

Surname
Other Names

Centre Number

Candidate Number
0



GCSE LINKED PAIR PILOT

4361/02

APPLICATIONS OF MATHEMATICS UNIT 1: APPLICATIONS 1 HIGHER TIER

A.M. WEDNESDAY, 13 June 2012

2 hours

ADDITIONAL MATERIALS

A calculator will be required for this paper.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** the questions in the spaces provided.

Take π as 3.14 or use the π button on your calculator.

INFORMATION FOR CANDIDATES

You should give details of your method of solution when appropriate.

Unless stated, diagrams are not drawn to scale.

Scale drawing solutions will not be acceptable where you are asked to calculate.

The number of marks is given in brackets at the end of each question or part-question.

You are reminded that assessment will take into account the quality of written communication (including mathematical communication) used in your answer to question 8.

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1	6	
2	4	
3	3	
4	5	
5	5	
6	9	
7	12	
8	7	
9	15	
10	4	
11	6	
12	5	
13	8	
14	5	
15	6	
TOTAL MARK		

1. (a) A plan of the layout of a number of cycle tracks to be made around a park is shown below.
In order to mark out the cycle tracks the size of the angles a , b , c and d need to be found.

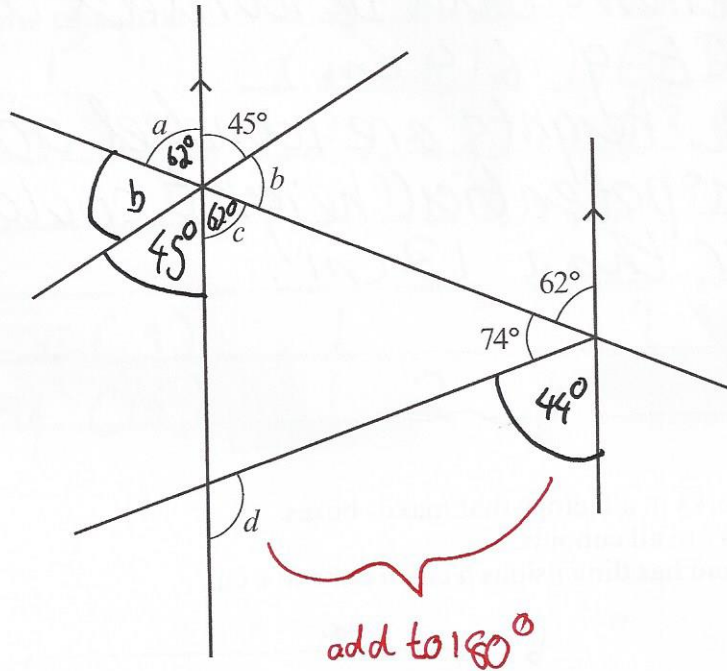


Diagram not drawn to scale

Calculate the angles marked a , b , c , and d .

$$2b = 360 - 45 - 45 - 62 - 62 = 146$$

$$\Rightarrow b = \frac{146}{2} = 73^\circ$$

$$d = 180 - 44 = 136^\circ$$

$a = 62^\circ$ F-Angle

$b = 73^\circ$

$c = 62^\circ$ Opposite Angle

$d = 136^\circ$ Add to 180°

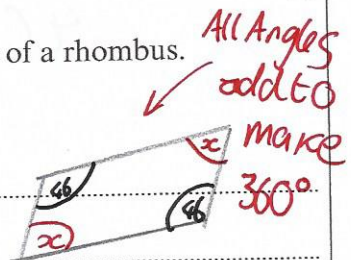
[4]

- (b) In another section of the park there is a flowerbed in the shape of a rhombus. One of the angles of the rhombus is 46° . Calculate the size of the other three angles of the rhombus.

$$2x = 360 - 46 - 46$$

$$\Rightarrow x = \frac{268}{2} = 134^\circ$$

\therefore Other angles are $46^\circ, 134^\circ, 134^\circ$



[2]

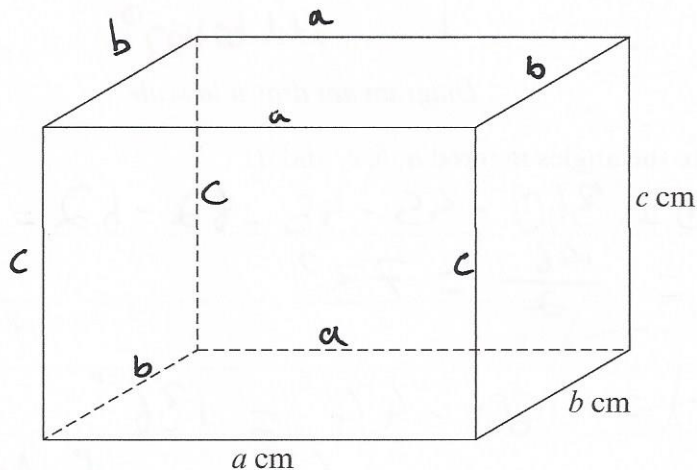
2. (a) Two boxes are stacked on top of each other.
The height of each box is 6 cm, measured to the nearest centimetre.

