UNIVERSITY of CAMBRIDGE
International Examinations

Cambridge
IGCSE

Example Candidate Responses
(Standards Booklet)

Cambridge IGCSE®
Mathematics
0580

Cambridge Secondary 2

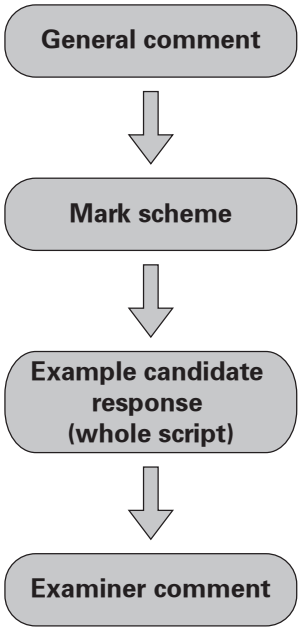
Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge IGCSE Mathematics (0580), and to show how different levels of candidates' performance relate to the subject's curriculum and assessment objectives.

In this booklet candidate responses have been chosen to exemplify grades C and E for Papers 1 and 3, and grades A, C and E for Papers 2 and 4. Each response is accompanied by a commentary explaining the strengths and weaknesses of the answers.

For ease of reference the following format for Papers 1, 2 and 3 has been adopted:



The mark scheme for each paper is followed by examples of marked candidate scripts, each with an examiner comment on performance. Comments are given to indicate where marks were awarded, and how additional marks could have been obtained. In this way, it is possible to understand what candidates have done to gain their marks and what they still have to do to improve their grades.

For Paper 4, the mark scheme is followed by examples of marked candidate responses for questions 4, 6, 8 and 9 with an examiner comment on performance for each. These questions are then followed by three whole scripts.

Past papers, Principal Examiner Reports for Teachers and other teacher support materials are available on our Teacher Support website at http://teachers.cie.org.uk

Assessment at a glance

Core curriculum *Grades available: C–G*	**Extended curriculum** *Grades available: A*–E*
Paper 1 1 hour Short-answer questions. Candidates should answer each question. Weighting: 35%	**Paper 2** 1½ hours Short-answer questions. Candidates should answer each question. Weighting: 35%
Paper 3 2 hours Structured questions. Candidates should answer each question. Weighting: 65%	**Paper 4** 2½ hours Structured questions. Candidates should answer each question. Weighting: 65%

Teachers are reminded that a full syllabus and other teacher support materials are available on www.cie.org.uk

Paper 1 (Core)

General comment

For Paper 1, two scripts have been chosen to exemplify a typical grade C and E script. Each script is accompanied by a brief commentary on each question. These two scripts were originally chosen as they had almost all questions attempted.

It is difficult to say what defines a typical script at a particular level as they vary so much. For a grade E script it is common to find quite a number of questions are either not attempted or simply have a small amount of working, suggesting no real knowledge of the topic. Such candidates then tend to have some topics that they clearly know very well and gain their marks on those topics, not all of which are recognised as the easiest ones. The script commented on at grade E suggests a candidate who has been quite well prepared for the examination as far as syllabus coverage is concerned. However, a combination of weakness in understanding and carelessness in interpreting the questions has resulted in this lower grade.

A general observation on grade C candidates is that they have covered the syllabus well and attempted all, or nearly all, the questions. All candidates are prone to errors, particularly those who have not been considered for extended level, and overall it is this factor that mainly reduces the mark from extremely high. Of course, even when a candidate is competent on a particular topic, they still need to interpret the particular question on that topic. Thorough practice on past papers and examination style questions can minimise this. The script selected was felt to be quite typical of a grade C candidate, with only a very few cases observed of lack of understanding, but mainly marks were lost through carelessness in reading and incorrectly interpreting what was required in certain questions.

Mark scheme

Abbreviations

cao	correct answer only
cso	correct solution only
dep	dependent
ft	follow through after error
isw	ignore subsequent working
oe	or equivalent
SC	Special Case
www	without wrong working

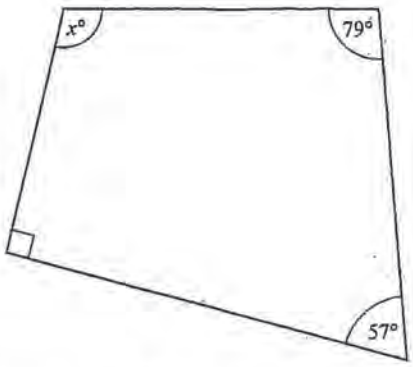
Qu.	Answers	Mark	Part Marks
1	134	1	
2	512(.00)	1	
3	**(a)** –7 **(b)** (+)6	1 1ft	 ft –1 – their **(a)**
4	1.43×10^9 final answer	2	**B1** for answers of 1.43×10^n ($n \neq 0$) or figs 143 or 1.429(….) $\times 10^9$ **SC1** for answer of 1.42×10^9 or 1.4×10^9

Qu.	Answers	Mark	Part Marks
5	899.5 ≤ w < 900.5	2	**B1** for 1 correct or **SC1** for correct but reversed.
6	10 www	2	**M1** for 15 ÷ 6 soi or **B1** for $\frac{6}{4} = \frac{15}{EF}$ oe or better
7	662.794 to 663.304…. final answer	3	**M2** for 600×1.034^3 or **M1** for $(600 + 0.034 \times 600) \times 0.034$ or $(600 \times 1.034) \times 0.034$ and **M1 dep** correct method for the remaining time.
8	**(a)** 4p(2q + 3r) **(b)** (p =) $\frac{s}{4(2q+3r)}$ oe	2 1ft	**B1** for p(8q + 12r) or 2p(4q + 6r) or 4p(aq + br) a, b integers or 4(2pq + 3pr) ft if p is a common factor in **(a)** or in working in **(b)**
9	**(a)** 245 **(b)** 360	1 2	**M1** for $\frac{3}{7} \times 840$ or **SC1** for answer 480
10	**(a)** $\frac{15}{43}$ cao final answer **(b)** $\frac{42}{43}$ cao final answer **(c)** 0 or $\frac{0}{43}$	1 1 1	If zero in **(a)** and **(b)** then **SC1** if both **(a)** and **(b)** are correct decimals or percentages as answers. (Mark as 0 for **(a)** and SC1 for **(b)**)
11	**(a)** (x=) 35 **(b)** (y=) 55	2 1 ft	**B1** for angle BDC = 90 soi May be marked on the diagram ft 90 – their x
12	**(a)** **(i)** (x=) 6 **(ii)** (x=) –2 **(b)** 3	1 1 1	

Qu.	Answers	Mark	Part Marks
13	**(a)** Two stage proof	2	**M1** for $\frac{1\times7+2\times5}{5\times7}$ or $\frac{1\times7}{5\times7}+\frac{2\times5}{5\times7}$ or alt $\frac{4}{5}-\frac{2}{7}$ or $\frac{5}{7}-\frac{1}{5}$ **M1dep** for 1– their $\frac{17}{35}$ or $\frac{18}{35}+\frac{17}{35}=\frac{35}{35}$ or alt $\frac{28-10}{35}$ oe or $\frac{25-7}{35}$ oe
	(b) $\frac{6}{35}$ final answer	2	**M1** for $\frac{1}{3}\times\frac{18}{35}$ oe If zero **SC1** for answer of $\frac{12}{35}$
14	**(a)** (i) $\frac{10\times8-0.5\times90}{5}$	1	
	(ii) 7(.0) cao	2	**B1** for 80 (from 10 × 8) or 45 (from 0.5 × 90) or 5 (denominator) seen
	(b) 5.92 or 5.919(…..)	1	
15	**(a)** **(i)** 175	1	
	(ii) 70	1	
	(b) 2 points plotted correctly (±1mm).	1	
	(c) Positive	1	
16	**(a)** Rotation or enlargement	1	Two transformations named, zero for **(a)**
	180° (SF) –1	1	Independent
	(about or centre) origin oe	1	Independent
	(b) Correct translation 5 right and 3 down	2	**B1** for 5 right or 3 down applied
17	**(a)** $\begin{pmatrix}-12\\-3\end{pmatrix}$	2	**B1** for 1 component correct.
	(b) $\begin{pmatrix}-3\\3\end{pmatrix}$	1	
	(c) **(i)** Vector AB drawn	1	Diagonal line, ignore working lines
	(ii) 134° to 136°	1	
18	**(a)** **(i)** 12.7 to 12.73	2	**M1** for $\frac{x}{18}$ = sin45 or $\frac{x}{18}$ = cos45 or better
	(ii) 161 to 162.1	2ft	**M1** for method for squaring their **(a)(i)**.
	(b) 254 to 255	2	**M1** for $\pi \times 9^2$

Example candidate response – grade C (whole script)

1



NOT TO SCALE

The diagram shows a quadrilateral.
Work out the value of x.

$x + 79 + 57 + 90 = 360$

$x + 226 = 360$

$x = 360 - 226$

$= 134°$

Answer $x =$ 134° [1]

---

2 Caroline changed £200 into New Zealand dollars (NZ$).
The exchange rate was £1 = NZ$2.56 .

How many New Zealand dollars did she receive?

200×2.56

$= 512$

Answer NZ$ 512 [1]

3 Francis recorded a temperature of −4°C on Sunday.
By Monday it had gone down by 3°C.

(a) Find the temperature on Monday.

Answer(a) -7 °C [1]

(b) On Tuesday the temperature was −1°C.

Find the change in temperature between Monday and Tuesday.

Answer(b) 6 °C [1]

---

4 The distance from the Sun to the planet Saturn is 1 429 400 000 kilometres.

Write this distance in standard form, correct to 3 significant figures.

Answer 1.429×10^9 km [2]

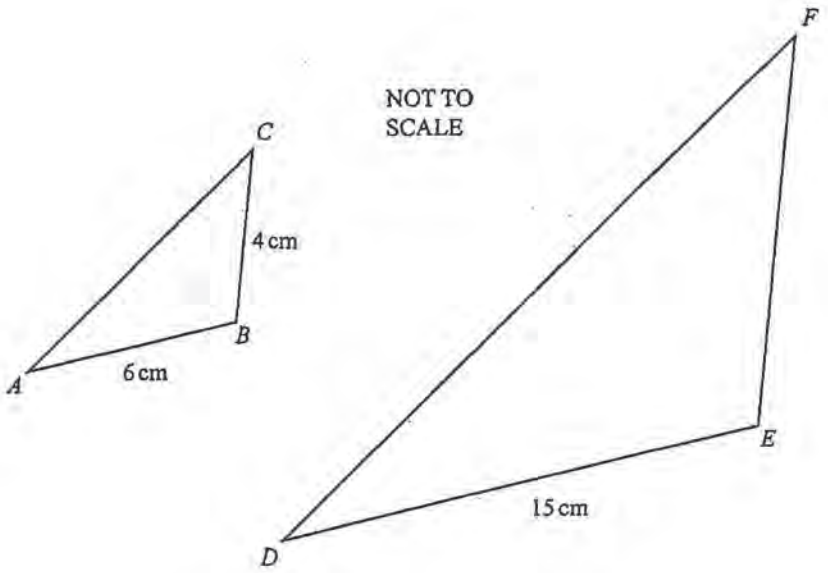
---

5 A factory makes doors that are each 900 millimetres wide, correct to the nearest millimetre.

Complete the statement about the width, w millimetres, of each door.

Answer 950 $\leqslant w <$ 949 [2]

6



The triangles ABC and DEF are similar.
$AB = 6$ cm, $BC = 4$ cm and $DE = 15$ cm.

Calculate EF.

$\frac{15}{6} = 2.5$ $\frac{x}{4} = 2.5$

$x = 2.5 \times 4$

$= 10$

Answer $EF =$ 10 cm [2]

---

7 Maria puts \$600 into a bank account for 3 years at a rate of 3.4% per year **compound** interest.

Calculate how much will be in the account at the end of the 3 years.

$\frac{3.4}{100} \times 600 = 20.4$

1st year $= 600 + 20.4 = 620.4$

$\frac{3.4}{100} \times 620.4 = 21.0936$

2nd year $= 620.4 + 21.0936$

$= 641.4936$

3rd year $= \frac{3.4}{100} \times 641.4936$

$= 21.8107824$

$641.4936 + 21.8107824$

$= 663.3043824$

Answer \$ 663.3 [3]

8 (a) Factorise completely.

$8pq + 12pr$

$8pq+12pr$

$4p(2q+3r)$

Answer(a) $4p(2q+3r)$ [2]

(b) Use your answer to **part (a)** to make p the subject of the formula below.

$s = 8pq + 12pr$

$S = 8pq + 12pr$

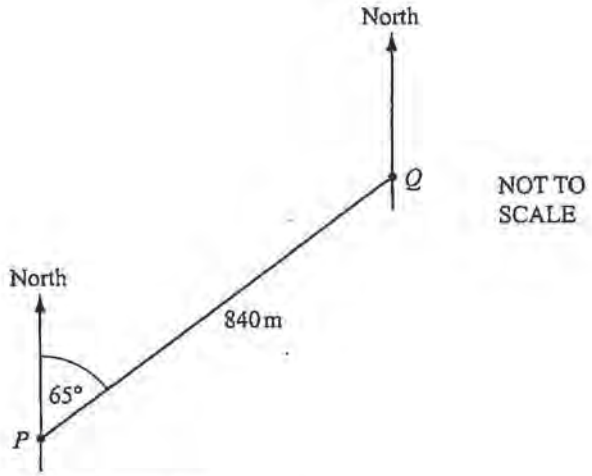
$4p(2q+3r) = S$

$4p = \frac{S}{(2q+3r)}$

$p = \frac{\frac{S}{(2q+3r)}}{4}$

Answer(b) $p = \frac{\frac{S}{(2q+3r)}}{4}$ [1]

9



The diagram shows a straight road PQ.
$PQ = 840$m and the bearing of Q from P is 065°.

(a) Work out the bearing of P from Q.

$180+65 = 245$

Answer(a) $245°$ [1]

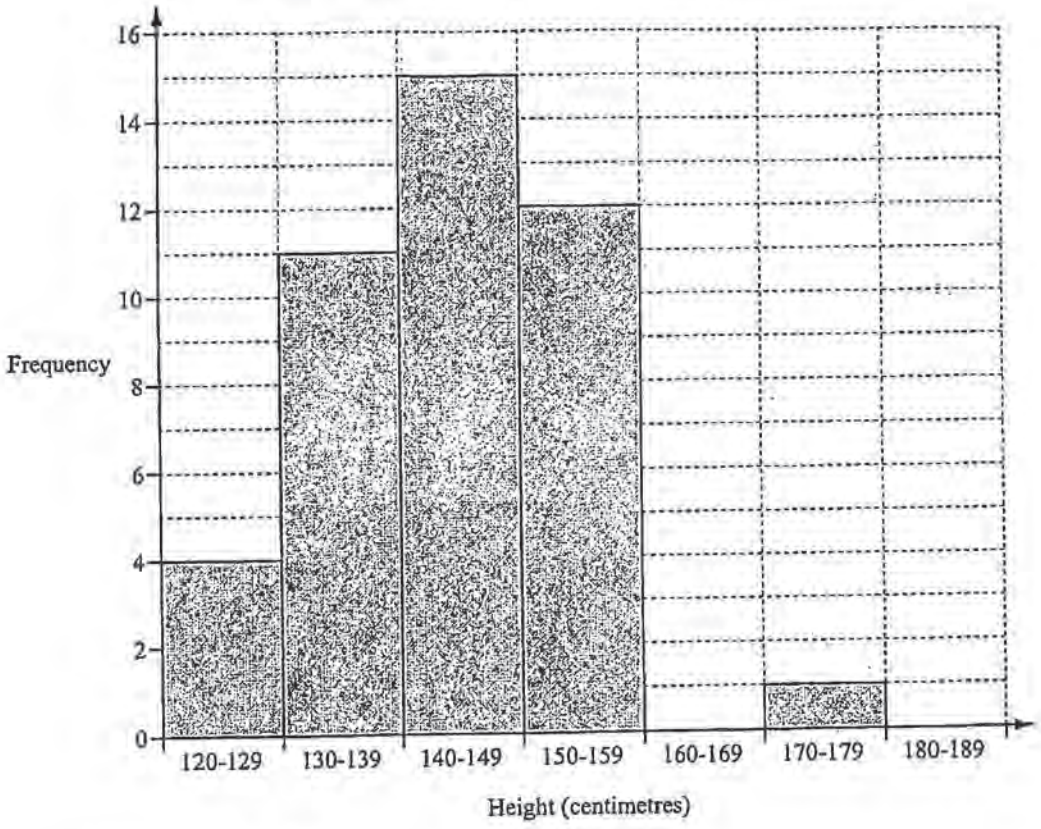
(b) Calvin walks $\frac{4}{7}$ of the distance from P to Q.

How far is he **from** Q?

$\frac{4}{7} \times 840 = 480$

Answer(b) 480 m [2]

10 The heights of 43 children are measured to the nearest centimetre.
Braima draws a bar chart from this information.



A child is chosen at random.
Write down, as a fraction, the probability that the child will be

(a) in the group 140 – 149 cm,

Answer(a) $\frac{1}{7}$ [1]

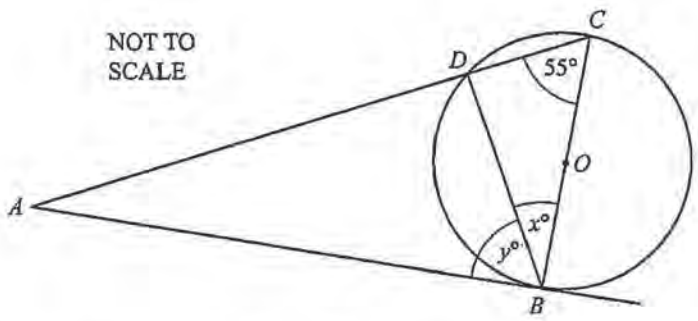
(b) less than 160 cm,

Answer(b) $\frac{4}{7}$ [1]

(c) in the group 160 – 169 cm.

Answer(c) 0 [1]

11



The diagram shows a circle, centre O, with diameter BC.
AB is a tangent to the circle at B and angle $BCD = 55°$.
A straight line from A meets the circle at D and C.

Calculate the value of

(a) x,

90 + 55 = 145
180 − 145 = 35

Answer(a) $x =$ 35° [2]

(b) y.

90 − 35 = 55

Answer(b) $y =$ 55° [1]

---

12 (a) Write down the value of x when

(i) $5^x \div 5^2 = 5^4$,

Answer(a)(i) $x =$ 6 [1]

(ii) $\frac{1}{49} = 7^x$.

Answer(a)(ii) $x =$ −2 [1]

(b) Write down the value of $3p^0$.

Answer(b) 0 [1]

13 Dominic, Esther, Flora and Galena shared a pizza.

(a) Dominic ate $\frac{1}{5}$ of the pizza and Esther ate $\frac{2}{7}$ of the pizza.

Show that $\frac{18}{35}$ of the pizza remained.

Do not use your calculator and show all your working.

Answer (a) LCM=35 $\frac{1\times7}{5\times7}=\frac{7}{35}$, $\frac{2\times5}{7\times5}=\frac{10}{35}$

Total they ate $=\frac{17}{35}$

So remained $=\frac{35}{35}-\frac{17}{35}=\frac{18}{35}$ // [2]

(b) Flora ate $\frac{2}{3}$ of the **pizza that remained.**

Find the fraction of the pizza that was left for Galena.

$\frac{18}{35}\times\frac{2}{3}=\frac{18}{35}\times\frac{2}{3}=\frac{16}{105}$

Answer(b) $\frac{16}{105}$ // [2]

14

$$\frac{9.6\times7.8-0.53\times86}{4.95}$$

(a) (i) Rewrite this calculation with each number written correct to 1 significant figure.

Answer(a)(i) $\frac{10\times8-1\times86}{5}$ [1]

(ii) Work out the answer to your calculation in **part(a)(i).**
Do not use a calculator and show all your working.

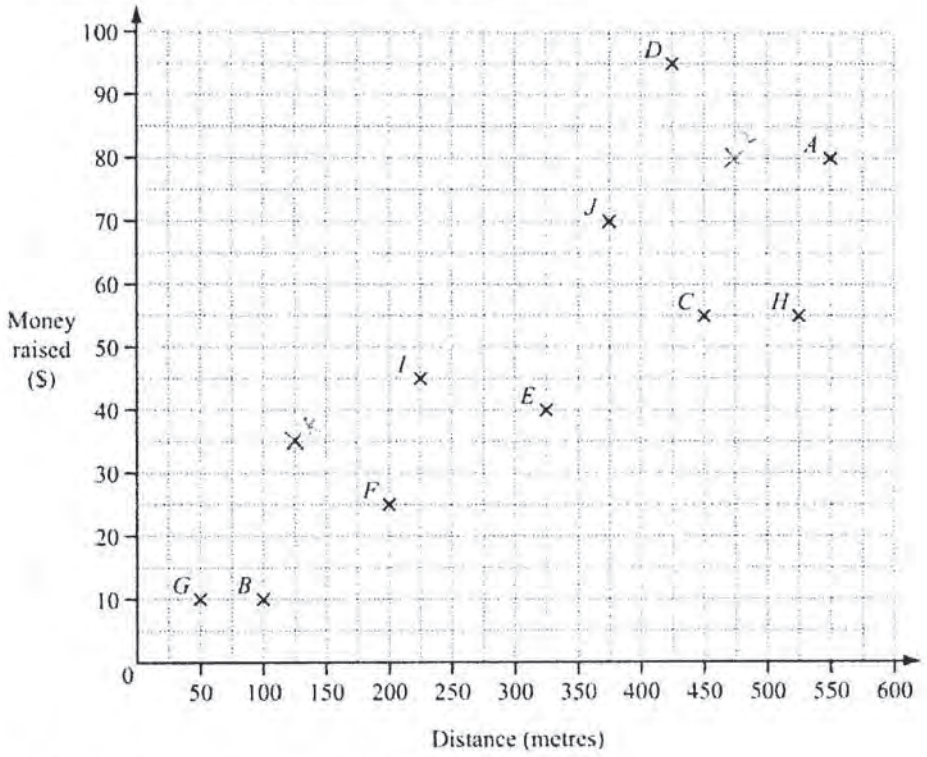
$\frac{10\times8-1\times86}{5}=\frac{80-86}{5}=\frac{-6}{5}=-1.2$

Answer(a)(ii) -1.2 // [2]

(b) Use your calculator to work out the correct answer to the original calculation.

Answer(b) $\frac{586}{99}$ // [1]

15 Some children took part in a sponsored swim to raise money for charity.
The scatter diagram shows the results for 10 of the children.



(a) (i) How much further did A swim than J?

Answer(a)(i) 175 m [1]

(ii) How much more money did D raise than F?

Answer(a)(ii) $ 70 [1]

(b) The results for 2 more children are given in the table below.

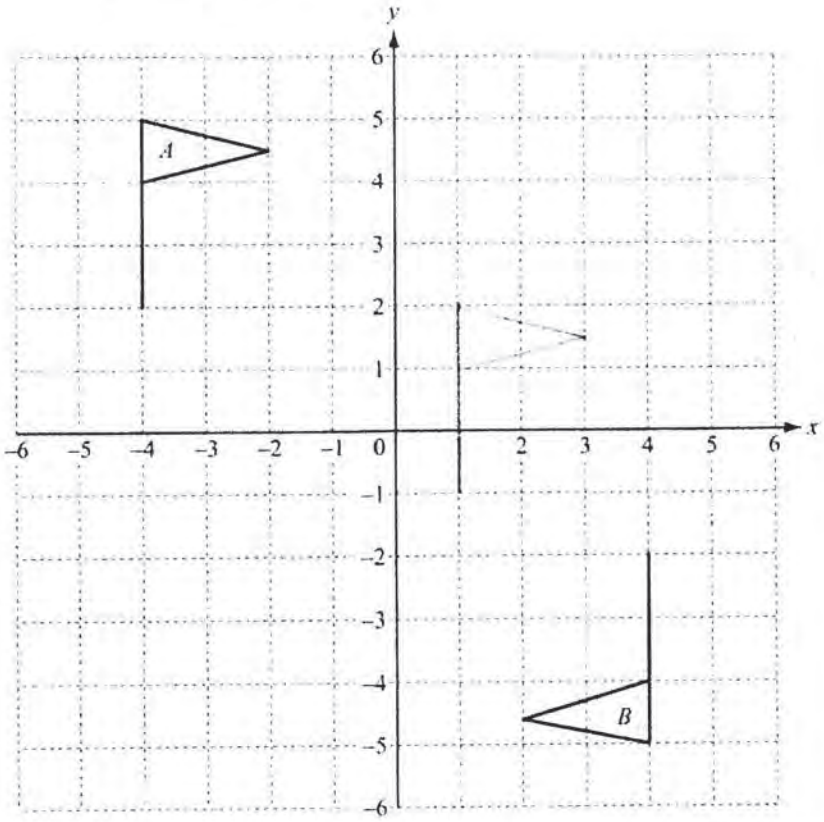
Child	Distance (m)	Money raised ($)
K	125	35
L	475	80

Plot the results for K and L on the scatter diagram. [1]

(c) What type of correlation does the scatter diagram show?

Answer(c) good correlation [1]

16 Flags A and B are shown on the grid.



(a) Describe fully the **single** transformation which maps flag A onto flag B.

Answer(a) Translation $x = 8$, $y = -4$ and rotation 180° clockwise [3]

(b) On the grid, draw the translation of flag A by the vector $\begin{pmatrix} 5 \\ -3 \end{pmatrix}$. [2]

17

$\overrightarrow{AB} = \begin{pmatrix} 3 \\ -3 \end{pmatrix}$ $\overrightarrow{AC} = \begin{pmatrix} -5 \\ 0 \end{pmatrix}$

(a) Calculate $\overrightarrow{AB} + 3\overrightarrow{AC}$.

$3AC = \begin{pmatrix} -5 \\ 0 \end{pmatrix} \times 3 = \begin{pmatrix} -15 \\ 0 \end{pmatrix}$

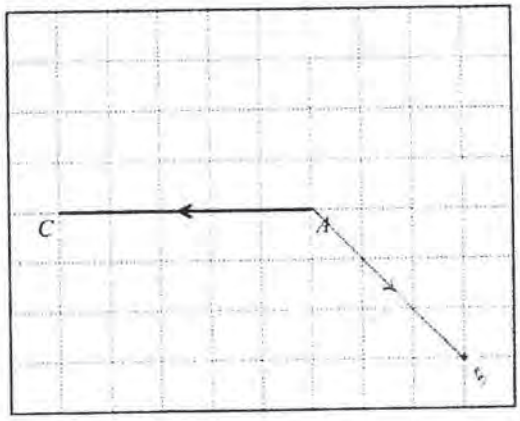
$\begin{pmatrix} 3 \\ -3 \end{pmatrix} + \begin{pmatrix} -15 \\ 0 \end{pmatrix}$

Answer(a) $\begin{pmatrix} -12 \\ -3 \end{pmatrix}$ [2]

(b) Write down $\overrightarrow{BA}$.

Answer(b) $\overrightarrow{BA} = \begin{pmatrix} -3 \\ 3 \end{pmatrix}$ [1]

(c) $\overrightarrow{AC}$ is drawn on the grid below.

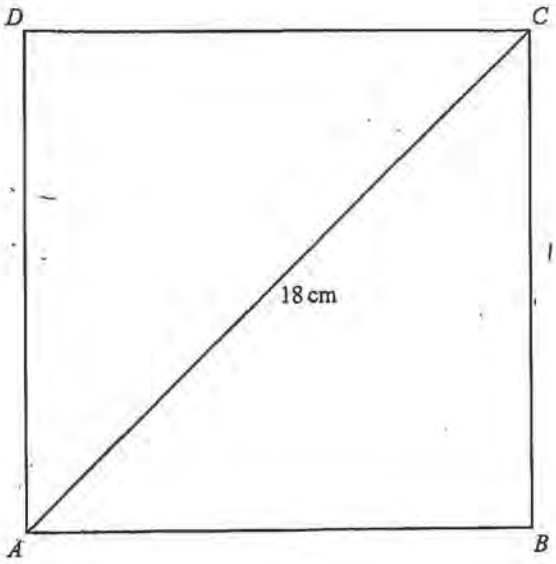


(i) On the grid, draw $\overrightarrow{AB}$. [1]

(ii) Write down the obtuse angle between $\overrightarrow{AB}$ and $\overrightarrow{AC}$.

Answer(c)(ii) 135° [1]

18



NOT TO SCALE

The diagram shows a square $ABCD$.
The length of the diagonal AC is 18 cm.

(a) Calculate

(i) the length of the side of the square,

$\sin(45) \times 18 = 9\sqrt{2}$

Answer(a)(i) ..... cm [2]

(ii) the area of the square.

$(9\sqrt{2})^2$ $9\sqrt{2}$

Answer(a)(ii) ..... cm^2 [2]

(b) A, B, C and D lie on a circle with diameter AC.

Calculate the area of this circle.

Area $= \pi r^2$ $\pi \times 9^2 =$

$r = 9$

Answer(b) 254.5 ..... cm^2 [2]

$\frac{1}{5} - \frac{2}{7}$

$\frac{1}{5} + \frac{2}{7} = \frac{17}{35}$

5 | 5, 7
7 | 1, 7

35

$\frac{1 \times 7}{5 \times 7} = \frac{7}{35}$

$\frac{2}{7} \times \frac{5}{5} = \frac{10}{35}$

$\frac{17}{35} = \frac{35}{85} - \frac{18}{35} =$

$\cos 45$

18

$\cos 45 = \frac{\text{oppo}}{18}$

~~opp~~ $x = \cos 45 \times 18$

$= 12.7$

$4\pi(2q + 3r) = 5$

$\tan 45 = \frac{x}{18}$

$x =$

Examiner comment

Question 1: As well as gaining the correct answer, full working was shown by writing out the equation for the sum of the angles of a quadrilateral. This was equated to 360, not known by some weaker candidates, and the steps of the solution for x were clearly shown.

Question 2: The common error on currency conversion is to choose the incorrect operation from multiplication or division. The working clearly showed the correct one, in this case multiplication by the conversion factor.

Question 3: On this question no working was shown but both answers were correct. The script, by lack of any working, showed an ability to visualise moving down 3 from –4 and that there was a difference of 6 between –7 and –1.

Question 4: The high level skill of standard form was clearly demonstrated by correctly putting the given value in that form. Some carelessness is suspected in not observing the instruction to give the answer to the required accuracy.

Question 5: Upper and lower bounds is the topic least well done at Core level. This response is to the nearest 100mm, rather than 1mm, but at least it has shown some understanding of a range of values.

Question 6: Although the appreciation of similarity is often tested, few questions at Core level use it to find an unknown length. In this response fully correct and clear working is shown, leading to the required answer.

Question 7: Compound interest questions can be resolved using the formula but that is not a syllabus requirement. It is a difficult topic at Core level but the script showed a very thorough understanding of the topic. This was displayed by a full explanation of finding the interest for each year after adding it on to the capital amount.

Question 8: Considerable success on algebraic questions is a good indicator of a grade C candidate at Core level. The script shows a clear one-step solution of common factor factorisation for part (a), even though 2 factors had to be found.

The part (b) response was very nearly correct. Changing the subject of a formula was clearly understood. However at the last step, regardless of correctly indicating division by 4, the form of the answer was not acceptable.

Question 9: Part (a) can be done by using parallel line properties (using the parallel north lines) or from knowledge of back bearings. Although a fairly straightforward topic, questions on bearings are generally poorly done. This response indicated clear knowledge of simply adding 180° to find the required solution.

Clear understanding of finding a fraction of a quantity was demonstrated, but the solution gave the distance from P rather than from Q. Once again a grade C candidate slipped up on reading the question, rather than not knowing the mathematics required.

Question 10: This question, though very straightforward, was misunderstood on this script where the probability was interpreted as being based on the number of groups (7) rather than the number of children (43). This was a common error and both parts (a) and (b) showed this with numerators of 1 and 4.

Recognition of 0 entries in the group 160–169 meant that this mark was gained regardless of the interpretation error. Fortunately 0 rather than $\frac{0}{7}$ was offered as this would not have scored.

Question 11: The question required knowledge of the two circle properties listed in the Core section of the syllabus. The response indicated a full understanding of these even though it is difficult to show an acceptable circle diagram without the angles at D and B appearing to be right angles. Once again clear calculations were shown to demonstrate the two steps in part (a) and the one step in part (b).

Question 12: The rule of subtracting indices when dividing these expressions was clearly understood. This more difficult question, finding the index, x, rather than just a straight subtraction presented no problem.

The property of $a^{-n} = \frac{1}{a^n}$ had to be known for part (a)(ii) This was clearly appreciated as well as recognition that 49 was 7^2.

The question p^0 is very common on Core papers and most candidates have no problem giving

the answer of 1. Making it $3p^0$ caused a lot of confusion with candidates, and simply 1 was a common response. In contrast to the general standard of the script, this part of the topic of indices was not understood.

Question 13: With not having a non-calculator paper, fraction questions are often in the form of 'show that'. The first stage of part (a) was adding the two fractions, which was fairly straightforward. Then subtraction from one was required, which was not so obvious. The script showed fully correct and clear working of both stages.

For part (b) the working suggested that it was realised that two-thirds had to be subtracted. However, the attempt lacked subtraction of two-thirds of the amount left (or simply finding one-third). Furthermore, ending with a negative fraction should have indicated an impossible situation for the context.

Question 14: Five numbers needed rounding to 1 significant figure for part (a)(i). Many, as in this case, made errors on some parts. The common errors made were 1 instead of 0.5 and 86 rather than 90.

Having not gained the first mark, some credit was gained for resolving the correct section of part (i).

Although the working is not displayed, the candidate appears to have multiplied numerator and denominator by 20 to produce the fraction offered. Had this been resolved to a single decimal answer, it would have been correct. This part was intended as a straight calculator resolution and tested, in particular, coping with the division stage, by ensuring that the whole of the numerator was divided by the denominator.

Question 15: Scatter diagrams were introduced to the syllabus in 2006 and once the topic is understood, the questions are fairly straightforward. Part (a) is simply reading the appropriate co-ordinate of 2 points and subtracting, which was performed successfully.

Part (b) required careful plotting of two points given in the table. The points were at the junction of lines on the grid and were plotted correctly.

The general trend of the points was that as one variable increased, so did the other. The response, rather surprisingly, suggested lack of appreciation of the different types of correlation.

Question 16: The vital word in the question is single. No marks are awarded if more than one transformation is given. The response gave a 'correct' description of moving from flag A to flag B, but no credit could be given as 2 transformations were involved.

Translation was clearly understood and the flag simply needed to be moved by the components of the vector.

Question 17: The question required multiplying a vector by 3 and then adding another vector to the result. The response demonstrated a mature approach by showing the stages separately in the working. This made it less likely for an error to be made, particularly when negative numbers are involved.

Part (b) simply involved multiplying by –1 or changing the signs of the components, which was done successfully, without working.

The vector had to be drawn, starting at point A, which was realised in this response. It was very rare for this to be done correctly.

This depended on (c)(i) being correct and knowing the definition of an obtuse angle. Once again this was correctly found. The command word in the question, write down, was used since it was expected that candidates realised it was 90 + 45, but an answer from measurement was acceptable.

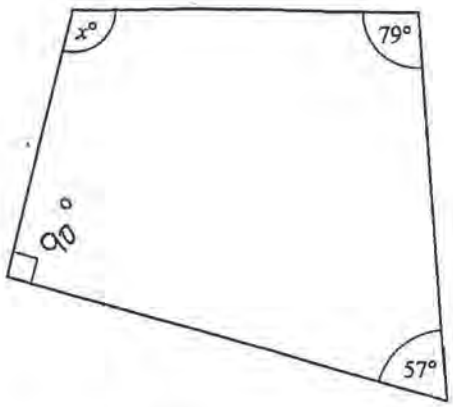
Question 18: Answers in surd form were not accepted for this question, so one mark was lost for that. A correct trigonometry calculation was shown indicating full understanding of how to find the side.

The area of a square is very straightforward and it was not surprising that the previous answer was successfully squared.

Although finding the area of a circle is quite straightforward this part needed realisation that the given diameter had to be halved first to find the radius for substitution into the formula.

Example candidate response – grade E (whole script)

1



NOT TO SCALE

The diagram shows a quadrilateral.
Work out the value of x.

$57^\circ + 79^\circ + 90^\circ$
$= 360^\circ - 223^\circ$
$= 134^\circ$

Answer $x =$ 134° [1]

---

2 Caroline changed £200 into New Zealand dollars (NZ$).
The exchange rate was £1 = NZ$2.56 .

How many New Zealand dollars did she receive?

£200 → NZ$

~~£200 :~~
£1 = NZ 2.56
£200 = NZ$ 512

Answer NZ$ 512 [1]

3 Francis recorded a temperature of −4°C on Sunday.
By Monday it had gone down by 3°C.

(a) Find the temperature on Monday.

$-4^\circ - 3^\circ$
$= -7^\circ$

Answer(a) ..... -7 ..... °C [1]

(b) On Tuesday the temperature was −1°C.

Find the change in temperature between Monday and Tuesday.

$3^\circ + -1^\circ$
$= 2$

Answer(b) ..... 2 ..... °C [1]

---

4 The distance from the Sun to the planet Saturn is 1 429 400 000 kilometres.

Write this distance in standard form, correct to 3 significant figures.

0 - 1429 400 000

0.143 / 1.430

Answer ..... 1.430 ..... km [2]

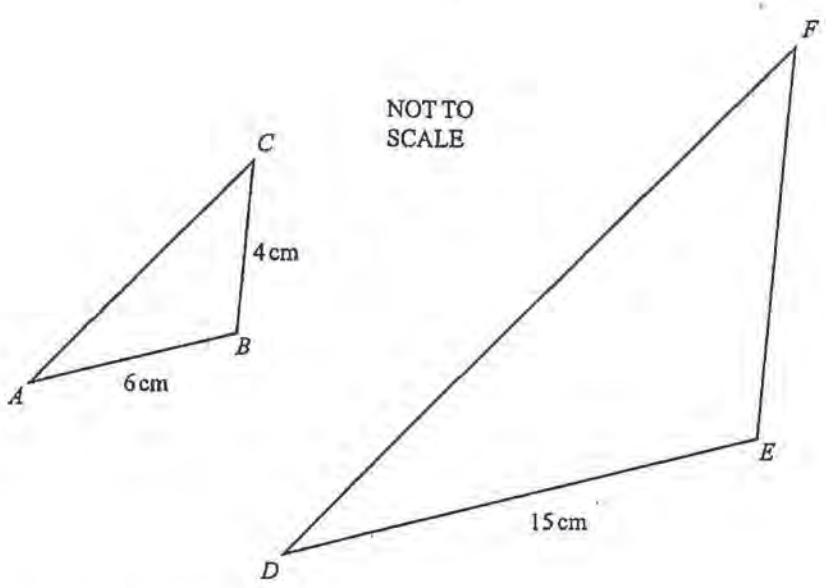
---

5 A factory makes doors that are each 900 millimetres wide, correct to the nearest millimetre.

Complete the statement about the width, w millimetres, of each door.

Answer ..... 899 ..... $\leqslant w <$ ..... 910 ..... [2]

6



The triangles ABC and DEF are similar.
$AB = 6$ cm, $BC = 4$ cm and $DE = 15$ cm.

Calculate EF.

AB = 6 : DE = 15
CB = 4 : FF = ? 13

Answer $EF =$ 13 cm [2]

---

7 Maria puts \$600 into a bank account for 3 years at a rate of 3.4% per year **compound** interest.

Calculate how much will be in the account at the end of the 3 years.

$600 \times \frac{3.4}{100} \times 1$

$= 20.4$

$620.4 \times \frac{3.4}{100} \times 3$

$= 6.328.08$

Answer \$ 6.328.08 [3]

8 (a) Factorise completely.

$8pq + 12pr$

8pq + 12pr

8(pxq) + 12(pxr)

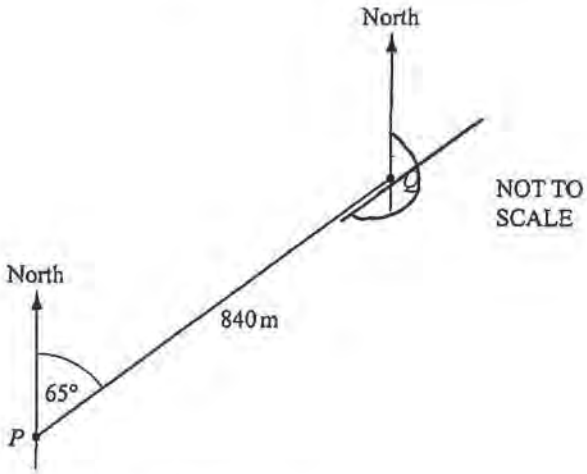
Answer(a) 8(pxq) + 12(pxr) [2]

(b) Use your answer to part (a) to make p the subject of the formula below.

$s = 8pq + 12pr$

Answer(b) $p =$ [1]

9



The diagram shows a straight road PQ.
$PQ = 840$m and the bearing of Q from P is 065°.

(a) Work out the bearing of P from Q.

180° + 65°

= 245°

Answer(a) 245° [1]

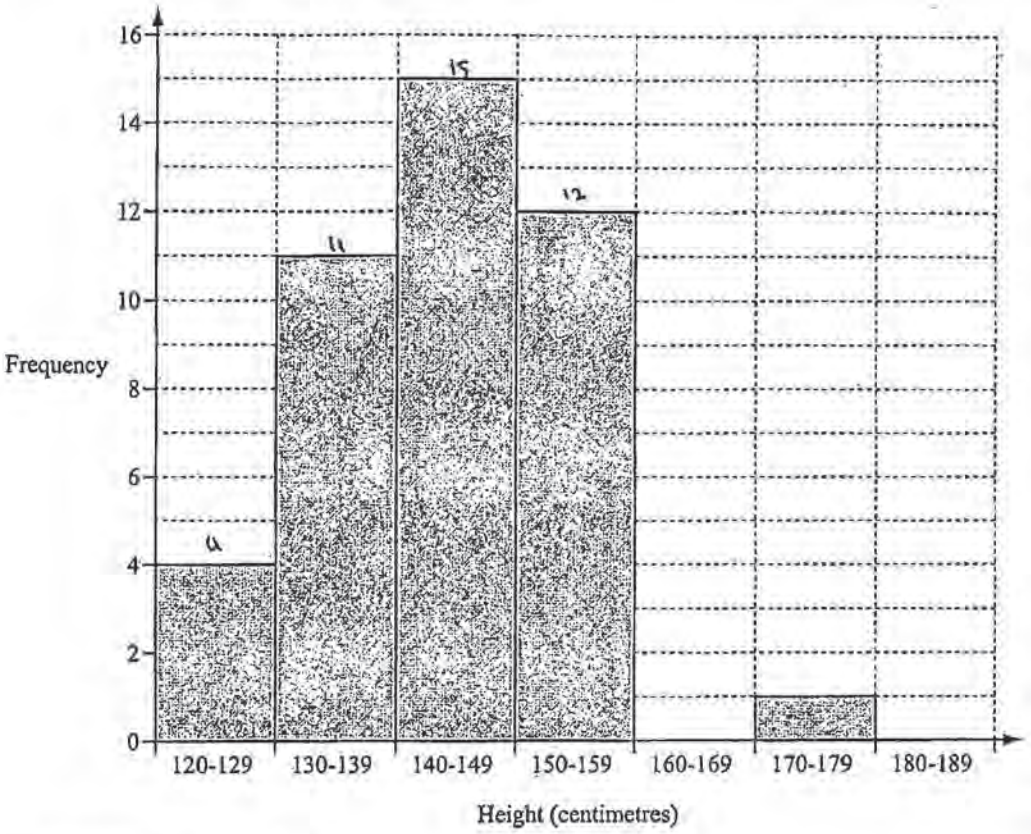
(b) Calvin walks $\frac{4}{7}$ of the distance from P to Q.

