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FAIRFIELD METHODIST SCHOOL (SECONDARY)
END-OF-YEAR EXAMINATION 2024
SECONDARY 2 EXPRESS

MATHEMATICS

Date: 7 October 2024

Duration: 2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
 Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.
 Do not use staples, paper clips, glue or correction fluid.

Section A and Section B

Answer **all** the questions.

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

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

The total of the marks for this paper is 90.

The use of an approved scientific calculator is expected, where appropriate.

If the degree of accuracy is not specified in the question and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.

For π , use either your calculator value or 3.142.

For Examiner's Use

Table of Penalties		Question Number
Presentation	☐ 1	
Rounding off	☐ 1	

Section A	/ 45
Section B	/ 45
Total	/ 90

Parent's/Guardian's Signature:

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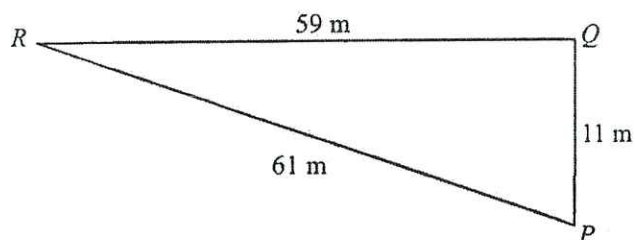
Section A (45 marks)

Answer all the questions in this section.

- 1 Expand and simplify $4(3-x)^2 - x(2-3x)$.

Answer [2]

- 2 The diagram shows a triangle PQR . $PQ = 11$ m, $QR = 59$ m, $PR = 61$ m.
Determine if PQR is a right-angled triangle. Show all necessary working.



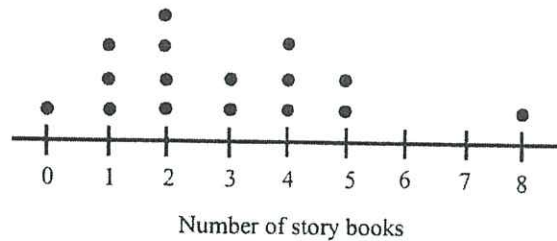
Answer

.....
.....
.....
.....
.....
..... [2]

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- 3 The dot diagram below shows the number of story books owned by a group of children.



- (a) Find the percentage of children who owned less than 2 story books.

Answer% [1]

- (b) Describe briefly the distribution of the number of story books owned.

.....

 [1]

- 4 (a) Solve $10 - 5x \leq -14 + 3x$.

Answer [2]

- (b) State the smallest integer value of x that is both a perfect square and a perfect cube.

Answer [1]

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- 5 The table below shows the weekly wages, \$ x , of 100 private hire car drivers.

Weekly wages (\$ x)	$0 \leq x < 100$	$100 \leq x < 200$	$200 \leq x < 300$	$300 \leq x < 400$	$400 \leq x < 500$
Number of drivers	10	10	30	36	14

- (a) Find an estimate of the mean wages of the private hire car drivers.

Answer \$..... [2]

- (b) A private hire car driver is selected at random. Find the probability that the driver earns a weekly wage of at least \$200. Leave your answer in the lowest terms.

Answer [1]

- 6 It is given that $\frac{u}{\sqrt{v}} = w^2 + u$. Express v in terms of u and w .

Answer [2]

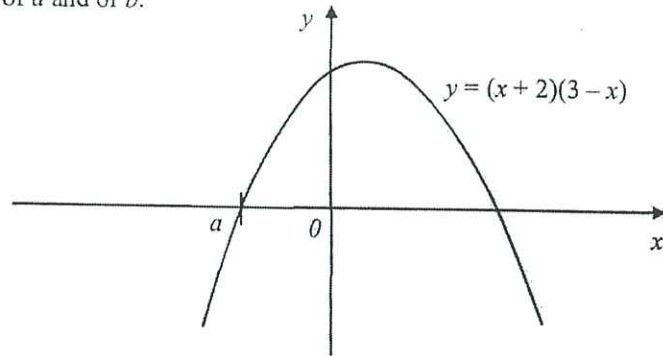
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- 7 The following diagram shows the graph of $y = (x+2)(3-x)$.