Explain why these two boxes may not fit in a space that is 12 cm high.

Measurement could be rounded down to 6 cm (E.g. 6.4 cm).
If both heights are rounded down then a potential height could be greater than 12 cm.

[2]

- (b) Joseph works in a factory that makes boxes.
The boxes are all cuboids.
Each cuboid has dimensions a cm, b cm and c cm.



Joseph has been asked to write a simplified expression for the total length of all the edges of the cuboid.

Joseph writes down the expression $2a + 3b + 4c$.

Joseph's expression is incorrect.

What should the correct simplified expression be for the total length of all the edges?

$$4(a + b + c)$$

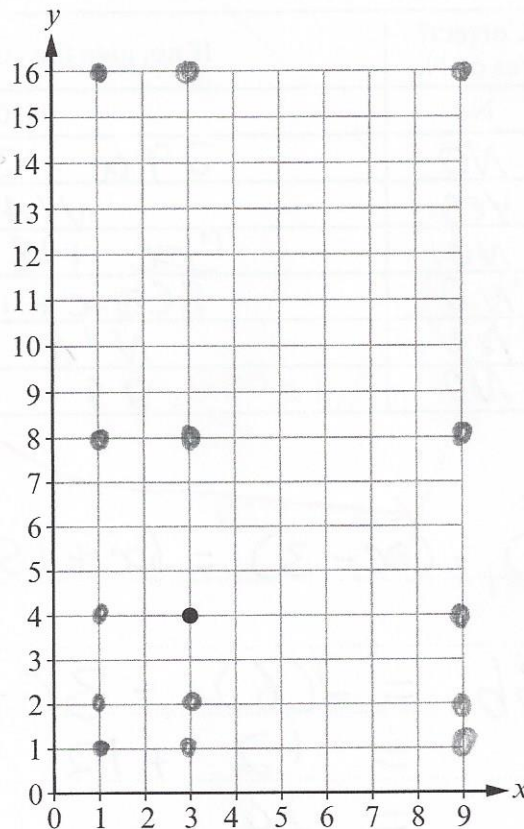
[2]

3. A pattern using dots is to be created on a background for a large window display. The instructions say that the background should be a grid 9 squares across by 16 squares up and the coordinate system for plotting should be used. Dots are then placed at points where the x -coordinate is a factor of 9 and the y -coordinate is a factor of 16, for example (3, 4). Use the grid below to plot all the dots for the window display.

Factors • $(1^x, 1^y), (1, 2), (1, 4), (1, 8), (1, 16)$
 • $(3, 1), (3, 2), (3, 4), (3, 8), (3, 16)$
 • $(9, 1), (9, 2), (9, 4), (9, 8), (9, 16)$

Combinations

factors of x (9) : 1 3 9
 factors of y (16) : 1 2 4 8 16



[3]

4. You are asked to check Damian's homework.
He has answered 7 questions.
The homework questions and Damian's answers are given in the table below.

Question number	Question	Damian's answer
1	Calculate $48 + 62$	100
2	Simplify $3a - 5b + 26a - 26b$	$29a + 31b$
3	Expand $6(x + 2)$	$6x + 12$
4	Simplify $3(2x + 5) - (x - 3)$	$5x + 12$
5	Factorise $24x + 8$	$8(3x + 0)$
6	Factorise $3x + 15$	$3(x + 5)$
7	Find the value of $2a - 3b$ when $a = 6$ and $b = -4$	0

Complete the table below to indicate if Damian's answers are correct or not.
If any of his answers are incorrect, you must give the correct answer.

Question number	Correct? Yes or No	If no, give the correct answer
1	No	110
2	NO	$29a - 31b$
3	Yes	N/A
4	NO	$5x + 18$
5	NO	$8(3x + 1)$
6	Yes	N/A
7	NO	24

Extra working space

$$3(2x + 5) - (x - 3) = 6x + 15 - x + 3 = 5x + 18$$

$$\begin{aligned} 2a - 3b &= 2(6) - 3(-4) \quad (- \times - = +) \\ &= 12 + 12 \\ &= 24 \end{aligned}$$

[5]