How far is he **from** Q?

$840 \times \frac{4}{7} = \frac{3360}{7} = 480$ m

Answer(b) 480 m [2]

10 The heights of 43 children are measured to the nearest centimetre.
Braima draws a bar chart from this information.



A child is chosen at random.
Write down, as a fraction, the probability that the child will be

(a) in the group 140 – 149 cm,

15/43

Answer(a) 15 out of 43 [1]

(b) less than 160 cm,

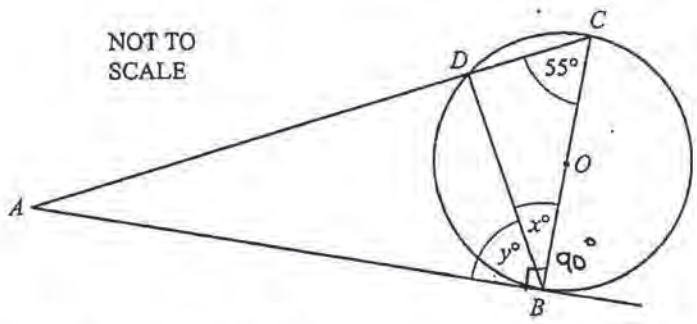
15+12+11+4
= 42/43

Answer(b) 42 out 43 [1]

(c) in the group 160 – 169 cm.

Answer(c) 0 out of 43 [1]

11



The diagram shows a circle, centre O, with diameter BC.
AB is a tangent to the circle at B and angle $BCD = 55°$.
A straight line from A meets the circle at D and C.

Calculate the value of

(a) x,

Answer(a) $x =$ 40 [2]

(b) y.

Answer(b) $y =$ 86° [1]

---

12 (a) Write down the value of x when

(i) $5^x \div 5^2 = 5^4$,

$5^6 \div 5^2 = 5^4$

Answer(a)(i) $x =$ 6 [1]

(ii) $\frac{1}{49} = 7^x$.

$\frac{1}{49} = 7^{-2}$

Answer(a)(ii) $x =$ −2 [1]

(b) Write down the value of $3p^0$.

$3p^0$

Answer(b) 0 [1]

13 Dominic, Esther, Flora and Galena shared a pizza.

(a) Dominic ate $\frac{1}{5}$ of the pizza and Esther ate $\frac{2}{7}$ of the pizza.

Show that $\frac{18}{35}$ of the pizza remained.

Do not use your calculator and show all your working.

Answer (a)

$\frac{1}{5} \times \frac{2}{7} = \frac{7}{35} + \frac{10}{35} = \frac{17}{35}$?

[2]

(b) Flora ate $\frac{2}{3}$ of the **pizza that remained.**

Find the fraction of the pizza that was left for Galena.

$\frac{17}{35} \times \frac{2}{5} = \frac{34}{175}$

Answer(b) $\frac{15}{32}$ [2]

14

$$\frac{9.6 \times 7.8 - 0.53 \times 86}{4.95}$$

(a) (i) Rewrite this calculation with each number written correct to 1 significant figure.

Answer(a)(i)

$\frac{10 \times 8 - 0.50 \times 86}{5}$

[1]

(ii) Work out the answer to your calculation in **part(a)(i).**
Do not use a calculator and show all your working.

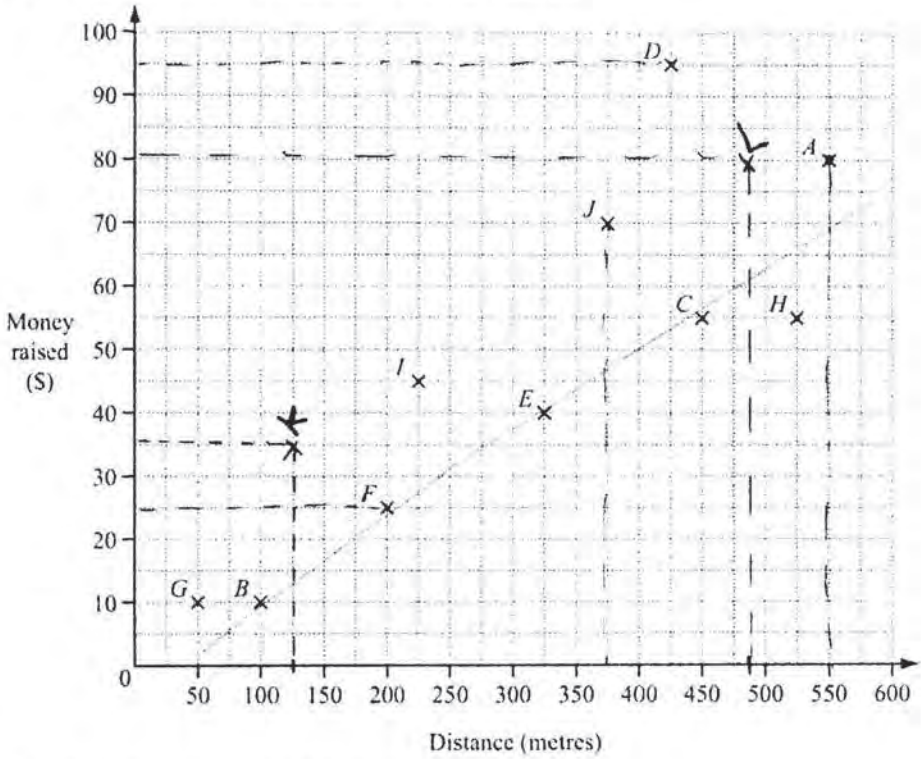
$\frac{10 \times 8 - 0.50 \times 86}{\frac{80 - 43}{5}} = \frac{37}{5} = 7.4$

Answer(a)(ii) 7.4 [2]

(b) Use your calculator to work out the correct answer to the original calculation.

Answer(b) 1.278.82. [1]

15 Some children took part in a sponsored swim to raise money for charity.
The scatter diagram shows the results for 10 of the children.



(a) (i) How much further did A swim than J?

550 m − 355
= 195

Answer(a)(i) 195 m [1]

(ii) How much more money did D raise than F?

$95 − $25
= $70

Answer(a)(ii) $ 70 [1]

(b) The results for 2 more children are given in the table below.

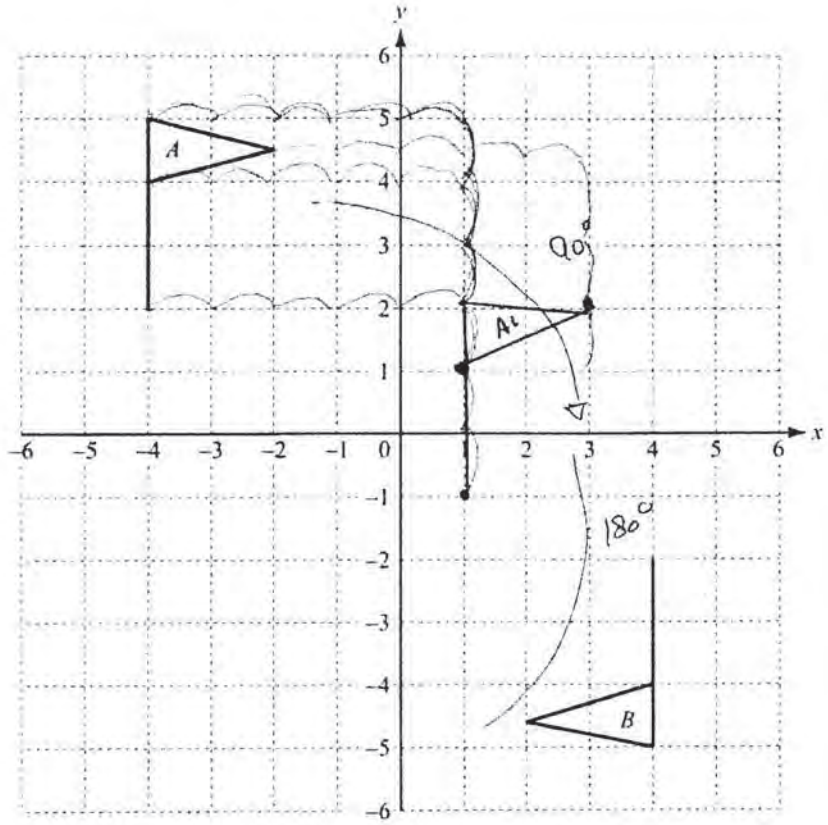
Child	Distance (m)	Money raised ($)
K	125	35
L	475	80

Plot the results for K and L on the scatter diagram. [1]

(c) What type of correlation does the scatter diagram show?

Answer(c) Straight line. [1]

16 Flags A and B are shown on the grid.



(a) Describe fully the **single** transformation which maps flag A onto flag B.

Answer(a) translation, clock wise, 180° degree

Rotation, (0,0) [3]

(b) On the grid, draw the translation of flag A by the vector $\begin{pmatrix} 5 \\ -3 \end{pmatrix}$. [2]

17

$\overrightarrow{AB} = \begin{pmatrix} 3 \\ -3 \end{pmatrix}$ $\overrightarrow{AC} = \begin{pmatrix} -5 \\ 0 \end{pmatrix}$

(a) Calculate $\overrightarrow{AB} + 3\overrightarrow{AC}$.

$\begin{pmatrix} 3 \\ -3 \end{pmatrix} + \begin{pmatrix} -15 \\ 0 \end{pmatrix}$

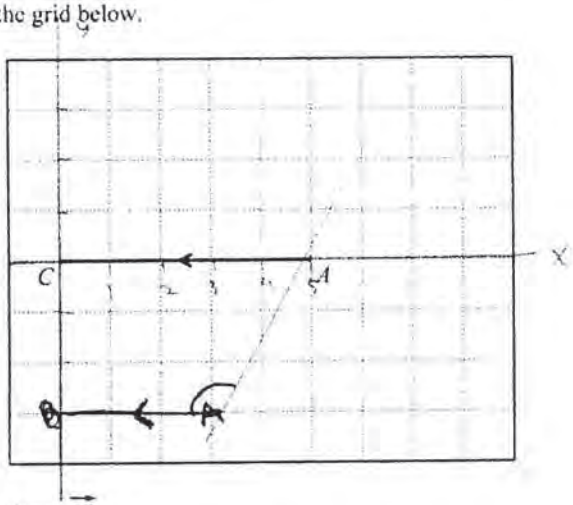
$= \begin{pmatrix} -12 \\ -3 \end{pmatrix}$

Answer(a) $\begin{pmatrix} -12 \\ -3 \end{pmatrix}$ [2]

(b) Write down $\overrightarrow{BA}$.

Answer(b) $\overrightarrow{BA} = \begin{pmatrix} -3 \\ 3 \end{pmatrix}$ [1]

(c) $\overrightarrow{AC}$ is drawn on the grid below.

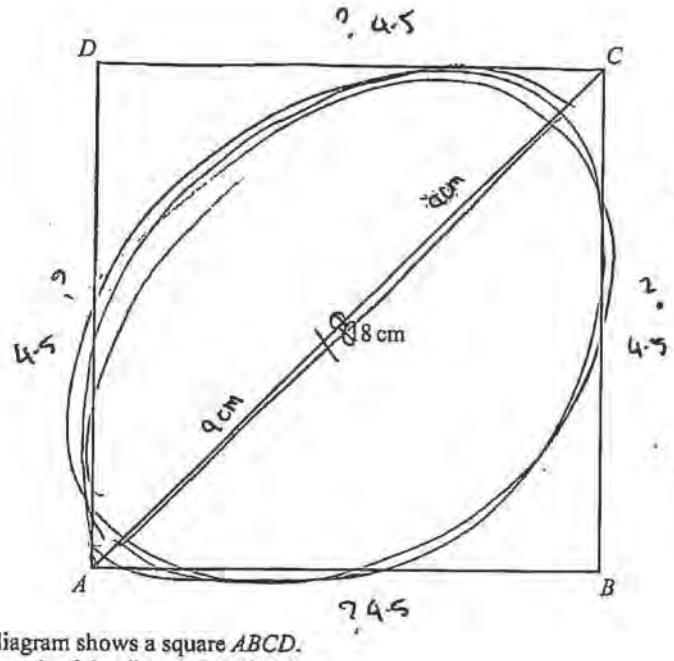


(i) On the grid, draw $\overrightarrow{AB}$. [1]

(ii) Write down the obtuse angle between $\overrightarrow{AB}$ and $\overrightarrow{AC}$.

Answer(c)(ii) 120° [1]

18



The diagram shows a square $ABCD$.
The length of the diagonal AC is 18 cm.

(a) Calculate

(i) the length of the side of the square,

$\frac{18}{4} = 4.5$ cm

Answer(a)(i) 4.5 cm [2]

(ii) the area of the square.

4.5×4.5

$= 20.25$

Answer(a)(ii) 20.25 cm^2 [2]

(b) A, B, C and D lie on a circle with diameter AC.

Calculate the area of this circle.

πr^2

$= \pi \times 9^2 = 254.46$

Answer(b) 254.46 cm^2 [2]

Examiner comment

Question 1: The response demonstrates clear understanding of angle sum of a quadrilateral and the resolution of the unknown angle.

Question 2: Although the correct answer indicates multiplication was applied, there is no clear expression of method.

Question 3: A clear expression of the arithmetic involved is shown, leading to a correct answer for part (a). Here is seen the first real indication of a lower level script. Although the question refers to temperatures on Monday and Tuesday, no reference is made to Monday's temperature, from the answer to part (a). This suggests lack of understanding of the wording of the question, typical of a lower grade script.

Question 4: Little appreciation of standard form, a higher grade topic, is seen in this response. However, the basic skill of rounding is successfully completed.

Question 5: The responses showed no understanding of lower and upper bounds. The figure '5' needed in all responses for this topic was not evident in this script.

Question 6: No understanding of the correct method for applying similarity to a specific case is seen. Rather than a ratio being applied the response simply subtracts 2 from 15 since 4 is 2 less than 6.

Question 7: The response suggests some idea of compound interest as interest for the first year is added to the amount invested. However, the remainder is confused with a multiplication by 3 appearing. The answer clearly shows no suggestion of an amount resulting at the end of 3 years.

Question 8: Understanding of simple algebraic operations is a good indication of a higher grade script. This script shows no progress on factorising in part (a) as the working does no more than illustrate the meaning of pq and pr.
One of the most difficult parts of the algebra in the Core level course was not attempted.

Question 9: The script shows an understanding of bearings in part (a) where the working is clear and leads to a correct answer.
In part (b) the skill of finding a fraction of a number is demonstrated successfully.
Unfortunately, it is the distance from P rather than from Q, which is found.

Question 10: Unfortunately, in all these parts, the answer is not expressed as a probability. This should always be expressed as a fraction, decimal or percentage. It is the answer quoted finally (in this case the one in the answer space) which is marked and it was rather unfortunate that all marks were lost, when the essence of probability was understood.

Question 11: Although diagrams are 'not to scale' the sizes of the angles in questions are set close to their actual values. Here the property of 'angle in a semi-circle' is clearly not known and an answer of 4° is clearly unrealistic for part (a).
The other circle property at Core level of the angle between tangent and diameter was realised and so the mark in part (b) could be awarded on a follow through, even though again, the size of the angle response is unrealistic.

Question 12: Some understanding of rules of indices is shown in part (a)(i) and a rather tricky question is well answered.
In part (a)(ii), the idea of a negative index is clearly not appreciated and an index of 7, rather even than 2 shows lack of knowledge of the topic.
The response suggests no knowledge of the result of $a^0 = 1$, a common question on Core papers.

Question 13: A correct addition of the two fractions is shown for the first stage of the solution in part (a). However, there is no attempt to then subtract the resulting fraction from one. This is quite common in lower grade scripts.
Some confused working was attempted in part (b) but nothing suggested any progress towards one-third (or even two-thirds) of the answer given in part (a).

Question 14: As in the grade C example, some correct rounding to 1 significant figure is seen, but 86 should have been 90.
Having not gained the first mark, some credit was gained for resolving the correct section of part(i).
No working was shown and the response does not seem to bear any relation to an attempt to find the exact value of the expression.

Question 15: Careful reading of a scale was required in part (a)(i) but the mid-point between 350 and 400 was read as 355 instead of 375. A fault in lower grade scripts is often misreading scales rather than not understanding what to do.
In this case the two readings were correctly taken and subtracted, showing understanding of this basic skill.
The plotting of point L was not accurate, again showing poor reading of the scale. 475 should have been on the line midway between 450 and 500.
The response indicated no understanding of types of correlation.

Question 16: Two transformations were offered and immediately this cannot be credited. Words in bold in questions should be strictly observed so it was clear that only a single transformation was required.
The response shows understanding of translation and the vector representing it. Unfortunately one point of the flag is incorrect. Again it is clear that lower grade candidates often understand much of the course but are not careful in applying their knowledge to the situation of the question.

Question 17: The work on vectors was clearly well known and the multiplication and addition in part (a) was correctly and clearly shown.
Part (b) needed no working, just a correct reverse of signs that was correctly performed.
Although vectors were clearly understood in the previous part the response shows lack of any understanding of showing a vector on the grid. The given point A was not used and a new one introduced.
As this part depended on (c)(i) it could not possibly be correct, although the incorrect angle marked was measured as close to its value.

Question 18: No recognition of the need to apply either Pythagoras or a trigonometry ratio was evident in part (a)(i). However, the response in part (a)(ii) showed knowledge and application of the area of a square.
Another basic skill, finding the area of a circle was demonstrated and the radius was correctly found from the given diameter.

Paper 2 (Extended)

General comment

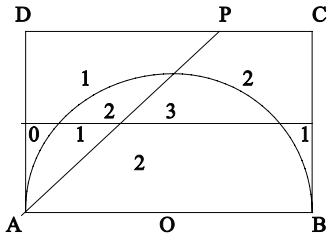
For Paper 2, three scripts have been chosen to exemplify a typical grade A, C and E script. Each script is accompanied by a commentary explaining the strengths and weaknesses of the answers.

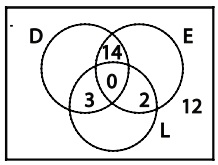
Mark scheme

Abbreviations

cao	correct answer only
cso	correct solution only
dep	dependent
ft	follow through after error
isw	ignore subsequent working
oe	or equivalent
SC	Special Case
www	without wrong working

Qu.	Answers	Mark	Part Marks
1	20 (but **3, 4 and 8 must be seen www**)	2	**M1** 3, 4 and 8 seen www
2	1.2496 cao	2	Allow 1 $\frac{156}{625}$ **M1** 1 + 0.2 + 0.04 + 0.008 + 0.0016
3	2	2	**M1** 3x – 1 – 3x + 3
4	0.9^3 0.9^2 $\sqrt{0.9}$ $\sqrt[3]{0.9}$	2	**M1** 0.94(8683…) 0.96(5489….) 0.8(1) 0.7(29)
5	**(a)** 5 **(b)** 2	1 1	
6	$1.15(2) \times 10^{-2}$	2	**M1** figs 115(2)
7	$\frac{5+x}{2x}$	2	**M1** 4 + 1 + x seen or **M1** $\frac{10+2x}{4x}$ oe
8	40.5	2	**M1** 6.75 seen or 6 × their LB
9	$674.92, 674.9(0) or 675	3	**M2** 600 × (1 + (4/100))^3 or better oe or **M1** 600 × 1.04^2 oe

Qu.	Answers	Mark	Part Marks
10	x = 4 y = –3	3	**M1** consistent mult and sub/add **A1** one correct value but M must be scored
11		3	Marks allocated for R in one of the regions shown
12	x = +/- √(5y) – 3 or x = +/- $\sqrt{5y}$ – 3	3	**M1** correct move of the 5 completed **M1** correct move of the square completed **M1** correct move of the 3 completed
13	x < –3	3	**M1** correct move **M1** correct move **M1** correct move
14	**(a)** 10(.0) **(b)** $2\frac{1}{2}$, 2.5(0)	1 2	 **M1** 2n – 3 = 2
15	31.4 cao	3	**M1** $\frac{1}{2} \times 2 \times \pi \times 3$ oe **M1** $6 + 8 + 6 + 1 + 1 + k\pi$
16	$\frac{x-3}{x+2}$	4	**B2** (x – 3)(x – 2) or **B1** (x + a)(x + b) where ab = 6 or a + b = –5 **B1** (x – 2)(x + 2)
17	**(a)** $\begin{pmatrix} 8 & 0 \\ 0 & 8 \end{pmatrix}$ oe **(b)** $\begin{pmatrix} \frac{1}{4} & \frac{1}{4} \\ \frac{1}{4} & -\frac{1}{4} \end{pmatrix}$ oe	2 2	**B1** for one column (or row) correct **B1** for $-1/8 \begin{pmatrix} a & c \\ b & d \end{pmatrix}$ or **B1** for $\begin{pmatrix} -2 & -2 \\ -2 & 2 \end{pmatrix}$ seen
18	**(a)** **(i)** Tangent **(ii)** 4.4 to 6 **(b)** 780	1 2 2	Correct tangent drawn dep **M1** attempting to find gradient of their tangent **M1** evidence of finding the area under the graph ONLY from t = 12 to t = 25

Qu.	Answers	Mark	Part Marks
19	**(a)** 20200 **(b)** 1260	2 2	**M1** 65 × 300 + 700 **M1** 71190 / 56.5
20	x = 0.84 or 7.16	4	**B1** $\frac{8 \pm k}{2}$ **B1** √(8² – 4 × 1 × 6) or better **A1 A1**
21	**(a)** Bisector **(b)** (4, 2) **(c)** y = –2x + 10 oe	2 1 3	**B1** accurate line **B1** two sets of correct arcs **B1** correct m **B1** correct c **M1** correct use of y = mx + c oe on answer line
22	**(a)**  **(b)** 11 **(c)** 23	4 1ft 1ft	**B1** 0 and 14 in correct place **B1** 2 in correct place **B1** 3 in correct place **B1** 12 in correct place **B1**ft 8 + their 3 **B1**ft 21 + their 2

Example candidate response – grade A (whole script)

1 Write each number correct to 1 significant figure and estimate the value of the calculation.
You must show your working.

$2.65 \times 4.1758 + 7.917$

$3 \times 4 + 8$

$3 \times 4 = 12 + 8 = 20$

Answer 20 [2]

---

2 Use a calculator to work out the exact value of

$$1 + \frac{1}{5} + \left(\frac{1}{5}\right)^2 + \left(\frac{1}{5}\right)^3 + \left(\frac{1}{5}\right)^4.$$

Answer 1,25 [2]

---

3 Expand the brackets and simplify.

$$\frac{1}{2}(6x - 2) - 3(x - 1)$$

$3x - 1 - 3x + 3$

$3x - 3x = 0$

$-1 + 3 = 2$

Answer 2 [2]

---

4 Write the following in order of size, **smallest first.**

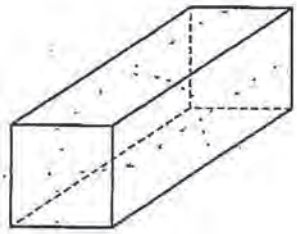
$\sqrt{0.9}$ $\sqrt[3]{0.9}$ 0.9^2 0.9^3

0,9486
0,9654
0,81
0,729

Answer $0,9^3 < 0,9^2 < \sqrt{0,9} < \sqrt[3]{0,9}$ [2]

---

5 (a)

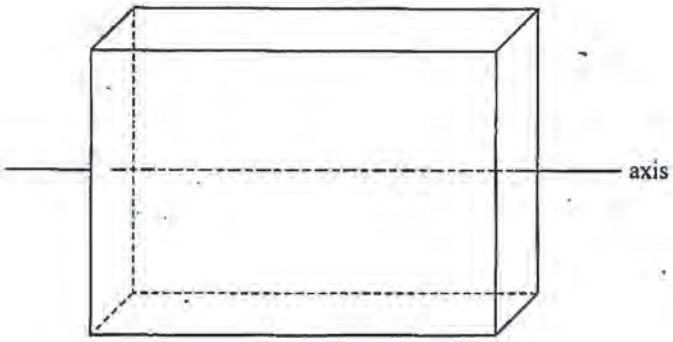


This cuboid has a **square** cross-section.

Write down the number of planes of symmetry.

Answer(a) ..... 3 [1]

(b)



This cuboid has a **rectangular** cross-section.

The axis shown passes through the centre of two opposite faces.

Write down the order of rotational symmetry of the cuboid about this axis.

Answer(b) ..... 2 ..... [1]

6 Work out $\frac{240^2}{5\times10^6}$.

Give your answer in standard form.

$= 0,01152$

$1,152\times10^{-2}$

Answer $1,152\times10^{-2}$ [2]

---

7 Write as a single fraction in its simplest form.

$$\frac{2}{x}+\frac{1}{2x}+\frac{1}{2}$$

$\frac{4+1+x}{2x}$

$= \frac{5+x}{2x}$

Answer $\frac{5+x}{2x}$ [2]

---

8 The length of a side of a regular hexagon is 6.8 cm, correct to one decimal place.

Find the smallest possible perimeter of the hexagon.

$6,75 \leq 6,8 < 6,85$

$6,75\text{cm} \times 6 \text{ sides}$

$= 40,5$

Answer 40,5 cm [2]

9 Johan invested $600 for 3 years at 4% per year **compound** interest.

Calculate the final amount he had after three years.

$P \times R^T = 600 \times 4\%^3$

$= 600 \times 1,04^3$

$= 674,91$

Answer $ 675 [3]

---

10 Solve the simultaneous equations $2x + y = 5$ and $2y = x - 10$.

$2x + y = 5$

$2y = x - 10 \Rightarrow 2y - x = -10$

$2x + y = 5 \times 2$

$2y - x = -10 \times 1$

$4x + 2y = 10$

$-x + 2y = -10$

$2y - x = -10 \times 1$

$y + 2x = 5 \times 2$

$2y - x = -10$

$2y + 4x = 10$

$2x + y = 5$

$2(4) + y = 5$

$8 + y = 5$

$y = -3$

$\frac{5x}{5} = \frac{20}{5}$

$x = 4$

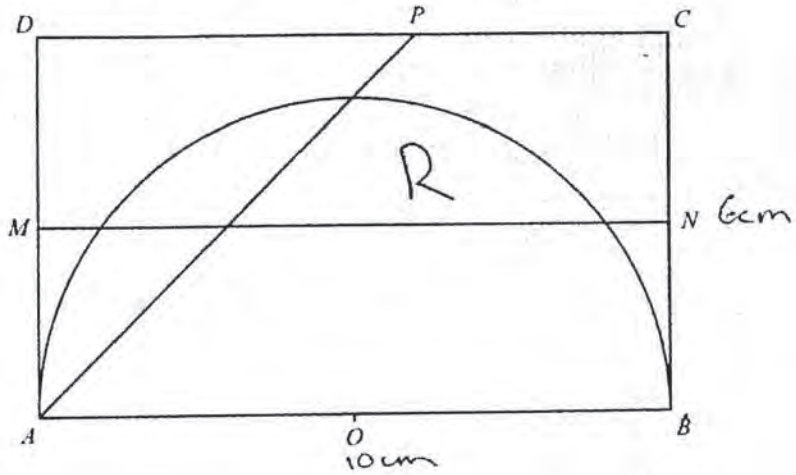
Answer $x =$ 4

$y =$ −3 [3]

11 $ABCD$ is a rectangle with $AB = 10$ cm and $BC = 6$ cm. MN is the perpendicular bisector of BC.

AP is the bisector of angle BAD.

O is the midpoint of AB and also the centre of the semicircle, radius 5 cm.



Write the letter R in the region which satisfies **all** three of the following conditions.

- nearer to AB than to AD
- nearer to C than to B
- less than 5 cm from O

[3]

---

12 Make x the subject of $y = \dfrac{(x+3)^2}{5}$.

$5y = (x+3)(x+3)$

$5y = x^2 + 6x + 9$

$5y = (x+3)^2$

$\sqrt{5y} = x + 3$

$3 + \sqrt{5y} = x$

Answer $x =$ $3 + \sqrt{5y}$ [3]

7

13 Solve the inequality. $2x+5 < \frac{x-1}{4}$

$4(2x+5) < x-1$

$8x+20 < x-1$

$8x+21 < x$

$21 < -7x$

$7x > -21$

$8x+20 < x-1$

$8x-x < -1-20$

$7x < -21$

$7x < -21$

Answer $7x < -21$ [3]

14 Find the value of n in the following equations.

(a) $2^n = 1024 \Rightarrow 2^n = 2^{10}$

$2^{10} = 1024$

$n = 10$

Answer(a) $n =$ 10 [1]

(b) $4^{2n-3} = 16$

$4^{2n-3} = 4^2$

$2n-3 = 2$

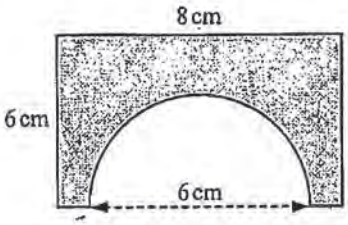
$2n = 5$

$\frac{2n}{2} = \frac{5}{2}$

$n = 2,5$

Answer(b) $n =$ 2,5 [2]

15



NOT TO SCALE

A semicircle of diameter 6 cm is cut from a rectangle with sides 6 cm and 8 cm.

Calculate the perimeter of the shaded shape, correct to 1 decimal place.

$8-6 = 2 + 8 + 6 = 16+6$

$2\pi r + 16$

$2 \times \pi \times 3 + 16 + 6$

$18,849 + 16 + 6$

$= 34,849 + 6$

$22 + 2\pi r$

$\Rightarrow 22 + 3\pi$

$\Rightarrow 22 + 9,4$

Answer 31,4 cm [3]

16 Simplify this fraction.

$$\frac{x^2-5x+6}{x^2-4} = \frac{(x-3)(x-2)}{(x+2)(x-2)} = \frac{x-3}{x+2}$$

Answer $\frac{x-3}{x+2}$ [4]

17

$$A = \begin{pmatrix} 2 & 2 \\ 2 & -2 \end{pmatrix}$$

Work out

(a) A^2,

$$\begin{pmatrix} 2 & 2 \\ 2 & -2 \end{pmatrix}\begin{pmatrix} 2 & 2 \\ 2 & -2 \end{pmatrix} = \begin{pmatrix} 4+4 & 4-4 \\ 4-4 & 4+4 \end{pmatrix}$$

Answer(a) $\begin{pmatrix} 8 & 0 \\ 0 & 8 \end{pmatrix}$ [2]

(b) A^{-1}, the inverse of A.

$$\begin{pmatrix} 2 & 2 \\ 2 & -2 \end{pmatrix} = \frac{1}{ad-bc}\begin{pmatrix} -2 & -2 \\ -2 & 2 \end{pmatrix}$$

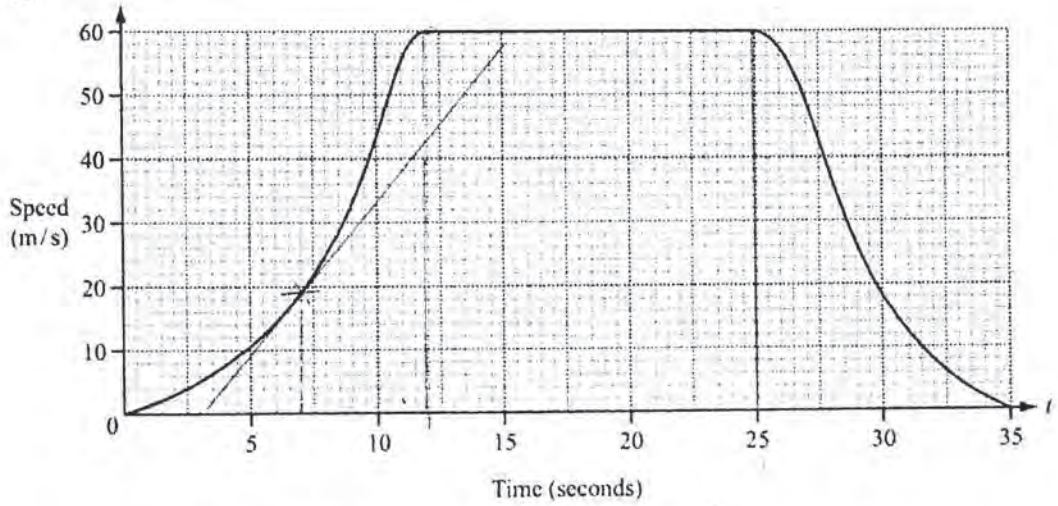
$$= \frac{1}{-4-4}\begin{pmatrix} -2 & -2 \\ -2 & 2 \end{pmatrix}$$

$$= \frac{1}{-8}\begin{pmatrix} -2 & -2 \\ -2 & 2 \end{pmatrix}$$

$$-\frac{1}{8}\begin{pmatrix} -2 & -2 \\ -2 & 2 \end{pmatrix}$$

Answer(b) [2]

18



The graph shows the speed of a sports car after t seconds.

It starts from rest and accelerates to its maximum speed in 12 seconds.

(a) **(i)** Draw a tangent to the graph at $t = 7$. [1]

(ii) Find the acceleration of the car at $t = 7$.

$\frac{S}{T} = \frac{19}{7} = 2,714$

Answer(a)(ii) 2,71 m/s² [2]

(b) The car travels at its maximum speed for 13 seconds.

Find the distance travelled by the car at its maximum speed.

L x W = 13 x 60 =

Answer(b) 780 m [2]

19 Reina went on holiday to New Zealand.

(a) She travelled the 65 km from Tokyo to Narita Airport by taxi.

The taxi journey cost 300 yen (¥) per kilometre plus a fixed charge of ¥700.

Calculate the cost of the taxi journey.

65 km x 300 = 19500

19500 + 700 = 20200

Answer(a) ¥ 20200 [2]

(b) At Narita Airport, Reina changed ¥71 190 into New Zealand dollars (NZ$).

The exchange rate was NZ$1 = ¥56.5.

How many New Zealand dollars did she receive?

$\frac{71\,190}{56{,}5}$

Answer(b) NZ$ 1260 [2]

---

20 Solve the equation.

$$x^2 - 8x + 6 = 0$$

Show all your working and give your answers correct to 2 decimal places.

$x^2 - 8x + 6 = 0$

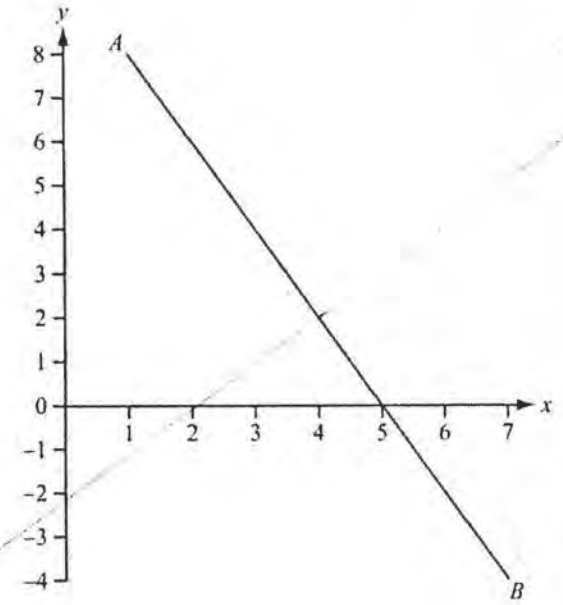
$\Rightarrow \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$\frac{-(-8) \pm \sqrt{(-8)^2 - 4 \times 1 \times 6}}{2 \times 1}$

$= 7{,}16$ or $0{,}8377 \Rightarrow 0{,}838$

Answer $x =$ 7,16 or $x =$ 0,838 [4]

21



(a) **Using a straight edge and compasses only,** construct the perpendicular bisector of AB on the diagram above. [2]

(b) Write down the co-ordinates of the midpoint of the line segment joining $A(1, 8)$ to $B(7, -4)$.

~~7=6~~ ~~7=1=6~~

~~8-(-4)=12~~

~~6/2=3~~

~~12/2=6~~

Answer(b) (4 , 2) [1]

(c) Find the equation of the line AB.

$\frac{y-y_1}{x-x_1} = \frac{8-(-4)}{1-7}$

$= \frac{12}{-6} = -2$

$y = mx + c$

$8 = -2(1) + c$

$8 = -2 + c$

$8 = -2 + c$

$10 = c$

$y = -2x + 10$

Answer(c) $y = -2x + 10$ [3]

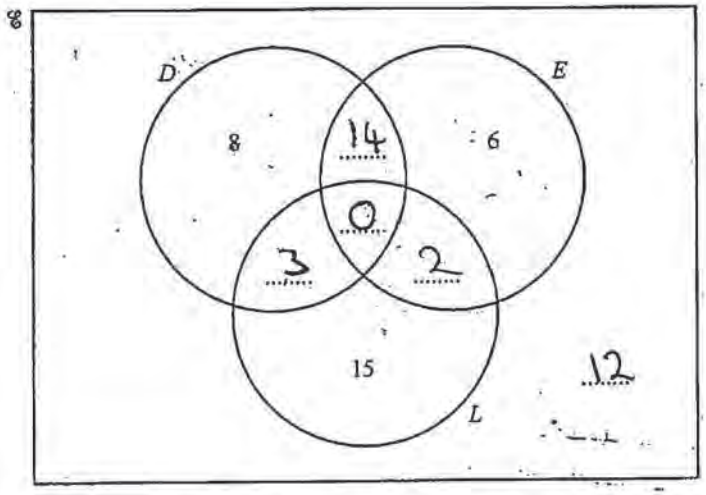
22 In a survey of 60 cars, 25 use diesel, 20 use liquid hydrogen and 22 use electricity.

No cars use all three fuels and 14 cars use both diesel and electricity.

There are 8 cars which use diesel only, 15 cars which use liquid hydrogen only and 6 cars which use electricity only.

In the Venn diagram below

$\mathscr{E}$ = {cars in the survey},
D = {cars which use diesel},
L = {cars which use liquid hydrogen},
E = {cars which use electricity}.



(a) Use the information above to fill in the five missing numbers in the Venn diagram. [4]

(b) Find the number of cars which use diesel but not electricity.

8 + 3 + ~~14~~
8 + 3 = 11

Answer(b) 11 [1]

(c) Find $n(D' \cap (E \cup L))$.

23

Answer(c) 23 [1]

Examiner comment

This is a very high standard grade A script. At this level the script is often characterised by the minimum working necessary to obtain the answer. This has some inherent risks as not enough working may have been shown to gain the method mark. The errors are generally careless mistakes rather than an inability to answer the question.

This can be seen for this candidate where the candidate has failed to respond to the accuracy required in the specific question rather than the general accuracy specified in the rubric. The answer has been given to an incorrect accuracy which will result in loss of marks. The candidate also made an operational error in the algebra of another question whilst quite clearly understanding the process and order required to solve the problem. In another question this candidate failed to spot that two parts were interconnected by the labels (a)(i) and (a)(ii) and used an inappropriate formula to attempt to solve the second part of the problem. This was probably the only real error in method on the paper. Finally, in two questions the candidate started the problem with the correct method but for some reason failed to complete the final step to the answer.

Candidates at this level should be spending a few minutes near the end of the allotted time in the examination checking that they have read the question carefully and followed all the instructions. This candidate could have easily scored four more marks by doing so.

Example candidate response – grade C (whole script)

1 Write each number correct to 1 significant figure and estimate the value of the calculation.
You must show your working.

$2.65 \times 4.1758 + 7.917$

$3 \times 4 + 8$

$= 12 + 8$

$= 20$

Answer 20 [2]

---

2 Use a calculator to work out the exact value of

$$1 + \frac{1}{5} + \left(\frac{1}{5}\right)^2 + \left(\frac{1}{5}\right)^3 + \left(\frac{1}{5}\right)^4.$$

Answer 1,2496 [2]

---

3 Expand the brackets and simplify.

$\frac{1}{2}(6x - 2) - 3(x - 1)$

$3x - 1 - 3x + 3$

$3x - 3x - 1 + 3$

$0 + 2$

Answer 2 [2]

---

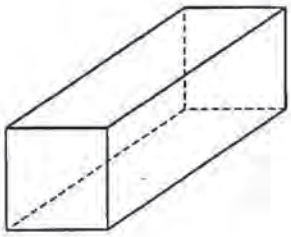
4 Write the following in order of size, smallest first.

$\sqrt{0.9}$ $\sqrt[3]{0.9}$ 0.9^2 0.9^3

0,95 0,97 0,81 0,729

Answer $0,9^3 < 0,9^2 < \sqrt{0,9} < \sqrt[3]{0,9}$ [2]

5 (a)

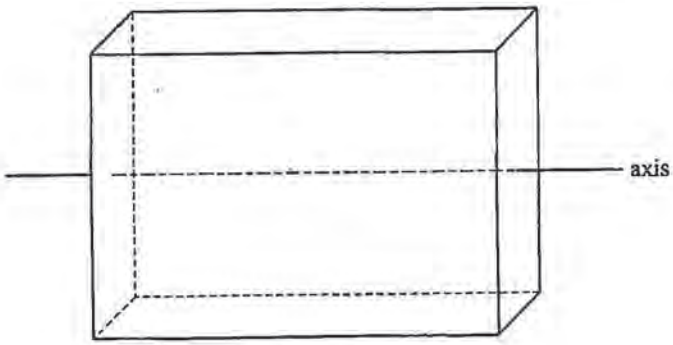


This cuboid has a **square** cross-section.

Write down the number of planes of symmetry.

Answer(a) ..... 2 ..... [1]

(b)



This cuboid has a **rectangular** cross-section.

The axis shown passes through the centre of two opposite faces.

Write down the order of rotational symmetry of the cuboid about this axis.

Answer(b) ..... 1 ..... [1]

6 Work out $\frac{240^2}{5\times10^6}$.

Give your answer in standard form.

$\frac{240\times240}{5\times10^6}$

$= \frac{57600}{5000000}$

$= 1,152\times10^{10}$

Answer $1,152\times10^{10}$ [2]

---

7 Write as a single fraction in its simplest form.

$\frac{2}{x}+\frac{1}{2x}+\frac{1}{2}$

$\frac{4+1+x}{2x}$

$\frac{5+x}{2x}$

Answer $\frac{5+x}{2x}$ [2]

---

8 The length of a side of a regular hexagon is 6.8 cm, correct to one decimal place.

Find the smallest possible perimeter of the hexagon.

$6,8\times6$

$= 40,8$

Answer 40,8 cm [2]

9 Johan invested $600 for 3 years at 4% per year **compound** interest.

Calculate the final amount he had after three years.

