(\frac{5}{2}\right)^2$

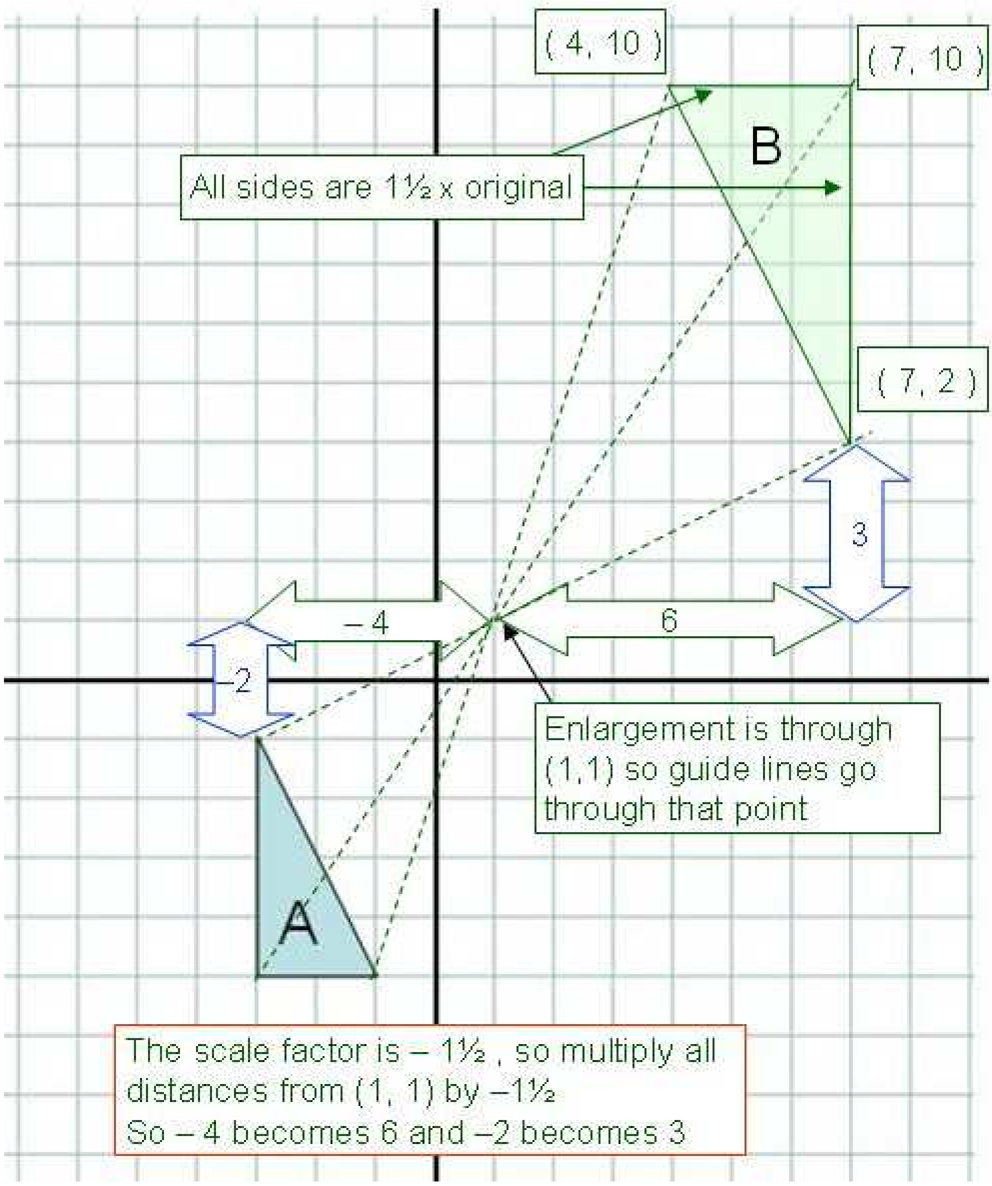
The surface area of the large cylinder can be found using the surface area of the small cylinder × scale factor for area

SA = $40^{10} \times \frac{5}{2} \times \frac{5}{2} = 250$ (40 cancelled to 10; each 2 struck through)

.........**250**...cm^3
(3)

14. Enlarge the triangle A using a scale factor of $-1\frac{1}{2}$, centre (1 , 1).

(3)