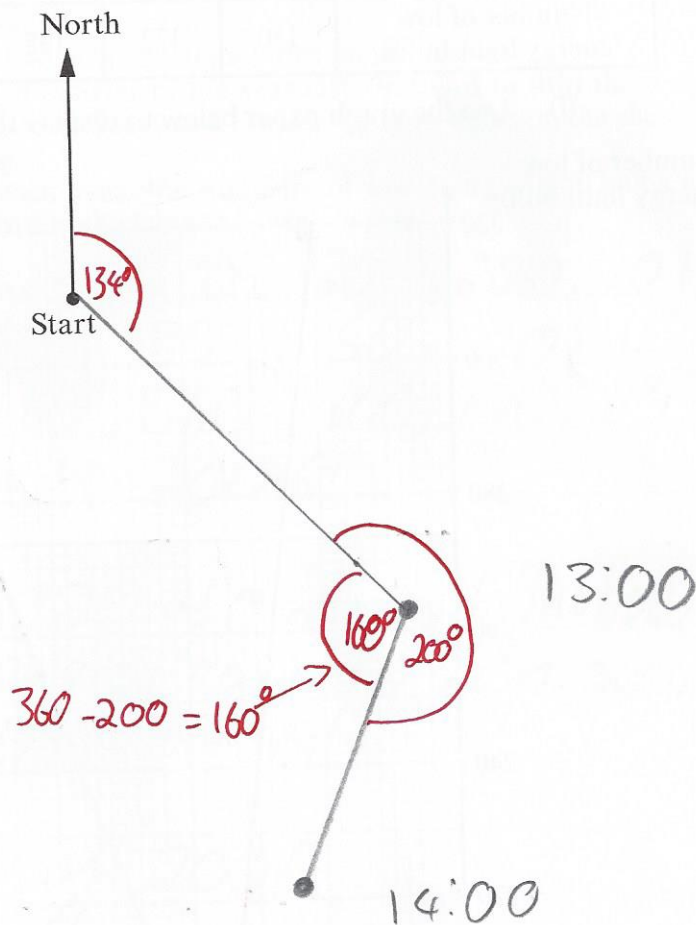
5. A chart is kept to show the position of a yacht at three times during the day. These are the notes that have been kept in order to plot the positions of the yacht on the chart.

Notes:

- Start time was 12 noon
- At 13:00 its position was 6 nautical miles on a bearing of 134° from the start
- At 14:00 its position was 4 nautical miles on a bearing of 200° from its position at 13:00

(a) Use a scale of **1 cm to represent 1 nautical mile** to complete the chart.

[3]



- (b) Write down the bearing of the yacht and its distance from the start position at 14:00.

Bearing 160°

Distance 8.5 nautical miles

[2]

6. The manager of an electrical store had a plan to gradually decrease the number of ordinary light bulbs, on the shelves, between 2005 and 2011.

At the same time, the plan was to increase the number of low energy light bulbs on the shelves.

The number of both types of light bulbs, on the shelves, has followed the general trends as planned.

There were no variations to the trend.

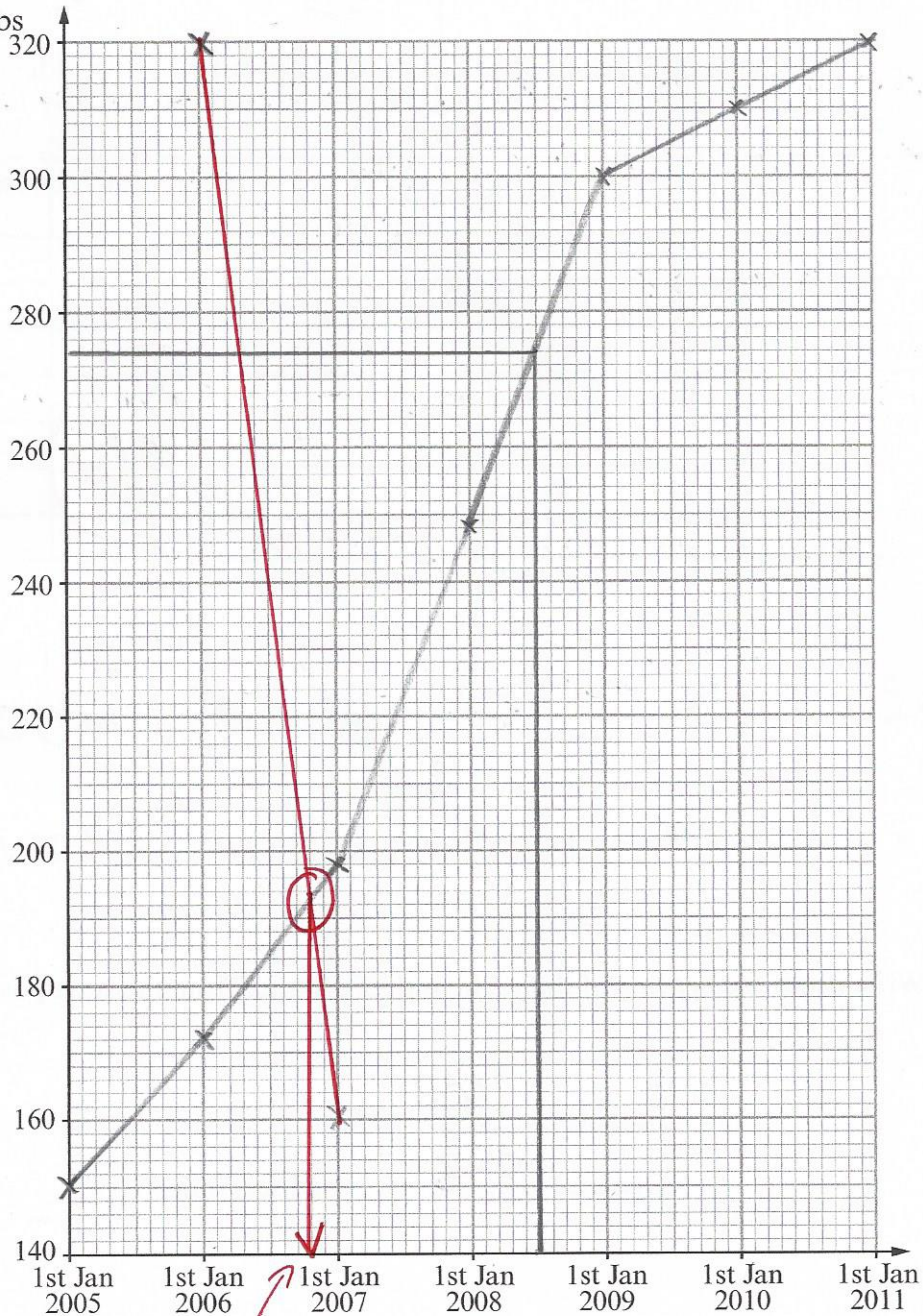
- (a) The number of low energy light bulbs was recorded each year on the 1st January. The table gives this information from 2005 to 2011.