Compound interest $= P(1+\frac{R}{100})^n$

$= 600(1+\frac{4}{100})^3$

$= \$674,92$

$= \$674,92$

$\$600 + 674,92$

$= \$1274,92$

Answer $ 1274,92 [3]

---

10 Solve the simultaneous equations $2x+y=5$ and $2y=x-10$.

$2x+y=5$

$-x+2y=-10$

$2(2x+y=5)$

$4x+2y=10$

$-x+2y=-10$

$4x=10$

$-x=-10$

$\frac{4x}{4}=\frac{20}{4}$

$x=4$

$2(4)+y=5$

$8+y=5$

$y=5-8$

$y=-3$

$y=-3$

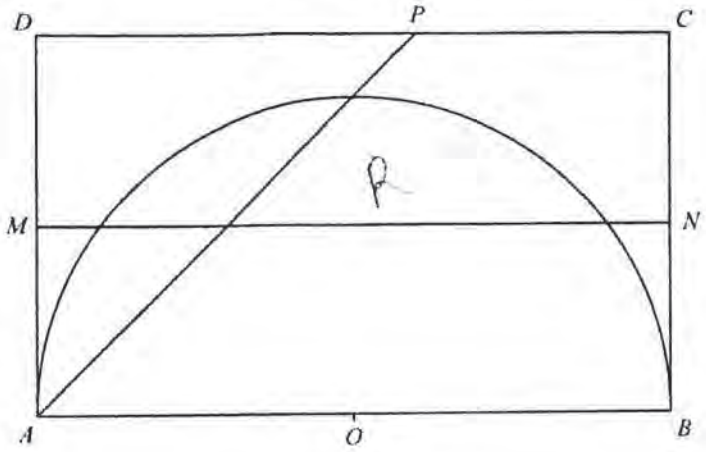
Answer $x=$ 4

$y=$ −3 [3]

11 $ABCD$ is a rectangle with $AB = 10$ cm and $BC = 6$ cm. MN is the perpendicular bisector of BC.

AP is the bisector of angle BAD.

O is the midpoint of AB and also the centre of the semicircle, radius 5 cm.



Write the letter R in the region which satisfies **all** three of the following conditions.

- nearer to AB than to AD
- nearer to C than to B
- less than 5 cm from O

[3]

---

12 Make x the subject of $y = \dfrac{(x+3)^2}{5}$.

$$y = \frac{(x+3)^2}{5}$$

$$5y = (x+3)^2$$

$$(5y)^2 = x+3$$

$$(5y)^2 - 3 = x$$

Answer $x =$ $(5y)^2 - 3$ [3]

13 Solve the inequality. $2x+5 < \frac{x-1}{4}$

$2x+5 = \frac{x-1}{4}$

$4(2x+5) = x-1$

$8x+20 = x-1$

$8x-x = -1-20$

$\frac{7x}{7} = \frac{-21}{7}$

$x < -3$

Answer $x < -3$ [3]

---

14 Find the value of n in the following equations.

(a) $2^n = 1024$

Answer(a) $n =$ 10 [1]

(b) $4^{2n-3} = 16$

$2n-3 = 2$

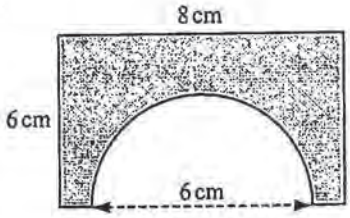
$2n = 2+3$

$\frac{2n}{2n} = \frac{5}{2}$

$n = 2,5$

Answer(b) $n =$ 2,5 [2]

15



NOT TO SCALE

A semicircle of diameter 6 cm is cut from a rectangle with sides 6 cm and 8 cm.

Calculate the perimeter of the shaded shape, correct to 1 decimal place.

$2(6+8) + \frac{2\pi r}{2}$

$28 + 18,85$

$= 9,15$

Answer 9,15 cm [3]

16 Simplify this fraction.

$$\frac{x^2-5x+6}{x^2-4}$$

$\frac{x^2-5x+6}{x^2-4}$

$\frac{-5x+6}{-4}$

$= 1,25x-1,5$

Answer $1,25x-1,5$ [4]

17

$$\mathbf{A}=\begin{pmatrix}2 & 2\\ 2 & -2\end{pmatrix}$$

Work out

(a) $\mathbf{A}^2$,

$\begin{pmatrix}2 & 2\\ 2 & -2\end{pmatrix}^2$

$= \begin{pmatrix}4 & 4\\ 4 & -4\end{pmatrix}$

Answer(a) $\begin{pmatrix}4 & 4\\ 4 & -4\end{pmatrix}$ [2]

(b) $\mathbf{A}^{-1}$, the inverse of **A**.

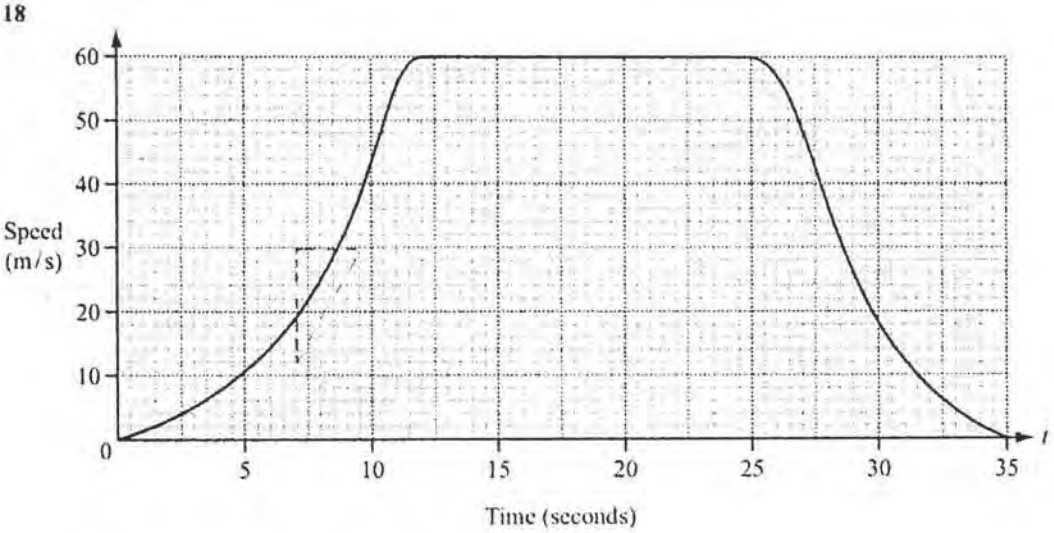
$\frac{1}{\det A}\begin{pmatrix}2 & 2\\ 2 & -2\end{pmatrix}$

$\frac{1}{-4-4}$

$\frac{1}{-8}\begin{pmatrix}-2 & -2\\ -2 & 2\end{pmatrix}$

Answer(b) $\begin{pmatrix}\frac{1}{4} & \frac{1}{4}\\ \frac{1}{4} & -\frac{1}{4}\end{pmatrix}$ [2]

18



The graph shows the speed of a sports car after t seconds.

It starts from rest and accelerates to its maximum speed in 12 seconds.

(a) **(i)** Draw a tangent to the graph at $t = 7$. [1]

(ii) Find the acceleration of the car at $t = 7$.

$$\frac{y_2 - y_1}{x_2 - x_1}$$

$$\frac{20 - 0}{7}$$

$$= 2,9$$

Answer(a)(ii) 2,9 m/s² [2]

(b) The car travels at its maximum speed for 13 seconds.

Find the distance travelled by the car at its maximum speed.

$D = S \times T$

$= 60 \times 13$

$D = 780$

$= 780$

Answer(b) 780 m [2]

19 Reina went on holiday to New Zealand.

(a) She travelled the 65 km from Tokyo to Narita Airport by taxi.

The taxi journey cost 300 yen (¥) per kilometre plus a fixed charge of ¥700.

Calculate the cost of the taxi journey.

~~¥1000 × 65~~ ¥300 × 65 = 19 500
~~= 65 000~~ + 700
¥20 200

Answer(a) ¥ ~~65 000~~ 20 200 [2]

(b) At Narita Airport, Reina changed ¥71 190 into New Zealand dollars (NZ$).

The exchange rate was NZ$1 = ¥56.5.

How many New Zealand dollars did she receive?

71 190 ÷ 56,5
= 1260

Answer(b) NZ$ 1260 [2]

---

20 Solve the equation.

$$x^2 - 8x + 6 = 0$$

Show all your working and give your answers correct to 2 decimal places.

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\frac{+8 \pm \sqrt{-8^2 - (4 \times 1 \times 6)}}{2}$$

$$\frac{+8 \pm \sqrt{40}}{2}$$

$$= \frac{+8 - 6,32}{2} \qquad \frac{+8 + 6,32}{2}$$

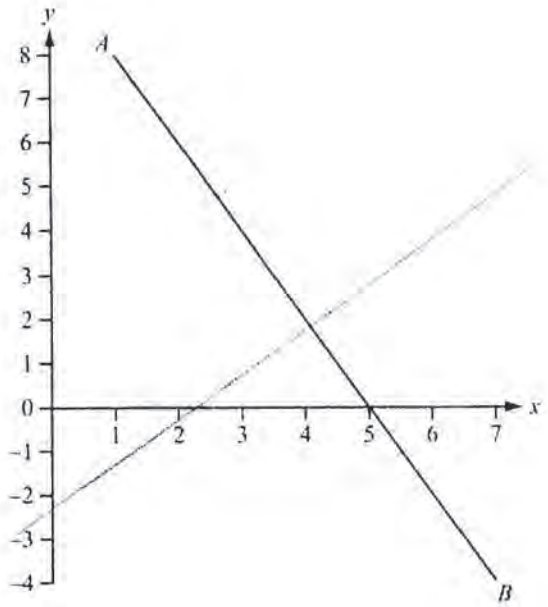
$$= 0,84 \qquad = 7,16$$

$$x + 0,84 = 0 \qquad = x =$$

$$x = -0,84$$

Answer $x =$ −0,84 or $x =$ −7,16 [4]

21



(a) **Using a straight edge and compasses only,** construct the perpendicular bisector of AB on the diagram above. [2]

(b) Write down the co-ordinates of the midpoint of the line segment joining $A(1, 8)$ to $B(7, -4)$.

$\frac{x_2 + x_1}{2}$, $\frac{y_2 + y_1}{2}$

$\frac{7+1}{2}$, $\frac{-4+8}{2}$

$(4, 2)$

Answer(b) (4 , 2) [1]

(c) Find the equation of the line AB.

$\frac{y-8}{x-1} = -2$

$y - 8 = -2(x - 1)$

$y - 8 + 8 = -2x + 2 + 8$

$y = -2x + 10$

Answer(c) $y = -2x + 10$ [3]

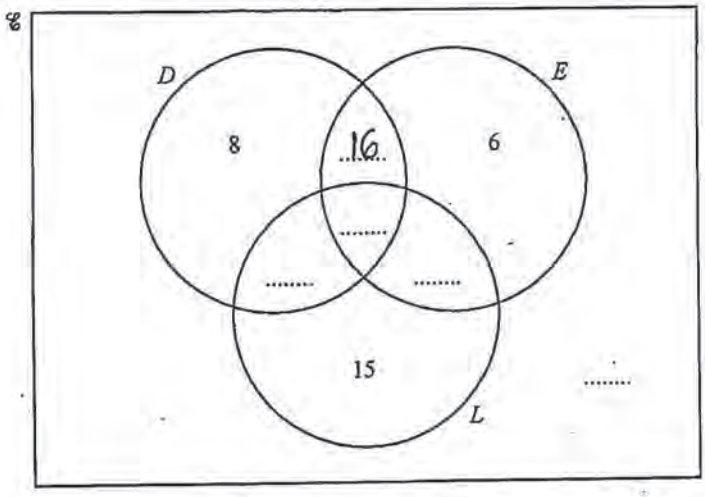
22 In a survey of 60 cars, 25 use diesel, 20 use liquid hydrogen and 22 use electricity.

No cars use all three fuels and 14 cars use both diesel and electricity.

There are 8 cars which use diesel only, 15 cars which use liquid hydrogen only and 6 cars which use electricity only.

In the Venn diagram below

$\mathscr{E}$ = {cars in the survey},
D = {cars which use diesel},
L = {cars which use liquid hydrogen},
E = {cars which use electricity}.



(a) Use the information above to fill in the five missing numbers in the Venn diagram. [4]

(b) Find the number of cars which use diesel but not electricity.

Answer(b) ..... [1]

(c) Find $n(D' \cap (E \cup L))$.

Answer(c) ..... [1]

Examiner comment

This is an above average script at grade C. The characteristics of scripts at this level are generally very good presentation, full methods shown and a good standard of knowledge with the exception of the more difficult questions towards the end of the paper. There will be some careless errors but generally the candidates at this level are working very carefully. The loss of marks is often due to an inability to answer some questions.

This can be seen for the above candidate where at least six questions were attempted with an incorrect method. One question was not attempted and two other questions were attempted correctly but mistakes made in the working. There were only two marks lost in careless errors.

Candidates may be able to realise that they have made an error in working or method by looking at the magnitude of their answer and asking themselves if the answer is sensible. This simple test would have helped this candidate to realise that they had made errors and it is estimated that this candidate could have saved themselves as much as ten marks.

Example candidate response – grade E (whole script)

1 Write each number correct to 1 significant figure and estimate the value of the calculation.
You must show your working.

$2.65 \times 4.1758 + 7.917$

Answer 18 19.0 [2]

---

2 Use a calculator to work out the exact value of

$$1 + \frac{1}{5} + \left(\frac{1}{5}\right)^2 + \left(\frac{1}{5}\right)^3 + \left(\frac{1}{5}\right)^4.$$

Answer 1,25 [2]

---

3 Expand the brackets and simplify.

$$\frac{1}{2}(6x-2)-3(x-1)$$

$3x - 1 - 3x + 3$

$3x - 3x - 1 + 3$

Answer 2 [2]

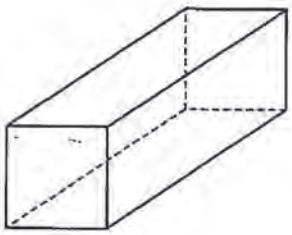
---

4 Write the following in order of size, **smallest first**.

$\sqrt{0.9}$ $\sqrt[3]{0.9}$ 0.9^2 0.9^3

Answer 0.9^3 < 0.9^2 < $\sqrt{0.9}$ < $\sqrt[3]{0.9}$ [2]

5 (a)

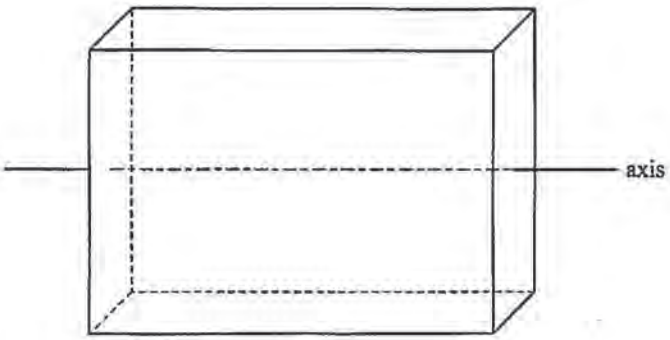


This cuboid has a **square** cross-section.

Write down the number of planes of symmetry.

Answer(a) ..... 2 ..... [1]

(b)



This cuboid has a **rectangular** cross-section.

The axis shown passes through the centre of two opposite faces.

Write down the order of rotational symmetry of the cuboid about this axis.

Answer(b) ..... 2 ..... [1]

6 Work out $\frac{240^2}{5\times10^6}$.

Give your answer in standard form.

$\frac{57600}{5000000} = 0.01152$

Answer 1.152×10^{-2} [2]

---

7 Write as a single fraction in its simplest form.

$$\frac{2}{x}+\frac{1}{2x}+\frac{1}{2}$$

$$\frac{2(2x)(2)+(x)(2)+(2x)(x)}{(x)(2x)(2)}$$

$$\frac{8x+2x+2x^2}{(x)(2x)(2)}$$

Answer $\frac{10x+2x^2}{(x)(2x)(2)}$ [2]

---

8 The length of a side of a regular hexagon is 6.8 cm, correct to one decimal place.

Find the smallest possible perimeter of the hexagon.

Perimeter = 6.8 cm × 6
= 40.8 cm
= 4.08 cm

Answer 4.08 cm [2]

9 Johan invested $600 for 3 years at 4% per year **compound** interest.

Calculate the final amount he had after three years.

① $600 × 3 = $1800

② $\frac{4}{100} \times \frac{600}{1} = \$12 \times 3$

$= 36$

③ $\$1800 + 36 = 1836$

Answer $ ..... 1836 ..... [3]

---

10 Solve the simultaneous equations $2x + y = 5$ and $2y = x - 10$.

$2x + y = 5$ → ①

$2y = x - 10$ → ②

$y = 5 - 2x$ → ③

Sub ③ into ②

$2(5 - 2x) = x - 10$

$10 - 4x = x - 10$

$10 + 10 = x + 4x$

$\frac{20}{5} = \frac{5x}{5}$

$\therefore x = 4$

Sub x into ③

$y = 5 - 2(4)$

$y = 5 - 8$

$\therefore y = -3$

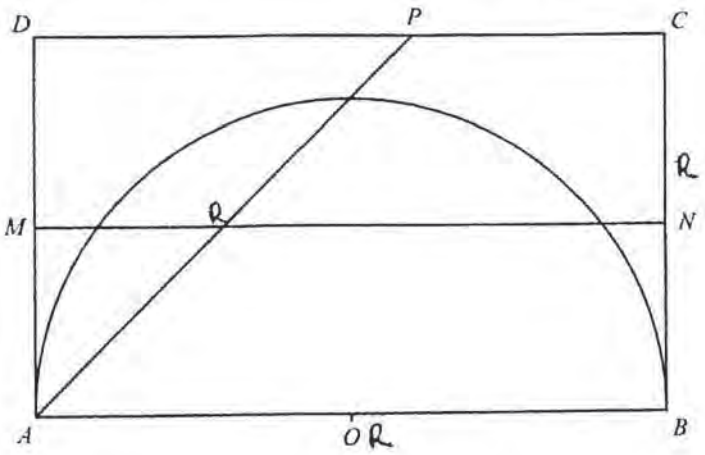
Answer $x =$ ..... 4 .....

$y =$ ..... -3 ..... [3]

11 $ABCD$ is a rectangle with $AB = 10$ cm and $BC = 6$ cm. MN is the perpendicular bisector of BC.

AP is the bisector of angle BAD.

O is the midpoint of AB and also the centre of the semicircle, radius 5 cm.



Write the letter R in the region which satisfies **all** three of the following conditions.

- nearer to AB than to AD
- nearer to C than to B
- less than 5 cm from O

[3]

---

12 Make x the subject of $y = \dfrac{(x+3)^2}{5}$.

$y = \dfrac{(x+3)^2}{5} \times 5$

$5y = (x+3)^2$

$\sqrt{5y-3} = \sqrt{x^2}$

$x = \sqrt{5y-3}$

Answer $x =$ $\pm\sqrt{5y-3}$ [3]

13 Solve the inequality. $2x + 5 < \frac{x-1}{4}$

$2x - x < \frac{-5-1}{4}$

$x < -\frac{3}{2}$

Answer $x < -\frac{3}{2}$ [3]

---

14 Find the value of n in the following equations.

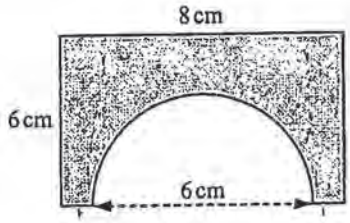
(a) $2^n = 1024$

Answer(a) $n =$ 10 [1]

(b) $4^{2n-3} = 16$

Answer(b) $n =$ $\frac{5}{2}$ [2]

15



NOT TO SCALE

A semicircle of diameter 6 cm is cut from a rectangle with sides 6 cm and 8 cm.

Calculate the perimeter of the shaded shape, correct to 1 decimal place.

Perimeter = L + W x 2
= 8 + 6 x 2
= 28 cm

Area = 48 cm

Area of circle πr^2
$\pi \times 3^2$
= 28 cm

= 48 cm - 28 cm

Answer 20 cm [3]

16 Simplify this fraction.

$$\frac{x^2-5x+6}{x^2-4}$$

$$\frac{(x-2)(x-3)}{(x-2)(x+2)}$$

Answer $\frac{x-3}{x+2}$ [4]

17

$$A=\begin{pmatrix}2 & 2\\ 2 & -2\end{pmatrix}$$

Work out

(a) A^2, $\begin{pmatrix}2 & 2\\ 2 & -2\end{pmatrix}\begin{pmatrix}2 & 2\\ 2 & -2\end{pmatrix}$

$4+4=8$
$4+4=8$
$4-4=0$
$4+4=8$

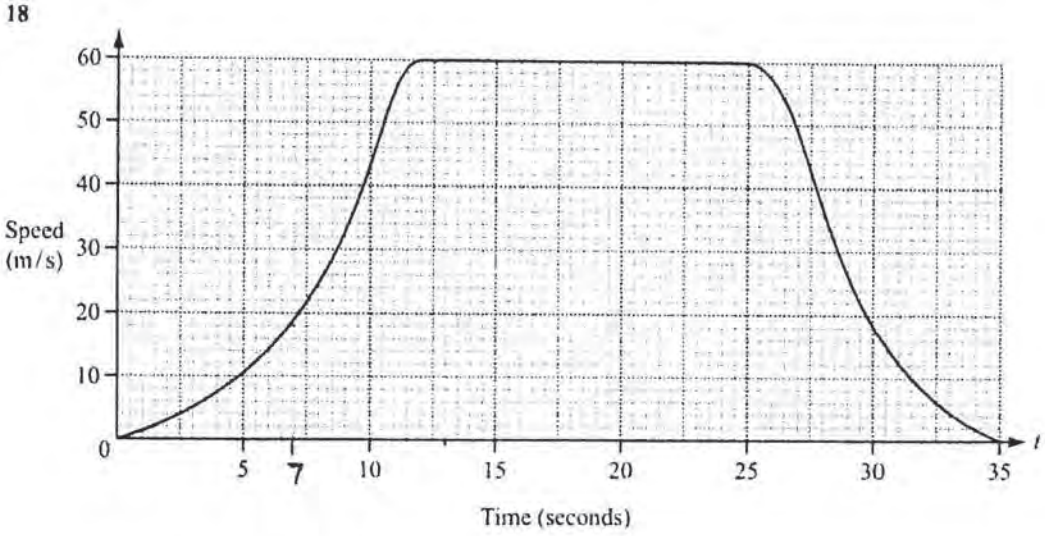
Answer(a) $\begin{pmatrix}8 & 8\\ 0 & 8\end{pmatrix}$ [2]

(b) A^{-1}, the inverse of **A**.

$\begin{pmatrix}2 & -2\\ 2 & 2\end{pmatrix}\begin{pmatrix}2 & -2\\ 2 & 2\end{pmatrix}$

Answer(b) $\begin{pmatrix}0 & 8\\ 8 & 8\end{pmatrix}$ [2]

18



The graph shows the speed of a sports car after t seconds.

It starts from rest and accelerates to its maximum speed in 12 seconds.

(a) (i) Draw a tangent to the graph at $t = 7$. [1]

(ii) Find the acceleration of the car at $t = 7$.

Answer(a)(ii) ..... 18 ..... m/s^2 [2]

(b) The car travels at its maximum speed for 13 seconds.

Find the distance travelled by the car at its maximum speed.

D
= 60 × 13

Answer(b) ..... 780 ..... m [2]

19 Reina went on holiday to New Zealand.

(a) She travelled the 65 km from Tokyo to Narita Airport by taxi.

The taxi journey cost 300 yen (¥) per kilometre plus a fixed charge of ¥700.

Calculate the cost of the taxi journey.

65km x 300

¥19500

Answer(a) ¥ 20200 [2]

(b) At Narita Airport, Reina changed ¥71 190 into New Zealand dollars (NZ$).

The exchange rate was NZ$1 = ¥56.5.

How many New Zealand dollars did she receive?

¥71190 / ¥56.5

Answer(b) NZ$ 1260 [2]

---

20 Solve the equation.

$$x^2 - 8x + 6 = 0$$

Show all your working and give your answers correct to 2 decimal places.

$ax^2 + bx + c$

$x^2 - 8x + 6 = 0$

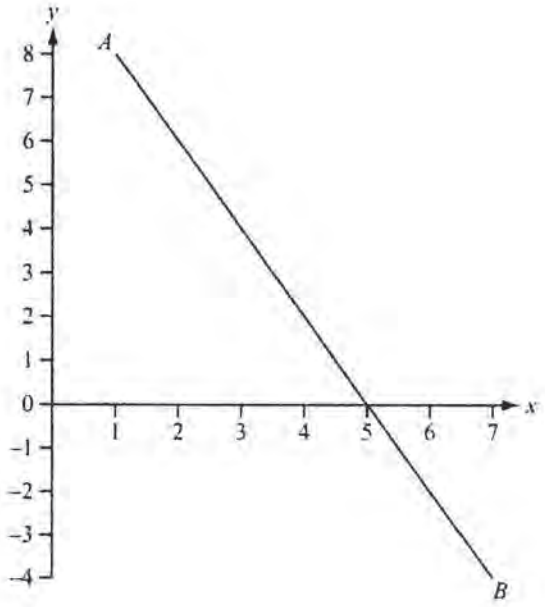
$$\frac{+b \pm \sqrt{b^2 + 4ac}}{2a}$$

① $\frac{+8 \sqrt{8^2 + 4(1)(6)}}{2(1)}$ = 37.52

② $\frac{-8 \sqrt{8^2 + 4(1)(6)}}{2(1)}$ = −37.52

Answer x = 37.52 or x = −37.52 [4]

21



(a) **Using a straight edge and compasses only,** construct the perpendicular bisector of AB on the diagram above. [2]

(b) Write down the co-ordinates of the midpoint of the line segment joining $A(1, 8)$ to $B(7, -4)$.

Answer(b) (..... , ...) [1]

(c) Find the equation of the line AB.

Answer(c) ..... [3]

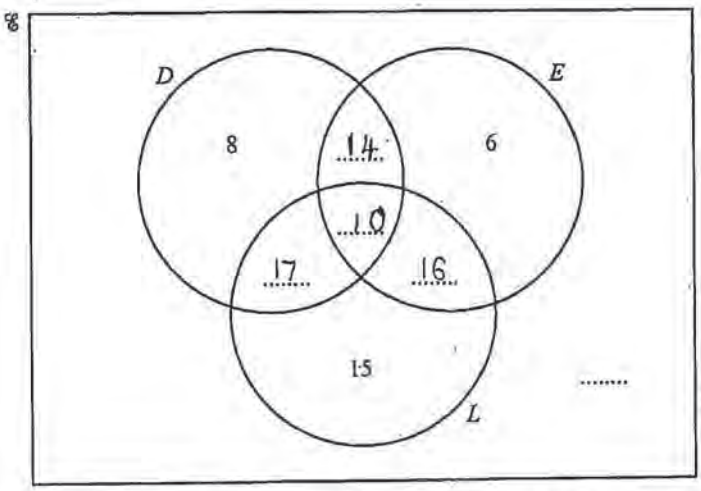
22 In a survey of 60 cars, 25 use diesel, 20 use liquid hydrogen and 22 use electricity.

No cars use all three fuels and 14 cars use both diesel and electricity.

There are 8 cars which use diesel only, 15 cars which use liquid hydrogen only and 6 cars which use electricity only.

In the Venn diagram below

$\mathscr{E}$ = {cars in the survey}, 60
D = {cars which use diesel}, 25
L = {cars which use liquid hydrogen}, 25
E = {cars which use electricity}. 22



(a) Use the information above to fill in the five missing numbers in the Venn diagram. [4]

(b) Find the number of cars which use diesel but not electricity.

Answer(b) 17 [1]

(c) Find $n(D' \cap (E \cup L))$.

Answer(c) ..... [1]

Examiner comment

This is a well below average script and at grade E level. Generally, very little, if any, working is shown at this level. The candidate can often answer a few questions very well indeed but they have no real understanding of many parts of the syllabus. They will often be using incorrect methods, some of which seem to have been invented during the examination. They are inclined to quote formulae rather than work out what is required by the question.

This particular candidate has eight perfectly correct answers and has shown an unusually high amount of working. The working however has indicated that, whilst recognising the question topic, they have not really understood the actual requirements of the question. Using the simple interest formula in a compound interest question will be a common error at this level. Similarly using the area of a circle when the perimeter is required.

For a candidate at this level to score more marks, they will need to ensure that they can quote formulae correctly. This candidate would have been able to score another ten marks by using this simple idea.

Paper 3 (Core)

General comment

The comments on Paper 1 (Core) apply equally to Paper 3 and the following generalisations also apply to all Core level papers.

'Grade Descriptions' in the syllabus (pages 19 to 21) give a general indication of the standards of achievement likely to have been shown by candidates at grades A, C and F.
Since the Core section of the syllabus curriculum content covers grades C to G and the grade descriptions for grades F and C give a general indication of the standards up to grade C, it is felt unnecessary to give further indication of grade level C. The section below is an attempt to summarise the knowledge and understanding expected at grade E in the four curriculum areas since a particular script analysis was requested for that grade.

Grade E
In number a basic understanding of place value, order of operations, different types of numbers, including negative numbers, factors, multiples and simple estimation is expected. Appreciation of fractions, decimals and percentages and the relationships between them is needed. Calculations involving numbers, money and other measures can include percentages and ratio where appropriate. Interpretation of tables and graphs, for example distance/time, is necessary, including simple change of linear units. Some simple knowledge of sequences, with regard to recognising patterns and describing rules, in words, for a linear sequence is expected.

Little algebra is expected at this level being mainly substitution into simple formulae and simplifying expressions with at most two variables. Solution of $ax + b = c$ where a, b and c are integers would be the limit of difficulty in equations. Completing tables of values and drawing graphs would only be expected for straight lines, though coordinates of intersections of graphs and lines should be recognised.
Much basic work in shape and space in relation to the use of instruments for drawing shapes, nets of 3 dimensional solids and scale drawings would be expected. Names of types of angles, triangles, quadrilaterals and common 3 dimensional solids should be known. Simple angle properties, including triangles, quadrilaterals and those associated with parallel lines need to be applied to finding unknown angles. Calculation of perimeter, given lengths of sides, areas of shapes made up of rectangular areas or counting squares and volume of cuboids would be expected. Recognition of line and rotational symmetry, simple reflections and enlargements and simple operations on vectors are required at this level.
Statistics at this level is mainly organising data, displaying the common forms of pictorial representation, including pie charts, and finding the measures of range, mode, median and mean for a set of numbers.
Probability is limited to simple application of the probability of a single event and appreciating the probability scale.

Mark scheme

Abbreviations

cao	correct answer only
cso	correct solution only
dep	dependent
ft	follow through after error
isw	ignore subsequent working
oe	or equivalent
SC	Special Case
www	without wrong working

Qu.	Answers	Mark	Part Marks
1	**(a)** 0.76 × 1000 = 760 oe	2	**B1** 0.76 × 1000 or 1000 – 0.24 × 1000
	(b) $\frac{19}{25}$ cao	2	**B1** for $\frac{760}{1000}$ or $\frac{76}{100}$ or $\frac{38}{50}$
	(c) 120	2	**M1** for 6 × 760 ÷ (6 + 15 + 17) or 6 ÷ (6 + 15 + 17) or 760 ÷ (6 + 15 + 17) or 20
	(d) 23 or art 23.1	3	**M1** for 80 – 65 (= 15) and **M1** dep for '15' ÷ 65 × 100
2	**(a) (i)** 2 and 45 or 3 and 30 or 5 and 18 or 6 and 15 or 9 and 10	1	
	(ii) 2, 3, and 5 (ignore 1 if included)	3	**B1** for each correct prime factor –1 for 1 or more non prime factors of 90 given in addition And –1 once if any non factors of 90 are given
	(b) (i) 15 or 19	1	
	(ii) 984	1	
	(iii) 81	1	
	(iv) 8 or 1	1	
	(v) 91	1	
	(vi) 4	1	
	(vii) 109	1	
3	**(a) (i)** 15 50 cao	1	
	(ii) 1.6 (km) cao	1	
	(iii) 14 (mins) cao	1	
	(iv) art 6.86 (km/h)	3ft	**M1** for '1.6' ÷ '14' and **M1ind** for '14' ÷ 60 soi
	(b) (i) (16 04, 4) to (16 10, 4) ('16 10', 4) to ('16 50', 0)	1 2ft	Line must be horizontal **M1** for dealing with the time 4 ÷ 6 × 60 ft for a time period of 40 minutes only
	(ii) 16 50	1ft	ft their time at home

Qu.	Answers	Mark	Part Marks
	(c) (i) Straight line from 15 48 to 16 34	2	**B1** for one end correct or both correct and line missing or not straight
	(ii) 16	1ft	ft their time difference on *x*-axis
4	**(a) (i)** Perpendicular bisector of *BC* with 2 pairs of arcs	2	**B1** correct without arcs
	(ii) *S* at midpoint of *BC*	1	Independent
	(iii) Bisector of angle *ABC* with two pairs of arcs	2	**B1** correct without arcs
	(iv) *R* clearly marked	1	ft their **(a)(i)** and **(a)(iii)**
	(v) *Q* marked on BA	1	ft their marked *R* and their marked *S*
	(vi) *BQRS* drawn	1	ft their *Q*, *R* and *S*
	(b) 829 to 974 cao (if their BQRS is approximately a square)	3	For square or rectangle **M2** their length × their width × 36 or **M1** for their length or width to metres or **M1ind** for their length × their width
	(c) Line from *A* at 070°	1	
	Line from *C* at 345°	1	
	(d) Circle radius 4 cm centre their *T*	2ft	**SC1** for any circle centre their *T* or **SC1** for any circle radius 4 cm
5	**(a) (i)** (2, 6) and (–3, –4)	2	**B1** for one pair correct
	(ii) (*n* =) 12 cao	1	
	(b) (i) 2 cao	1	
	(ii) Lines of symmetry drawn	1, 1	
	(iii) $y = x$ oe and $y = -x$ oe cao	1, 1	
	(c) (i) (*x* =) 3.3 to 3.7 and	1ft	ft their graph
	(*x* =) –3.3 to –3.7	1ft	
	(ii) Line parallel to line in **(c)(i)** through (0, 4)	1ft	**(c)(i)** line must be linear
	(iii) $y = x + 4$ oe	2ft	**B1** for $y = mx + 4$ ($m \neq 0$) or for $y = x + k$ ($k \neq 0$) **B1**ft for $y = mx +$ '4' ($m \neq 0$) or for $y =$ 'm'$x + k$ ($k \neq 0$)
6	**(a) (i)** 140	2	**M1** for 180 × (9 – 2) ÷ 9 or better
	(ii) 180*n* – 360	1	
	(iii) 15	3	**M2** for 360 ÷ (180 – 156) or **M1** for 156*n* = their **(a)(ii)** and **M1dep** for $pn = q$ from their linear expression
	(b) (*x* =) –2, (*y* =) 3	3	**M1** for equating coefficients of *x* or *y* and adding or subtracting, allow 1 error **A1** for 1 correct
7	**(a)** Trapezium	1	
	(b) 68.2	3	**M2** for tan = 50 ÷ (85–65) or better **B1** for 85 – 65 (= 20) seen in working area

Qu.	Answers	Mark	Part Marks
	(c) 3750	2	**M1** for 0.5(65 + 85) × 50
	(d) 360 000 cm^3	1ft 1	ft their **(c)** × 96, correct to a minimum of 3sf units mark independent
8	**(a) (i)** 150 ÷ 360 × 24 (= 10)	2	**M1** for their '150' ÷ 360 × 24 or **B1** for 150
	(ii) (lost) 8, (drawn) 6	3	**B1** for 120 or 90 seen and **M1** for '120' ÷ 360 × 24 or '90' ÷ 360 × 24
	(b) (i) 5, 7, 6, 3, 2, 1	2	**B1** for 5 correct or 4 correct with total 24 or **SC1** if only tallies seen (all must be correct)
	(ii) 1	1ft	ft their table
	(iii) 1.5	2	**M1** for evidence of attempt at middle value
	(iv) 1.7 or 1.71 or 1.70(8…) cao	3	**M1** for 0 × '5' + 1 × '7' + 2 × '6' + 3 × '3' + 4 × '2' + 5 × '1' and **M1dep** division by 24
9	**(a) (i)** 3.82 art	2	**M1** for $2.7^2 + 2.7^2$ or better or sin 45 = $\frac{27}{BD}$ or better or cos 45 = $\frac{27}{BD}$ or better
	(ii) Isosceles	1	
	(iii) 45 cao	1	
	(b) (i) Diagram 4	1	
	(ii) 10, 13, 16	2	**B1** for 2 correct or difference of 3 seen between diagram 4 and diagram 5 in table
	(c) (i) 28	1	
	(ii) $3n + 1$ oe	2	**B1** for $pn + 1$ ($p \neq 0$) or $3n + q$
	(d) 25	2ft	**M1** for 76 = their **(c)(ii)** (if linear)
	(e) $3n + 2$ oe	1ft	ft their **(c)(ii)** + 1 (must be a linear expression)

Example candidate response – grade C (whole script)

1 A drink consists of water and fruit juice.

(a) 24% of the drink is water.

Show that there is a total of 760 cm^3 of fruit juice in one litre of the drink.

Answer(a)

1) 24% → ? | 100% → 1000 ... = $\frac{24000}{100}$ = 240 cm^3

2) 100% = 1000

3) 1000 − 240 = 760 cm^3

[2]

(b) What fraction of one litre of the drink is fruit juice?

Give your answer in its simplest form.

$\frac{760}{1000}$

Answer(b) $\frac{19}{25}$ [2]

(c) The 760 cm^3 of fruit juice in one litre of the drink is made from apple, mango and peach in the following ratio.

Apple : Mango : Peach = 6 : 15 : 17

Calculate the amount of apple juice.

$\frac{6}{38} \times 760 = 120$

Answer(c) 120 cm^3 [2]

(d) A shopkeeper buys bottles of the drink for 65 cents each.
He sells them for 80 cents each.

Calculate the percentage profit he makes on each bottle he sells.

$\frac{15}{80} \times 100 = 18.75$

Answer(d) 19 % [3]

2 (a) (i) $f \times g = 90$

f and g are both integers **greater than 1.**

Write down one possible pair of values of f and g.

Answer(a)(i) $f =$ 90 and $g =$ 2 [1]

(ii) Find all the prime factors of 90.

Answer(a)(ii) ..... [3]

(b) Six number cards are shown below.

0	4	9	5	1	8

One or more of the cards are chosen to make different numbers.

For example | 5 | 9 | makes the number 59.

Choosing a card or cards, write down

(i) a 2-digit odd number less than 40,

Answer(b)(i) 15 [1]

(ii) the largest 3-digit even number,

Answer(b)(ii) ..... [1]

(iii) a 2-digit square number greater than 50,

Answer(b)(iii) 81 [1]

(iv) a cube number,

Answer(b)(iv) 8 [1]

(v) a 2-digit multiple of 13,

Answer(b)(v) ..... [1]

(vi) the cube root of 64,

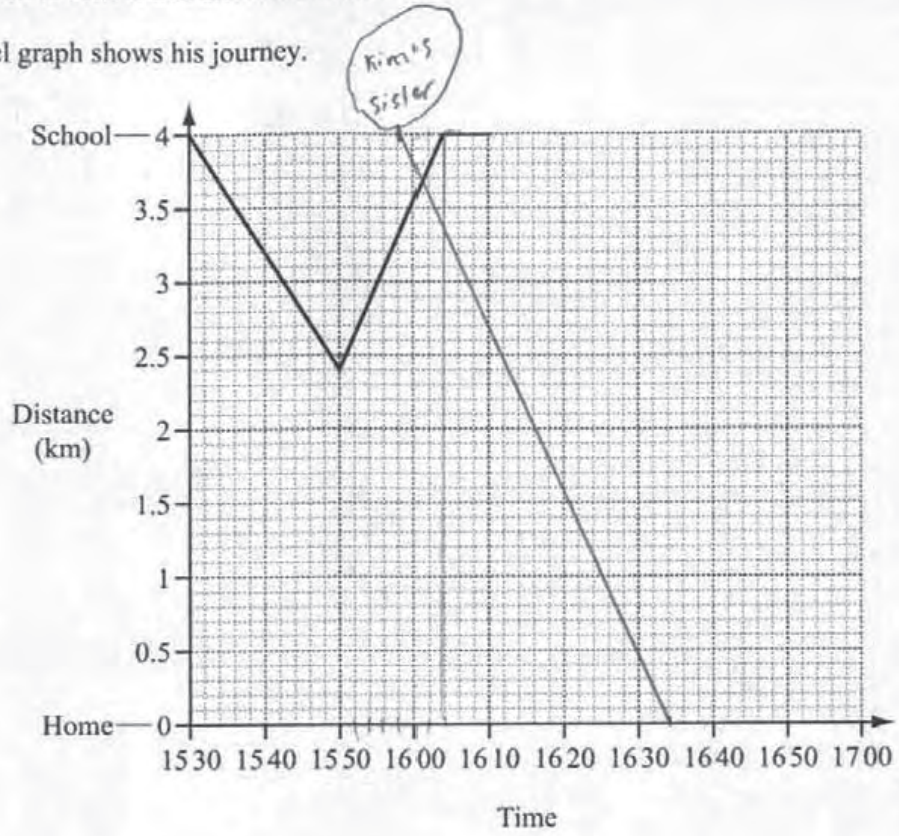
Answer(b)(vi) 4 [1]

(vii) a prime number between 100 and 120.

Answer(b)(vii) 102 [1]

3 Kim left school at 1530 to walk home.
On the way home he remembered he had left a book at school.
He ran back to school and arrived at 1604.

The travel graph shows his journey.



(a) Use the graph to answer the following questions.

(i) At what time did Kim start to run back to school?

Answer(a)(i) 15:50 [1]

(ii) How far was he from school at this time?

Answer(a)(ii) 1.6 km [1]

(iii) How many minutes did he take to run back to school?

Answer(a)(iii) 14 min [1]

(iv) What was his speed, in kilometres per hour, on his journey back to school?

Speed = $\frac{D}{t} = \frac{1.6}{0.23} = 6.956 = 7$

Answer(a)(iv) 7 km/h [3]

(b) Kim spent 6 minutes at school collecting his book.
He then walked home at a speed of 6 km/h.

(i) Complete the travel graph. $\frac{\text{Speed } 6}{\text{Distance } 4} = 1.5 \times 60 = 90$ min [3]

(ii) At what time did Kim arrive home?

Answer(b)(ii) ..... [1]

(c) Kim's sister, Julie, left the school at 15 48.
She walked at a steady speed, without stopping, and arrived home 46 minutes later. 15 48 + 46 = 16 34

(i) On the grid, draw the travel graph of Julie's journey home from school. [2]

(ii) Complete the sentence.

..... arrived home first by ..... minutes. [1]

4 An accurate scale drawing of three sides of a garden, AB, BC, and CD is shown on the opposite page. A is due north of B and C is due east of B.

(a) A vegetable area is to be constructed in the garden.

Parts (i) and (iii) must be completed using a straight edge and compasses only.