15. Sylvia played a game of dominoes and then a game of darts.

The probability that she will win the game of dominoes is $\frac{4}{7}$

The probability that she will win the game of darts is $\frac{3}{8}$

Assume that she only won or lost

a) Draw a probability tree to show this information

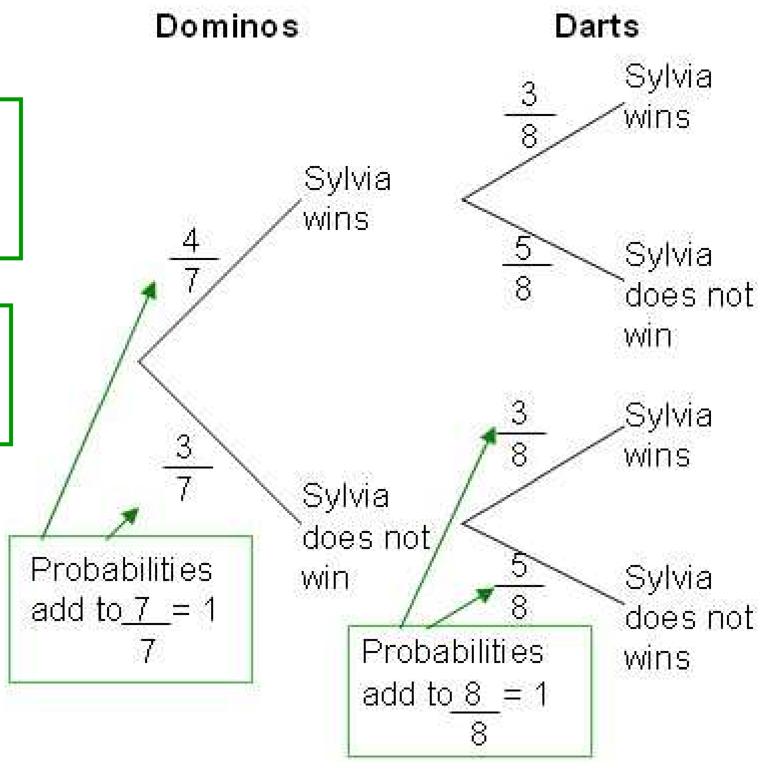
A probability TREE shows the probabilities at each stage.

As it forks both must add up to 1

Sylvia is CERTAIN to WIN or LOSE , so these two probabilities must add up to 1

Probability Win dominos = $\frac{4}{7}$

Probability Lose dominos = $1 - \frac{4}{7} = \frac{3}{7}$



(2)

b) What is the probability that Sylvia will lose one game

Sylvia loses one game which means she loses then wins or wins then loses

There are two paths on the probability tree. We work out each path and add them.

So we ADD probability (win-lose) and probability (lose-win)

probability (win-lose) = $\frac{4}{7} \times \frac{5}{8} = \frac{20}{56}$

probability (lose-win) = $\frac{3}{7} \times \frac{3}{8} = \frac{9}{56}$

Now add these together

probability (win-lose) + probability (lose-win) = $\frac{20}{56} + \frac{9}{56} = \frac{29}{56}$

$\frac{29}{56}$ ✓

(2)

16. Make x the subject of the formula $y = \dfrac{3x - 4}{2ax - 3}$

Multiply both sides by 2ax – 3
To remove the 2ax – 3 from the right side → $y(2ax - 3) = 3x - 4$

Expand the left side → $y(2ax - 3) = y \times 2ax + y \times -3$
$= 2axy - 3y$

We have $2axy - 3y = 3x - 4$

Get *x*'s on left – subtract 3*x* from both sides → $2axy - 3y - 3x = 3x - 4 - 3x$
$2axy - 3y - 3x = -4$

Get *y*'s on right – add 3*y* to both sides → $2axy - 3y + 3y - 3x = -4 + 3y$
$2axy - 3x = -4 + 3y$

Factorise left side with *x* as the factor → $x(2ay - 3) = -4 + 3y$

Divide both sides by (2ay – 3) to get *x* → $\dfrac{x(2ay - 3)}{2ay - 3} = \dfrac{-4 + 3y}{2ay - 3}$
$x = \dfrac{-4 + 3y}{2ay - 3}$

$$\frac{3y - 4}{2ay - 3}$$

....
(3)

17. What is $0.\dot{1}7\dot{1}$ as a fraction in its simplest form

Recurring decimals have a pattern of digits which repeat forever
e.g. $0.\dot{3}$ means 0. 333333333 …