1st January, Year	2005	2006	2007	2008	2009	2010	2011
Number of low energy light bulbs	150	172	198	248	300	310	320

- (i) Use the graph paper below to display this information.

[3]

Number of low energy light bulbs



- (ii) Use the information given to write down a reasonable estimate for the number of low energy light bulbs, on the shelves, on 1st July 2008.
You can assume that, within each year, the number of low energy light bulbs on the shelves increases at a steady rate.

Consider point half way between 1st Jan 2008 and 1st Jan 2009, \Rightarrow 274

[2]

- (b) The number of ordinary light bulbs, on the shelves, halved every year between 1st January 2005 and 1st January 2011.

On 1st January 2005 there were 640 ordinary light bulbs on the shelves.

Find in which year and in which quarter of the year (1st, 2nd, 3rd or 4th) there were approximately an equal number of ordinary and low energy light bulbs on the shelves.

You must show all your working.

You can assume that, within each year, the numbers of low energy light bulbs and ordinary light bulbs on the shelves both change at a steady rate.

	2005	2006	2007	2008	2009	2010	2011
Ordinary \Rightarrow	640	320	160	80	40	20	10
Low Energy \Rightarrow	300	320	480	560	600	620	630

\therefore Equal numbers At 2006

Plotting 640 and 320 of Ordinary light bulbs on graph of energy saving, then seeing where intersection occurs.

\therefore 4th Quarter of 2006

[4]

7. Cheryl and Ben planned a cycle ride using a 1 : 25 000 scale map. The route they planned measured approximately 80 cm on the map.

(a) Calculate approximately how far they planned to cycle. You must give your answer in km.

$$1 \text{ cm} = 25,000 \text{ cm}$$

$$\Rightarrow 80 \text{ cm} = 80 \times 25,000 = 2,000,000 \text{ cm}$$

$$1 \text{ km} = 100,000 \text{ cm} \text{ (} 1000 \text{ m} \times 100 \text{ cm)}$$

$$\Rightarrow \frac{2,000,000}{100,000} = 20 \text{ km}$$

[5]

(b) After the ride Cheryl's cycle-computer showed that she travelled 24 km. What was this measurement on the map in centimetres?

$$24 \text{ km} = 24 \times 1000 \times 100 = 2,400,000 \text{ cm}$$

$$\Rightarrow \frac{2,400,000}{25,000} = 96 \text{ cm on map}$$

← 1:25,000

[3]

(c) Ben and Cheryl's cycle-computers showed 24 km after the ride. The ratio of the distance Ben cycled to the distance he pushed his bike uphill was 5:1. The ratio of the distance Cheryl cycled to the distance she pushed her bike uphill was 11:1.

Calculate how far Ben cycled and how far he pushed his bike uphill.