On the scale drawing

(i) construct the perpendicular bisector of BC, [2]

(ii) mark the point S at the midpoint of BC, [1]

(iii) construct the bisector of angle ABC, [2]

(iv) mark the point R where this line crosses the perpendicular bisector of BC, [1]

(v) mark the point Q on BA where $BQ = SR$, [1]

(vi) draw the vegetable area, quadrilateral $BQRS$. [1]

(b) On the scale drawing, 1 centimetre represents 6 metres.

Calculate the vegetable area in square metres.

$5^2 = 25$

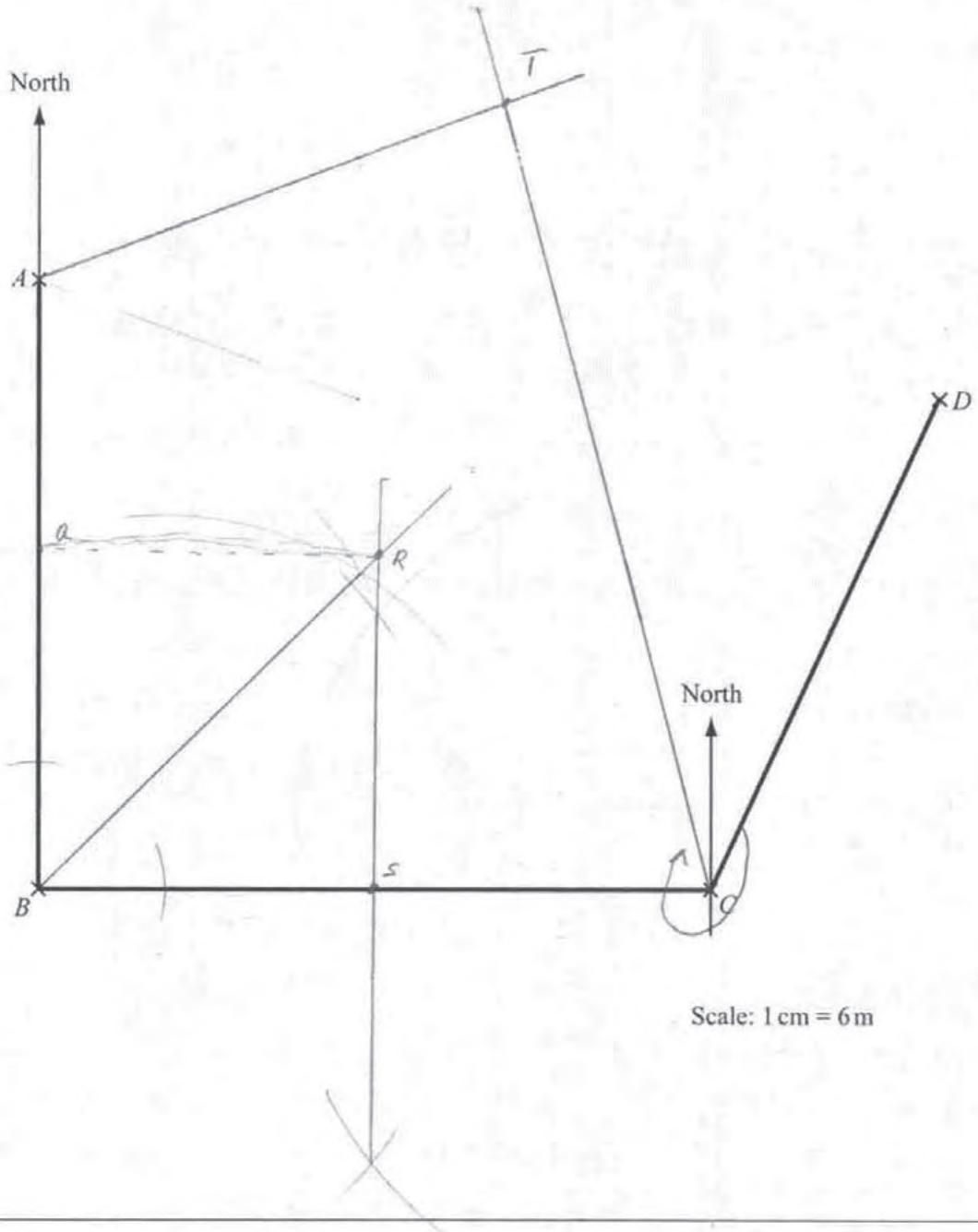
$25 \times 6 = 150$

Answer(b) 150 m^2 [3]

(c) A tree, T, is on a bearing of 070° from A and 345° from C.

On the scale drawing, mark the position of T. [2]

(d) Draw accurately the locus of points which are 24 metres from the tree, T. [2]



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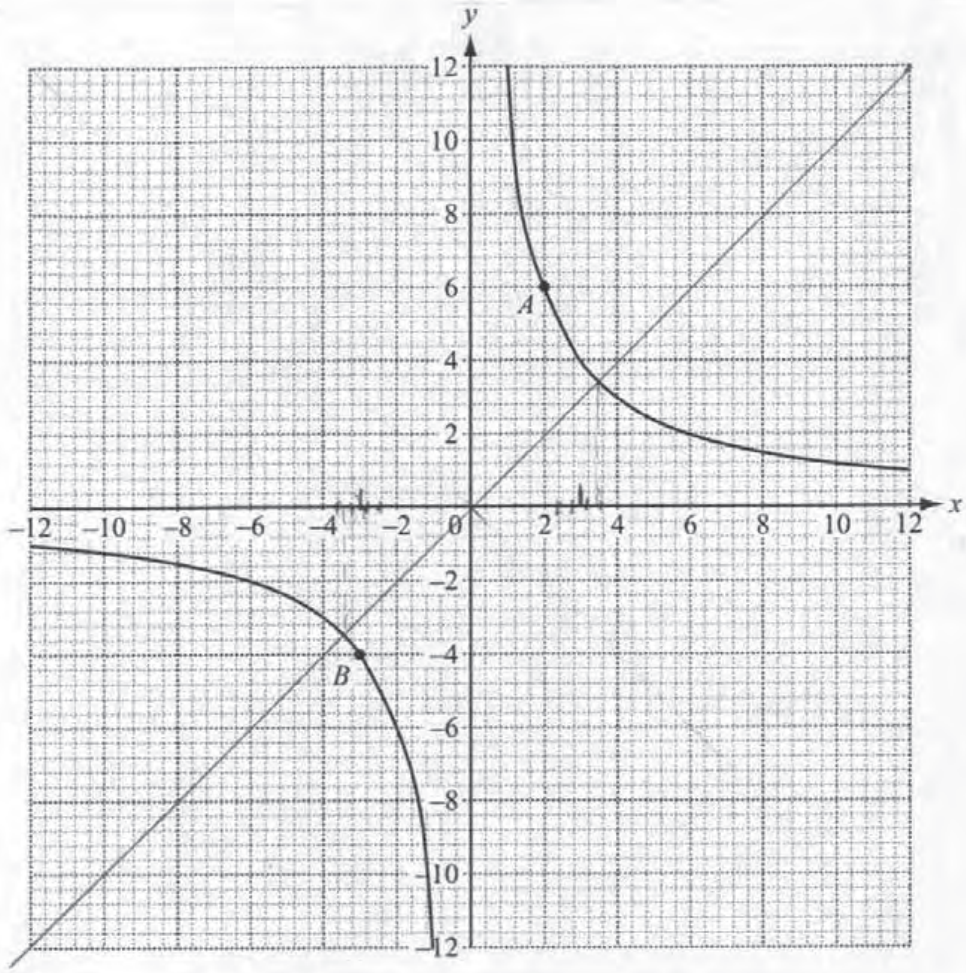


A graph is drawn on the grid.
Points A and B are marked on the curves.

(a) (i) Write down the co-ordinates of the points A and B.

Answer(a)(i) $A($ 2 , 6 $)$ and $B($ −4 , −4 $)$ [2]

(ii) The equation of the graph is $xy = n$.

Write down the value of n.

Answer(a)(ii) $n =$ ..... [1]

(b) (i) Write down the order of rotational symmetry of the graph.

Answer(b)(i) 2 [1]

(ii) On the grid, draw the lines of symmetry of the graph. [2]

(iii) Write down the equation of each line of symmetry.

Answer(b)(iii) ..... and ..... [2]

(c) (i) One line of symmetry crosses both curves.

Write down the x co-ordinates of the points where this line meets each curve.
Give your answers to 1 decimal place.

Answer(c)(i) $x =$ −3.8 and $x =$ 3.6 [2]

(ii) On the grid, draw the line which passes through the point (0, 4) and is parallel to the line of symmetry in **part (c)(i)**. [1]

(iii) Write down the equation of this line in the form $y = mx + c$.

Answer(c)(iii) $y =$ ..... [2]

6 (a) The formula for finding the interior angle of a regular polygon with n sides is given below.

$$\text{Interior angle} = \frac{180(n-2)}{n}$$

(i) Find the size of the interior angle of a regular polygon with 9 sides.

$\frac{180(9-2)}{9} = 140$

Answer(a)(i) 140 [2]

(ii) Multiply out the brackets.

$180(n-2)$

$180n - 360$

Answer(a)(ii) $180n - 360$ [1]

(iii) A regular polygon has an interior angle of 156°.

How many sides does this polygon have?

Answer(a)(iii) 15 [3]

(b) Solve the simultaneous equations.

$3x + 5y = 9$ | $\times 2$
$x + 2y = 4$ | $\times -5$

$y = 1$

$6x + 10y = 18$
$-5x - 10y = -20$

$x = -2$

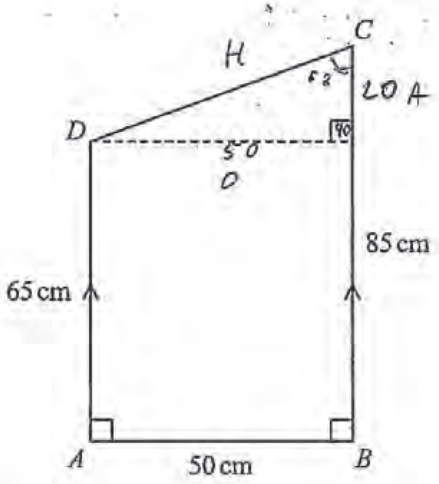
$-6 + 5y = 9$
$5y = 15$
$y = 3$

check $-6 + 15 = 9$

Answer(b) $x =$ -2

$y =$ 3 [3]

7



The diagram represents the cross-section of a storage box.
$AB = 50$ cm, $AD = 65$ cm and $BC = 85$ cm.
AD is parallel to BC.

(a) Write down the geometrical name of the quadrilateral $ABCD$.

Trapezium

Answer(a) ..... [1]

(b) Calculate angle DCB.

$\tan = \frac{50}{20} = 68.2$

Answer(b) Angle DCB = 68.2 ..... [3]

(c) Calculate the area of the cross-section $ABCD$.

1) $50 \times 65 = 3250$

2) $20^2 + 50^2 = x^2$, $\sqrt{2900}$, $x = 53.9 = x = 54$

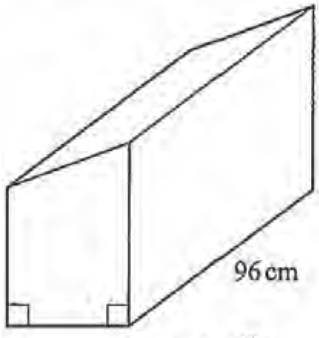
3) $3250 + 54 = 2$

Answer(c) 3304 ..... cm^2 [2]

(d) The storage box is 96 cm long.

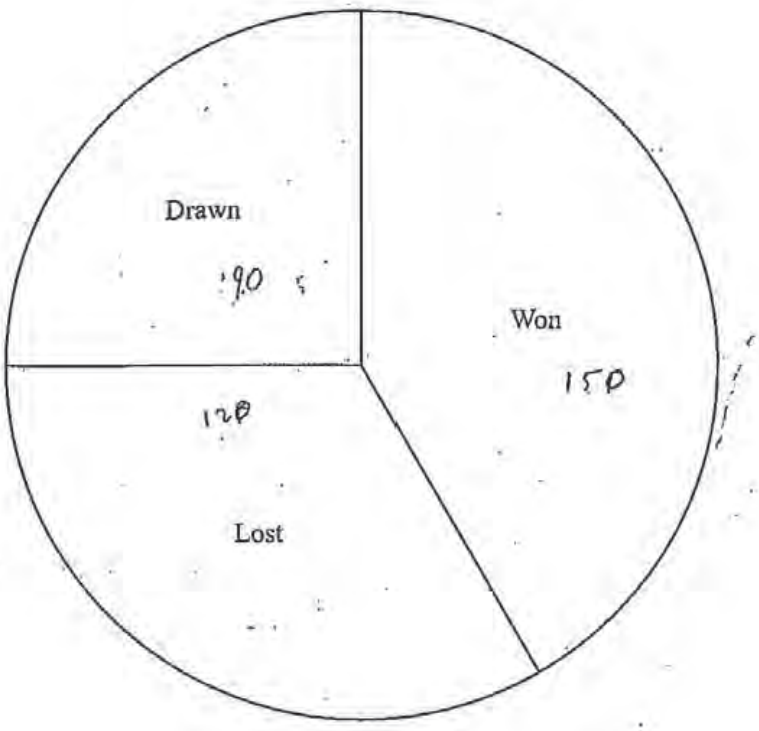
Calculate the volume of the box.
Write down the units of your answer.

$\frac{1}{2}(54 + 50) \times 85$



Answer(d) 4420 ..... [2]

8 (a) The results of 24 games of hockey played by a school team in one year are shown in the pie chart below.



(i) Show that the school team won 10 games during the year.

Answer(a)(i)

$\frac{150}{360} \times 24 = 10$

[2]

(ii) Find how many games were lost and how many games were drawn.

$\frac{120}{360} \times 24 = 8$

$\frac{90}{360} \times 24 = 6$

Answer(a)(ii) Lost 8

Drawn 6 [3]

(b) The number of goals scored by the hockey team in each of the 24 games are shown below.

0 2 1 1 0 3 2 5
3 0 2 3 2 1 4 0
2 1 2 1 0 1 4 1

(i) Complete the frequency table below. You may use the tally column to help you.

Number of goals per game	Tally	Number of games
0	𝍸	5
1	𝍸 | |	7
2	𝍸 |	6
3	|||	3
4	||	2
5	|	1

[2]

(ii) Write down the mode.

Answer(b)(ii) 1 [1]

(iii) Find the median.

0 0 0 0 1 1 1 1 1 1 1 2 2 2 2 2 2 2 3 3 3 4 4 5

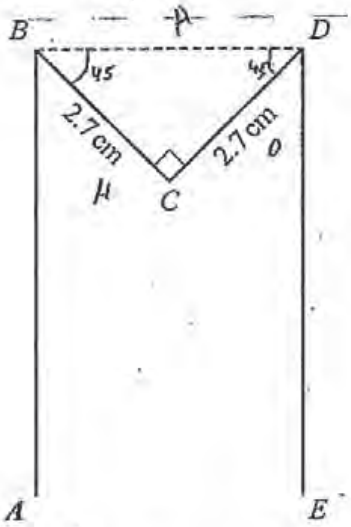
Answer(b)(iii) 2 [2]

(iv) Calculate the mean number of goals per game.

$\frac{5+7+6+3+2+1}{6} = 24$

Answer(b)(iv) 4 [3]

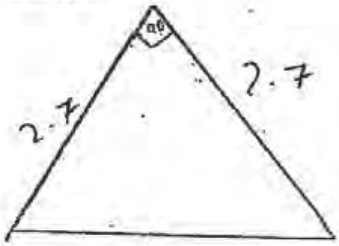
9



NOT TO SCALE

(a) In the diagram above, AB and ED are vertical.
The diagram is symmetrical about a line through C parallel to AB.
Angle $BCD = 90°$ and $BC = CD = 2.7$ cm.

(i) Calculate BD.



$2.7^2 + 2.7^2 = y^2$

$\sqrt{14.58}$

Answer(a)(i) BD = 3.8 cm [2]

(ii) Complete the statement.

Triangle BCD is right-angled and equilibrium = equal side [1]

(iii) Find the size of angle ABC.

$90 - 45 = 45$

Answer(a)(iii) Angle ABC = 45 [1]

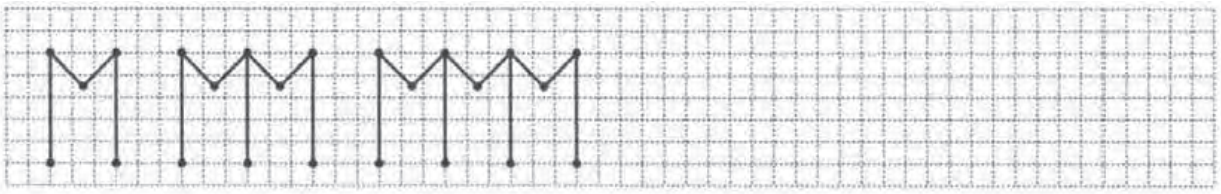


Diagram 1 Diagram 2 Diagram 3 Diagram 4

(b) The pattern of diagrams above is continued by adding more lines and dots.

(i) On the grid, draw diagram 4. [1]

(ii) Complete the table below.

Diagram	1	2	3	4	5
Number of lines	4	7	10	13	16

3 3 3 3 [2]

(c) How many lines will there be in

(i) Diagram 9,

$3(9)+1=28$

Answer(c)(i) 28 [1]

(ii) Diagram n?

$3n+1$

Answer(c)(ii) $3n+1$ [2]

(d) The number of lines in Diagram r is 76.

Find the value of r.

$3r+1=76$

$3r=75$

$r=\frac{75}{5}$ $r=15$

Answer(d) $r=$ 15 [2]

(e) Write down an expression, in terms of n, for the number of **dots** in Diagram n.

Answer(e) $3n+1$ [1]

Examiner comment

Question 1: The question was answered well by the candidate and marks were only lost in the final part.
In part (a) which required full working 24% of a litre was clearly shown in cubic centimetres. From there the subtraction from 1000 was shown to result in the required answer.
In part (b) the correct un-simplified fraction was shown before the correct simplified form was given. The no intermediate working suggests that the fraction key on the calculator was sensibly applied to the simplification.
The standard calculation for finding the amount of one item, given a ratio, was shown by the candidate, thus ensuring the method mark, though the correct answer was also found.
In part (d) the working showed the profit thus ensuring that method mark, even though the second method mark was lost by dividing by the selling rather than the cost price.

Question 2: This question demonstrated some weaknesses in the basic knowledge of this otherwise quite able candidate. The terms prime factor, 3-digit even number and multiple of 13 produced no responses, although in the last two this may have been that the candidate could not find examples from the six number cards.
It is felt that part (a)(i) was a slip although putting one of the integers as 90 was a common error.
The more demanding parts of (b) were done correctly with an understanding shown of square and cube numbers, as well as cube root. Some uncertainty on prime numbers was demonstrated by an even number answer in part (vii)

Question 3: This question did cause problems for many candidates although this script did gain most of the straightforward marks. Reading the scales to gain the first 3 marks showed good understanding of what was required and the ability to correctly identify the meaning of the 2mm divisions on each of the scales. Part (a)(iv) was clearly understood but the candidate over approximated when changing 14 minutes to a decimal of an hour, thus losing the accuracy mark.
Unfortunately in part (b)(i) only the first part of the continued graph was shown. The candidate incorrectly attempted to find the time to return home by working $6 \div 4$ rather than $4 \div 6$. Consequently the time of arriving home was off the scale of the graph.
In part (c) a slip in the starting point of the line lost 1 mark but the final mark could not be gained without an answer to part (b)(ii).

Question 4: While this question proved challenging for many this candidate gained most of the marks. Part (a) was standard bookwork for constructions of line and angle bisector as well as following the guidance for marking specific points. As expected from a grade C candidate this was all done accurately.
The step in part (b) of changing the scale to metres is best done first, before finding the area to avoid the common error of multiplying by the factor 6, rather than 6×6. This candidate made that error and so only gained a mark for the basic area calculation.
However the more challenging bearings question in part (c) was completed successfully, although it was then surprising that the circle locus of points from a specific object was not attempted.

Question 5: A slip in reading one of the co-ordinates of one of the intersection points not only lost a mark in (a)(i) but probably caused the 'no response' in part (a)(ii). Had the coordinates been completely correct it would have been clear that working out xy in both cases resulted in a value of 12.
There was certainly weaknesses displayed in this question but it was carelessness on the part of the candidate to not observe that 'lines' rather than 'line' of symmetry was requested indicating more than one. Hence a mark was lost here and the equations of the diagonal lines were not offered in part (b)(iii).
Some lack of accuracy was evident in part (c)(i) but surprisingly the remainder of the question was not attempted.

Question 6: This candidate gained full marks showing all necessary working for substitution and expansion of brackets. Un-typically no working was shown for part (a)(iii) even though the correct answer was found.
The elimination method for simultaneous equations was clearly shown leading to fully correct answers.

Question 7: The candidate clearly knew and could apply trigonometry successfully to find an angle in part (b). Also they could spell 'trapezium' correctly! Although finding the area of a trapezium in part (c) from the formula was not essential, there was confusion between finding the hypotenuse of the triangle and calculating the area. In part (d) the candidate incorrectly reverted to the formula for the area of a trapezium instead of simply multiplying area by length.
This question has shown that although the candidate has thorough knowledge of and ability to apply most of the topics, necessary to achieve a grade C, there are questions such as this one which show weaknesses rather than slips.

Question 8: Most of this question was well done, in particular part (a). Once again a 'show that' question was fully explained to the extent of an angle of 150° marked on the diagram and the appropriate calculation shown. Following this it is not surprising that part (a)(ii) was successfully completed. The basic formation of the frequency table was accurately done and the mode found. The technique for the median was shown but a slip on identifying the middle value (in fact midway between 1 and 2) lost a mark. Unfortunately the candidate simply did not know how to find the mean from a frequency table.

Question 9: Although the candidate clearly understood this question there were places where errors and omissions were made.
Part (a)(i) was fully understood and worked correctly but a mark was lost by giving the answer to 2 instead of 3 significant figures, without a more accurate answer in the working space. Unfortunately the candidate could not recall the term 'isosceles' for the triangle. However, the straightforward part (a)(iii) was done successfully.
In part (b), for no apparent reason, the candidate did not do the obvious part (i). While it may be easy to miss a simple part, there should be adequate time to go back and look again for parts missed and it seems certain had that been done this Diagram 4 would have been completed. The remainder of part (c) was perfect showing a full understanding of linear sequences. Carelessness caused the loss of a mark in part (d)(i) where $3n = 75$ led to $75 \div 5$.
Giving the same answer for part (e) as part (c)(ii) showed a lack of thought as there were clearly more dots than lines.

The candidate gained a grade C for this paper and deserved it by showing clearly developed and accurate solutions for most of the questions. Careful reading and interpreting of the more problem type questions typical of Paper 3 is at least as important as being able to do the mathematics involved.

Example candidate response – grade E (whole script)

1 A drink consists of water and fruit juice.

(a) 24% of the drink is water.

Show that there is a total of 760 cm^3 of fruit juice in one litre of the drink.

Answer(a)

1000 cm^3 of fruit Juice
760 cm^3 – fruit Juice
240 cm^3 – water
1000 cm^3 –

[2]

(b) What fraction of one litre of the drink is fruit juice?

Give your answer in its simplest form.

$\frac{3}{4}$ $\frac{760\ cm}{1000}$

Answer(b) $\frac{760}{1000}$ [2]

(c) The 760 cm^3 of fruit juice in one litre of the drink is made from apple, mango and peach in the following ratio.

Apple : Mango : Peach = 6 : 15 : 17

Calculate the amount of apple juice.

$\frac{6+15+17}{760} = \frac{760}{38} = 20 = 20 \times 6 = 120$

120

Answer(c) 0.03000 cm^3 [2]

(d) A shopkeeper buys bottles of the drink for 65 cents each.
He sells them for 80 cents each.

Calculate the percentage profit he makes on each bottle he sells.

10% = 6.5
= 15/6.5 = 23.07692308

Answer(d) 23.1 % [3]

2 (a) (i) $f \times g = 90$

f and g are both integers **greater than 1**.

Write down one possible pair of values of f and g.

Answer(a)(i) $f =$ 15 and $g =$ 2 [1]

(ii) Find all the prime factors of 90.

Answer(a)(ii) 15, 18 [3]

(b) Six number cards are shown below.

0	4	9	5	1	8

One or more of the cards are chosen to make different numbers.

For example, 5 9 makes the number 59.

Choosing a card or cards, write down

(i) a 2-digit odd number less than 40,

Answer(b)(i) 19 [1]

(ii) the largest 3-digit even number,

Answer(b)(ii) 198 [1]

(iii) a 2-digit square number greater than 50,

Answer(b)(iii) 8^2 [1]

(iv) a cube number,

Answer(b)(iv) 9 [1]

(v) a 2-digit multiple of 13,

Answer(b)(v) 91 [1]

(vi) the cube root of 64,

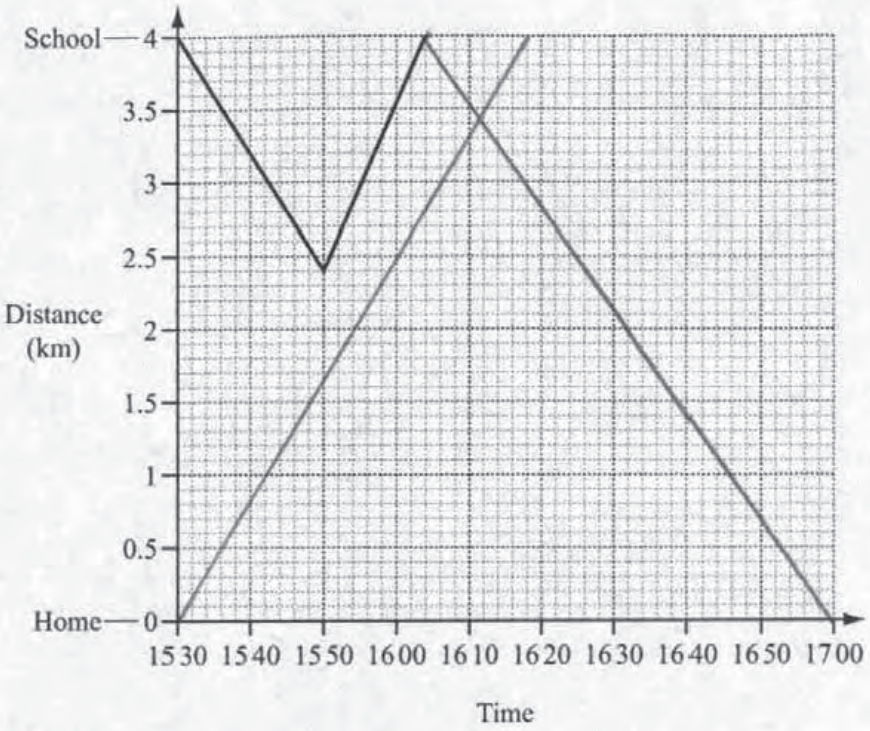
Answer(b)(vi) 8 [1]

(vii) a prime number between 100 and 120.

Answer(b)(vii) 108 [1]

3 Kim left school at 1530 to walk home.
On the way home he remembered he had left a book at school.
He ran back to school and arrived at 1604.

The travel graph shows his journey.



(a) Use the graph to answer the following questions.

(i) At what time did Kim start to run back to school?

Answer(a)(i) ..... 15.50 ..... [1]

(ii) How far was he from school at this time?

Answer(a)(ii) ..... 1.6 ..... km [1]

(iii) How many minutes did he take to run back to school?

Answer(a)(iii) ..... 14 ..... min [1]

(iv) What was his speed, in kilometres per hour, on his journey back to school?

1.6 x 4 = 6.4

= .1 / 6.5106

Answer(a)(iv) ..... 6.5106 ..... km/h [3]

(b) Kim spent 6 minutes at school collecting his book.
He then walked home at a speed of 6 km/h.

(i) Complete the travel graph. [3]

(ii) At what time did Kim arrive home?

16·54 TO 16·58

Answer(b)(ii) 4 3 mins [1]

(c) Kim's sister, Julie, left the school at 15 48.
She walked at a steady speed, without stopping, and arrived home 46 minutes later.

(i) On the grid, draw the travel graph of Julie's journey home from school. [2]

(ii) Complete the sentence.

KIM arrived home first by 4 6 minutes. [1]

4 An accurate scale drawing of three sides of a garden, AB, BC, and CD is shown on the opposite page. A is due north of B and C is due east of B.

(a) A vegetable area is to be constructed in the garden.

Parts (i) and (iii) must be completed using a straight edge and compasses only.

On the scale drawing

(i) construct the perpendicular bisector of BC, [2]

(ii) mark the point S at the midpoint of BC, [1]

(iii) construct the bisector of angle ABC, [2]

(iv) mark the point R where this line crosses the perpendicular bisector of BC, [1]

(v) mark the point Q on BA where $BQ = SR$, [1]

(vi) draw the vegetable area, quadrilateral $BQRS$. [1]

(b) On the scale drawing, 1 centimetre represents 6 metres.

Calculate the vegetable area in square metres.

$5.1 \times 4 = 20.4$

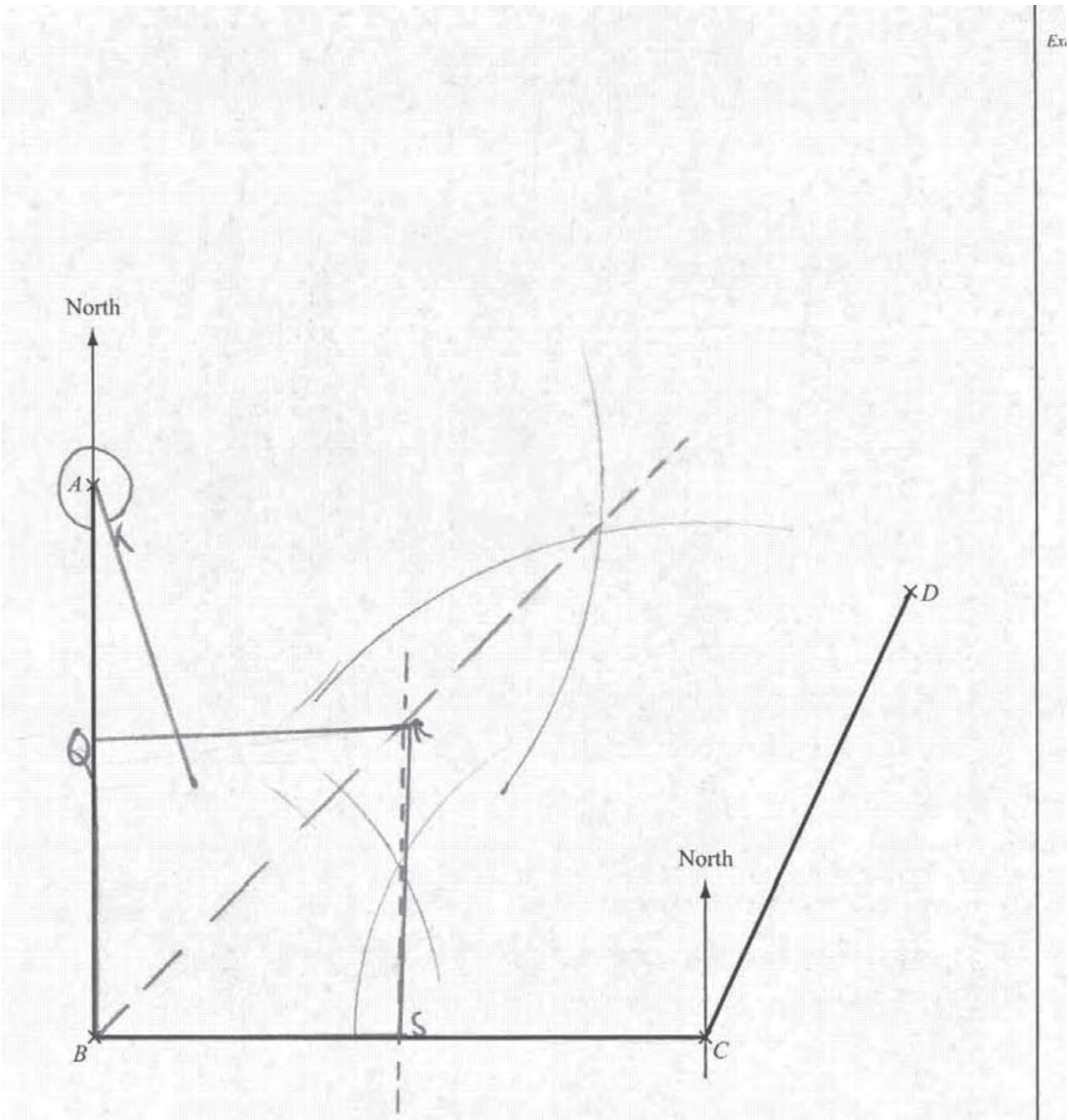
$= 4.51$

Answer(b) 4.51 m^2 [3]

(c) A tree, T, is on a bearing of 070° from A and 345° from C.

On the scale drawing, mark the position of T. [2]

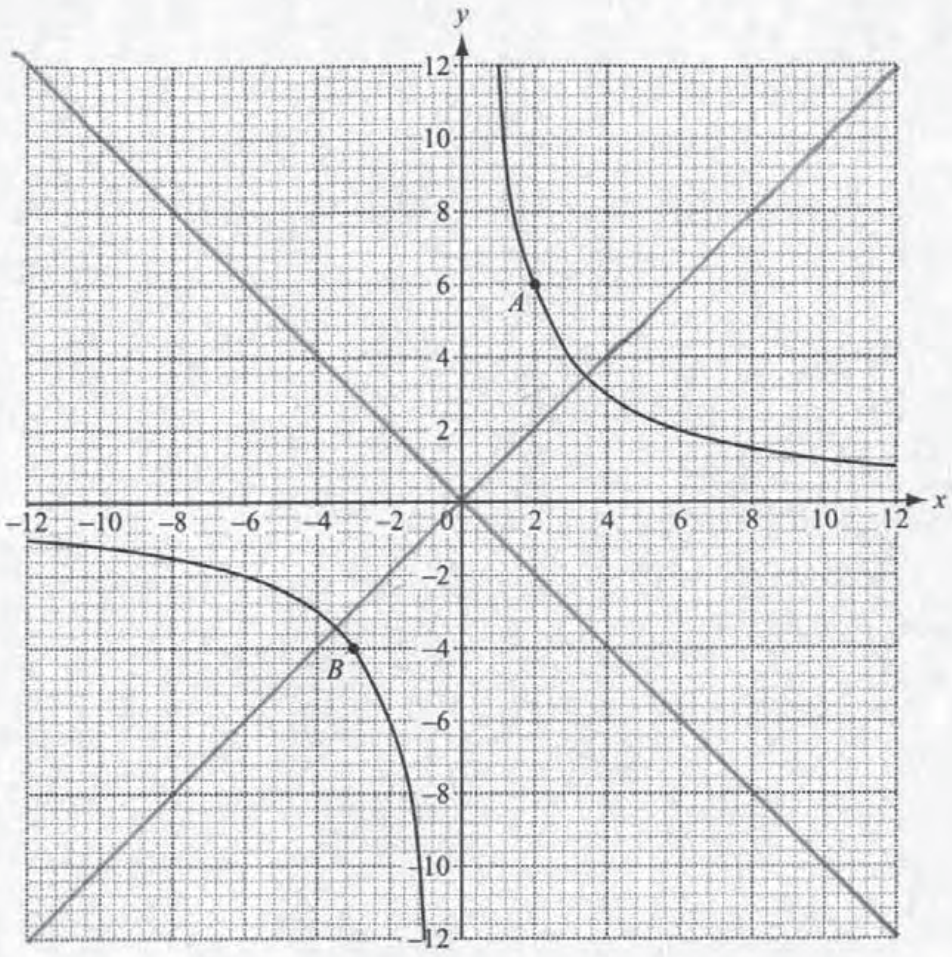
(d) Draw accurately the locus of points which are 24 metres from the tree, T. [2]



Scale: 1 cm = 6 m

[Turn over

5



A graph is drawn on the grid.
Points A and B are marked on the curves.

(a) (i) Write down the co-ordinates of the points A and B.

Answer(a)(i) $A($ 6 , 12 $)$ and $B($ −4 , −12 $)$ [2]

(ii) The equation of the graph is $xy = n$.

Write down the value of n.

Answer(a)(ii) $n =$ $6 \times 12 + (-4) \times (-12)$ [1]

(b) (i) Write down the order of rotational symmetry of the graph.

Answer(b)(i) Reflex [1]

(ii) On the grid, draw the lines of symmetry of the graph. [2]

(iii) Write down the equation of each line of symmetry.

Answer(b)(iii) -3.8 3.8 and 3.8 3.8 [2]

(c) (i) One line of symmetry crosses both curves.

Write down the x co-ordinates of the points where this line meets each curve.
Give your answers to 1 decimal place.

3.8 -3.8 3.8

Answer(c)(i) $x =$ 1 and $x =$ 1 [2]

(ii) On the grid, draw the line which passes through the point (0, 4) and is parallel to the line of symmetry in **part (c)(i)**. [1]

(iii) Write down the equation of this line in the form $y = mx + c$.

$y = mx + c$

$= 1 + 0$

Answer(c)(iii) $y =$ 1 [2]

6 (a) The formula for finding the interior angle of a regular polygon with n sides is given below.

$$\text{Interior angle} = \frac{180(n-2)}{n}$$

(i) Find the size of the interior angle of a regular polygon with 9 sides.

$\frac{180(9-2)}{9}$

Answer(a)(i) 140° [2]

(ii) Multiply out the brackets.

$180(n-2)$

Answer(a)(ii) 1260 [1]

(iii) A regular polygon has an interior angle of 156°.

How many sides does this polygon have?

Answer(a)(iii) 8 sides [3]

(b) Solve the simultaneous equations.

$3x + 5y = 9$
$x + 2y = 4$

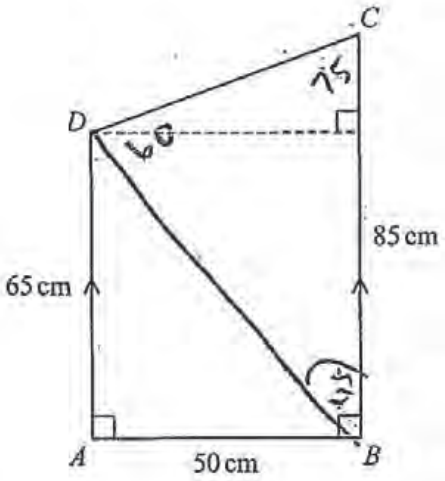
$3x + 5y = 9$
$3x + 2y = 4$
$5y = 13$
$y = \frac{5}{13} = 2.6$

$\frac{9}{13} = \frac{3x + 3(10y)}{5x + 10y}$
$\frac{6}{}$

Answer(b) $x =$ 0.69

$y =$ 2.6 [3]

7



NOT TO SCALE

The diagram represents the cross-section of a storage box.
$AB = 50$ cm, $AD = 65$ cm and $BC = 85$ cm.
AD is parallel to BC.

(a) Write down the geometrical name of the quadrilateral $ABCD$.

Answer(a) Trapezium [1]

(b) Calculate angle DCB.

90 + x + y = 180°
90 + 60 + 75

Answer(b) Angle DCB = 75° [3]

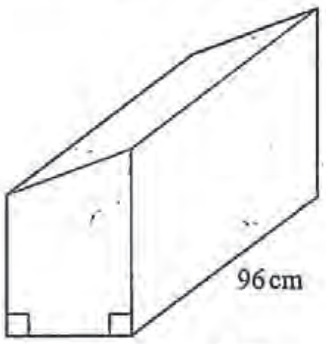
(c) Calculate the area of the cross-section $ABCD$.

50 + 50 + 65 + 80 = 250 cm

Answer(c) 250 cm² [2]

(d) The storage box is 96 cm long.

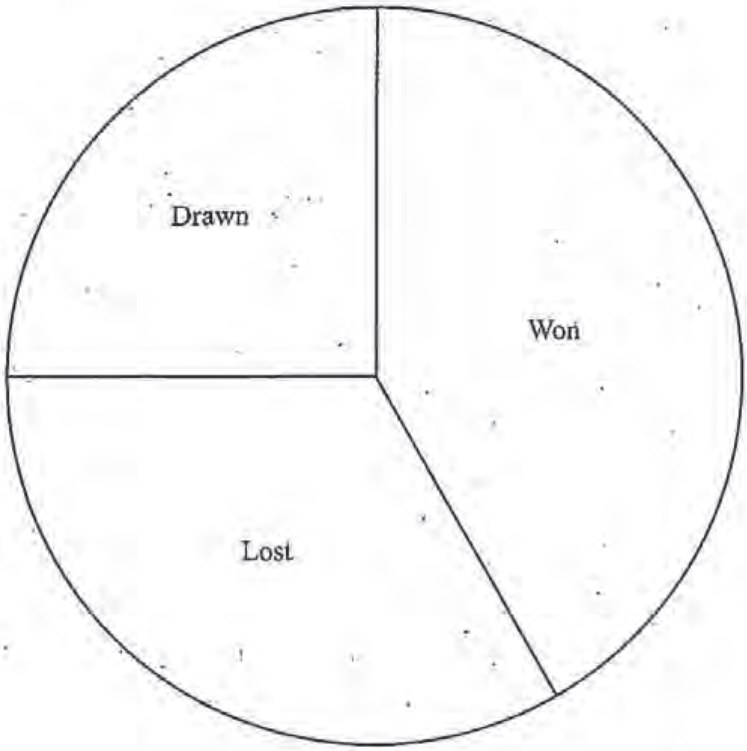
Calculate the volume of the box.
Write down the units of your answer.



240 cm per side
96 × 2 = 192
48 × 2 = 96

Answer(d) 288 cm² [2]

8 (a) The results of 24 games of hockey played by a school team in one year are shown in the pie chart below.



(i) Show that the school team won 10 games during the year.

Answer(a)(i)

Draw = 90° = 6 =
Lost = 120° = 8
won = 150° = 10 6

[2]

(ii) Find how many games were lost and how many games were drawn.

Draw = 90° = 6 games
Lost = 120° = 8 games.

Answer(a)(ii) Lost ..... 8 games .....

Drawn ..... 6 games ..... [3]

(b) The number of goals scored by the hockey team in each of the 24 games are shown below.

0	2	1	1	0	3	2	5
3	0	2	3	2	1	4	0
2	1	2	1	0	1	4	1

(i) Complete the frequency table below. You may use the tally column to help you.

Number of goals per game	Tally	Number of games
0	𝍸	5
1	𝍸 II	7
2	𝍸 I	6
3	III	3
4	II	2
5	I	1

1 2 3 5 6 7 [2]

(ii) Write down the mode.

Answer(b)(ii) 7 [1]

(iii) Find the median.

$\frac{8}{6} = 1.33$

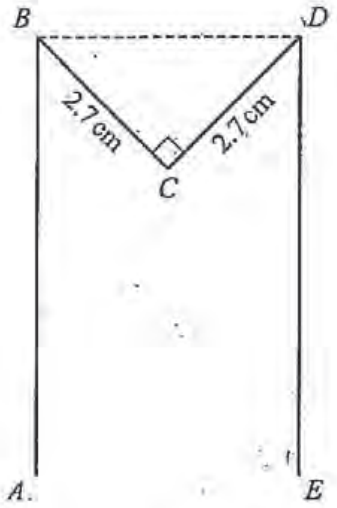
Answer(b)(iii) 1·33 [2]

(iv) Calculate the mean number of goals per game.