Count the number of digits in the pattern that are repeating. The dot above a digit tells you that it is repeating. So $0.\dot{1}7\dot{1}$ is 0.171171171and has 3 repeating digits

Multiplying your recurring decimal by either 10, 100, 1000 etc.
Select the one which has the same number of zeros as the repeating pattern
So multiply $0.\dot{1}7\dot{1}$ with three repeating digits, by 1000 which has 3 zeros

$0.\dot{1}7\dot{1} \times 1000 = 171.171171$ etc

If we subtract the original we get an exact integer:
171.171171 – 0.171171 = 171
This is like multiplying our original by 999 (1000 – 1)

$0.\dot{1}7\dot{1} \times 999 = 171$

Rearranging $0.\dot{1}7\dot{1} \times 999 = 171$
we get $0.\dot{1}7\dot{1} = \frac{171}{999}$

$$0.\dot{1}7\dot{1} \times \mathbf{1000} - 0.\dot{1}7\dot{1} \times \mathbf{1} = \mathbf{171}$$
$$0.\dot{1}7\dot{1} \times \mathbf{999} = \mathbf{171}$$
$$0.\dot{1}7\dot{1} = \frac{\mathbf{171}}{\mathbf{999}} = \frac{\mathbf{19}}{\mathbf{111}}$$

……………. **(2)**

18. a) Factorise $y^2 - 14y + 25$ by completing the square.

$y^2 - 14y \rightarrow (y - 7)^2$

Halve 14 = 7

Work on the first two terms first. Look at the number for the x term and halve it. Put this number inside the squared bracket as shown.

$y^2 - 14y = (y - 7)^2 - 49$

Subtract $7^2 = 49$

There will be an extra value created by the squaring the number in the bracket. To make both sides of the equation equal we have to subtract it.

$y^2 - 14y + 7 = (y - 7)^2 - 49 + 25$

$= (y - 7)^2 - 24$

Finally we have to put the third term back and then simplify the equation

$(y - 7)^2 - 24$ ✓

(3)

b) Hence solve $y^2 - 14y + 25 = 0$. Leave your answer in the form $a \pm b\sqrt{6}$.

	$y^2 - 14y + 25 = (y - 7)^2 - 24$
	$(y - 7)^2 - 24 = 0$
Add 24 both sides	$(y - 7)^2 = 24$
Square root both sides	$(y - 7) = \sqrt{24}$
add 7 both sides	$y = 7 \pm\sqrt{24}$
	$y = 7 \pm 2\sqrt{6}$

y = **$7 \pm 2\sqrt{6}$** ✓

(2)

19. The gravitational force F (Newtons) between two masses is inversely proportional to the square of the distance d between them.

When d = 3, F = 15

To the square means the value squared

a) Find a formula for F in terms of d.

Since F is inversely proportional to d squared we write this as $F \propto \frac{1}{d^2}$

We can replace the $\propto$ sign by = k where k is a constant. So $F = k\frac{1}{d^2}$

If know that when $d = 3$, F = 15 and can use this to find k:

So $F = k\frac{1}{d^2}$

so $15 = k\frac{1}{3^2}$ so $k = 15 \times 9 = 135$

We can rewrite the formula as $F = 135\frac{1}{d^2}$

$F = \frac{135}{d^2}$

(3)

b) Hence or otherwise calculate F when d = 5

Now we can work out F when d = 5 , using the formula above

$F = 135\frac{1}{d^2}$

so $F = \frac{135}{25} = \frac{27}{5} = 5.4$

5.4

(1)

20. a) Write 7×10^4 as an **ordinary number**

10^4 means 10 times itself 4 times or 10000.
$7 \times 10^4 = 7 \times 10000 = 70,000$

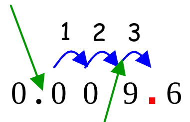
70 000

(1)

b) Write 0.0096 in **standard form**

To convert a number to standard form count the jumps needed to get the decimal point between the first two numbers.

Start at the decimal point



Jump over digits going right until you are just before last digit

We made 3 jumps right so we get 10^{-3}

9.6×10^{-3} ………………...…………

(1)

c) Work out $(7 \times 10^4)^2$
Give your answer in standard form.

$(7 \times 10^4)^2 = (7 \times 10^4) \times (7 \times 10^4) = 49 \times 10^8$

We have to change the 49 to 4.9 for standard form so we add an extra power to the 10 to compensate.

$49 \times 10^8 = 4.9 \times 10 \times 10^8 = 4.9 \times 10^9$

4.9×10^9 …..