Ben 5:1 \Rightarrow 6 parts

$$1 \text{ part} \Rightarrow \frac{24}{6} = 4 \text{ km} \quad \Rightarrow 5 \text{ parts} = 5 \times 4 = 20 \text{ km}$$

Cycled $\frac{20}{5}$ km	Pushed bike uphill $\frac{4}{1}$ km
--------------------------	-------------------------------------

Calculate how far Cheryl cycled and how far she pushed her bike uphill.

Cheryl 11:1 \Rightarrow 12 parts

$$1 \text{ part} \Rightarrow \frac{24}{12} = 2 \text{ km} \quad 11 \text{ parts} = 11 \times 2 = 22 \text{ km}$$

Cycled 22 km	Pushed bike uphill 2 km
--------------	-------------------------

[4]

8. You will be assessed on the quality of your written communication in this question.

A fishing competition is to be held out at sea in a rectangular area that is 5 km by 4 km and marked out by buoys. Safety boats are positioned at two different corners of the rectangular area marked out by the buoys.

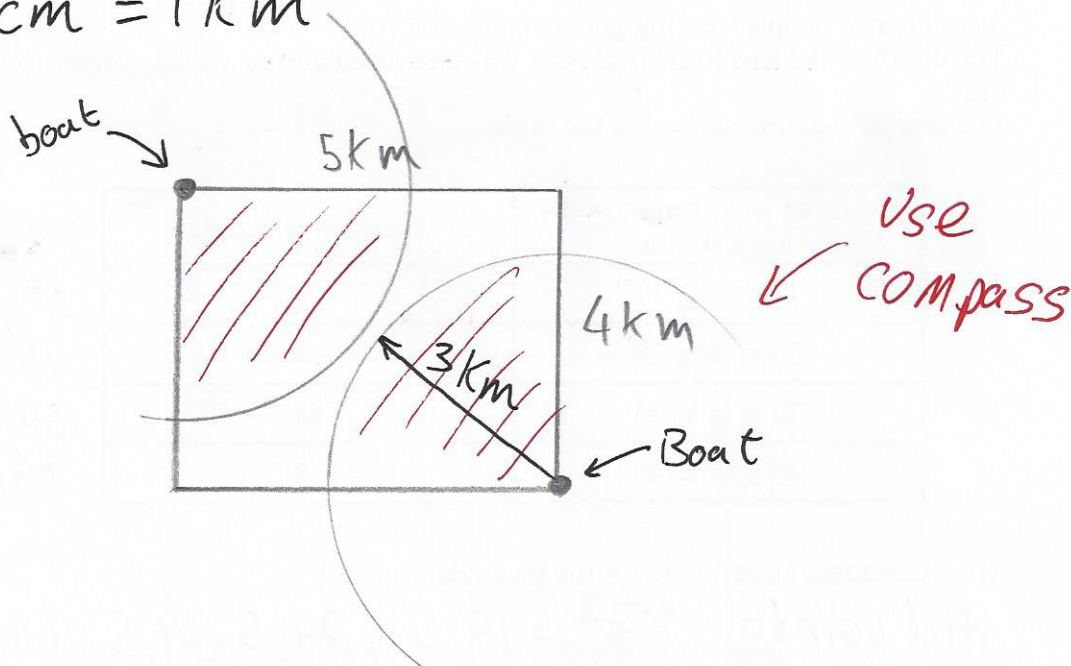
Each safety boat patrols an area not exceeding 3 km from its initial position.

Consider the options for positioning the two safety boats.

Decide which of your options is best for positioning the two safety boats.

You must clearly show and explain why your solution is the best option.

Scale 1 cm = 1 km

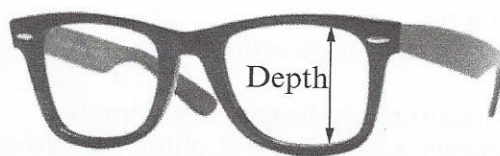


Explanation:

Positioning Boats in diagonally opposite corners covers the most area. This set up means that boats do not patrol the same area (overlap), which is not efficient.

[7]

9. (a) The depth of a lens in a pair of glasses is measured as shown below.



A number of people wearing glasses were surveyed.
The depth of the lens in their glasses was measured and recorded correct to the nearest mm.
The results are summarised in the table.