$\frac{1+2+3+5+6+7}{24} = 4$

Answer(b)(iv) 4 [3]

9



NOT TO SCALE

(a) In the diagram above, AB and ED are vertical.
The diagram is symmetrical about a line through C parallel to AB.
Angle $BCD = 90°$ and $BC = CD = 2.7$ cm.

(i) Calculate BD.

BC + CD = 5.4

BD = 2BC

= 2.7 × 2 =

Answer(a)(i) BD = 5.4 cm [2]

(ii) Complete the statement.

Triangle BCD is right-angled and forms triangle of 180° [1]

(iii) Find the size of angle ABC.

ABC = 45°

= 90° − 45°

Answer(a)(iii) Angle ABC = 45° [1]

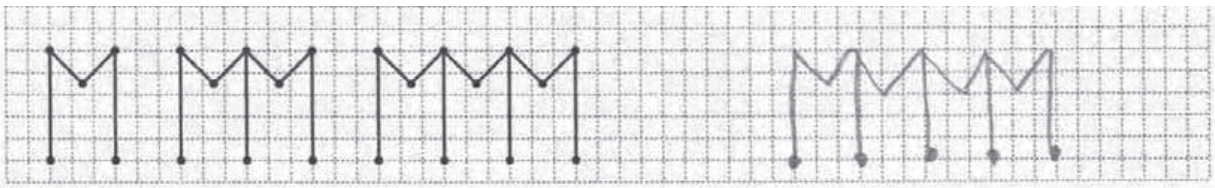


Diagram 1 Diagram 2 Diagram 3 Diagram 4

(b) The pattern of diagrams above is continued by adding more lines and dots.

(i) On the grid, draw diagram 4. [1]

(ii) Complete the table below.

Diagram	1	2	3	4	5
Number of lines	4	7	10	13	16.

[2]

(c) How many lines will there be in

(i) Diagram 9,

Answer(c)(i) ..... 28 ..... [1]

(ii) Diagram n?

Answer(c)(ii) ..... 3 ..... [2]

(d) The number of lines in Diagram r is 76.

Find the value of r.

Answer(d) $r =$ ..... 25 ..... [2]

(e) Write down an expression, in terms of n, for the number of **dots** in Diagram n.

Answer(e) ..... starting and ending point [1]

Examiner comment

Question 1: Although the candidate knew there was 1000cm in 1 litre and deduced 240cm of water there was no relating to the percentage. Even though the answer is given in the question, the method needs to be precisely as if it had to be found and not 'show that'.
Some progress was made in part (b) with a statement of the correct un-simplified fraction. It may have been a case of not reading the question carefully that resulted in no attempt to simplify.
Regardless of the low total mark, this candidate clearly knew how to do the standard ratio question and percentage profit, showing clear well worked solutions.

Question 2: In contrast with the grade C script, this candidate seemed reasonably competent with the more basic number types but uncertain of the higher level ones.
While finding two integers with a product of 90, the candidate could not cope with splitting up further into prime factors, and by not even putting 2 from the first part, it is clear that this topic was not known.
Lack of understanding of square numbers, cube numbers and cube roots, the more challenging parts of (b), was shown and the candidate's response of an even number for a prime over 100 showed a lack of appreciation of 2 as the only even prime.

Question 3: The lower level skill of reading times and distances from a graph was correctly done but the candidate could not cope with the more demanding calculations related to speed.
Lack of ability was again shown in part (b) by not showing a section of the graph at the school or attempting any calculation for the time of the journey home. The line on the graph was presumably intended for part (c) though the start did not relate to 15 48 and the home end went back in time.
Clearly apart from the skill of reading times and distances, the candidate had little idea of what was involved in questions on this section of the syllabus.

Question 4: Some progress was made on the early part of this question. The bisectors of BC and angle ABC were correctly shown but not from correct constructions. Only 1 pair of arcs was seen in part (a)(i) and incorrect arcs (from A and C instead of using arcs on BA and BC) were shown in (a)(iii).
Although the square was drawn, lengths were measured incorrectly and no attempt was made to convert to metres.
Bearings, one of the more challenging topics at Core level, was not attempted and so part (d) could not be done.

Question 5: This question was very poorly done and illustrates the limited knowledge of the candidate on these parts of the syllabus.
Part (a)(i) simply required the basic skill on graphs of reading co-ordinates and the responses had no relation to the required points. Consequently it was not possible to deduce a meaningful answer to part (a)(ii).
Rotational symmetry was not known but the candidate clearly understood line symmetry, producing the two correct lines. However, the step to their equations was too much with not even an attempt in terms of algebra.
Again in part (c) the weakness on co-ordinates was evident and no attempt was made at a parallel line or its equation.
It is very common for lower ability candidates to find it difficult to progress far with algebraic representation.

Question 6: Part (a)(i) required simple substitution and consequently simple calculator arithmetic to reach the answer. This was the only part the candidate got correct. Weakness in algebra was again evident in part (a)(ii) as the response to expansion of a very simple bracket did not even produce an algebraic expression.
No method was shown for an attempt at the sides of the polygon and it is felt that the answer of 8 was just a guess.
Although there was some suggestion of combining the two equations in part (b) it was clear that the candidate had no knowledge of this topic.

Question 7: This was another poorly done question with only the name of the quadrilateral gaining a mark. Clearly the candidate was not familiar with trigonometry as the attempt at the angle was by assuming two angles of a created triangle to find the third angle from the sum of angles property.
The response to area looked like a slightly incorrect attempt at perimeter and clearly there was no attempt to connect area and volume needed for part (d).

Question 8: Some understanding of pie charts was shown in part (a)(i) and it was a pity that the angle was measured as 160° instead of 150°. Had a check been made on the total of the three measured angles, the candidate may have realised the error. Clearly the method was understood since part(a)(ii) was completely correct.
The straightforward skill of forming a frequency table was done successfully but the later parts of part (b) on the statistical measures were clearly not understood. The common error of giving the frequency for the mode was seen while the attempt at the median seemed to be putting the frequencies in order and finding the average of the middle two numbers. The attempt at the mean simply added the frequencies and divided by 24, which if correctly worked out would have produced a meaningless value.
In this question the candidate has again coped with basic work but shown much confusion over the measures and how to calculate them.

Question 9: Clearly the candidate had no experience of Pythagoras theorem and gave an impossible answer of twice BC for the length of BD. No recognition of an isosceles triangle was evident in the response to part (a)(ii). However, the fairly obvious result, 45° for part (iii) was found.
In part (b) all the numerical parts were done successfully.
The candidate was able to develop the sequence, extend four more terms and even work back from 76 lines to the correct diagram number. However, once again, it is the move into algebra that this candidate cannot achieve and no expressions containing n were evident in either parts (c)(ii) or (e).

It is clear that this candidate has some skills in parts of Cambridge IGCSE mathematics. However, the marks almost entirely involved arithmetic skills or simply following basic instructions to read and interpret information shown on graphs and diagrams. Much of the syllabus tested on this paper was clearly not known or understood at all and certainly any questions involving significant algebra were beyond the ability of the candidate. As such what was shown by the candidate was just about worth the grade E that was obtained and while many of the responses were incorrect there were areas of positive achievement that deserve to be recognised.

Paper 4 (Extended)

General comment

For Paper 4, three scripts have been chosen to exemplify a typical grade A, C and E script.

All nine questions on this paper had parts which were intended to discriminate through all the grades and, although only questions 4, 6, 8 and 9 will be looked at and commented on in detail, the chosen answers will show the different levels of performance. These examples are followed by the whole grade A, C and E candidate scripts to illustrate the standard for the whole paper across all of the nine questions.

A brief account of the questions not chosen for analysis will now be given.

Question 1 was accessible to all candidates and only the reverse percentage question would be expected to create difficulties for grade E candidates.

Question 2 candidates would be expected to draw and describe straightforward transformations but the matrix and transformation parts of the question certainly acted as discriminators for the higher grades.

Question 3 involved quite a lot of graph work and all candidates are expected to cope with the completion of a table of values, the plotting of points and the drawing of the curve, thus scoring 7 of the 16 marks on this question. The other parts of question 3 involved proof of an expression, factorising and interpreting the graph and these parts were more discriminating through the grades.

Question 5 also offered a number of marks accessible for all candidates with the drawing of a cumulative frequency diagram and the readings from it. The more challenging combined probability question and the completion of a histogram were for the higher grade candidates.

Question 7 contained a simple column vector question, which should have been accessible for all candidates. The angle properties of a circle would be expected to be challenging for grade D and E candidates and most of the vector geometry in part (c) would discriminate amongst the higher grades.

Mark scheme

Abbreviations

cao	correct answer only
cso	correct solution only
dep	dependent
ft	follow through after error
isw	ignore subsequent working
oe	or equivalent
SC	Special Case
www	without wrong working
art	anything rounding to
soi	seen or implied

Qu.	Answers	Mark	Part Marks
1	**(a) (i)** 1088	2	**M1** for 3136 ÷ (17 + 32) soi by 64 or 2048
	(ii) Their 1088 × 2		
	and (3136 – their 1088) × 4.5	M1	2048 may be 32 × 64
	2176 + 9216	E1	
	(b) 11.9 to 11.9031 www	3	**M2** for $\frac{(12748-11392)\times 100}{11392}$ oe
			or **M1** for $\frac{12748-11392}{11392}$ soi by 0.1119
			or $\frac{12748}{11392}(\times 100)$ soi by 111.9 or 112 or 1.119
	(c) 8900	3	**M2** for 11392 ÷ 1.28 oe or **M1** for 11392 = 128(%) oe
2	**(a) (i)** Correct reflection (1, –1) (4, –1) (4, –3)	2	**SC1** for reflection in *y*-axis or vertices only of correct triangle
	(ii) Correct rotation (–1, 1) (–1, 4) (–3, 4)	2	**SC1** for rotation 90 clockwise about O or vertices only of correct triangle
	(iii) Reflection only	1dep	Two transformations scores 0 Dependent on at least **SC1** scored in **both (i)** and **(ii)**
	$y = x$ oe **or** $y = -x$ oe	1	Only from **2 and 2** or **SC1 and SC1** scored Only from **2 and SC1** or **SC1 and 2** scored
	(b) (i) $\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$ oe	2	**B1** for either column correct or determinant = 1
	(ii) Rotation, 90° clockwise, origin oe	2	**B1** for rotation **and** origin **B1** for 90° clockwise oe
3	**(a)** $72 - 2x$ oe seen	M1	
	$x(72 - 2x) = 72x - 2x^2$	E1	No errors or omissions
	(b) $2x(36 - x)$ or $-2x(x - 36)$	2	isw solutions **B1** for answers $2(36x - x^2)$ or $x(72 - 2x)$ or correct answer spoiled by incorrect simplification
	(c) 630, 640, 70	3	**B1** for each correct value
	(d) 8 correct plots	P3ft	ft for their values ft **P2** for 6 or 7 correct plots ft **P1** for 4 or 5 correct plots
		C1	Curve of **correct shape** through minimum of 7 of their points No ruled sections
	(e) (i) 7.5 to 8.5 27.5 to 28.5	2	**B1** for either value correct
	(ii) 641 to 660	1	
	(f) 41	2	**M1** for 500 ÷ 12 soi by 41.6… to 42

Qu.	Answers	Mark	Part Marks
4	**(a)** $1.5^2 + 2^2$	M1	soi by 6.25
	$(l =)$ 2.5	A1	May be on diagram
	$\pi \times 1.5 \times$ their 2.5	M1	Their $2.5 \neq 2$ soi by 11.77 to 11.8 or 3.75π
	$2 \times \pi \times 1.5 \times 4$	M1	soi by 37.68 to 37.715 or 12π
	Addition of their areas for cone and cylinder	M1	soi by 15.75π This **M** mark is lost if any circles are added
	49.45 to 49.5	A1	www 6
	(b) (i) $\pi \times 1.5^2 \times 4$	M1	soi by 28.26 to 28.3 or 9π
	$\frac{1}{3}\pi \times 1.5^2 \times 2$	M1	soi by 4.71 to 4.72 or 1.5π
	Addition of their volumes	M1	10.5π implies M3
	32.9(7) to 32.99…	E1	
	(ii) 84(.0) to 84.1 www	3	**M1** for $\frac{1}{2} \pi \times 0.5^2$ soi by 0.392 to 0.393 or $\pi/8$ and **M1** for their $33 \div (\frac{1}{2} \pi \times 0.5^2)$ soi by $264/\pi$ or **SC1** for 42 to 42.1 as answer
	(c) (i) 33000	1	
	(ii) 18min 20s cao	2	**M1** for their 33000 ÷ 1800 soi by 18.3(3…) or correct in mins and secs for their 33000
5	**(a)** 8 correct plots	P3	**P2** for 6 or 7 correct plots **P1** for 4 or 5 correct plots
	Joined by curve or ruled lines	C1ft	ft their points Must join minimum of 7 points
	(b) (i) 161 to 162	1	
	(ii) 171 to 172	1	
	(iii) Their **(b)(ii)** – 150	1ft	**Strict** ft provided > 0
	(c) (i) $\frac{5}{200}$ oe $\left(\frac{11}{40}\right)$	1	isw incorrect cancelling for both parts of **(c)**
	(ii) $\frac{1100}{39800}$ oe $\left(\frac{11}{398}\right)$	3	**M2** for $2 \times$ their $\frac{55}{200} \times \frac{10}{199}$ oe soi by 0.0276… or **M1** for their $\frac{55}{200} \times \frac{10}{199}$ oe $\left(\frac{11}{796}\right)$ soi by 0.0138…
	(d) (i) 30, 35, 20	2	**B1** for 1 correct value
	(ii) Blocks in correct position		
	w = 1cm, fd = 4	1	
	w = 1cm, fd = 6	1ft	**Strict** ft from their 30 unless 0
	w = 2cm, fd = 3.5	1ft	**Strict** ft from their 35 unless 0

Qu.	Answers	Mark	Part Marks
6	**(a) (i)** 13 cao www	2	**M1** for $\frac{PQ}{19.5} = \frac{11}{16.5}$ oe or sf = 2/3 or 1.5 seen or correct trig
	(ii) 10.39 to 10.4 www	3	**M2** for $\sqrt{19.5^2 - 16.5^2}$ or explicit trig or **M1** for $x^2 + 16.5^2 = 19.5^2$ or implicit trig
	(iii) 57.76 to 57.81 www	2	**M1** for sin = $\frac{16.5}{19.5}$ oe
	(iv) 655 to 655.4	2	**M1** for $0.02 \times (32)^3$
	(b) (i) 163.5 to 164 www	4	**M2** for $67^2 + 105^2 - 2 \times 67 \times 105\cos 143$ or **M1** for implicit form **A1** for 26732 to 26896
	(ii) 100.8 to 100.9 or 101 www	4	**B1** for (DEF =) 78° May be on diagram and **M2** for $\frac{105 \times \sin 70}{\sin \text{their } 78}$ provided their 78 ≠ 32 or 70 or **M1** for $\frac{EF}{\sin 70} = \frac{105}{\sin \text{their } 78}$ oe their 78 ≠ 32 or 70

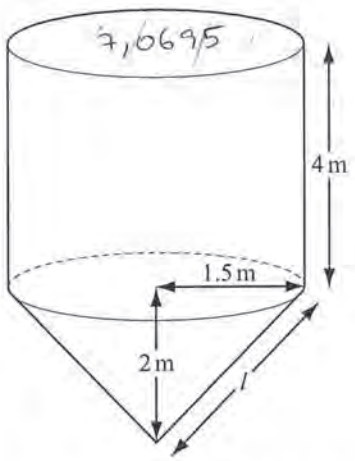
Qu.	Answers	Mark	Part Marks
7			The marks for the reasons are **dependent** on the correct angle or correct ft angle Any incorrect statement in reason loses that mark
	(a) $w = 59$	1	
	(angle in) isosceles (triangle)	1	
	$x = 31$	1ft	ft 90 – their w
	(angle in) semicircle (= 90) oe	1	Allow diameter
	$y = 62$	1	
	(angles in) same segment or (on) same arc (are =)	1	
	$z = 28$	1ft	ft 180 – their($w + x + y$) or 90 – their y
	(angles in) triangle (= 180)	1	
	(b) **(i)** $\begin{pmatrix}2\\3\end{pmatrix}$	1	
	(ii) $\begin{pmatrix}-2\\4\end{pmatrix}$	2ft	ft $\begin{pmatrix}0\\7\end{pmatrix}$ – their **(i)** **B1** ft for one correct element
	(c) **(i)** $\frac{1}{3}\mathbf{t}$ final answer	1	
	(ii) $\frac{1}{3}(-\mathbf{t} + \mathbf{r})$ final answer	2	**M1** for correct unsimplified answer or $\overrightarrow{\mathbf{TR}} = -\mathbf{t} + \mathbf{r}$ oe or $\overrightarrow{\mathbf{TP}} = \frac{1}{3}\overrightarrow{\mathbf{TR}}$ oe
	(iii) $\frac{1}{3}\mathbf{r}$ final answer	2	**M1** for correct unsimplified answer or $\overrightarrow{\mathbf{QT}} + \overrightarrow{\mathbf{TP}}$ oe for any correct path or $\frac{1}{3}\mathbf{t}$ + their **(ii)**
	(iv) $QP = \frac{1}{3}OR$ oe	1dep	**Dependent** on correct answer in **(iii)**
	QP is parallel to OR or $\mathbf{r}$	1dep	**Dependent** on multiple of **r** as answer in **(iii)**

Qu.	Answers	Mark	Part Marks
8	**(a) (i)** 3	1	
	(ii) 4	1	
	(iii) $4x - 3$ final answer	2	**M1** for $2(2x - 1) - 1$
	(iv) $\frac{x+1}{2}$ oe final answer	2	**M1** for $x = 2y - 1$ or $\frac{y+1}{2}$ oe or $\frac{f(x)+1}{2}$ oe
	(v) $-\frac{1}{2}$ and $1\frac{1}{2}$	4	**B1** for $(2x - 1)^2$ soi **M2** for $2x - 1 = \pm 2$ **or M1** for $2x - 1 = 2$ **M1** for $4x^2 - 2x - 2x + 1$ **and M1** for $(2x + 1)(2x - 3)$ or correct substitution in formula soi by $(4 \pm \sqrt{64})/8$
	(b) (i) $y = \frac{k}{x}$ oe	2	Condone $y = k/x$ and $k = 16$ stated **M1** for $y = \frac{k}{x}$ oe
	(ii) 32	1	
9	**(a) (i)** 21	1	
	(ii) $P_6 = ½ \times 6 \times 7$ or better (= 21)	1	Allow $3(6 + 1)$
	(iii) 1275	1	
	(iv) 3825	1ft	ft for $3 \times$ their **(iii)**
	(v) 11325	1	
	(vi) 7500	1ft	ft their **(v)** – their **(iv)** provided > 0
	(b) (i) 56	2	**M1** for $1 \times 6 + 2 \times 5 + 3 \times 4 + 4 \times 3 + 5 \times 2 + 6 \times 1$
	(ii) $S_6 = \frac{1}{6} \times 6 \times 7 \times 8$ or better (= 56)	1	
	(iii) 1540	1	
	(c) $56 - 35 = 21$	1	
	(d) Correct algebraic proof with no errors	3	**M1** for $\frac{1}{6}n(n + 1)(n + 2) - \frac{1}{6}(n - 1)(n)(n + 1)$ oe and **M1** for $\frac{1}{6}n(n + 1)(3)$ oe

Question 4

Example candidate response – grade A

4



NOT TO SCALE

For Examiner Use

An **open** water storage tank is in the shape of a cylinder on top of a cone.
The radius of both the cylinder and the cone is 1.5 m.
The height of the cylinder is 4 m and the height of the cone is 2 m.

(a) Calculate the **total** surface area of the **outside** of the tank.
[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

- Acone = $\pi r l$ = 3,142 . 1,5 . 2,5 = 11,78 m²
- Acyl = $\pi r^2 h$ = 2 . 3,142 . 1,5 . 4 = 37,704
- 11,78 + 37,704 = 49,484 m²
- 49,484 − 7,0695 = 42,4145 m²

1,5
2
l

$2^2 + 1,5^2 = l^2$
$4 + 2,25 = l^2$
$6,25 = l^2$
$\sqrt{6,25} = l$
$l = 2,5$

Answer(a) 42,4 m² [6]

M1 A1 M1 M1 M0

(b) The tank is completely full of water.

(i) Calculate the volume of water in the tank and show that it rounds to 33 m³, correct to the nearest whole number.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

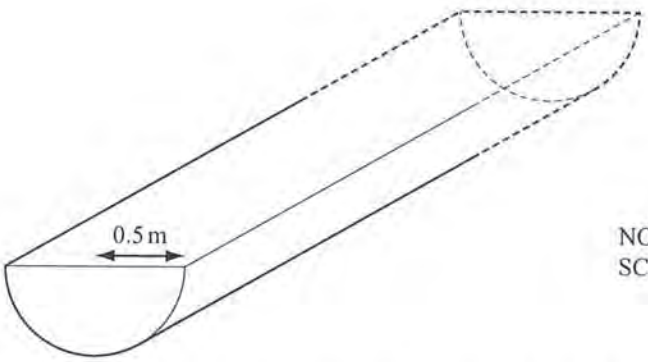
Answer(b)(i)

- Vcone = $\frac{1}{3}$. 3,142 . 1,5² . 2 = 4,713 m³
- Vcyl = 3,142 . 1,5² . 4 = 28,278 m³
- 28,278 + 4,713 = 32,991 m³
- 32,991 => 33 rounded up.

[4]

4

(ii)



NOT TO SCALE

For Examiner Use

The cross-section of an irrigation channel is a semi-circle of radius 0.5 m.
The 33 m^3 of water from the tank completely fills the irrigation channel.

Calculate the length of the channel.

$V_{cyl} \Rightarrow (\pi . r^2 . h) \div 2$

$\Rightarrow 33 = (3,142 . 0,5 . h) \div 2$

$\Rightarrow 33 \times 2 = 3,142 . 0,5 . h$

$\Rightarrow \frac{66}{1571} = h \Rightarrow h = 42,01$

M0

Answer(b)(ii) ..... 42,01 ..... m [3]

Sc 1

(c) (i) Calculate the number of litres in a full tank of 33 m^3.

Answer(c)(i) ..... litres [1]

0

(ii) The water drains from the tank at a rate of 1800 litres per minute.

Calculate the time, in minutes and seconds, taken to empty the tank.

Answer(c)(ii) ..... min ..... s [2]

0

9

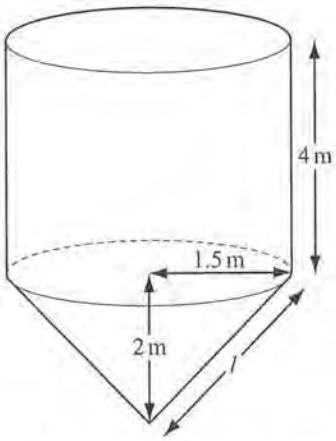
Examiner comment

Part (a) was a multi-step question requiring the understanding of the context and the ability to produce the correct strategy. Grade A candidates would be expected to break the problem down into using Pythagoras and calculating the two areas. This candidate did succeed in doing this but showed a misunderstanding of the tank being open. Part (b)(i) offered a straightforward application of a given formula and the showing

of how the answer rounded to the given value. As would be expected the candidate gained all marks here. Part (ii) should also have been accessible to most candidates and this candidate demonstrated a full understanding of the reverse volume calculation but made a careless slip when applying values into a correct statement. Part (c) involved knowing how to convert cubic metres into litres and then carry out a division to calculate a time in minutes and seconds. Grade A candidates would be expected to have little difficulty with this part but this candidate omitted the question, probably being unable to do the conversion.

Example candidate response – grade C

4



NOT TO SCALE

For Examiner Use

An **open** water storage tank is in the shape of a cylinder on top of a cone.
The radius of both the cylinder and the cone is 1.5 m.
The height of the cylinder is 4 m and the height of the cone is 2 m.

(a) Calculate the **total** surface area of the **outside** of the tank.
[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

Answer(a) ..... m^2 [6]

(b) The tank is completely full of water.

(i) Calculate the volume of water in the tank and show that it rounds to 33 m^3, correct to the nearest whole number.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

Answer(b)(i)

$V = \frac{1}{3}\pi r^2 h$

$\frac{1}{3}\pi \times 2.25 \times 2 = 4.71$

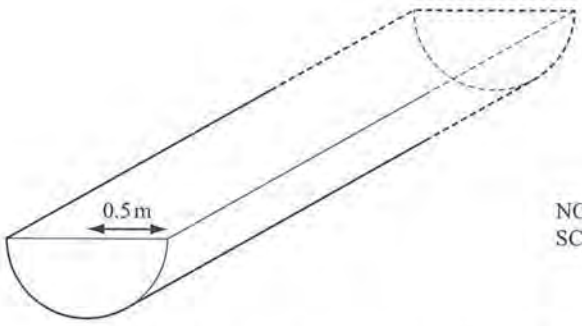
$28.27 + 4.71 = 32.98$

$\pi \times r^2 \times h$

$\pi \times 2.25 \times 4 = 28.27$

[4]

(ii)



For Examiner Use

The cross-section of an irrigation channel is a semi-circle of radius 0.5 m.
The 33 m^3 of water from the tank completely fills the irrigation channel.

Calculate the length of the channel.

$\frac{\pi \times r^2}{2}$

$\frac{\pi \times 0.5^2}{2}$

$\frac{\pi \times 0.25}{2} = 0.39 \times X = \frac{33}{0.39}$

$X = 84.62$

M2

Answer(b)(ii) 84.62 m [3]

(c) (i) Calculate the number of litres in a full tank of 33 m^3.

0

Answer(c)(i) 3300 litres [1]

(ii) The water drains from the tank at a rate of 1800 litres per minute.

Calculate the time, in minutes and seconds, taken to empty the tank.

0

Answer(c)(ii) ..... min ..... s [2]

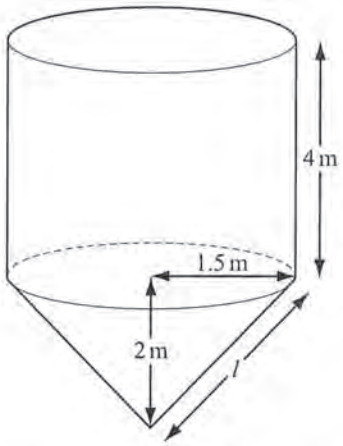
6

Examiner comment

This candidate could not produce a strategy in part (a) and omitted this part completely. Grade C candidates would be expected to at least calculate the curved surface of the cylindrical part of the tank. The given diagram should also have made a grade C candidate realise the need to use Pythagoras. This candidate demonstrated the ability to move on to part (b), which was much more straightforward and answered it successfully. In part (b)(ii) the reverse volume calculation was correctly set up but the candidate used a rounded value within a calculation, an error not expected of this level of candidate. In part (c), an incorrect conversion was given, a common error, and no attempt was made to divide the volume by the rate. This concept should not have been beyond a grade C candidate. This candidate did not reach the expected level of grade C in question 4.

Example candidate response – grade E

4



NOT TO SCALE

For Examiner Use

An **open** water storage tank is in the shape of a cylinder on top of a cone.
The radius of both the cylinder and the cone is 1.5 m.
The height of the cylinder is 4 m and the height of the cone is 2 m.

(a) Calculate the **total** surface area of the **outside** of the tank.
[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

Cylinder $2\pi rh + \pi r^2$
$= (2 \times \pi \times 1.5 \times 4) + (2 \times \pi \times 1.5^2)$
$= 51.8$ $51.8 + 15.7 = 67.5$
Cone $= \pi rl$ $l = 2.5$
$= \pi \times 2 \times 2.5 = 15.7$

M1
A1
M0
M1
M0

Answer(a) 6.75 m² [6]

(b) The tank is completely full of water.

(i) Calculate the volume of water in the tank and show that it rounds to 33 m³, correct to the nearest whole number.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

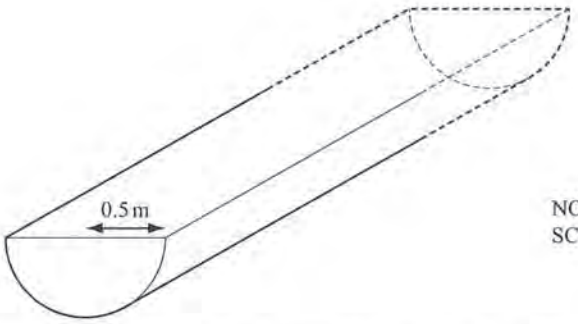
Answer(b)(i)

Cylinder $= \pi r^2 h = \pi \times 1.5^2 \times 4 = 28.$
Cone $= \frac{1}{3}\pi r^2 h = \frac{1}{3} \times \pi \times 1.5^2 \times 2.5 = 5$
$28 + 5 = 33$

M1
M0

[4]

(ii)



For Examiner's Use

The cross-section of an irrigation channel is a semi-circle of radius 0.5 m.
The 33 m^3 of water from the tank completely fills the irrigation channel.

Calculate the length of the channel.

$\pi \times 0.5^2$

$2\pi r = 2 \times \pi \times 0.5$

$= 3.1\ m$

M0

3.1 ✗

Answer(b)(ii) ..... m [3]

(c) (i) Calculate the number of litres in a full tank of 33 m^3.

35937 ✓

Answer(c)(i) 35937 litres [1]

(ii) The water drains from the tank at a rate of 1800 litres per minute.

Calculate the time, in minutes and seconds, taken to empty the tank.

$1500 : 1$
$35937 : x$

$\frac{35937 \times 1}{1800} = 19.97$ ✓

M1

Answer(c)(ii) 19 min 57 s [2]

(5)

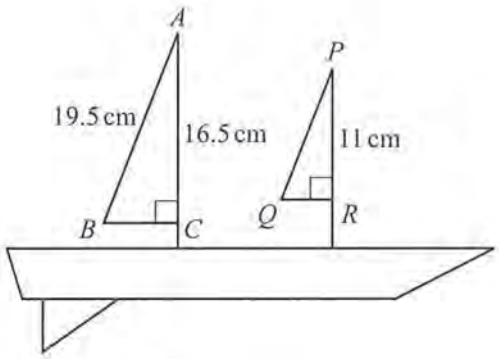
Examiner comment

This candidate made a reasonable attempt at part (a) for this level of candidate. Marks were gained for the curved surface area of the cylindrical part, even though the candidate stated a formula for the total surface area of a closed cylinder. A correct length of the hypotenuse was stated but not supported by any working and, as this is a grade E script, it is difficult to know how the correct value was found. Having found the length of the hypotenuse, the calculation of the curved surface of the area of the cone should have been accessible to a grade E candidate but in this example the given formula was not applied correctly. In part (b)(i), only part of the volume was calculated correctly when perhaps all candidates taking this examination would be expected to know the volume of a cylinder and to apply a given formula for the volume of the cone. Part (b)(ii) would be expected to be challenging for a lower grade candidate and this candidate was unable to apply a correct strategy. In part (c) an incorrect conversion was seen but the candidate carried out a correct division, but did not convert the follow through answer correctly into minutes and seconds. The overall performance of this candidate in question 4 was about the level to be expected.

Question 6

Example candidate response – grade A

6 (a)



The diagram shows a toy boat.
$AC = 16.5$ cm, $AB = 19.5$ cm and $PR = 11$ cm.
Triangles ABC and PQR are **similar**.

(i) Calculate PQ.

- $\frac{L}{l} = k \rightarrow \frac{16,5}{11} = k \rightarrow k = 1,5$
- $\frac{19,5}{PQ} = 1,5 \rightarrow 19,5 = 1,5 \cdot PQ \rightarrow \frac{19,5}{1,5} = PQ \rightarrow PQ = 13\,cm$

Answer(a)(i) $PQ =$ ..... 13 ..... cm [2]

(ii) Calculate BC.

$BC^2 + 16,5^2 = 19,5^2 \rightarrow BC^2 = 19,5^2 - 16,5^2 \rightarrow BC^2 = 108 \rightarrow$

$BC = \sqrt{108} \rightarrow BC = 10,4$

Answer(a)(ii) $BC =$ ..... 10,4 ..... cm [3]

(iii) Calculate angle ABC.

$\sin A\hat{B}C = \frac{16,5}{19,5} \rightarrow \sin A\hat{B}C = 0,84615 \rightarrow A\hat{B}C = 57,8°$

Answer(a)(iii) Angle $ABC =$ ..... 57,8° ..... [2]

(iv) The toy boat is mathematically similar to a real boat.
The length of the real boat is 32 times the length of the toy boat.
The fuel tank in the toy boat holds 0.02 litres of diesel.

Calculate how many litres of diesel the fuel tank of the real boat holds.

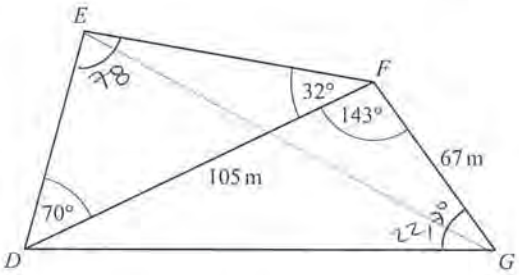
$\frac{x}{0,02} = 32^3 \rightarrow x = 655,36$

Answer(a)(iv) ..... 655,36 litres [2]

For Examiner's Use

2

(b)



NOT TO SCALE

The diagram shows a field *DEFG*, in the shape of a quadrilateral, with a footpath along the diagonal *DF*.
DF = 105 m and *FG* = 67 m.
Angle *EDF* = 70°, angle *EFD* = 32° and angle *DFG* = 143°.

(i) Calculate *DG*.

$a^2 = 105^2 + 67^2 - 2 \cdot 105 \cdot 67 \cdot \cos 143°$
$a^2 = 105^2 + 67^2 + 11236,8$
$a^2 = 26750,8$
$a = \sqrt{26750,8}$
$a = 164$

Answer(b)(i) *DG* = ... 164 ..... m [4]

4

(ii) Calculate *EF*.

$180 - (70 + 32) = 78°$

$\frac{105}{\sin 78°} = \frac{EF}{\sin 70°} \rightarrow EF = 100,9$

Answer(b)(ii) *EF* = ... 101 ..... m [4]

4

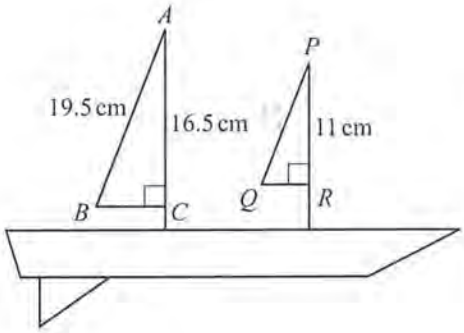
17

Examiner comment

This grade A candidate answered this question perfectly showing working throughout. Parts (a)(iv) and (b) were all around the standard of grade A and this candidate demonstrated ability at this level. The presentation of work, including the replacement of some incorrect working, shows what is expected of a high grade candidate.

Example candidate response – grade C

6 (a)



For Examin Use

The diagram shows a toy boat.
$AC = 16.5$ cm, $AB = 19.5$ cm and $PR = 11$ cm.
Triangles ABC and PQR are **similar**.

(i) Calculate PQ.

16.5 — 11
19.5 — x

$\frac{19.5 \times 11}{16.5} = 13$

Answer(a)(i) $PQ =$ 13 cm [2]

2

(ii) Calculate BC.

$C^2 + C^2 = H^2$
$16.5^2 + x^2 = 19.5^2$
$272.25 + x^2 = 380.25 - 272.25$
$x^2 = \sqrt{108}$
$x = 10.39$

Answer(a)(ii) $BC =$ 10.39 cm [3]

3

(iii) Calculate angle ABC.

$A^2 = B^2 + C^2 - 2BC \times \cos \hat{A}$
$16.5^2 = 19.5^2 + 10.39^2 - 2 \times 19.5 \times 10.39 \times \cos \hat{A}$
$272.25 = 380.25 + 107.95 - 405.21 \times \cos \hat{A}$
$272.25 = 488.2 - 405.21 \times \cos \hat{A}$
$\frac{272.25}{82.49} = 82.49 \times \cos \hat{A}$
$\cos \hat{A} = 3.28$
$\hat{A} =$

$\frac{\sin 90}{19.5} = \frac{\sin x}{16.5}$
$\frac{1}{19.5} \times 16.5 = 0.85$
$\sin x = 0.85$
$x = 58.21$

Answer(a)(iii) Angle $ABC =$ 58.21 [2]

p.a.

M1

(iv) The toy boat is mathematically similar to a real boat.
The length of the real boat is 32 times the length of the toy boat.
The fuel tank in the toy boat holds 0.02 litres of diesel.

Calculate how many litres of diesel the fuel tank of the real boat holds.

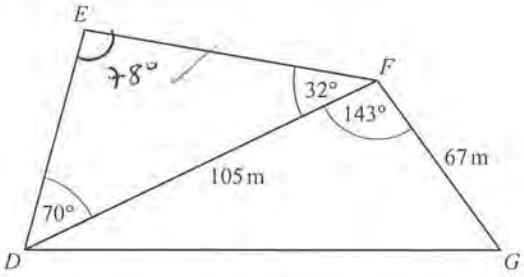
$0.02 \times 32 = 0.64$

Answer(a)(iv) ..... 0.64 ..... litres [2]

For Examiner Use

0

(b)



NOT TO SCALE

The diagram shows a field *DEFG*, in the shape of a quadrilateral, with a footpath along the diagonal *DF*.
DF = 105 m and *FG* = 67 m.
Angle *EDF* = 70°, angle *EFD* = 32° and angle *DFG* = 143°.

(i) Calculate *DG*.

$A^2 = 105^2 + 67^2 - 2 \times 105 \times 67 \times \cos 143$ → −0.80

$A^2 = 11025 + 4489 - 14070 \times -0.80$

$A^2 = 15514 + 11256$

$A^2 = 26770$

$A = 163.62$

Answer(b)(i) *DG* = ... 163.62 ..... m [4]

4

(ii) Calculate *EF*.

$\frac{\sin 70}{x} = \frac{\sin 78^\circ}{105}$

$\frac{0.94}{x} = \frac{0.98}{105}$

B1

M1

Answer(b)(ii) *EF* = ... m [4]

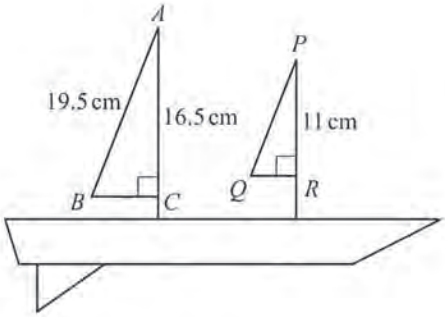
12

Examiner comment

This grade C candidate succeeded in the ratio of lengths in similar triangles and in the Pythagoras parts in part (a). In part (a)(iii), the candidate used the sine rule in a right-angled triangle when a grade C candidate would be expected to use right-angled trigonometry. The candidate approximated a value in the working as in question 4. All candidates of all levels would be expected to work to a much greater accuracy. In part (a)(iv) the candidate did not cube the ratio of lengths to obtain the ratio of volumes and this particular topic is generally seen as being for the higher level candidate. The candidate successfully answered the cosine rule part of part (b) and was also partly successful with the sine rule. These two trigonometric topics may be seen as high level topics but candidates of all levels often do well in the same way as this example. The overall performance of this candidate was probably a little higher than expected at this level.

Example candidate response – grade E

6 (a)



For Examiner's Use

The diagram shows a toy boat.
$AC = 16.5$ cm, $AB = 19.5$ cm and $PR = 11$ cm.
Triangles ABC and PQR are **similar**.

(i) Calculate PQ.

$\frac{AB}{PQ} = \frac{AC}{PR} = \frac{19.5}{x} \times \frac{16.5}{11}$

$= 13$

Answer(a)(i) $PQ =$ 13 cm [2]

2

(ii) Calculate BC.

$\frac{AB}{PQ} = \frac{AC}{PR} = \frac{BC}{QR}$ $\quad \frac{19.5}{13} = \frac{x}{16.5} \quad \frac{16.5}{11}$

$16.5x + 14.5x = 130 + 11x$

$13 \div 19.5 \times 11 = 8.25$

Answer(a)(ii) $BC =$ 8.25 cm [3]

MC

(iii) Calculate angle ABC.

$\cos x = \frac{a^2 + b^2 + c^2}{2ab}$

$= \frac{8.25^2 + 16.5^2 + 19.5^2}{2 \times 8.25 \times 19.5}$ $\quad 720.5625$ $\quad 321.75$

Answer(a)(iii) Angle $ABC =$ ..... [2]

0

(iv) The toy boat is mathematically similar to a real boat.
The length of the real boat is 32 times the length of the toy boat.
The fuel tank in the toy boat holds 0.02 litres of diesel.

Calculate how many litres of diesel the fuel tank of the real boat holds.

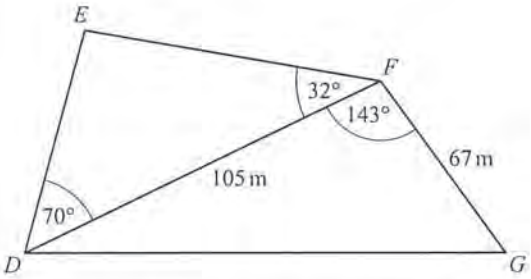
32 × 0.02 = 0.64

Answer(a)(iv) 0.64 litres [2]

For Examiner's Use

0

(b)



NOT TO SCALE

The diagram shows a field *DEFG*, in the shape of a quadrilateral, with a footpath along the diagonal *DF*.
DF = 105 m and *FG* = 67 m.
Angle *EDF* = 70°, angle *EFD* = 32° and angle *DFG* = 143°.

(i) Calculate *DG*.

$DG = 105^2 + 67^2 - (2 \times 105 \times 67 \times \cos 143)$
$15514 - - 11236$
$DG^2 = \sqrt{26750}$
$= 163$

Answer(b)(i) *DG* = 163 m [4]

M2
A1

(ii) Calculate *EF*.