(2)

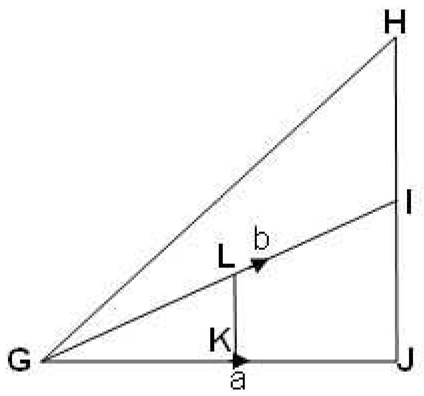
21.

A **vector** is a quantity with both magnitude (size) and direction.

e.g. force, velocity, momentum

The **arrow** shows the direction of the vector. When you go in the opposite direction to the arrow, reverse the sign.

So $\overrightarrow{GJ} = \vec{a}$ so $\overrightarrow{JG} = -\vec{a}$



$\overrightarrow{GJ} = a$ $\overrightarrow{GI} = b$ and $\overrightarrow{JI} = \overrightarrow{IH}$

a) Find the vector $\overrightarrow{JI}$

To go from J to I we use the route J to G and then to I

We say $\overrightarrow{JI} = \overrightarrow{JG} + \overrightarrow{GI}$
$= -a + b$

–a + b ✓

(1)

b) Find the vector $\overrightarrow{GH}$

To go from G to H we use the route G to J and then to H

We say $\overrightarrow{GH} = \overrightarrow{GJ} + \overrightarrow{JH}$
$= a + \overrightarrow{JH}$
$\overrightarrow{JH} = \overrightarrow{JI} + \overrightarrow{IH}$ so $= a + \overrightarrow{JI} + \overrightarrow{IH}$
$\overrightarrow{JI} = \overrightarrow{IH}$ so $= a + (-a + b) + (-a + b)$
$= a - 2a + 2b = -a + 2b$

–a + 2b ✓

(1)

K is the mid point of GJ and L is the mid point of GI

c) Prove $\overrightarrow{KL}$ is parallel to $\overrightarrow{JI}$

To prove something is parallel we have to show that the vector parts of both are the same. We have JI so we need to work out KL.

$\overrightarrow{KL} = \overrightarrow{KG} + \overrightarrow{GL}$
$\overrightarrow{KG}$ is ½ $\overrightarrow{JG}$ (– a) $= -\frac{1}{2}a + \overrightarrow{GL}$
$\overrightarrow{GL}$ is ½ $\overrightarrow{GI}$ (b) $= -\frac{1}{2}a + \frac{1}{2}b$
Factorise $= \frac{1}{2}(-a + b)$

$\overrightarrow{JI} = -a + b$
the vector parts are the same so they are parallel

$\overrightarrow{KL}$ is half of $\overrightarrow{JI}$

$\overrightarrow{KL} = \frac{1}{2}(-a + b)$
$\overrightarrow{JI} = -a + b$
So they are parallel ✓

(2)

22. a) Rationalise the denominator and simplify $\frac{18}{\sqrt{6}}$

Rationalise the denominator means make the √3 into a rational number. Do this by multiplying top and bottom by √3

$$\frac{18}{\sqrt{6}} \times \frac{\sqrt{6}}{\sqrt{6}} = \frac{18\sqrt{6}}{6} = 3\sqrt{6}$$

3√6

....

(2)

b) Prove that $(\sqrt{8} + \sqrt{7})^2 = 15 + 4\sqrt{14}$

REMEMBER $(\sqrt{8} + \sqrt{7})^2$ has 4 multiplications

$$(\sqrt{8} + \sqrt{7})^2 = (\sqrt{8} + \sqrt{7})(\sqrt{8} + \sqrt{7})$$
$$= \sqrt{8} \times \sqrt{8} + \sqrt{7} \times \sqrt{8} + \sqrt{7} \times \sqrt{8} + \sqrt{7} \times \sqrt{7}$$
$$= 8 + 2\sqrt{7} \times \sqrt{8} + 7$$
$$= 15 + 2\sqrt{7 \times 8}$$
$$= 15 + 2\sqrt{7 \times 4 \times 2}$$
$$= 15 + 2 \times 2\sqrt{14}$$
$$= 15 + 4\sqrt{14}$$