Depth of lens, x mm, to the nearest mm	Number of people
$10 \leq x \leq 19$	6
$20 \leq x \leq 29$	28
$30 \leq x \leq 39$	48
$40 \leq x \leq 49$	18

x midpoint

14.5

24.5

34.5

44.5

- (i) Calculate an estimate for the mean depth of a lens.

$$\text{Mid points : } \frac{10+19}{2} = 14.5, 24.5, 34.5, 44.5$$

$$\begin{aligned} \sum f \cdot x &= (6 \times 14.5) + (28 \times 24.5) + (48 \times 34.5) + (18 \times 44.5) \\ &= 3230 \end{aligned}$$

$$\text{Mean} = \frac{\sum f \cdot x}{100} = \frac{3230}{100} = 32.3 \text{ mm}$$

[4]

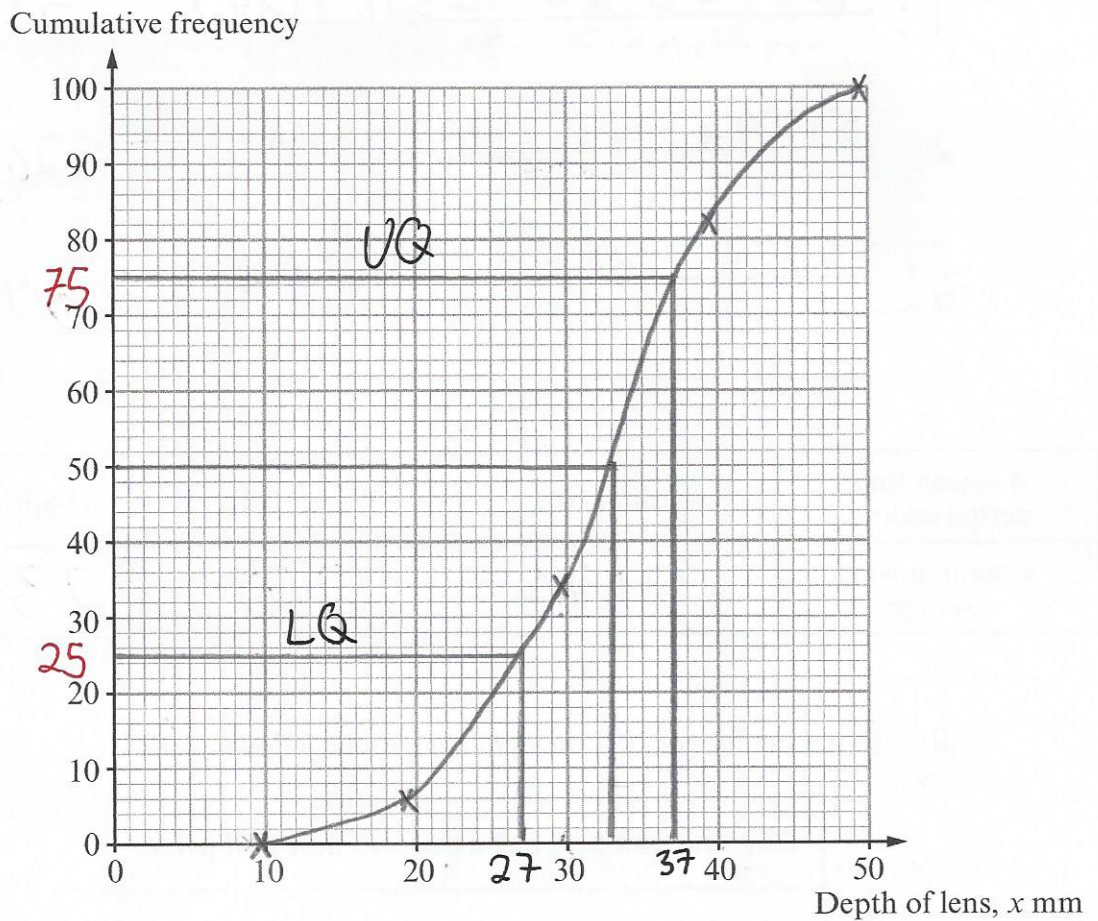
100 people \nearrow

(ii) Complete the following cumulative frequency table.

Depth of lens, x mm	$x < 9.5$	$x < 19.5$	$x < 29.5$	$x < 39.5$	$x < 49.5$
Cumulative frequency	0	6	34	82	100

[1]
 $34 + 48 \rightarrow$ $82 + 18 \rightarrow$

(iii) On the graph paper below, draw a cumulative frequency diagram to show this information. [2]



(iv) Use your graph to estimate each of the following.

The median depth of a lens.

33 mm

The interquartile range for the depth of a lens.

$$\begin{aligned}
 IQR &= UQ - LQ \\
 &= 37 - 27 \\
 &= 10
 \end{aligned}$$

[3]

(b) An optician records the number of pairs of glasses she sells in each season.

Year	2011				2012	
Season	Winter	Spring	Summer	Autumn	Winter	Spring
Number of pairs of glasses	1084	2124	4326	1242	1348	2456

(i) Calculate the 4-point moving averages and complete the table below.

$$1: \frac{1084 + 2124 + 4326 + 1242}{4} = 2194$$

$$2: \frac{2124 + 4326 + 1242 + 1348}{4} = 2260$$

$$3: \frac{4326 + 1242 + 1348 + 2456}{4} = 2343$$

4 season time period ending:	Autumn 2011	Winter 2012	Spring 2012
4-point moving average:	2194	2260	2343

[3]

(ii) In the summer of 2011 the optician had the following offer

Buy one pair and get a second pair half price.