$\frac{105}{\sin 70} \times \frac{x}{\sin 32} = \frac{105 \times \sin 32}{\sin 70} = 59$

Answer(b)(ii) *EF* = 59 m [4]

B0
M0

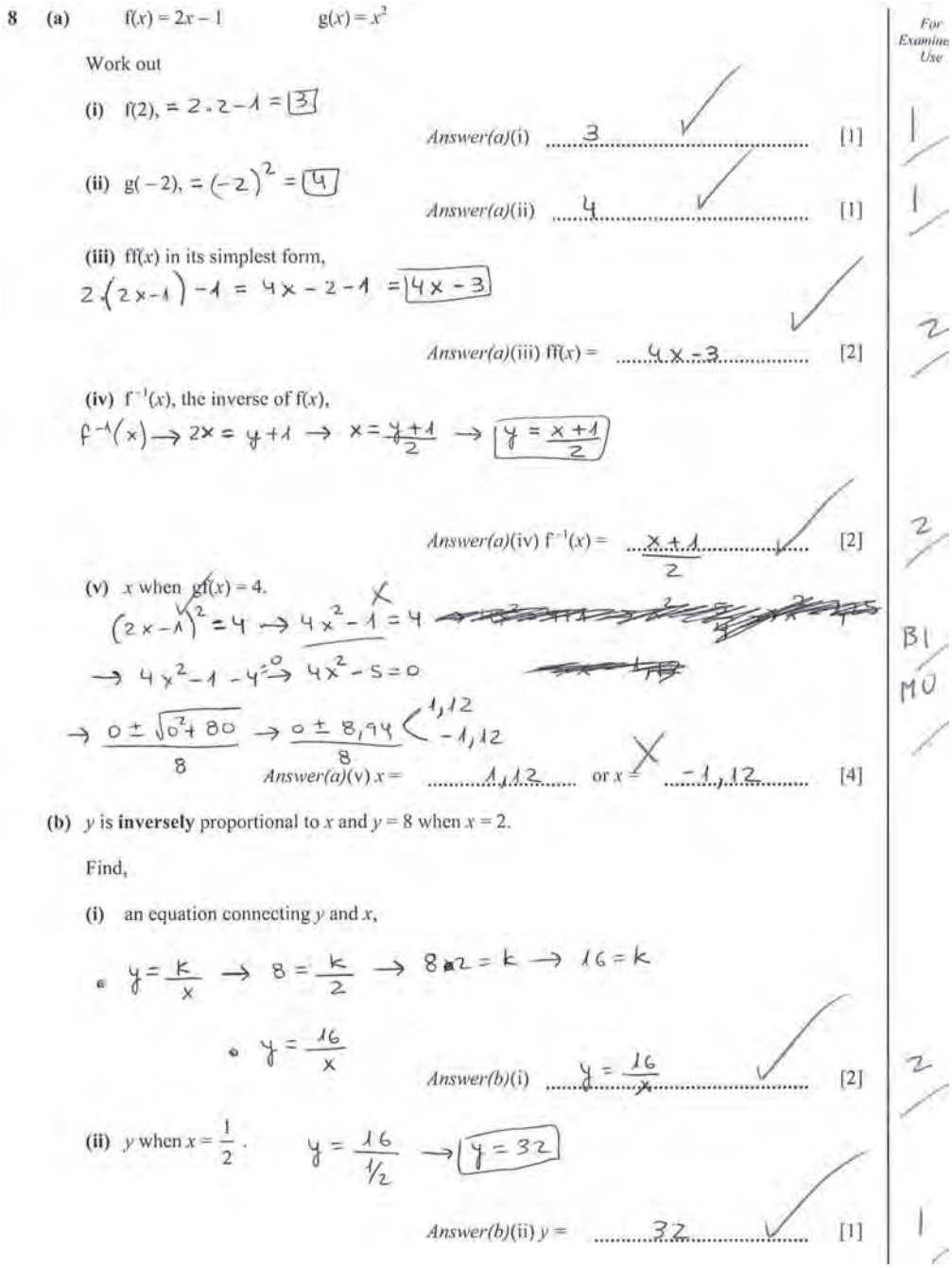
(5)

Examiner comment

This grade E candidate found this question very challenging. There was success with the ratio of lengths of the similar triangles and, perhaps surprisingly, with the cosine rule. Part (a)(ii) on Pythagoras can be met with success by grade E candidates although this script reflected what is often seen at this level when part (ii) is seen to be the same concept as part (i). The candidate failed to use right-angled trigonometry and it appeared that there had been much preparation on the cosine rule and the sine rule at the expense of more basic trigonometry. The ratio of similar volumes saw the familiar error of not cubing the ratio of the lengths, frequently seen at this level. This answer attained a mark in this question typical of a grade E candidate but some of these marks were gained by answering a higher level topic.

Question 8

Example candidate response – grade A



8 (a) $f(x) = 2x - 1$ $g(x) = x^2$

Work out

(i) $f(2) = 2 \cdot 2 - 1 = 3$

Answer(a)(i) 3 [1]

(ii) $g(-2) = (-2)^2 = 4$

Answer(a)(ii) 4 [1]

(iii) $ff(x)$ in its simplest form,

$2(2x-1) - 1 = 4x - 2 - 1 = 4x - 3$

Answer(a)(iii) $ff(x) =$ $4x - 3$ [2]

(iv) $f^{-1}(x)$, the inverse of $f(x)$,

$f^{-1}(x) \rightarrow 2x = y + 1 \rightarrow x = \frac{y+1}{2} \rightarrow y = \frac{x+1}{2}$

Answer(a)(iv) $f^{-1}(x) =$ $\frac{x+1}{2}$ [2]

(v) x when $gf(x) = 4$.

$(2x-1)^2 = 4 \rightarrow 4x^2 - 1 = 4$

$\rightarrow 4x^2 - 1 - 4 = 0 \rightarrow 4x^2 - 5 = 0$

$\rightarrow \frac{0 \pm \sqrt{0^2 + 80}}{8} \rightarrow \frac{0 \pm 8{,}94}{8}$ 1,12 / -1,12

Answer(a)(v) $x =$ 1,12 or $x =$ -1,12 [4]

(b) y is **inversely** proportional to x and $y = 8$ when $x = 2$.

Find,

(i) an equation connecting y and x,

$y = \frac{k}{x} \rightarrow 8 = \frac{k}{2} \rightarrow 8 \cdot 2 = k \rightarrow 16 = k$

$y = \frac{16}{x}$

Answer(b)(i) $y = \frac{16}{x}$ [2]

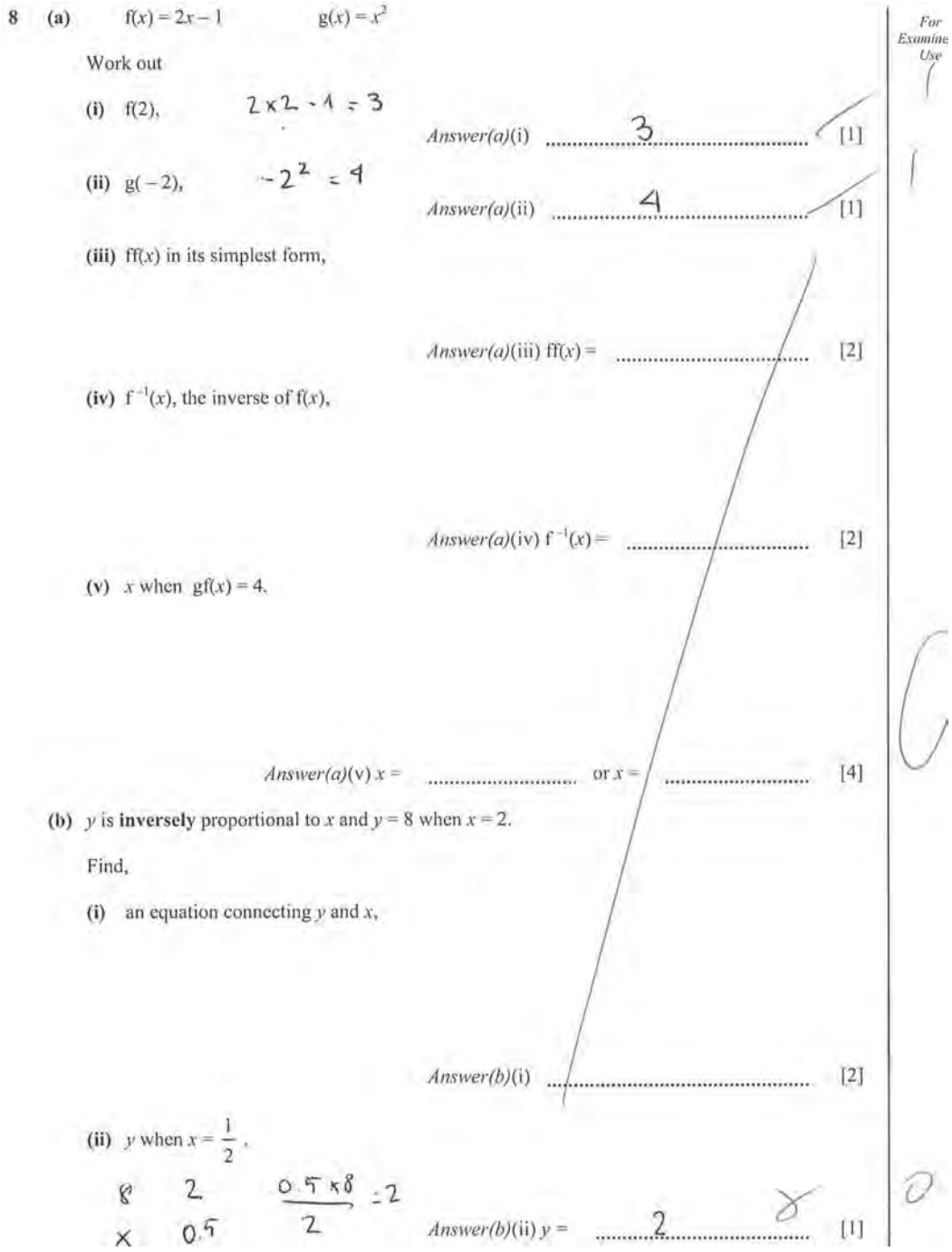
(ii) y when $x = \frac{1}{2}$. $y = \frac{16}{1/2} \rightarrow y = 32$

Answer(b)(ii) $y =$ 32 [1]

Examiner comment

Functions is considered to be a high grade concept and only the stronger candidates would be expected to score highly in this question, probably the most discriminating of the paper.This candidate followed this pattern and the only marks lost were the result of a poor attempt at expanding $(2x-1)^2$. A correct expansion would have led to a quadratic which would factorise but an even better approach would have been to use $(2x-1) = \pm 2$. The inverse proportion question of part (b) was successfully answered. Apart from part (a)(v) this script shows what can be expected of a grade A candidate i.e. all necessary working clearly seen followed by accurate answers.

Example candidate response – grade C



8 (a) $f(x) = 2x - 1$ $g(x) = x^2$

Work out

(i) f(2), 2×2 - 1 = 3

Answer(a)(i) 3 [1]

(ii) g(−2), $-2^2 = 4$

Answer(a)(ii) 4 [1]

(iii) ff(x) in its simplest form,

Answer(a)(iii) ff(x) = ... [2]

(iv) $f^{-1}(x)$, the inverse of f(x),

Answer(a)(iv) $f^{-1}(x)$ = ... [2]

(v) x when $gf(x) = 4$.

Answer(a)(v) x = ... or x = ... [4]

(b) y is **inversely** proportional to x and $y = 8$ when $x = 2$.

Find,

(i) an equation connecting y and x,

Answer(b)(i) ..... [2]

(ii) y when $x = \frac{1}{2}$.

8 2 0.5×8 / 2 = 2

× 0.5

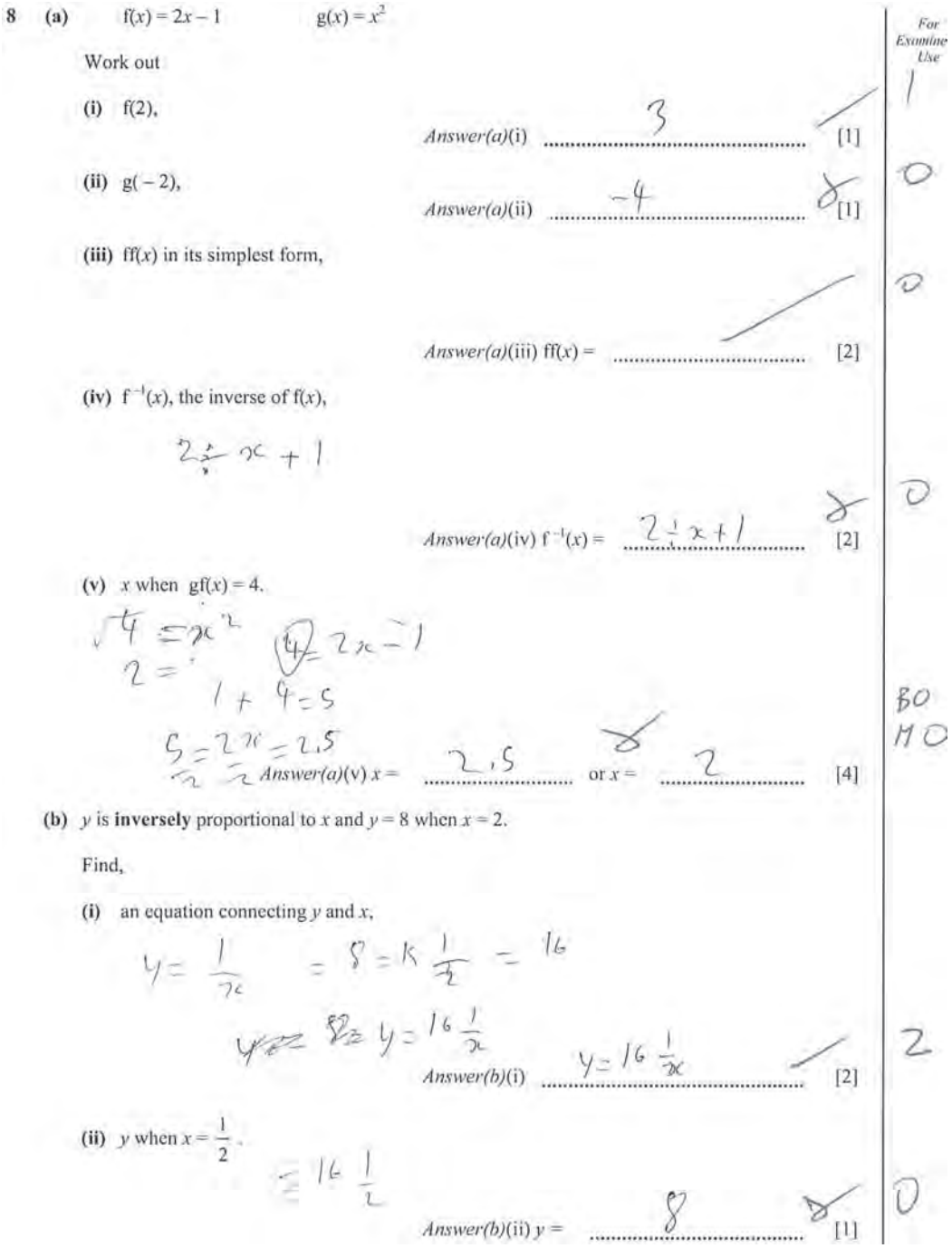
Answer(b)(ii) y = 2 [1]

For Examiner Use

Examiner comment

This grade C candidate could only manage the very straightforward numerical substitutions into two functions and, as might be expected, found all the algebraic parts too difficult to even attempt. In part (b) (i) this candidate could not set up a variation statement and the working in part (ii) had no connection to the problem. Many grade C candidates would have scored a few more marks in this question, often in the inverse of a linear function part as this is a frequently tested concept. However, most of this question is above the grade C level.

Example candidate response – grade E



8 (a) $f(x) = 2x - 1$ $g(x) = x^2$

Work out

(i) f(2),

Answer(a)(i) 3 [1]

(ii) g(−2),

Answer(a)(ii) −4 [1]

(iii) ff(x) in its simplest form,

Answer(a)(iii) ff(x) = [2]

(iv) $f^{-1}(x)$, the inverse of f(x),

$\frac{1}{2}x + 1$

Answer(a)(iv) $f^{-1}(x)$ = $\frac{1}{2}x + 1$ [2]

(v) x when gf(x) = 4.

$\sqrt{4} = x^2$ $4 = 2x - 1$

$2 =$ $1 + 4 = 5$

$5 = 2x = 2.5$

Answer(a)(v) x = 2.5 or x = 2 [4]

(b) y is **inversely** proportional to x and y = 8 when x = 2.

Find,

(i) an equation connecting y and x,

$y = \frac{1}{x}$ $= 8 = k\frac{1}{2} = 16$

$y = 16\frac{1}{x}$

Answer(b)(i) $y = 16\frac{1}{x}$ [2]

(ii) y when $x = \frac{1}{2}$.

$= 16\frac{1}{2}$

Answer(b)(ii) y = 8 [1]

For Examiner Use

1

0

0

0

B0

M0

2

0

Examiner comment

This grade E candidate demonstrated only limited ability in the functions part, gaining only one mark for a simple numerical substitution. In part (b)(i) this candidate actually found a correct expression in a variation situation, much higher than grade E level. A final mark was lost in part (b)(ii) as a result of a numerical slip. Many grade E candidates would have found both parts of this question too difficult and the grade descriptors would suggest zero marks for this level of candidate.

Question 9

Example candidate response – grade A

9 **(a)** The first five terms P_1, P_2, P_3, P_4 and P_5 of a sequence are given below.

For Examiner's Use

$1 = 1 = P_1$

$1 + 2 = 3 = P_2$

$1 + 2 + 3 = 6 = P_3$

$1 + 2 + 3 + 4 = 10 = P_4$

$1 + 2 + 3 + 4 + 5 = 15 = P_5$

(i) Write down the next term, P_6, in the sequence 1, 3, 6, 10, 15...

$1+2+3+4+5+6 = 21 = P_6$

Answer(a)(i) 21 [1] 1

(ii) The formula for the nth term of this sequence is

$$P_n = \frac{1}{2}n(n+1).$$

Show this formula is true when $n = 6$.

Answer (a)(ii) $P_6 \Rightarrow \frac{1}{2} \cdot 6(6+1) = \frac{1}{2}(36+6) = 18+3 = 21$

[1] 1

(iii) Use the formula to find P_{50}, the 50th term of this sequence.

$P_{50} : \frac{1}{2} \cdot 50(50+1) = \frac{1}{2}(2500+50) = 1250 + 25 = 1275$

Answer(a)(iii) 1275 [1] 1

(iv) Use your answer to **part (iii)** to find $3 + 6 + 9 + 12 + 15 + \ldots\ldots + 150$.

165

30 630

60 1395

90 2,460

120 3825

Answer(a)(iv) 3825 [1] 1

(v) Find $1 + 2 + 3 + 4 + 5 + \ldots\ldots + 150$.

$+50 = 1275$

5050

Answer(a)(v) 11325 [1] 1

(vi) Use your answers to **parts (iv)** and **(v)** to find the sum of the numbers less than 150 which are **not** multiples of 3.

$11325 - 3825 = 7500$

Answer(a)(vi) 7500 [1] 1

16

This question continues on the next page.

(b) The first five terms, S_1, S_2, S_3, S_4 and S_5 of a different sequence are given below.

$(1 \times 1) = 1 = S_1$

$(1 \times 2) + (2 \times 1) = 4 = S_2$

$(1 \times 3) + (2 \times 2) + (3 \times 1) = 10 = S_3$

$(1 \times 4) + (2 \times 3) + (3 \times 2) + (4 \times 1) = 20 = S_4$

$(1 \times 5) + (2 \times 4) + (3 \times 3) + (4 \times 2) + (5 \times 1) = 35 = S_5$

(i) Work out the next term, S_6, in the sequence 1, 4, 10, 20, 35...

$(1 \times 6) + (2 \times 5) + (3 \times 4) + (4 \times 3) + (5 \times 2) + (6 \times 1) = 56$

Answer(b)(i) ..... 56 ..... [2]

(ii) The formula for the nth term of this sequence is

$$S_n = \frac{1}{6}n(n+1)(n+2).$$

Show this formula is true for $n = 6$.

Answer(b)(ii) $S_6 = \frac{1}{6} \cdot 6(6+1)(6+2) = \left(\frac{1}{2}\right) \cdot 6(36+12+6+2)$

$= \frac{1}{6}(216 + 72 + 36 + 12) =$ ~~168 + 36 + 12 + 6 =~~

$36 + 12 + 6 + 2 = 56$ [1]

(iii) Find $(1 \times 20) + (2 \times 19) + (3 \times 18) \ldots\ldots\ldots\ldots + (20 \times 1)$.

Answer(b)(iii) ..... [1]

(c) Show that $S_6 - S_5 = P_6$, where P_6 is your answer to **part (a)(i)**.

Answer(c)

[1]

(d) Show by algebra that $S_n - S_{n-1} = P_n$. $\left[P_n = \frac{1}{2}n(n+1)\right]$

Answer(d)

[3]

Examiner comment

This investigative question did not always follow the performance levels of the other questions. Candidates who had experienced an investigative approach to their learning did well in this question, whilst some candidates of a high level in the other eight questions struggled in this different situation. Learning through investigating has its place in the teaching of mathematics and students become better equipped to answer other parts of the examination, especially where strategies need to be decided upon.

This candidate gained full marks in part (a), although the working in parts (iv) and (v) suggests that the

candidate did not quite see the patterns intended and did not use the suggested method in part (iv). However, part (vi) was carried out as expected. Part (b) started successfully but the more challenging part (iii) was not attempted when it was hoped that candidates able to find the 6th term in part (i) would recognise that part (iii) was asking for the 20th term. Parts (c) and (d) were not attempted, probably as a result of the suffix notation used. Although suffices are in the lists at the beginning of both parts (a) and (b) it is possible that this candidate did not realise that there was a need to look at these two parts. It is also possible that the candidate did not have sufficient time to complete the paper but this is unlikely. Grade A candidates could be expected to do a little better than this candidate, although part (d) could be seen as an A* discriminator.

Example candidate response – grade C

9 **(a)** The first five terms P_1, P_2, P_3, P_4 and P_5 of a sequence are given below.

$1 = 1 = P_1$

$1 + 2 = 3 = P_2$

$1 + 2 + 3 = 6 = P_3$

$1 + 2 + 3 + 4 = 10 = P_4$

$1 + 2 + 3 + 4 + 5 = 15 = P_5$

(i) Write down the next term, P_6, in the sequence 1, 3, 6, 10, 15...

Answer(a)(i) 1+2+3+4+5+6 [1]

(ii) The formula for the nth term of this sequence is

$$P_n = \frac{1}{2}n(n+1).$$

Show this formula is true when $n = 6$.

Answer (a)(ii) $P_6 = \frac{1}{2} 6(6+1)$

$P_6 = 3 \times 7$

$P_6 = 21$ [1]

(iii) Use the formula to find P_{50}, the 50th term of this sequence.

$P_{50} = \frac{1}{2} 50(50+1)$

$P_{50} = 25 \times 51 = 1275$ *Answer(a)*(iii) 1275 [1]

(iv) Use your answer to **part (iii)** to find 3 + 6 + 9 + 12 + 15 + ...1080... + 150.

1275 - 195 =

Answer(a)(iv) 1080 [1]

(v) Find 1 + 2 + 3 + 4 + 5 +..... + 150.

$P_{150} = \frac{1}{2} 150(150+1)$

$P_{150} = 75 \times 151 = 11325 - 165 = 11160$

Answer(a)(v) 11160 [1]

(vi) Use your answers to **parts (iv)** and **(v)** to find the sum of the numbers less than 150 which are **not** multiples of 3.

11160

Answer(a)(vi) ..... [1]

This question continues on the next page.

(b) The first five terms, S_1, S_2, S_3, S_4 and S_5 of a different sequence are given below.

For Examiner's Use

$(1 \times 1) = 1 = S_1$

$(1 \times 2) + (2 \times 1) = 4 = S_2$

$(1 \times 3) + (2 \times 2) + (3 \times 1) = 10 = S_3$

$(1 \times 4) + (2 \times 3) + (3 \times 2) + (4 \times 1) = 20 = S_4$

$(1 \times 5) + (2 \times 4) + (3 \times 3) + (4 \times 2) + (5 \times 1) = 35 = S_5$

(i) Work out the next term, S_6, in the sequence 1, 4, 10, 20, 35...

$(1 \times 6) + (2 \times 5) + (3 \times 4) + (4 \times 3) + (5 \times 2) + (6 \times 1) = 56$

Answer(b)(i) 56 [2]

2

(ii) The formula for the nth term of this sequence is

$$S_n = \frac{1}{6}n(n+1)(n+2).$$

Show this formula is true for $n = 6$.

Answer(b)(ii) $S_6 = \frac{1}{6} 6(6+1)(6+2)$

$S_6 = 1 \times 7 \times 8 = 56$ [1]

1

(iii) Find $(1 \times 20) + (2 \times 19) + (3 \times 18) \ldots\ldots\ldots + (20 \times 1)$.

Answer(b)(iii) ..... [1]

0

(c) Show that $S_6 - S_5 = P_6$, where P_6 is your answer to **part (a)(i)**.

Answer(c) $56 - 35 = 21$

[1]

1

(d) Show by algebra that $S_n - S_{n-1} = P_n$. $\left[P_n = \frac{1}{2}n(n+1)\right]$

Answer(d) $\frac{1}{6}n(n+1)(n+2) - \frac{1}{6}n-1(n)(n+1) = \frac{1}{2}n(n+1)$

$\frac{1}{6}n\,n^2 + 3n + 2 - \frac{1}{6}n-1\,n$

[3]

M1

5

Examiner comment

This grade C candidate struggled in part (a), showing a basic misunderstanding of the next term in part (i). The next two parts were answered correctly and correct working was seen. The more challenging parts (iv), (v) and (vi) were either incorrectly answered or omitted. A correct answer in part (v) was spoiled by the subtraction of a number, with no obvious reason. Grade C candidates would be expected to do a little better in this part. Part (b) was more successful with the first two parts correctly answered. The understanding shown in part (b)(i) was not applied in part (a)(i). This candidate did not realise that part (iii) was asking for the 20th term, although the 6th term had been correctly found in part (i). The candidate understood the connection between parts (a) and (b) to answer parts (c) and (d) but was unable to complete the algebraic proof in part (d). Apart from the absence of one pair of brackets, a correct statement was made in this part, thus gaining a method mark. The work in parts (b), (c) and (d) were at least of a grade C standard in spite of a weak part (a).

Example candidate response – grade E

9 **(a)** The first five terms P_1, P_2, P_3, P_4 and P_5 of a sequence are given below.

For Examiner's Use

$1 = 1 = P_1$

$1 + 2 = 3 = P_2$

$1 + 2 + 3 = 6 = P_3$

$1 + 2 + 3 + 4 = 10 = P_4$

$1 + 2 + 3 + 4 + 5 = 15 = P_5$

(i) Write down the next term, P_6, in the sequence 1, 3, 6, 10, 15...

Answer(a)(i) 21 [1] 1

(ii) The formula for the nth term of this sequence is

$$P_n = \frac{1}{2}n(n + 1).$$

Show this formula is true when $n = 6$.

Answer (a)(ii) $\frac{1}{2} \times 6 \times (6+1) = 21$ ✗ [1] 0

(iii) Use the formula to find P_{50}, the 50th term of this sequence.

Answer(a)(iii) 1275 [1] 1

(iv) Use your answer to **part (iii)** to find 3 + 6 + 9 + 12 +15 + ... + 150.

Answer(a)(iv) n3 ✗ [1] 0

(v) Find 1 + 2 + 3 + 4 + 5 +..... + 150.

Answer(a)(v) n3 ✗ [1] 0

(vi) Use your answers to **parts (iv)** and **(v)** to find the sum of the numbers less than 150 which are **not** multiples of 3.

Answer(a)(vi) [1] 0

5

This question continues on the next page.

(b) The first five terms, S_1, S_2, S_3, S_4 and S_5 of a different sequence are given below.

$(1 \times 1) = 1 = S_1$

$(1 \times 2) + (2 \times 1) = 4 = S_2$

$(1 \times 3) + (2 \times 2) + (3 \times 1) = 10 = S_3$

$(1 \times 4) + (2 \times 3) + (3 \times 2) + (4 \times 1) = 20 = S_4$

$(1 \times 5) + (2 \times 4) + (3 \times 3) + (4 \times 2) + (5 \times 1) = 35 = S_5$

(i) Work out the next term, S_6, in the sequence 1, 4, 10, 20, 35...

Answer(b)(i) ..... [2]

(ii) The formula for the nth term of this sequence is

$$S_n = \frac{1}{6}n(n+1)(n+2).$$

Show this formula is true for $n = 6$.

Answer(b)(ii) 56

[1]

(iii) Find $(1 \times 20) + (2 \times 19) + (3 \times 18) \ldots\ldots\ldots + (20 \times 1)$.

Answer(b)(iii) ..... [1]

(c) Show that $S_6 - S_5 = P_6$, where P_6 is your answer to **part (a)(i)**.

Answer(c)

[1]

(d) Show by algebra that $S_n - S_{n-1} = P_n$. $\left[P_n = \frac{1}{2}n(n+1)\right]$

Answer(d)

[3]

Examiner comment

This grade E candidate successfully answered two parts of part (a) demonstrating some knowledge of sequences and nth terms. The parts requiring more understanding and applying of the given formula proved to be too difficult. These difficulties continued into parts (b), (c) and (d) and an answer to part (b)(ii) was in fact the answer to part (b)(i). A typical grade E candidate could be expected to answer parts (b)(i) and (iii), where part (i) was the next term of a sequence and part (iii) was using a given formula to find the 20th term of a sequence. Parts (c) and (d) would normally be only accessible to higher grade candidates or candidates more familiar with investigative questions.

Example candidate response – grade A (whole script)

For Examiner's Use

1 (a) In 2008 the total number of tickets sold for an athletics meeting was 3136.
The ratio child tickets sold : adult tickets sold = 17 : 32.

(i) How many child tickets were sold?

49 — 3136
17 — x
x = 1088

Answer(a)(i) ..... 1088 ✓ [2]

2

(ii) Child tickets cost $2 each and adult tickets cost $4.50 each.

Show that the total amount received from the sale of the tickets in 2008 was $11 392.

Answer(a)(ii)

49 — 3136
32 — x
x = 2048

✓ ✓
2 · 1088 + 4,50 · 2048 = 11392 ✓

M1
E0

[2]

(b) In 2009 the amount received from the sale of tickets for the athletics meeting was $12 748.

Calculate the percentage increase in the amount received from 2008 to 2009.

11392 — 100%
12748 — x
x = 112 % ✓

PA

Answer(b) ..... 112 ..... % [3]

M2
A0

(c) In 2008 the amount of $11 392 was 28% more than the amount received in 2007.

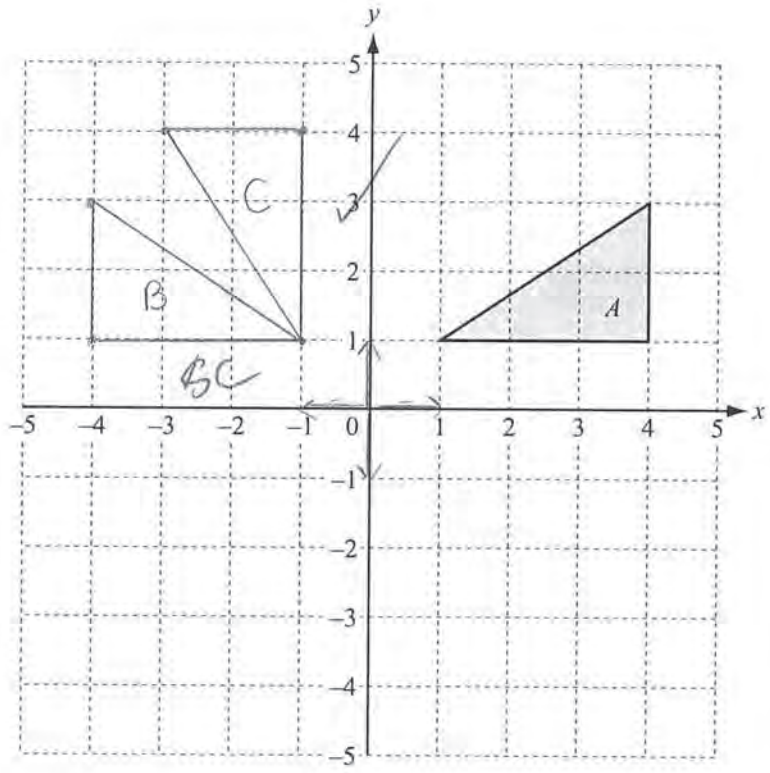
Calculate how much was received in 2007.

11392 — 128
x — 100
x = 8900

Answer(c) $ ..... 8900 ✓ [3]

3

2 (a)



(i) Draw the image when triangle A is reflected in the line $y = 0$.
Label the image B. [2]

(ii) Draw the image when triangle A is rotated through 90° anticlockwise about the origin.
Label the image C. [2]

(iii) Describe fully the **single** transformation which maps triangle B onto triangle C.

Answer(a)(iii) reflection on $y = -x$ [2]

(b) Rotation through 90° anticlockwise about the origin is represented by the matrix $\mathbf{M} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$.

(i) Find $\mathbf{M}^{-1}$, the inverse of matrix $\mathbf{M}$.

determinant = $ad - bc = 0.0 - -1.1 = 1$

$M^{-1} = \frac{1}{1} \cdot \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$

Answer(b)(i) $\mathbf{M}^{-1} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$ [2]

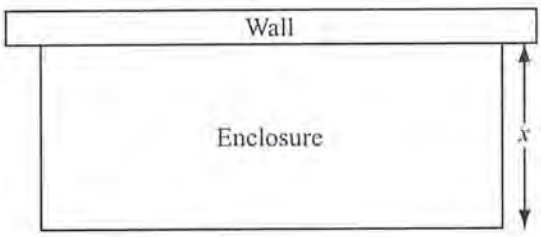
(ii) Describe fully the **single** transformation represented by the matrix $\mathbf{M}^{-1}$.

Answer(b)(ii) rotation centre (0,0) 180° anticlockwise [2]

For Examiner's Use

SC1
2
2
2
1
0
16

3



NOT TO SCALE

For Examiner's Use

A farmer makes a rectangular enclosure for his animals.
He uses a wall for one side and a total of 72 metres of fencing for the other three sides.

The enclosure has width x metres and area A square metres.

(a) Show that $A = 72x - 2x^2$.

Answer (a) ~~A = x~~

[2]

(b) Factorise completely $72x - 2x^2$.

$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-72 \pm \sqrt{72^2 - 0}}{-4} = \frac{-72 \pm 72}{-4}$ < 0, 36

Answer(b) $-2(x-0)(x-36)$ [2]

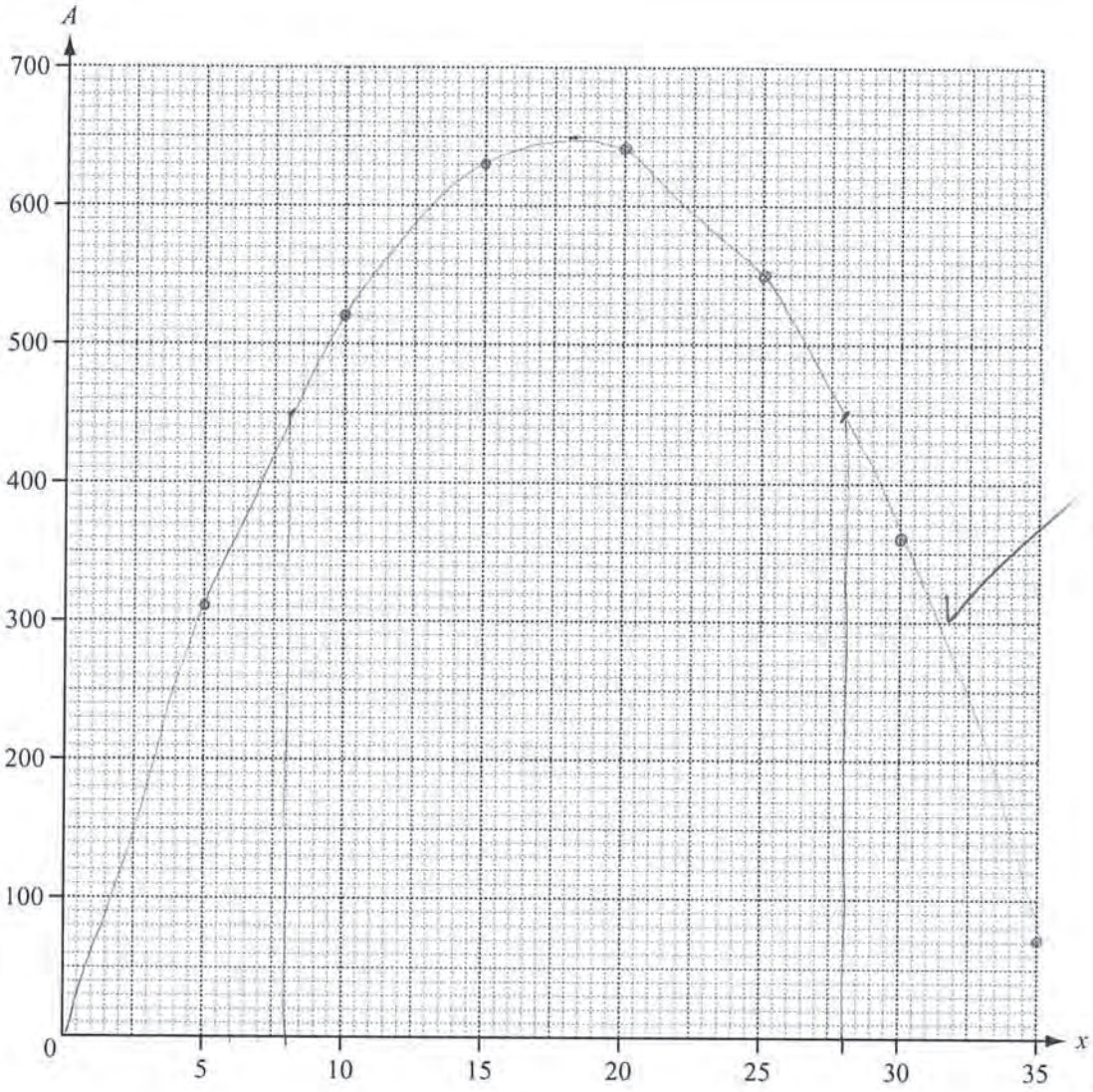
coordinate

(c) Complete the table for $A = 72x - 2x^2$.

x	0	5	10	15	20	25	30	35
A	0	310	520	630	640	550	360	70

[3]

(d) Draw the graph of $A = 72x - 2x^2$ for $0 \leqslant x \leqslant 35$ on the grid opposite.



[4]

For Examiner's Use

(e) Use your graph to find

(i) the values of x when $A = 450$,

Answer(e)(i) $x =$ ....8.... or $x =$ ....28.... [2]

(ii) the maximum area of the enclosure.

Answer(e)(ii) .....650..... m^2 [1]

(f) Each animal must have at least 12 m^2 for grazing.

Calculate the greatest number of animals that the farmer can keep in an enclosure which has an area of 500 m^2.

1 — 12 m^2

x — 500 m^2

$x = 41,7$

Answer(f) .....41..... [2]

4

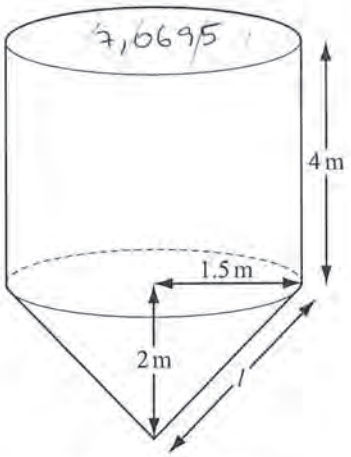
2

1

2

14

4



NOT TO SCALE

For Examiner's Use

An **open** water storage tank is in the shape of a cylinder on top of a cone.
The radius of both the cylinder and the cone is 1.5 m.
The height of the cylinder is 4 m and the height of the cone is 2 m.

(a) Calculate the **total** surface area of the **outside** of the tank.
[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

- $A_{cone} = \pi r l = 3,142 \cdot 1,5 \cdot 2,5 = 11,78\ m^2$
- $A_{cyl} = \pi r^2 h$ → $2 \cdot 3,142 \cdot 1,5 \cdot 4 = 37,704$
- $11,78 + 37,704 = 49,488\ m^2$
- $49,488 - 7,0695 = 42,4145\ m^2$ (1 end)

$2^2 + 1,5^2 = l^2$
$4 + 2,25 = l^2$
$6,25 = l^2$
$\sqrt{6,25} = l$
$l = 2,5$

M1 A1 M1 M1 M0

Answer(a) ..... 42,4 ✗ m^2 [6]

(b) The tank is completely full of water.

(i) Calculate the volume of water in the tank and show that it rounds to 33 m^3, correct to the nearest whole number.

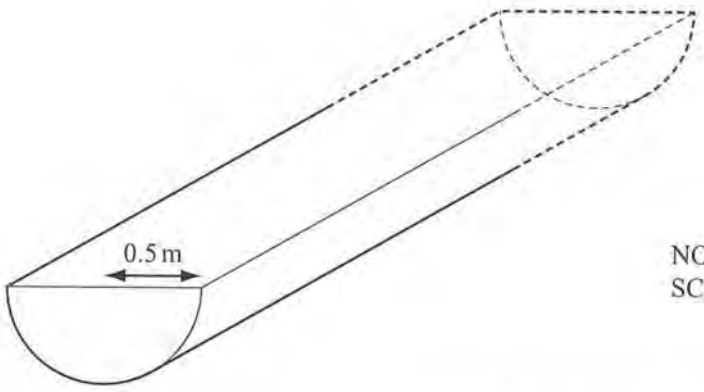
[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

Answer(b)(i)

- $V_{cone} = \frac{1}{3} \cdot 3,142 \cdot 1,5^2 \cdot 2 = 4,713\ m^3$
- $V_{cyl} = 3,142 \cdot 1,5^2 \cdot 4 = 28,278\ m^3$
- $28,278 + 4,713 = 32,991\ m^3$
- $32,991 \Rightarrow 33$ rounded up.

[4] 4

(ii)



NOT TO SCALE

For Examiner's Use

The cross-section of an irrigation channel is a semi-circle of radius 0.5 m.
The 33 m^3 of water from the tank completely fills the irrigation channel.

Calculate the length of the channel.

$V_{cyl} \Rightarrow \left(\frac{1}{2} \cdot \pi \cdot r^2 \cdot h\right) \div 2$

$\Rightarrow 33 = (3,142 \cdot 0,5 \cdot h) \div 2$

$\Rightarrow 33 \times 2 = 3,142 \cdot 0,5 \cdot h$

$\Rightarrow \frac{66}{1571} = h \Rightarrow h = 42,01$

MO

Answer(b)(ii) ..... 42,01 ..... m [3]

Sc 1

(c) (i) Calculate the number of litres in a full tank of 33 m^3.

Answer(c)(i) ..... litres [1]

0

(ii) The water drains from the tank at a rate of 1800 litres per minute.

Calculate the time, in minutes and seconds, taken to empty the tank.