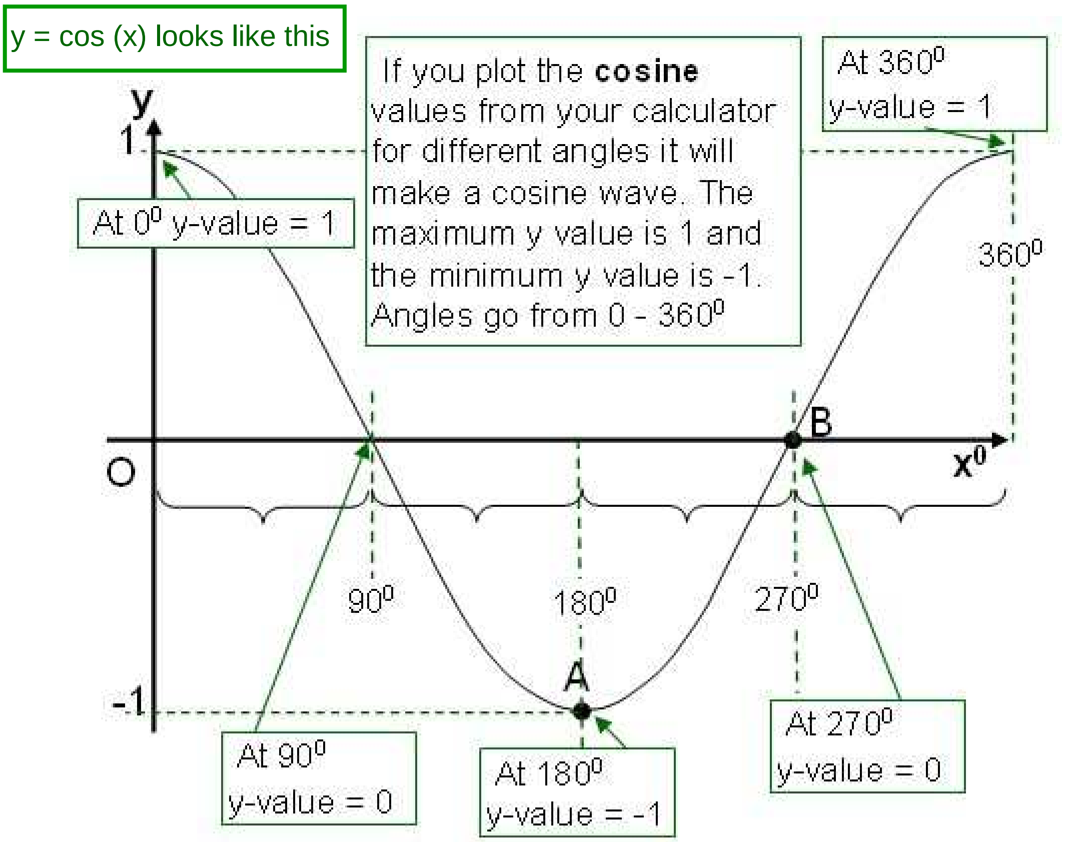
$\sqrt{8} \times \sqrt{8} = 8$

$\sqrt{7} \times \sqrt{8} = \sqrt{7 \times 8}$

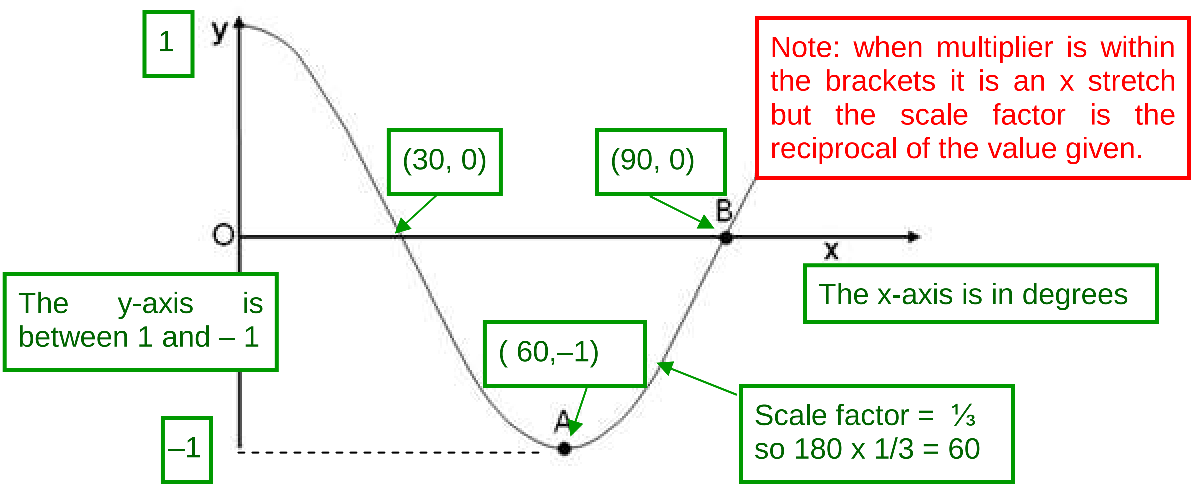
We know $\sqrt{4}$ is 2 so we can take it outside the square root