She has decided not to repeat this offer in the summer of 2012, but instead to have a promotion in the autumn of 2012

Buy one pair get one free.

Explain fully what impact this may have on the 4-point moving average for the 4 season time period ending in the summer of 2012.

Moving average may be lower, due to summer 2012 value is likely to be less than summer 2011.

[2]

10. Jade entered a number into her calculator.

To this number, she added the square of the original number and the cube of the original number.

Jade got the answer 432.288

Find the number that Jade first entered into her calculator.

Show all your working.

$$432.288 = x + x^2 + x^3$$

$$\text{Test with } x=7 = 399$$

$$\text{Test with } x=8 = 584$$

\therefore Number between 7 and 8

x	$x + x^2 + x^3$
7.1	415.421
7.2	432.288
7.3	449.607
7.4	...
7.5	...
etc...	
to 8	

[4]

\therefore Number is 7.2

[Reason we know is not 6 or 9 is when we put those values into $x + x^2 + x^3$ the outcome is $>$ or $<$ than 432.288]

11. The Earth is approximately spherical.



- (a) The radius of the Earth is 6378.1 km.
Calculate the circumference of the Earth, giving your answer in standard form correct to 3 significant figures.

Circumference $\Rightarrow \pi D = 2\pi r$
 $= 2 \times \pi \times 6378.1$
 $= 40074.78 \dots \text{ km}$
 $= 40100 \text{ km}$
 $= 4.01 \times 10^4 \text{ km}$ [4]

formula to learn

- (b) The total surface area of the Earth is approximately 5.112×10^8 square kilometres.
Oceans cover an approximate area of 3.618×10^8 square kilometres and the remainder of the surface is covered by land.
Calculate the area of the Earth covered by land, giving your answer in standard form.

Area of Land $= 5.112 \times 10^8 - 3.618 \times 10^8$
 $= 1.5 \times 10^8 \text{ km}^2$

[2]

12. The fee for advertising on an Internet website includes a charge for the number of words in an advertisement, as well as a standard charge.
There is a standard charge of R pounds for the placement of each advertisement.
The charge, in pounds, for the number of words in an advertisement is equal to one-tenth of the total number of words.

- (a) Derive a formula for B , the total fee in pounds, for placing an advertisement which has h words.

$$B = R + \frac{h}{10}$$

[3]

- (b) A seller is charged a fee of £4.60 for placing an advertisement on this website.
The standard charge is £2.
Calculate how many words were placed in the advertisement.

$$B = R + \frac{h}{10}$$

$$\Rightarrow \frac{h}{10} = B - R$$

$$h = 10(B - R) = 10(4.6 - 2) = 26$$

Words

[2]

13. A production line making chocolates sometimes develops a fault and shuts down.

The distance the chocolates travel towards the next process before shut down is d metres.
The speed of the production line is v m/s.

When the fault occurs, it is noticed that the distance the chocolates travel towards the next process, is inversely proportional to the square of the speed of the production line.

The fault last occurred when the distance the chocolates moved on towards the next process was 8 m and the speed of the production line was 4 m/s.

- (a) Find an expression for d in terms of v .

$$d \propto \frac{1}{v^2} \Rightarrow d = \frac{k}{v^2}$$

when $d=8$ $v=4$

Have to learn
for a to be inversely
Proportional to b.
Means: $a \propto \frac{1}{b}$

$$\Rightarrow 8 = \frac{k}{(4)^2} \Rightarrow k = 128$$

$$\therefore d = \frac{128}{v^2}$$

(May also
be asked
directly
proportional)

[3]

- (b) Calculate d when $v = 6$ m/s.

$$d = \frac{128}{6^2} = 3.6 \text{ m}$$

[2]

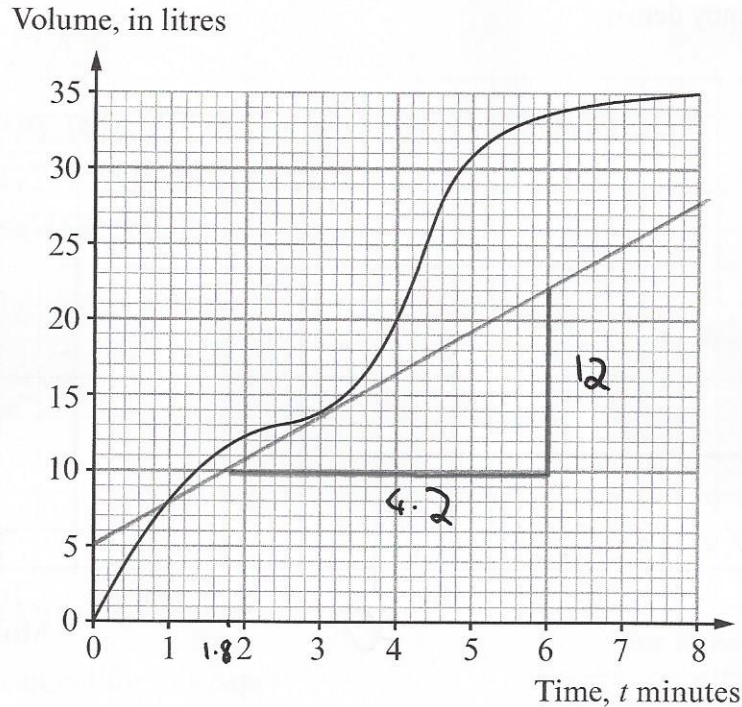
- (c) Calculate v when d is 25 cm.