Answer(c)(ii) ..... min ..... s [2]

0

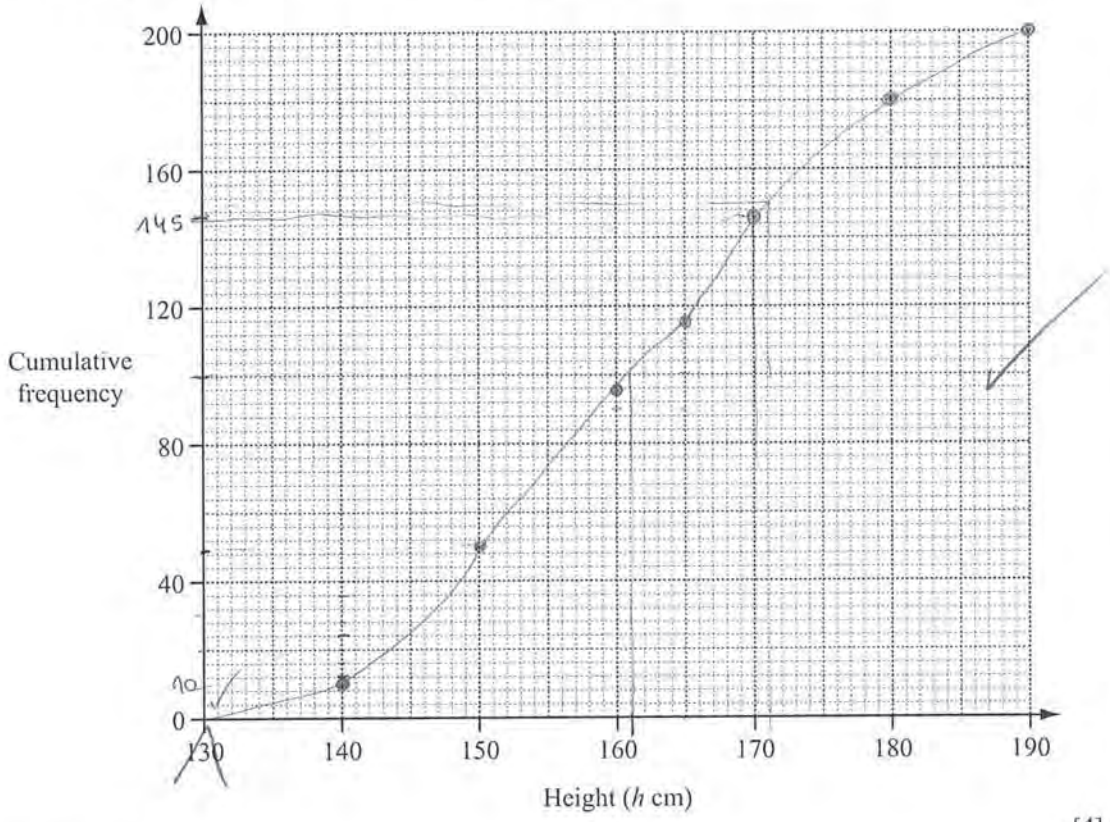
9

5 The cumulative frequency table shows the distribution of heights, h centimetres, of 200 students.

Height (h cm)	⩽130	⩽140	⩽150	⩽160	⩽165	⩽170	⩽180	⩽190
Cumulative frequency	0	10	50	95	115	145	180	200

For Examiner's Use

(a) Draw a cumulative frequency diagram to show the information in the table.



[4]

(b) Use your diagram to find

(i) the median,

Answer(b)(i) ..... 161 ..... cm [1]

(ii) the upper quartile,

Answer(b)(ii) ..... 171 ..... cm [1]

(iii) the interquartile range.

171 − 150 = 21

Answer(b)(iii) ..... 21 ..... cm [1]

(c) **(i)** One of the 200 students is chosen at random.

Use the table to find the probability that the height of this student is greater than 170 cm.
Give your answer as a fraction.

200 − 145 = 55

Answer(c)(i) ..... $\frac{55}{200}$ ..... [1]

(ii) One of the 200 students is chosen at random and then a second student is chosen at random from the remaining students.

Calculate the probability that one has a height greater than 170 cm and the other has a height of 140 cm or less.
Give your answer as a fraction.

$\frac{55}{200} \times \frac{10}{199} = \frac{11}{796}$

Answer(c)(ii) ..... $\frac{11}{796}$ [3]

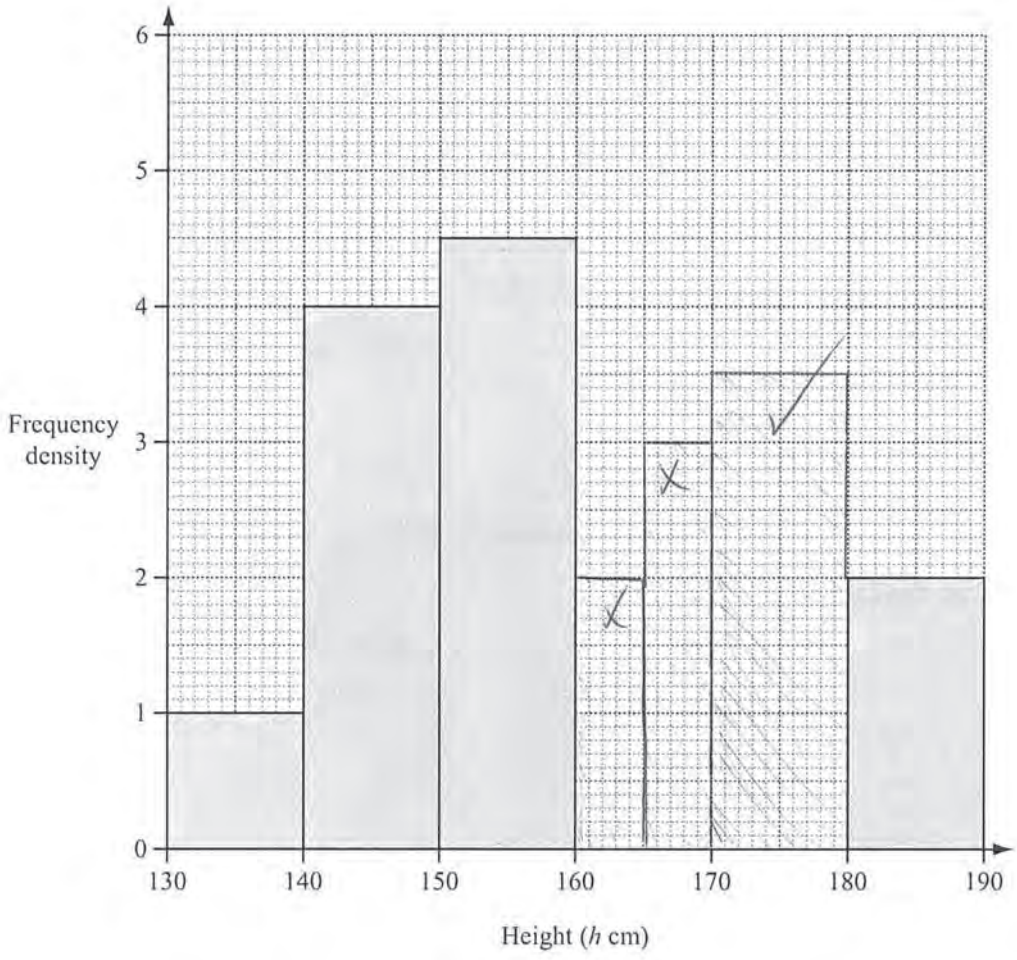
For Examiner's Use

(d) (i) Complete this frequency table which shows the distribution of the heights of the 200 students.

Height (h cm)	$130<h\leq140$	$140<h\leq150$	$150<h\leq160$	$160<h\leq165$	$165<h\leq170$	$170<h\leq180$	$180<h\leq190$
Frequency	10	40	45	20	30	35	20

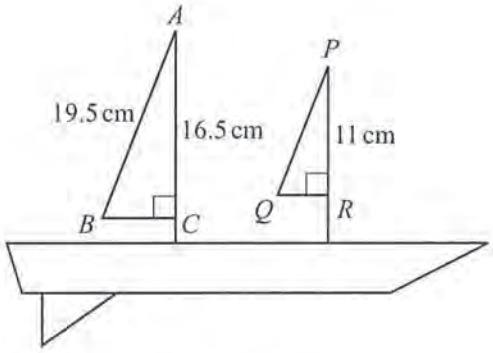
[2]

(ii) Complete this histogram to show the distribution of the heights of the 200 students.



[3]

6 (a)



The diagram shows a toy boat.
$AC = 16.5$ cm, $AB = 19.5$ cm and $PR = 11$ cm.
Triangles ABC and PQR are **similar**.

(i) Calculate PQ.

- $\frac{l}{l} = k \rightarrow \frac{16,5}{11} = k \rightarrow k = 1,5$
- $\frac{19,5}{PQ} = 1,5 \rightarrow 19,5 = 1,5 \cdot PQ \rightarrow \frac{19,5}{1,5} = PQ \rightarrow PQ = 13\,cm$

Answer(a)(i) $PQ =$ ..... 13 ..... cm [2]

2

(ii) Calculate BC.

$BC^2 + 16,5^2 = 19,5^2 \rightarrow BC^2 = 19,5^2 - 16,5^2 \rightarrow BC^2 = 108 \rightarrow$

$BC = \sqrt{108} \rightarrow BC = 10,4$

Answer(a)(ii) $BC =$ ..... 10,4 ..... cm [3]

3

(iii) Calculate angle ABC.

$\sin A\hat{B}C = \frac{16,5}{19,5} \rightarrow \sin A\hat{B}C = 0,84615 \rightarrow A\hat{B}C = 57,8°$

Answer(a)(iii) Angle $ABC =$ ..... 57,8° ..... [2]

2

(iv) The toy boat is mathematically similar to a real boat.
The length of the real boat is 32 times the length of the toy boat.
The fuel tank in the toy boat holds 0.02 litres of diesel.

Calculate how many litres of diesel the fuel tank of the real boat holds.

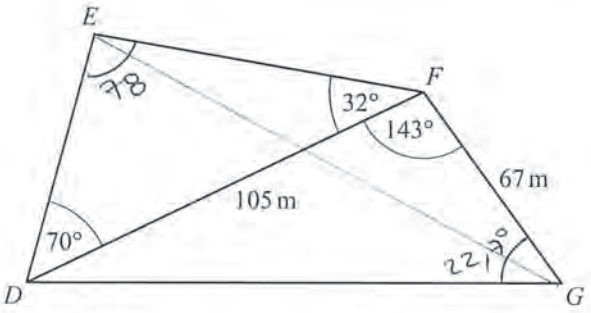
For Examiner's Use

$\frac{x}{0,02} = 32^3 \rightarrow x = 655,36$

Answer(a)(iv) ..... 655,36 litres [2]

2

(b)



NOT TO SCALE

The diagram shows a field *DEFG*, in the shape of a quadrilateral, with a footpath along the diagonal *DF*.
DF = 105 m and *FG* = 67 m.
Angle *EDF* = 70°, angle *EFD* = 32° and angle *DFG* = 143°.

(i) Calculate *DG*.

$a^2 = 105^2 + 67^2 - 2 \cdot 105 \cdot 67 \cdot \cos 143°$

$a^2 = 105^2 + 67^2 + 11236,8$

$a^2 = 26750,8$

$a = \sqrt{26750,8}$

$a = 164$

Answer(b)(i) *DG* = ... 164 ..... m [4]

4

(ii) Calculate *EF*.

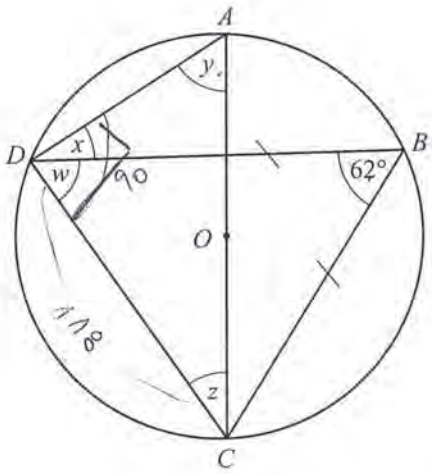
- $\frac{164}{\sin 143°} = \frac{105}{\sin x}$ ... $x = 28°$
- $180 - (70 + 32) = 78°$
- $\frac{105}{\sin 78°} = \frac{EF}{\sin 70°} \rightarrow EF = 100,9$

Answer(b)(ii) *EF* = ... 101 ..... m [4]

4

17

7 (a)



NOT TO SCALE

For Examiner's Use

A, B, C and D are points on the circumference of a circle centre O.
AC is a diameter.
$BD = BC$ and angle $DBC = 62°$.

Work out the values of w, x, y and z.
Give a reason for each of your answers.

$w =$ 62° because angle in a semicircle. (90°) so 90 − 28 = 62° [2]

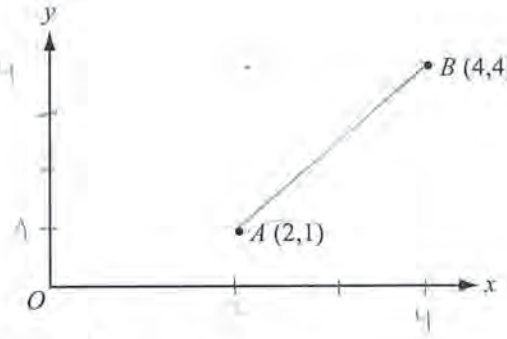
$x =$ 28 because 180 − (62 + 90) [2]

$y =$ 62° because angles subtended by the same arc [2]

$z =$ 28° because angle in a semicircle therefore 180 − (90 + 62) [2]

0
1
2
1

(b)



NOT TO SCALE

(i) Write down $\overrightarrow{AB}$ as a column vector.

Answer(b)(i) $\overrightarrow{AB} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$ [1]

1

(ii) $\overrightarrow{AC} = \begin{pmatrix} 0 \\ 7 \end{pmatrix}$.

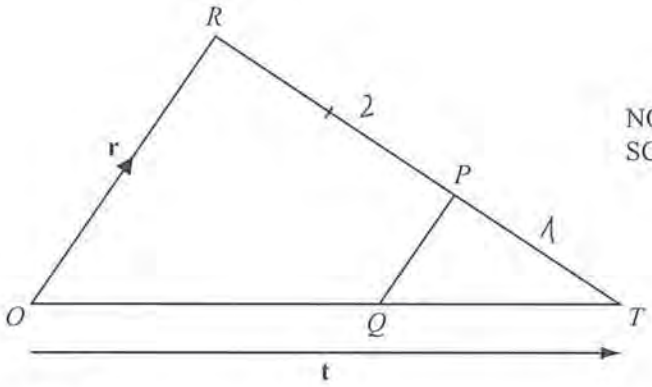
Work out $\overrightarrow{BC}$ as a column vector.

Answer(b)(ii) $\overrightarrow{BC}$ = $\begin{pmatrix} -2 \\ 3 \end{pmatrix}$ [2]

For Examiner's Use

B1

(c)



NOT TO SCALE

$\overrightarrow{OR}$ = **r** and $\overrightarrow{OT}$ = **t**.
P is on RT such that $RP : PT = 2 : 1$.
Q is on OT such that $OQ = \frac{2}{3}OT$.

Write the following in terms of **r** and/or **t**.
Simplify your answers where possible.

(i) $\overrightarrow{QT}$

Answer(c)(i) $\overrightarrow{QT}$ = $\frac{1}{3}t$ [1]

1

(ii) $\overrightarrow{TP}$ $-r + \frac{2}{3}t$

Answer(c)(ii) $\overrightarrow{TP}$ = $-\frac{1}{3}t + \frac{1}{2}$ [2]

0

(iii) $\overrightarrow{QP} = QT + TP$

Answer(c)(iii) $\overrightarrow{QP}$ = ... [2]

M1

(iv) Write down two conclusions you can make about the line segment QP.

Answer(c)(iv) .....

..... [2]

0

8

8 **(a)** $f(x) = 2x - 1$ $g(x) = x^2$

For Examiner's Use

Work out

(i) $f(2), = 2 \cdot 2 - 1 = 3$

Answer(a)(i) 3 [1]

(ii) $g(-2), = (-2)^2 = 4$

Answer(a)(ii) 4 [1]

(iii) $ff(x)$ in its simplest form,

$2(2x-1) - 1 = 4x - 2 - 1 = 4x - 3$

Answer(a)(iii) $ff(x) =$ $4x - 3$ [2]

(iv) $f^{-1}(x)$, the inverse of $f(x)$,

$f^{-1}(x) \rightarrow 2x = y + 1 \rightarrow x = \frac{y+1}{2} \rightarrow y = \frac{x+1}{2}$

Answer(a)(iv) $f^{-1}(x) =$ $\frac{x+1}{2}$ [2]

(v) x when $gf(x) = 4$.

$(2x-1)^2 = 4 \rightarrow 4x^2 - 1 = 4$

$\rightarrow 4x^2 - 1 - 4 = 0 \rightarrow 4x^2 - 5 = 0$

$\rightarrow \frac{0 \pm \sqrt{0^2 + 80}}{8} \rightarrow \frac{0 \pm 8{,}94}{8}$ $1{,}12$ $-1{,}12$

Answer(a)(v) $x =$ 1,12 or $x =$ -1,12 [4]

(b) y is **inversely** proportional to x and $y = 8$ when $x = 2$.

Find,

(i) an equation connecting y and x,

$y = \frac{k}{x} \rightarrow 8 = \frac{k}{2} \rightarrow 8 \cdot 2 = k \rightarrow 16 = k$

$y = \frac{16}{x}$

Answer(b)(i) $y = \frac{16}{x}$ [2]

(ii) y when $x = \frac{1}{2}$. $y = \frac{16}{1/2} \rightarrow y = 32$

Answer(b)(ii) $y =$ 32 [1]

9 **(a)** The first five terms P_1, P_2, P_3, P_4 and P_5 of a sequence are given below.

For Examiner's Use

$1 = 1 = P_1$

$1 + 2 = 3 = P_2$

$1 + 2 + 3 = 6 = P_3$

$1 + 2 + 3 + 4 = 10 = P_4$

$1 + 2 + 3 + 4 + 5 = 15 = P_5$

(i) Write down the next term, P_6, in the sequence 1, 3, 6, 10, 15...

$1+2+3+4+5+6 = 21 = P_6$

Answer(a)(i) 21 [1]

(ii) The formula for the nth term of this sequence is

$$P_n = \frac{1}{2}n(n+1).$$

Show this formula is true when $n = 6$.

Answer (a)(ii) $P_6 \Rightarrow \frac{1}{2} \cdot 6(6+1) = \frac{1}{2}(36+6) = 18+3 = 21$

[1]

(iii) Use the formula to find P_{50}, the 50th term of this sequence.

$P_{50} : \frac{1}{2} \cdot 50(50+1) = \frac{1}{2}(2500+50) = 1250 + 25 = 1275$

Answer(a)(iii) 1275 [1]

(iv) Use your answer to **part (iii)** to find $3 + 6 + 9 + 12 + 15 + \ldots\ldots + 150$.

165

30 60 90 120

630 1395 2,460 3825

Answer(a)(iv) 3825 [1]

(v) Find $1 + 2 + 3 + 4 + 5 + \ldots\ldots + 150$.

$+50 = 1275$

5050

Answer(a)(v) 11325 [1]

(vi) Use your answers to **parts (iv)** and **(v)** to find the sum of the numbers less than 150 which are **not** multiples of 3.

$11325 - 3825 = 7500$

Answer(a)(vi) 7500 [1]

16

This question continues on the next page.

(b) The first five terms, S_1, S_2, S_3, S_4 and S_5 of a different sequence are given below.

(1×1) $= 1 = S_1$

$(1 \times 2) + (2 \times 1)$ $= 4 = S_2$

$(1 \times 3) + (2 \times 2) + (3 \times 1)$ $= 10 = S_3$

$(1 \times 4) + (2 \times 3) + (3 \times 2) + (4 \times 1)$ $= 20 = S_4$

$(1 \times 5) + (2 \times 4) + (3 \times 3) + (4 \times 2) + (5 \times 1)$ $= 35 = S_5$

(i) Work out the next term, S_6, in the sequence 1, 4, 10, 20, 35...

$(1 \times 6) + (2 \times 5) + (3 \times 4) + (4 \times 3) + (5 \times 2) + (6 \times 1) = 56$

Answer(b)(i) ..... 56 ..... [2]

(ii) The formula for the nth term of this sequence is

$$S_n = \frac{1}{6}n(n+1)(n+2).$$

Show this formula is true for $n = 6$.

Answer(b)(ii) $S_6 = \frac{1}{6} \cdot 6(6+1)(6+2) = \left(\frac{1}{2}\right) \cdot 6(36+12+6+2)$

$= \frac{1}{6}(216 + 72 + 36 + 12) =$ ~~[illegible]~~

$36 + 12 + 6 + 2 = 56$ [1]

(iii) Find $(1 \times 20) + (2 \times 19) + (3 \times 18)$ ..... $+ (20 \times 1)$.

Answer(b)(iii) ..... [1]

(c) Show that $S_6 - S_5 = P_6$, where P_6 is your answer to **part (a)(i)**.

Answer(c)

[1]

(d) Show by algebra that $S_n - S_{n-1} = P_n$. $\left[P_n = \frac{1}{2}n(n+1)\right]$

Answer(d)

[3]

Example candidate response – grade C (whole script)

1 (a) In 2008 the total number of tickets sold for an athletics meeting was 3136.
The ratio child tickets sold : adult tickets sold = 17 : 32.

For Examiner Use

(i) How many child tickets were sold?

17+32= 49

$\frac{3136}{49}$ = 64 × 17 = 1088

2

Answer(a)(i) 1088 [2]

(ii) Child tickets cost $2 each and adult tickets cost $4.50 each.

Show that the total amount received from the sale of the tickets in 2008 was $11 392.

Answer(a)(ii)

64 × 32 = 2048 × 4.50 = 9216

1088 × 2 = 2176

9216 + 2176 = 11392

2

[2]

(b) In 2009 the amount received from the sale of tickets for the athletics meeting was $12 748.

Calculate the percentage increase in the amount received from 2008 to 2009.

11392 + x × 11392 = 12748

$\frac{x}{100} \times 11392 = \frac{1356}{11392} \times 100$

x = 11.9

3

Answer(b) 11.9 % [3]

(c) In 2008 the amount of $11 392 was 28% more than the amount received in 2007.

Calculate how much was received in 2007.

11392 — 128

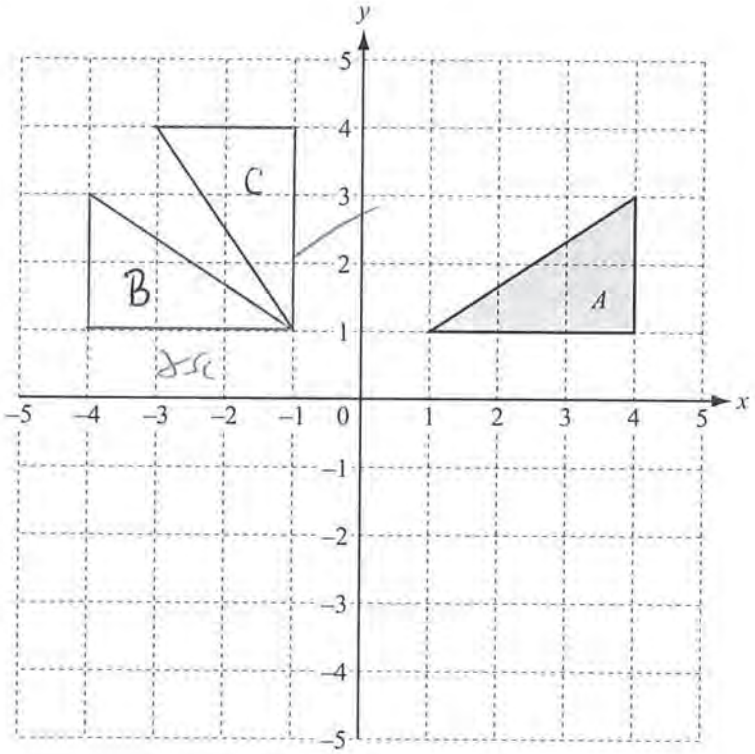
x — 100

$\frac{11392 \times 100}{128}$ = 8900

3

Answer(c) $ [3]

2 (a)



(i) Draw the image when triangle A is reflected in the line $y = 0$.
Label the image B. [2]

(ii) Draw the image when triangle A is rotated through 90° anticlockwise about the origin.
Label the image C. [2]

(iii) Describe fully the **single** transformation which maps triangle B onto triangle C.

Answer(a)(iii) Reflection y=x x = -y [2]

(b) Rotation through 90° anticlockwise about the origin is represented by the matrix $\mathbf{M} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$.

(i) Find $\mathbf{M}^{-1}$, the inverse of matrix $\mathbf{M}$.

$\frac{1}{ad-bc} \times \begin{pmatrix} a & -b \\ -c & a \end{pmatrix}$

$\frac{1}{0+1} \times \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$

Answer(b)(i) $\mathbf{M}^{-1} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$ [2]

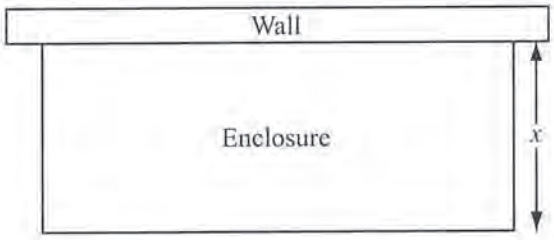
(ii) Describe fully the **single** transformation represented by the matrix $\mathbf{M}^{-1}$.

Answer(b)(ii) ROTATION 90° CLOCKWISE $\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$ [2]

For Examiner's Use

sc 1
2
2
2
1
18

3



NOT TO SCALE

For Examiner Use

A farmer makes a rectangular enclosure for his animals.
He uses a wall for one side and a total of 72 metres of fencing for the other three sides.

The enclosure has width x metres and area A square metres.

(a) Show that $A = 72x - 2x^2$.

Answer (a)

0

[2]

(b) Factorise completely $72x - 2x^2$.

$2x(36 - 1^2)$

Answer(b) $2x(36-1^2)$ [2]

0

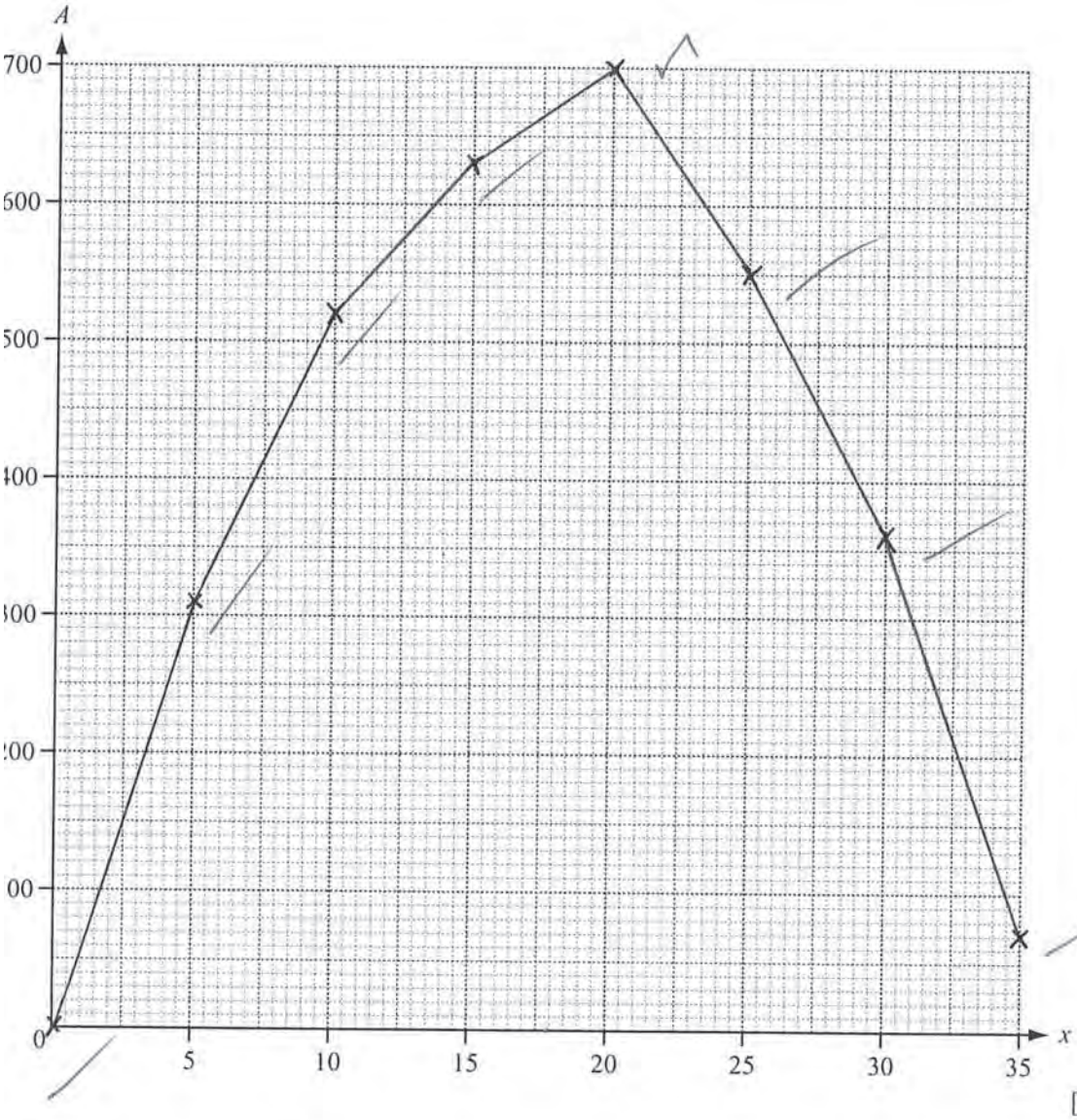
(c) Complete the table for $A = 72x - 2x^2$.

x	0	5	10	15	20	25	30	35
A	0	310	520	630	700	550	360	70

[3]

2

(d) Draw the graph of $A = 72x - 2x^2$ for $0 \leqslant x \leqslant 35$ on the grid opposite.



[4]

For Examiner's Use

P3
C0

(e) Use your graph to find

(i) the values of x when $A = 450$,

Answer(e)(i) $x =$ 8.5 or $x =$ 27.5 [2]

2

(ii) the maximum area of the enclosure.

Answer(e)(ii) 700 ~~m²~~ [1]

0

(f) Each animal must have at least 12 m^2 for grazing.

Calculate the greatest number of animals that the farmer can keep in an enclosure which has an area of 500 m^2.

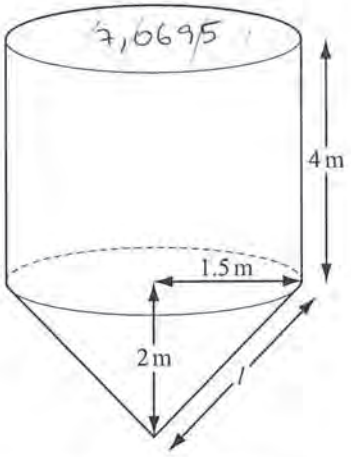
$\frac{500}{12} = 41.6$

Answer(f) 41 [2]

2

(9)

4



NOT TO SCALE

For Examiner's Use

An **open** water storage tank is in the shape of a cylinder on top of a cone.
The radius of both the cylinder and the cone is 1.5 m.
The height of the cylinder is 4 m and the height of the cone is 2 m.

(a) Calculate the **total** surface area of the **outside** of the tank.
[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

$A_{cone} = \pi r l = 3,142 \cdot 1,5 \cdot 2,5 = 11,78\ m^2$

$A_{cyl}: \pi r^2 h = 2 \cdot 3,142 \cdot 1,5 \cdot 4 = 37,704$

$11,78 + 37,704 = 49,484\ m^2$

$49,484 - 7,0695 = 42,4145\ m^2$

$2^2 + 1,5^2 = l^2$
$4 + 2,25 = l^2$
$6,25 = l^2$
$\sqrt{6,25} = l$
$l = 2,5$

Answer(a) ..... 42,4 ..... m^2 [6]

M1 A1 M1 M1 M0

(b) The tank is completely full of water.

(i) Calculate the volume of water in the tank and show that it rounds to 33 m^3, correct to the nearest whole number.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

Answer(b)(i)

$V_{cone}: \frac{1}{3} \cdot 3,142 \cdot 1,5^2 \cdot 2 = 4,713\ m^3$

$V_{cyl}: 3,142 \cdot 1,5^2 \cdot 4 = 28,278\ m^3$

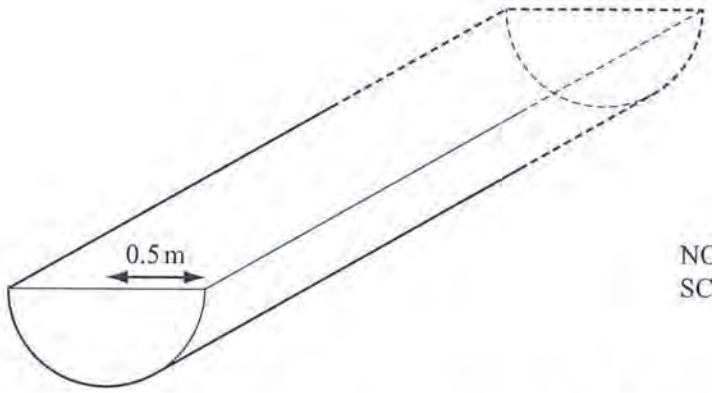
$28,278 + 4,713 = 32,991\ m^3$

$32,991 \Rightarrow 33$ rounded up.

[4]

4

(ii)



NOT TO SCALE

For Examiner's Use

The cross-section of an irrigation channel is a semi-circle of radius 0.5 m.
The 33 m^3 of water from the tank completely fills the irrigation channel.

Calculate the length of the channel.

$\frac{\pi \times r^2}{2}$

$\frac{\pi \times 0.5^2}{2}$

$\frac{\pi \times 0.25}{2} = 0.39 \times X = \frac{33}{0.34}$

$X = 84.62$

M2

Answer(b)(ii) 84.62 m [3]

(c) (i) Calculate the number of litres in a full tank of 33 m^3.

0

Answer(c)(i) 3300 litres [1]

(ii) The water drains from the tank at a rate of 1800 litres per minute.

Calculate the time, in minutes and seconds, taken to empty the tank.

0

Answer(c)(ii) ..... min ..... s [2]

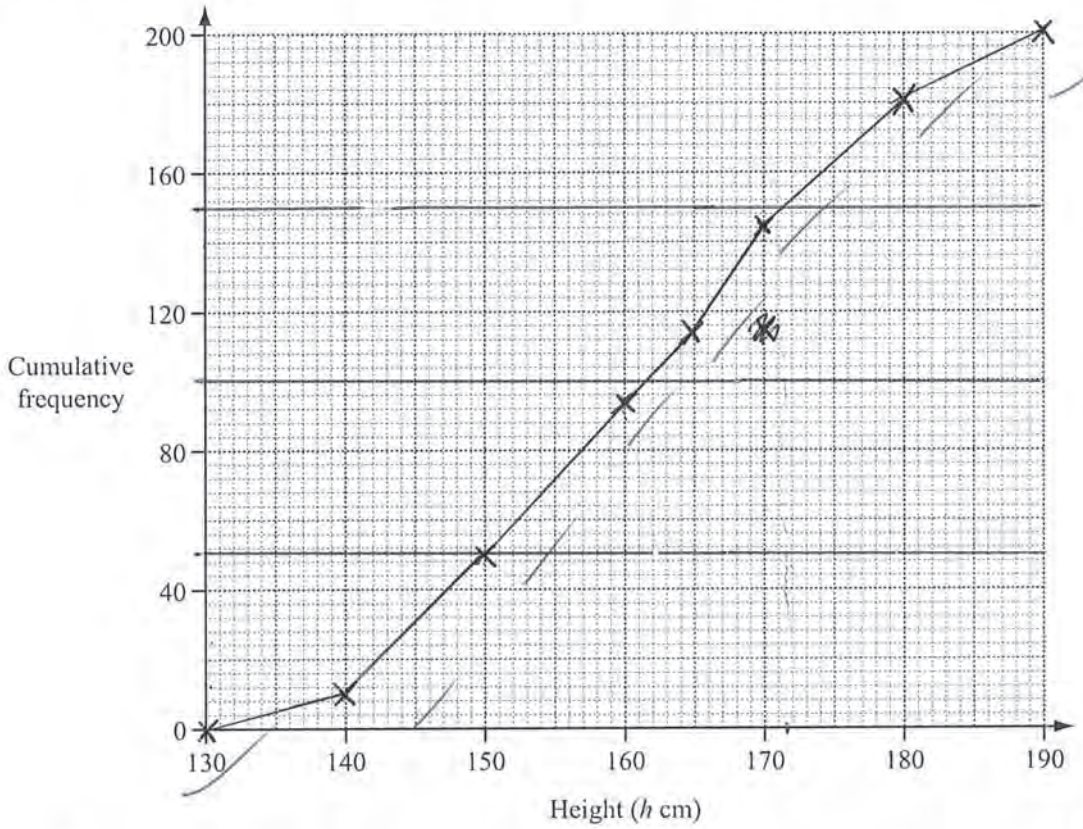
6

5 The cumulative frequency table shows the distribution of heights, h centimetres, of 200 students.

For Examiner's Use

Height (h cm)	⩽130	⩽140	⩽150	⩽160	⩽165	⩽170	⩽180	⩽190
Cumulative frequency	0	10	50	95	115	145	180	200

(a) Draw a cumulative frequency diagram to show the information in the table.



[4]

(b) Use your diagram to find

(i) the median,

Answer(b)(i) 173.74 cm [1]

(ii) the upper quartile, 171.5 − 150 = 21.5

Answer(b)(ii) 171.5 cm [1]

(iii) the interquartile range.

Answer(b)(iii) 21.5 cm [1]

(c) **(i)** One of the 200 students is chosen at random.

Use the table to find the probability that the height of this student is greater than 170 cm. Give your answer as a fraction.

380/795

Answer(c)(i) 76/159 [1]

(ii) One of the 200 students is chosen at random and then a second student is chosen at random from the remaining students.

Calculate the probability that one has a height greater than 170 cm and the other has a height of 140 cm or less.
Give your answer as a fraction.

$\frac{76}{159} \times \frac{2}{159}$

$\frac{10}{795}$

Answer(c)(ii) ..... [3]

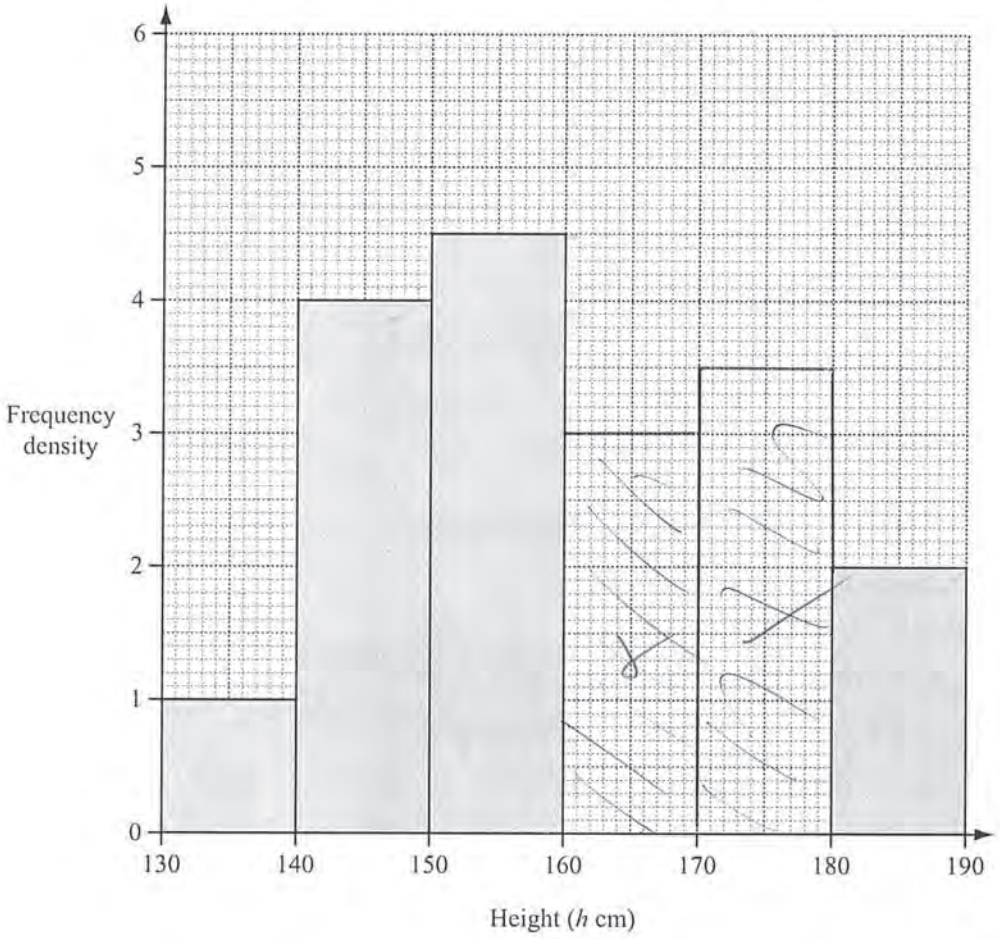
For Examiner's Use

(d) (i) Complete this frequency table which shows the distribution of the heights of the 200 students.

Height (h cm)	$130<h\leq140$	$140<h\leq150$	$150<h\leq160$	$160<h\leq165$	$165<h\leq170$	$170<h\leq180$	$180<h\leq190$
Frequency	10	40	45	20	30	35	20

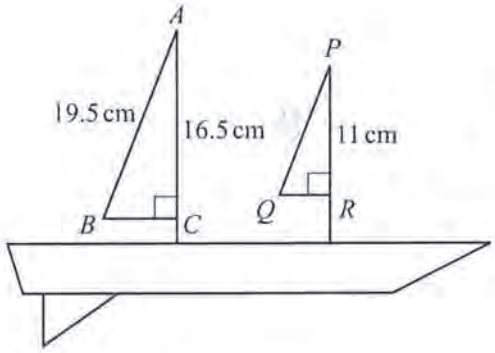
[2]

(ii) Complete this histogram to show the distribution of the heights of the 200 students.



[3]

6 (a)



NOT TO SCALE

For Examiner Use

The diagram shows a toy boat.
$AC = 16.5$ cm, $AB = 19.5$ cm and $PR = 11$ cm.
Triangles ABC and PQR are **similar**.

(i) Calculate PQ.

$16.5 \rightarrow 11$ $\quad \frac{19.5 \times 11}{16.5} = 13$
$19.5 \rightarrow x$

Answer(a)(i) $PQ =$ 13 cm [2] 2

(ii) Calculate BC.

$c^2 + c^2 = H^2$
$16.5^2 + x^2 = 19.5^2$
$272.25 + x^2 = 380.25 - 272.25$
$x^2 = \sqrt{108}$
$x = 10.39$

Answer(a)(ii) $BC =$ 10.39 cm [3] 3

(iii) Calculate angle ABC.

$A^2 = B^2 + C^2 - 2BC \times \cos \hat{A}$
$16.5^2 = 19.5^2 + 10.34^2 - 2 \times 19.5 \times 10.39 \times \cos \hat{A}$
$272.25 = 380.25 + 107.95 - 405.21 \times \cos \hat{A}$
$272.25 = 488.2 - 405.21 \times \cos \hat{A}$
$\frac{272.25}{82.99} = 82.99 \times \cos \hat{A}$
$\cos \hat{A} = 3.28$
$\hat{A} =$

$\frac{\sin 90}{19.5} = \frac{\sin x}{16.5}$
$\frac{1}{19.5} \times 16.5 = 0.85$
$\sin x = 0.85$
$x = 58.21$

p.a.