(2)

23. The graph of y = cos $(3x)^0$ is shown for values from x = 0^0 to 360^0



y = cos (3x) is similar to y = cos (x) with a scale factor of ⅓ , a scrunch



The curve cuts the x-axis at point B and has a minimum value at point A

a) What are the co-ordinates of point A

The cosine curve moves between 1 (for 0^o) and –1(for 180^o)

Cos (3x) is a stretch in the horizontal x-axis by a factor of ⅓

A was originally at (180, – 1). After the stretch it is (60, –1)

(.. **60, –1** ....) ✓

(1)

b) What are the co-ordinates of point B

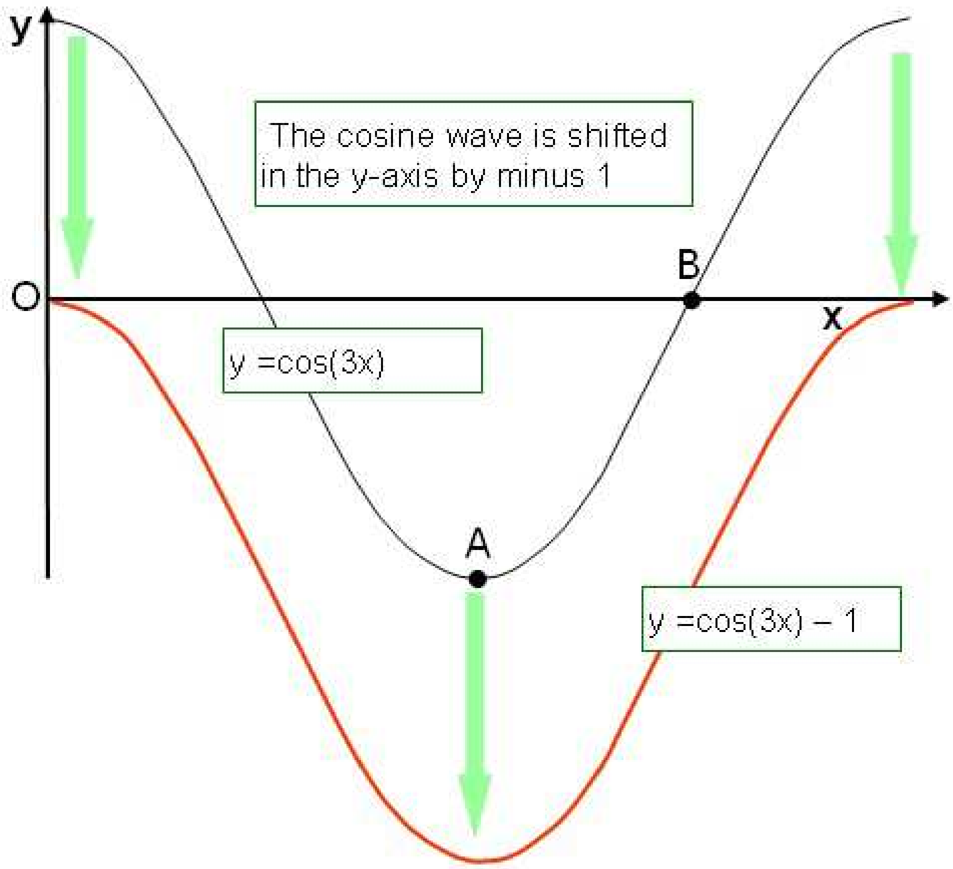
The cosine curve has a full cycle between 0 – 360

The normal ¾ point for Cos x is 270,so for Cos(3x) it is 90

(.. **90, 0** ....) ✓

(1)

c) Sketch the graph of y = cos (3x) – 1 on the diagram above



(1)

TOTAL FOR PAPER: 100 MARKS
END