$$v^2 = \frac{128}{d}$$

$$\Rightarrow v = \sqrt{\frac{128}{d}} = \sqrt{\frac{128}{25}} = 2.26 \text{ ms}^{-1}$$

[3]

14. A tank has been filled with water.
The graph below shows the volume of water in the tank over a time period of 8 minutes.



- (a) Calculate the gradient of the graph at time $t = 3$.
You must state the units of your answer.

$$\text{Grad} = \frac{\Delta Y}{\Delta X} = \frac{12}{4.2} = 2.9 \text{ Litres per minute}$$

Units $\frac{\text{Litres}}{\text{mins}}$

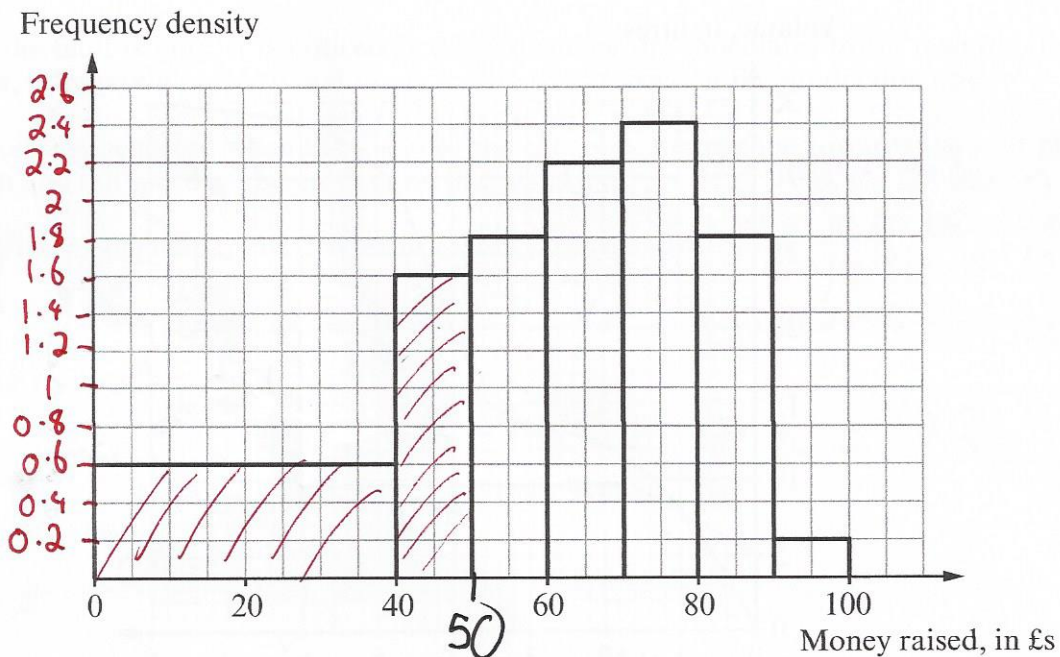
[4]

- (b) Explain what the gradient of the graph is measuring.

Rate of change of volume with time

[1]

15. Jack arranged a raffle to raise money.
He has drawn a histogram to show the distribution of money raised from the raffle.



Jack has forgotten to write the scale on the vertical axis.
He knows that 40 people each raised £50 or less.
Calculate an estimate for the total money raised.

Area < £50 = 40
x is unknown

$$(40 \times 3x) + (10 \times 8x) = 40$$

Each square represents 1 person

$$\rightarrow 120x + 80x = 40$$

$$200x = 40$$

$$x = 0.2$$

Estimate

$$\begin{aligned} \text{Total Money} &= (0.6 \times 20 \times 40) + (1.6 \times 45 \times 10) \\ &+ (1.8 \times 55 \times 10) + (2.2 \times 65 \times 10) \\ &+ (2.4 \times 75 \times 10) + (1.8 \times 85 \times 10) \\ &+ (0.2 \times 95 \times 10) \\ &= \text{£}7140 \end{aligned}$$

[6]