Answer(a)(iii) Angle $ABC =$ 58.21 [2] M1

(iv) The toy boat is mathematically similar to a real boat.
The length of the real boat is 32 times the length of the toy boat.
The fuel tank in the toy boat holds 0.02 litres of diesel.

Calculate how many litres of diesel the fuel tank of the real boat holds.

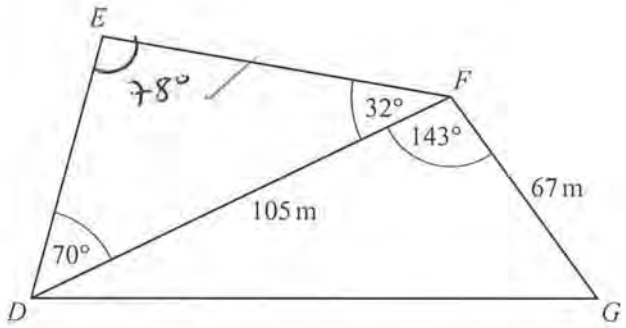
$0.02 \times 32 = 0.64$

Answer(a)(iv) ..... 0.64 ..... litres [2]

For Examiner's Use

0.

(b)



NOT TO SCALE

The diagram shows a field *DEFG*, in the shape of a quadrilateral, with a footpath along the diagonal *DF*.
DF = 105 m and *FG* = 67 m.
Angle *EDF* = 70°, angle *EFD* = 32° and angle *DFG* = 143°.

(i) Calculate *DG*.

$A^2 = 105^2 + 67^2 - 2 \times 105 \times 67 \times \cos 143^\circ$ → −0.80

$A^2 = 11025 + 4489 - 14070 \times -0.80$

$A^2 = 15514 + 11256$

$A^2 = 26770$

$A = 163.62$

Answer(b)(i) *DG* = ... 163.62 ..... m [4]

4

(ii) Calculate *EF*.

$\frac{\sin 70}{x} = \frac{\sin 78^\circ}{105}$

$\frac{0.94}{x} = \frac{0.98}{105}$

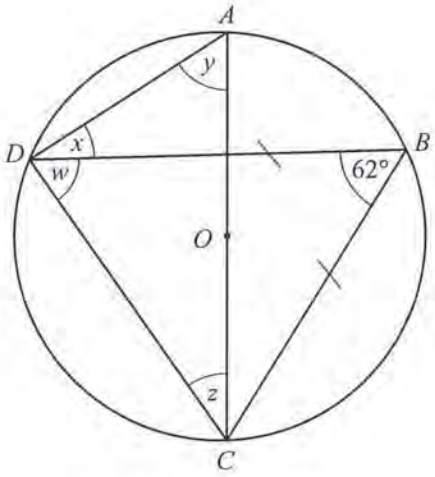
B1

M1

Answer(b)(ii) *EF* = ... m [4]

12

7 (a)



NOT TO SCALE

For Examiner Use

A, B, C and D are points on the circumference of a circle centre O.
AC is a diameter.
$BD = BC$ and angle $DBC = 62°$.

Work out the values of w, x, y and z.
Give a reason for each of your answers.

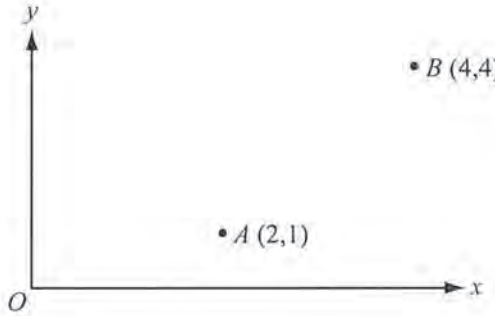
$w =$ 59° because both sides are equal [2]

$x =$ 31° because it is in the diameter so it is 90°-w [2]

$y =$ 62° because it shares kow with $\hat{DBC}$ [2]

$z =$ 28° because $180 - \hat{A} - \hat{B} = \hat{C}$ [2]

(b)



NOT TO SCALE

(i) Write down $\overrightarrow{AB}$ as a column vector.

$\begin{pmatrix} 4 \\ 4 \end{pmatrix} \begin{pmatrix} 2 \\ 1 \end{pmatrix}$

Answer(b)(i) $\overrightarrow{AB} =$ $\begin{pmatrix} 8 \\ 8 \end{pmatrix}$ [1]

(ii) $\overrightarrow{AC} = \begin{pmatrix} 0 \\ 7 \end{pmatrix}$.

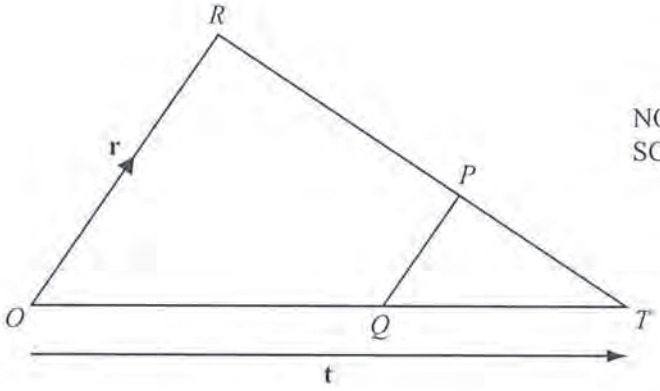
Work out $\overrightarrow{BC}$ as a column vector.

$\begin{pmatrix} 4 \\ 4 \end{pmatrix} \begin{pmatrix} 0 \\ 7 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$

Answer(b)(ii) $\overrightarrow{BC} = \begin{pmatrix} 0 \\ 6 \end{pmatrix}$ [2]

For Examiner's Use

(c)



NOT TO SCALE

$\overrightarrow{OR} = \mathbf{r}$ and $\overrightarrow{OT} = \mathbf{t}$.
P is on RT such that $RP : PT = 2 : 1$.
Q is on OT such that $OQ = \frac{2}{3}OT$.

Write the following in terms of **r** and/or **t**.
Simplify your answers where possible.

(i) $\overrightarrow{QT}$

$\frac{1}{3}t$

Answer(c)(i) $\overrightarrow{QT}$ = $\frac{1}{3}t$ [1]

(ii) $\overrightarrow{TP}$

Answer(c)(ii) $\overrightarrow{TP}$ = ... [2]

(iii) $\overrightarrow{QP}$

Answer(c)(iii) $\overrightarrow{QP}$ = ... [2]

(iv) Write down two conclusions you can make about the line segment QP.

Answer(c)(iv) .....

..... [2]

(6)

8 **(a)** $f(x) = 2x - 1$ $g(x) = x^2$

For Examiner Use

Work out

(i) f(2), $2 \times 2 - 1 = 3$

Answer(a)(i) 3 [1]

(ii) g(−2), $-2^2 = 4$

Answer(a)(ii) 4 [1]

(iii) ff(x) in its simplest form,

Answer(a)(iii) ff(x) = ... [2]

(iv) $f^{-1}(x)$, the inverse of f(x),

Answer(a)(iv) $f^{-1}(x)$ = ... [2]

(v) x when $gf(x) = 4$.

Answer(a)(v) x = ... or x = ... [4]

(b) y is **inversely** proportional to x and $y = 8$ when $x = 2$.

Find,

(i) an equation connecting y and x,

Answer(b)(i) ..... [2]

(ii) y when $x = \frac{1}{2}$.

$8 \quad 2 \qquad \frac{0.5 \times 8}{2} = 2$

$\times \quad 0.5$

Answer(b)(ii) y = 2 [1]

9 **(a)** The first five terms P_1, P_2, P_3, P_4 and P_5 of a sequence are given below.

$1 = 1 = P_1$

$1 + 2 = 3 = P_2$

$1 + 2 + 3 = 6 = P_3$

$1 + 2 + 3 + 4 = 10 = P_4$

$1 + 2 + 3 + 4 + 5 = 15 = P_5$

(i) Write down the next term, P_6, in the sequence 1, 3, 6, 10, 15...

Answer(a)(i) 1+2+3+4+5+6 [1]

(ii) The formula for the nth term of this sequence is

$$P_n = \frac{1}{2}n(n+1).$$

Show this formula is true when $n = 6$.

Answer (a)(ii) $P_6 = \frac{1}{2} 6(6+1)$

$P_6 = 3 \times 7$

$P_6 = 21$ [1]

(iii) Use the formula to find P_{50}, the 50th term of this sequence.

$P_{50} = \frac{1}{2} 50(50+1)$

$P_{50} = 25 \times 51 = 1275$ *Answer(a)*(iii) 1275 [1]

(iv) Use your answer to **part (iii)** to find 3 + 6 + 9 + 12 + 15 + ... 1080 ... + 150.

1275 - 195 =

Answer(a)(iv) 1080 [1]

(v) Find 1 + 2 + 3 + 4 + 5 + ... + 150.

$P_{150} = \frac{1}{2} 150(150+1)$

$P_{150} = 75 \times 151 = 11325 - 165 = 11160$

Answer(a)(v) 11160 [1]

(vi) Use your answers to **parts (iv)** and **(v)** to find the sum of the numbers less than 150 which are **not** multiples of 3.

11160

Answer(a)(vi) [1]

This question continues on the next page.

(b) The first five terms, S_1, S_2, S_3, S_4 and S_5 of a different sequence are given below.

For Examiner's Use

$(1 \times 1) = 1 = S_1$

$(1 \times 2) + (2 \times 1) = 4 = S_2$

$(1 \times 3) + (2 \times 2) + (3 \times 1) = 10 = S_3$

$(1 \times 4) + (2 \times 3) + (3 \times 2) + (4 \times 1) = 20 = S_4$

$(1 \times 5) + (2 \times 4) + (3 \times 3) + (4 \times 2) + (5 \times 1) = 35 = S_5$

(i) Work out the next term, S_6, in the sequence 1, 4, 10, 20, 35...

$(1 \times 6) + (2 \times 5) + (3 \times 4) + (4 \times 3) + (5 \times 2) + (6 \times 1) = 56$

Answer(b)(i) 56 [2]

2

(ii) The formula for the nth term of this sequence is

$$S_n = \frac{1}{6}n(n+1)(n+2).$$

Show this formula is true for $n = 6$.

Answer(b)(ii) $S_6 = \frac{1}{6} 6(6+1)(6+2)$

$S_6 = 1 \times 7 \times 8 = 56$ [1]

1

(iii) Find $(1 \times 20) + (2 \times 19) + (3 \times 18) \ldots\ldots\ldots\ldots + (20 \times 1)$.

Answer(b)(iii) ..... [1]

0

(c) Show that $S_6 - S_5 = P_6$, where P_6 is your answer to **part (a)(i)**.

Answer(c) $56 - 35 = 21$

[1]

1

(d) Show by algebra that $S_n - S_{n-1} = P_n$. $\left[P_n = \frac{1}{2}n(n+1)\right]$

Answer(d) $\frac{1}{6}n(n+1)(n+2) - \frac{1}{6}n-1(n)(n+1) = \frac{1}{2}n(n+1)$

$\frac{1}{6}n\,n^2 + 3n + 2 - \frac{1}{6}n-1\,n$

[3]

M1

5

Example candidate response – grade E (whole script)

1 **(a)** In 2008 the total number of tickets sold for an athletics meeting was 3136.
The ratio child tickets sold : adult tickets sold = 17 : 32.

For Examiner Use

(i) How many child tickets were sold?

17 + 32 = 49

$\frac{17}{49} \times 3136 = 1088$

2

Answer(a)(i) 1088 [2]

(ii) Child tickets cost $2 each and adult tickets cost $4.50 each.

Show that the total amount received from the sale of the tickets in 2008 was $11 392.

Answer(a)(ii)

child = 2176

$\frac{32}{49} \times 3136 = 2048 \times 4.50$

$= 9216 + 2176$

$= 11392$

$\frac{17}{49} \times 3136 = 1088 \times 2$

2

[2]

(b) In 2009 the amount received from the sale of tickets for the athletics meeting was $12 748.

Calculate the percentage increase in the amount received from 2008 to 2009.

11392 = 2008

12748 = 2009

1356

$\div 24140 \times 100 = 5.6$

M0

Answer(b) 5.6 % [3]

(c) In 2008 the amount of $11 392 was 28% more than the amount received in 2007.

Calculate how much was received in 2007.

100 28 128

1% 11392

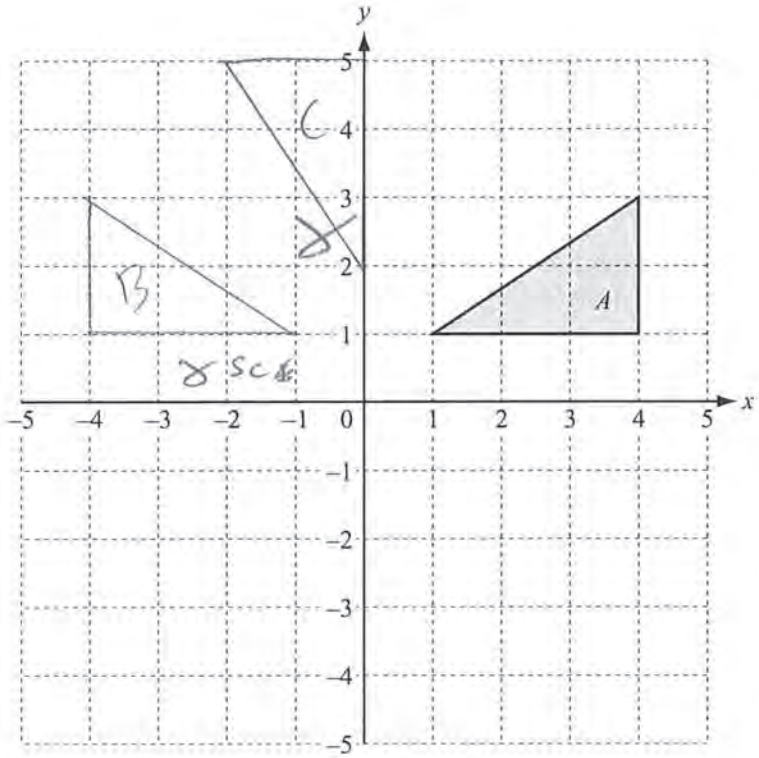
$\frac{11392 \times 100}{128} = 8900$

3

Answer(c) $ 8900 [3]

2 (a)

For Examiner's Use



(i) Draw the image when triangle A is reflected in the line $y = 0$.
Label the image B. [2]

(ii) Draw the image when triangle A is rotated through 90° anticlockwise about the origin.
Label the image C. [2]

(iii) Describe fully the **single** transformation which maps triangle B onto triangle C.

Answer(a)(iii) Reflection DEP ..... [2]

(b) Rotation through 90° anticlockwise about the origin is represented by the matrix $\mathbf{M} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$.

(i) Find $\mathbf{M}^{-1}$, the inverse of matrix $\mathbf{M}$.

$\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$

$(0 \times 0) - (1 \times -1)$

$0 - -1 = 1$

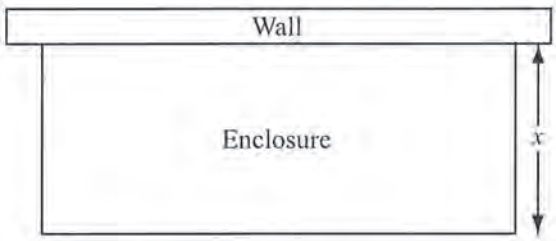
Answer(b)(i) $\mathbf{M}^{-1} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$ [2]

(ii) Describe fully the **single** transformation represented by the matrix $\mathbf{M}^{-1}$.

Answer(b)(ii) Enlargement ..... [2]

SC1 0 0 2 0 10

3



NOT TO SCALE

For Examiner Use

A farmer makes a rectangular enclosure for his animals.
He uses a wall for one side and a total of 72 metres of fencing for the other three sides.

The enclosure has width x metres and area A square metres.

(a) Show that $A = 72x - 2x^2$.

Answer (a) $A = a \times b$

$= 72 \times x$

$=$

[2]

(b) Factorise completely $72x - 2x^2$.

$2x(36 - x)$

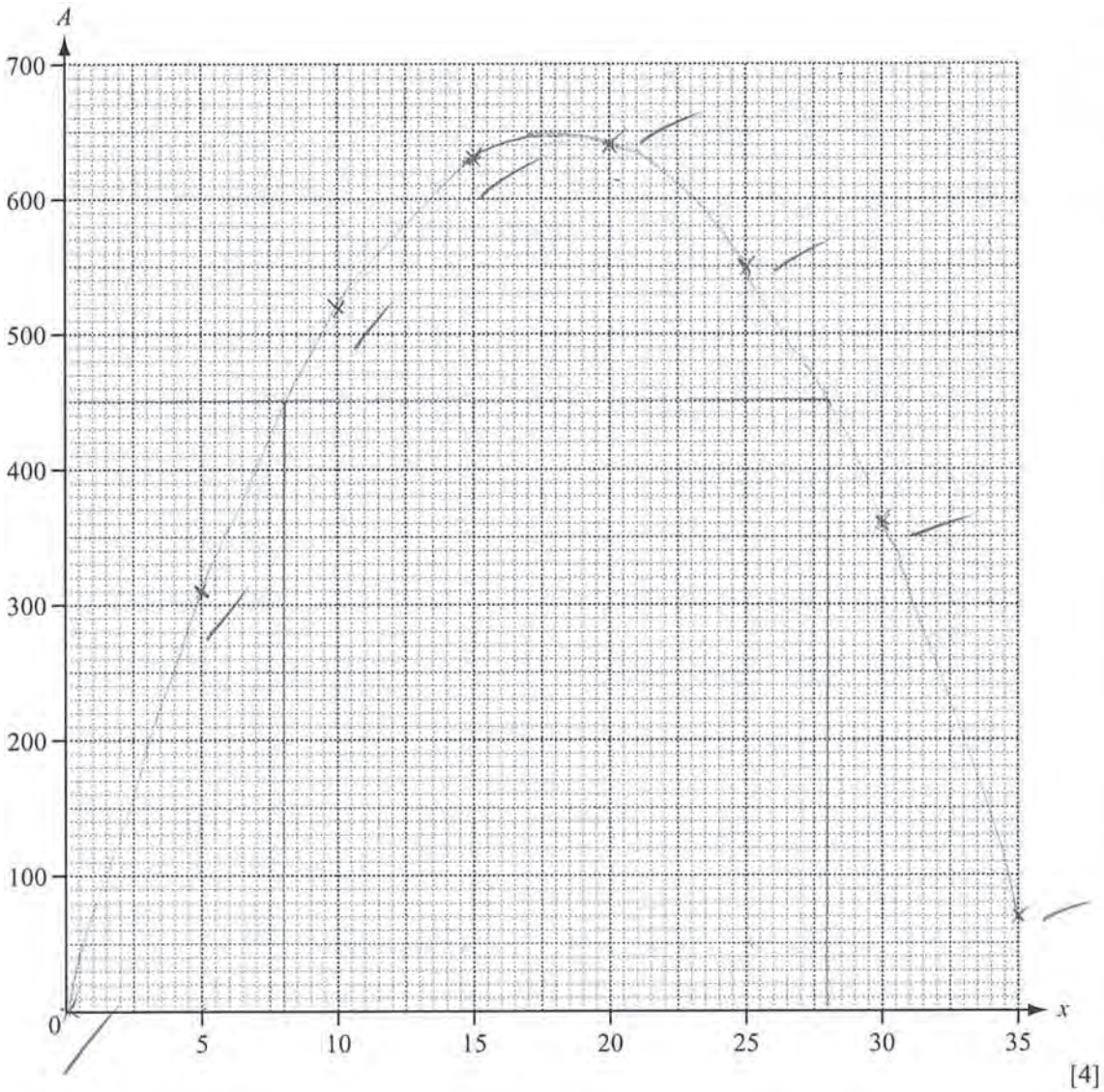
Answer(b) $2x(36 - x)$ [2]

(c) Complete the table for $A = 72x - 2x^2$.

x	0	5	10	15	20	25	30	35
A	0	310	520	630	640	550	360	70

[3]

(d) Draw the graph of $A = 72x - 2x^2$ for $0 \leqslant x \leqslant 35$ on the grid opposite.



[4]

For Examiner's Use

4

(e) Use your graph to find

(i) the values of x when $A = 450$,

Answer(e)(i) $x =$ 7 or $x =$ 26 [2]

0

(ii) the maximum area of the enclosure.

Answer(e)(ii) 650 m^2 [1]

1

(f) Each animal must have at least 12 m^2 for grazing.

Calculate the greatest number of animals that the farmer can keep in an enclosure which has an area of 500 m^2.

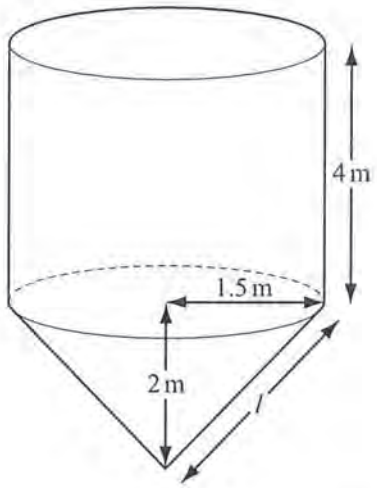
$\frac{1}{12} \times 500$

Answer(f) 42 [2]

M1

(11)

4



NOT TO SCALE

For Examiner's Use

An **open** water storage tank is in the shape of a cylinder on top of a cone.
The radius of both the cylinder and the cone is 1.5 m.
The height of the cylinder is 4 m and the height of the cone is 2 m.

(a) Calculate the **total** surface area of the **outside** of the tank.
[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

Cylinder $2\pi rh + 2\pi r^2$
$= (2 \times \pi \times 1.5 \times 4) + (2 \times \pi \times 1.5^2)$ M1
$= 51.8$ A1
$51.8 + 15.7 = 67.5$ M0
$l = 2.5$
Cone $= \pi rl$
$= \pi \times 2 \times 2.5 = 15.7$ M1

Answer(a) 6.75 m² [6] M0

(b) The tank is completely full of water.

(i) Calculate the volume of water in the tank and show that it rounds to 33 m³, correct to the nearest whole number.

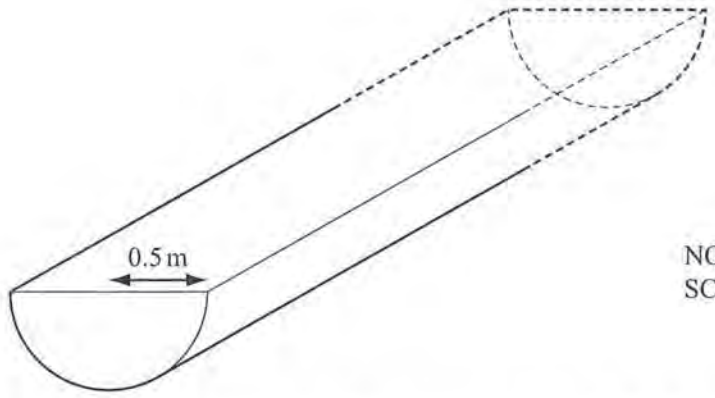
[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

Answer(b)(i)

Cylinder $= \pi r^2 h = \pi \times 1.5^2 \times 4 = 28.$ M1
Cone $= \frac{1}{3}\pi r^2 h = \frac{1}{3} \times \pi \times 1.5^2 \times 2.5 = 5$ M0
$28 + 5 = 33$

[4]

(ii)



NOT TO SCALE

For Examiner's Use

The cross-section of an irrigation channel is a semi-circle of radius 0.5 m.
The 33 m^3 of water from the tank completely fills the irrigation channel.

Calculate the length of the channel.

$\pi \times 0.5^2$

$2\pi r = 2 \times \pi \times 0.5$

$= 3.1\ m$

M0

3.1 ✗

Answer(b)(ii) ..... m [3]

(c) (i) Calculate the number of litres in a full tank of 33 m^3.

0 ✗

Answer(c)(i) 35937 litres [1]

(ii) The water drains from the tank at a rate of 1800 litres per minute.

Calculate the time, in minutes and seconds, taken to empty the tank.

1800 \ 1
35937 \ 20

$\frac{35937 \times 1}{1800} = 19.97$ ✓

M1

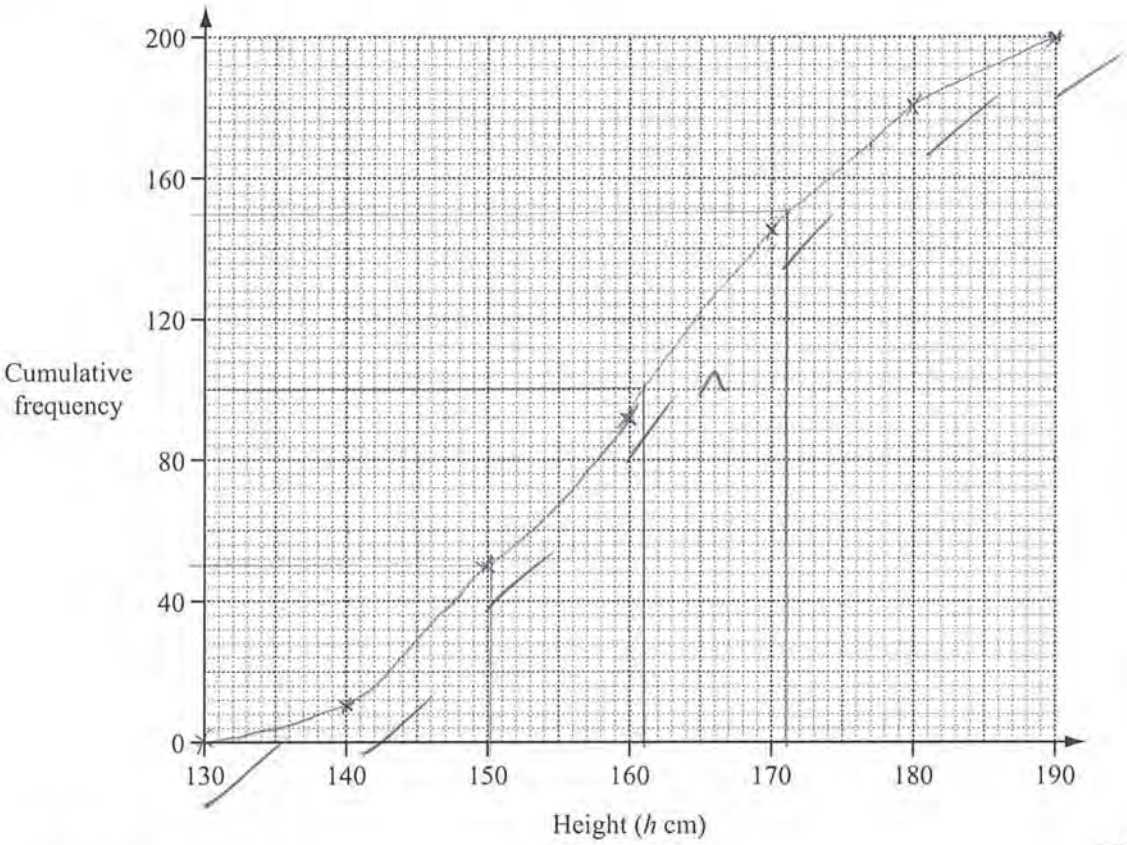
Answer(c)(ii) 19 min 57 s [2]

(5)

5 The cumulative frequency table shows the distribution of heights, h centimetres, of 200 students.

Height (h cm)	⩽130	⩽140	⩽150	⩽160	⩽165	⩽170	⩽180	⩽190
Cumulative frequency	0	10	50	95	115	145	180	200

(a) Draw a cumulative frequency diagram to show the information in the table.



[4]

(b) Use your diagram to find

(i) the median,

Answer(b)(i) 161 cm [1]

(ii) the upper quartile,

Answer(b)(ii) 171 cm [1]

(iii) the interquartile range.

Answer(b)(iii) 11 cm [1]

(c) **(i)** One of the 200 students is chosen at random.

Use the table to find the probability that the height of this student is greater than 170 cm.
Give your answer as a fraction.

Answer(c)(i) $\frac{1}{10}$ [1]

(ii) One of the 200 students is chosen at random and then a second student is chosen at random from the remaining students.

Calculate the probability that one has a height greater than 170 cm and the other has a height of 140 cm or less.
Give your answer as a fraction.

Answer(c)(ii) ..... [3]

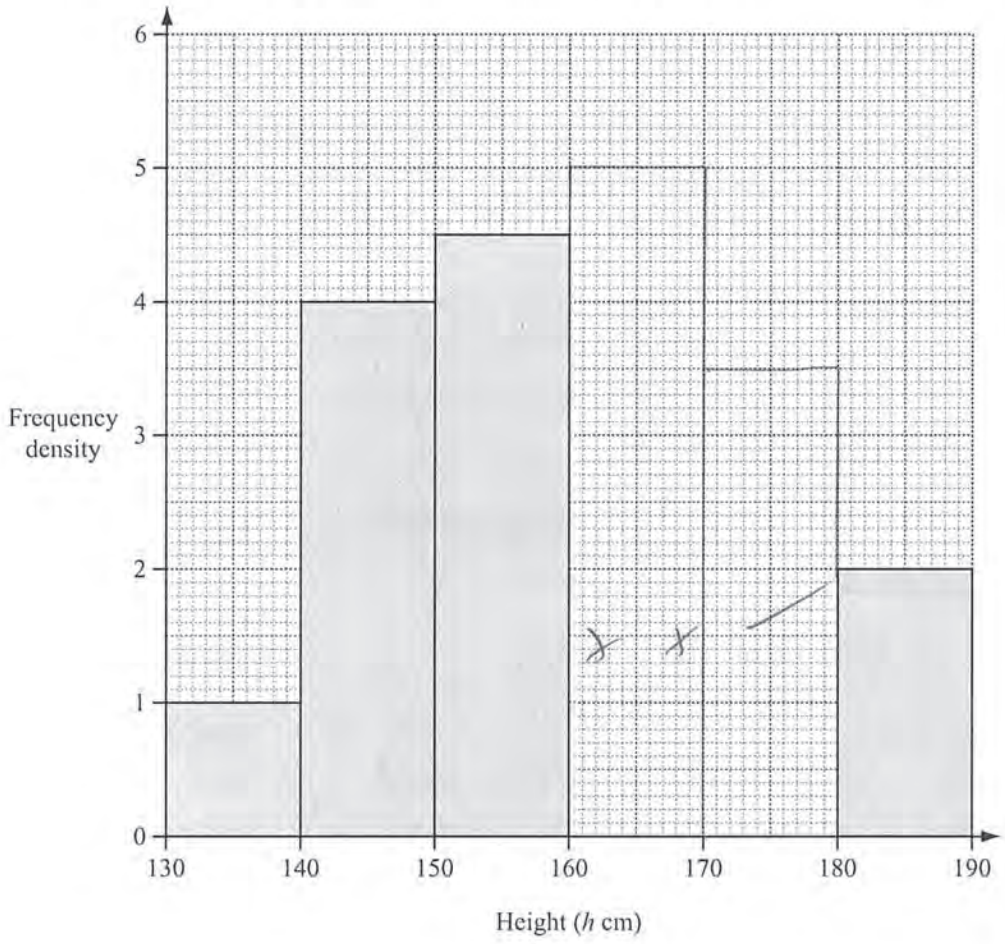
For Examiner's Use

(d) (i) Complete this frequency table which shows the distribution of the heights of the 200 students.

Height (h cm)	$130<h\leq140$	$140<h\leq150$	$150<h\leq160$	$160<h\leq165$	$165<h\leq170$	$170<h\leq180$	$180<h\leq190$
Frequency	10	40	45	20	30	35	20

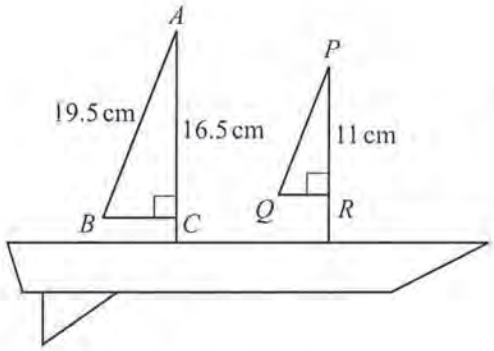
[2]

(ii) Complete this histogram to show the distribution of the heights of the 200 students.



[3]

6 (a)



NOT TO SCALE

For Examiner's Use

The diagram shows a toy boat.
$AC = 16.5$ cm, $AB = 19.5$ cm and $PR = 11$ cm.
Triangles ABC and PQR are **similar**.

(i) Calculate PQ.

$\frac{AB}{PQ} = \frac{AC}{PR} = \frac{19.5}{x} \times \frac{16.5}{11}$

$= 13$

2

Answer(a)(i) $PQ =$ ..... 13 ..... cm [2]

(ii) Calculate BC.

$\frac{AB}{PQ} = \frac{AC}{PR} = \frac{BC}{QR}$ $\quad \frac{19.5}{13} = \frac{x}{16.5} = \frac{}{11}$

$16.5x + 14.5x \div 13x + 11x - 24$

$13 \div 19.5 \times 11 = 8.25$

MO

Answer(a)(ii) $BC =$ ..... 8.25 ..... cm [3]

(iii) Calculate angle ABC.

$\cos x = \frac{a^2 + b^2 + c^2}{2ab}$

$= \frac{8.25^2 + 16.5^2 + 19.5^2}{2 \times 8.25 \times 19.5}$ $\quad \frac{720.5625}{321.75}$

0

Answer(a)(iii) Angle $ABC =$ ..... [2]

(iv) The toy boat is mathematically similar to a real boat.
The length of the real boat is 32 times the length of the toy boat.
The fuel tank in the toy boat holds 0.02 litres of diesel.

Calculate how many litres of diesel the fuel tank of the real boat holds.

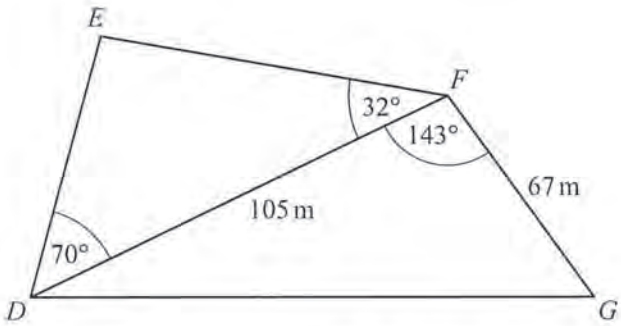
$32 \times 0.02 = 0.64$

Answer(a)(iv) 0.64 litres [2]

For Examiner's Use

D

(b)



NOT TO SCALE

The diagram shows a field *DEFG*, in the shape of a quadrilateral, with a footpath along the diagonal *DF*.
DF = 105 m and *FG* = 67 m.
Angle *EDF* = 70°, angle *EFD* = 32° and angle *DFG* = 143°.

(i) Calculate *DG*.

$DG = 105^2 + 67^2 - (2 \times 105 \times 67 \times \cos 143)$
$15514 - -11236$
$DG^2 = \sqrt{26750}$
$= 163$

Answer(b)(i) *DG* = 163 m [4]

M2
A1

(ii) Calculate *EF*.

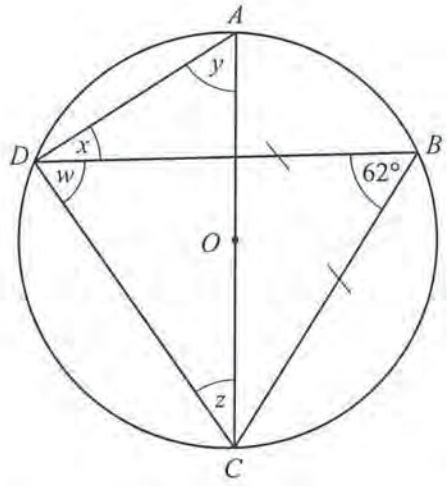
$\frac{105}{\sin 70} = \frac{x}{\sin 32}$ $= \frac{105 \times \sin 32}{\sin 70} = 59$

Answer(b)(ii) *EF* = 59 m [4]

B0
M0

(5)

7 **(a)**



NOT TO SCALE

For Examiner Use

A, B, C and D are points on the circumference of a circle centre O.
AC is a diameter.
$BD = BC$ and angle $DBC = 62°$.

Work out the values of w, x, y and z.
Give a reason for each of your answers.

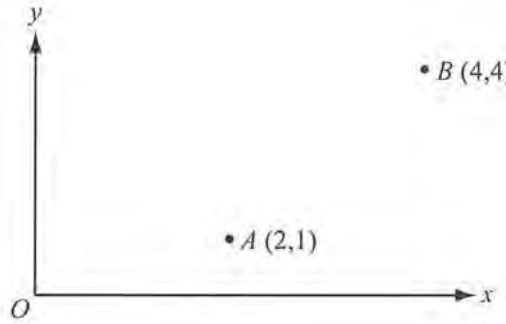
$w =$ 62 because opposite B [2]

$x =$ 62 because [2]

$y =$ 31 because opposite 2 [2]

$z =$ 31 because opposite y [2]

(b)



NOT TO SCALE

(i) Write down $\overrightarrow{AB}$ as a column vector.

Answer(b)(i) $\overrightarrow{AB} = \begin{pmatrix} 4 \\ 4 \end{pmatrix}$ [1]

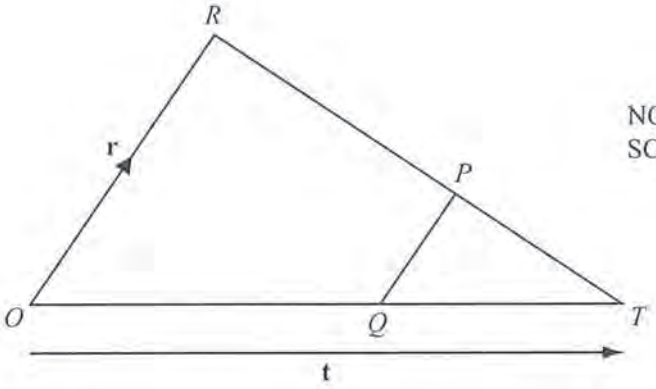
For Examiner's Use

(ii) $\overrightarrow{AC} = \begin{pmatrix} 0 \\ 7 \end{pmatrix}$.

Work out $\overrightarrow{BC}$ as a column vector.

Answer(b)(ii) $\overrightarrow{BC} = \begin{pmatrix} 4 \\ 7 \end{pmatrix}$ [2]

(c)



NOT TO SCALE

$\overrightarrow{OR} = \mathbf{r}$ and $\overrightarrow{OT} = \mathbf{t}$.
P is on RT such that $RP : PT = 2 : 1$.
Q is on OT such that $OQ = \frac{2}{3}OT$.

Write the following in terms of **r** and/or **t**.
Simplify your answers where possible.

(i) $\overrightarrow{QT}$

Answer(c)(i) $\overrightarrow{QT}$ = $\frac{1}{2}t$ [1]

(ii) $\overrightarrow{TP}$

Answer(c)(ii) $\overrightarrow{TP}$ = $-t + r$ [2]

(iii) $\overrightarrow{QP}$

Answer(c)(iii) $\overrightarrow{QP}$ = $\frac{1}{2}t + r$ [2]

(iv) Write down two conclusions you can make about the line segment QP.

Answer(c)(iv) ..... [2]

8 **(a)** $f(x) = 2x - 1$ $g(x) = x^2$

Work out

(i) f(2),

Answer(a)(i) ..... [1]

(ii) g(−2),

Answer(a)(ii) ..... [1]

(iii) ff(x) in its simplest form,

Answer(a)(iii) ff(x) = ... [2]

(iv) $f^{-1}(x)$, the inverse of f(x),

Answer(a)(iv) $f^{-1}(x)$ = ... [2]

(v) x when gf(x) = 4.

Answer(a)(v) x = ... or x = ... [4]

(b) y is **inversely** proportional to x and $y = 8$ when $x = 2$.

Find,

(i) an equation connecting y and x,

Answer(b)(i) ..... [2]

(ii) y when $x = \frac{1}{2}$.

Answer(b)(ii) y = ... [1]

For Examiner Use

9 **(a)** The first five terms P_1, P_2, P_3, P_4 and P_5 of a sequence are given below.

For Examiner's Use

$1 = 1 = P_1$

$1 + 2 = 3 = P_2$

$1 + 2 + 3 = 6 = P_3$

$1 + 2 + 3 + 4 = 10 = P_4$

$1 + 2 + 3 + 4 + 5 = 15 = P_5$

(i) Write down the next term, P_6, in the sequence 1, 3, 6, 10, 15...

Answer(a)(i) 21 [1] 1

(ii) The formula for the nth term of this sequence is

$$P_n = \frac{1}{2}n(n + 1).$$

Show this formula is true when $n = 6$.

Answer (a)(ii) $\frac{1}{2} \times 6 \times (6 + 1) = 21$ ✗ 0

[1]

(iii) Use the formula to find P_{50}, the 50th term of this sequence.

Answer(a)(iii) 1275 [1] 1

(iv) Use your answer to **part (iii)** to find $3 + 6 + 9 + 12 + 15 + \ldots\ldots + 150$.

Answer(a)(iv) n3 [1] ✗ 0

(v) Find $1 + 2 + 3 + 4 + 5 + \ldots\ldots + 150$.

Answer(a)(v) n3 [1] ✗ 0

(vi) Use your answers to **parts (iv)** and **(v)** to find the sum of the numbers less than 150 which are **not** multiples of 3.

Answer(a)(vi) [1] 0

(5)

This question continues on the next page.

(b) The first five terms, S_1, S_2, S_3, S_4 and S_5 of a different sequence are given below.

(1×1) $= 1 = S_1$

$(1 \times 2) + (2 \times 1)$ $= 4 = S_2$

$(1 \times 3) + (2 \times 2) + (3 \times 1)$ $= 10 = S_3$

$(1 \times 4) + (2 \times 3) + (3 \times 2) + (4 \times 1)$ $= 20 = S_4$

$(1 \times 5) + (2 \times 4) + (3 \times 3) + (4 \times 2) + (5 \times 1)$ $= 35 = S_5$

(i) Work out the next term, S_6, in the sequence 1, 4, 10, 20, 35...

Answer(b)(i) ..... [2]

(ii) The formula for the nth term of this sequence is

$$S_n = \frac{1}{6}n(n+1)(n+2).$$

Show this formula is true for $n = 6$.

Answer(b)(ii) 56

[1]

(iii) Find $(1 \times 20) + (2 \times 19) + (3 \times 18) \ldots\ldots\ldots + (20 \times 1)$.

Answer(b)(iii) ..... [1]

(c) Show that $S_6 - S_5 = P_6$, where P_6 is your answer to **part (a)(i)**.

Answer(c)

[1]

(d) Show by algebra that $S_n - S_{n-1} = P_n$. $\left[P_n = \frac{1}{2}n(n+1)\right]$

Answer(d)

[3]

Conclusion

It is extremely rare for a candidate to perform at the same grade level throughout a paper of this type. Abilities in different areas of mathematics will vary and experiences during the course will differ too. There are topics of a high level that are often answered by candidates of a lower level, such as trigonometry in general triangles, quadratic equations and the inverse of a function. This is probably the result of very good examination preparation. The example candidate responses selected for this document endorse this comment and their final totals out of 130 should be considered when assessing standards.

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