One of the x -intercepts is a and the y -coordinate of the maximum point is b .

Find the value of a and of b .



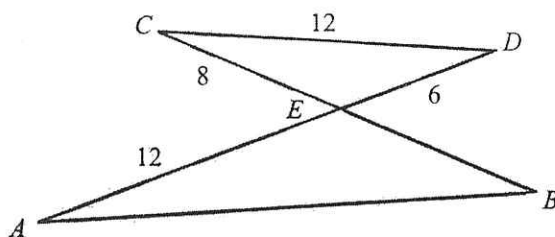
Answer $a = \dots\dots\dots$ [1]

$b = \dots\dots\dots$ [2]

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- 8 In the diagram, triangle ABE is similar to triangle CDE .
All measurements are in centimetres.



- (a) Triangle CDE is a reduction of triangle ABE .
Find the reduction scale factor. Leave your answer in the lowest terms.

Answer [1]

- (b) Find the length of AB .

Answer cm [1]

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- 9 There were 36 rings in a box. 6 of the rings were yellow, 8 were blue and the rest were red. Matthew picked a ring from the box at random. Leave your answer in the lowest terms.

(a) Find the probability that he picked a green ring.

Answer [1]

(b) Find the probability that he did not pick a blue ring.

Answer [1]

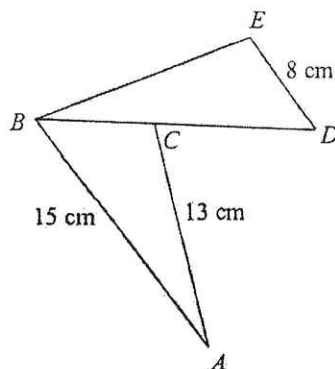
- (c) When Matthew added x blue rings to the bag, the probability of choosing a blue ring became $\frac{3}{10}$. Form an equation in x and solve it to find the number of blue rings added.

Answer $x =$ [2]

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- 10 In the diagram, triangle ABC is congruent to triangle BDE .
 $AB = 15$ cm, $AC = 13$ cm and $DE = 8$ cm.



- (a) Find

(i) BC ,

Answercm [1]

(ii) CD .

Answercm [1]

- (b) Given that the area of triangle BDE is 45 cm², find the shortest distance between point E and the line BD .

Answercm [2]

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11 A map is drawn to a scale of 1 : 20 000.

- (a) On the map, the perimeter of a field is 157 cm.
Find the actual perimeter in kilometres.

Answerkm [2]

- (b) The actual size of a farm is 5 km². Calculate the area of farm on the map, in square centimetres.

Answercm² [2]

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12 (a) Factorise completely $6xy - 21y + 8x^2 - 28x$.

Answer [2]

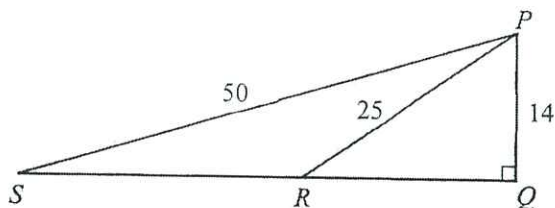
(b) Hence, simplify $\frac{4x^2 - 49}{6xy - 21y + 8x^2 - 28x}$.

Answer [2]

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- 13 In the triangle PQS , $\angle PQS = 90^\circ$, $PQ = 14$ m and $PS = 50$ m.
 R is a point on SQ where $PR = 25$ m.



Find

- (a) $\cos \angle QPR$,

Answer [1]

- (b) $\angle SPR$,

Answer $^\circ$ [3]

- (c) SR .

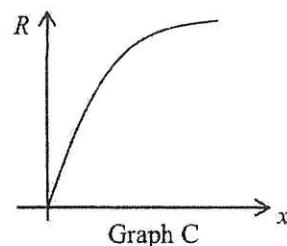
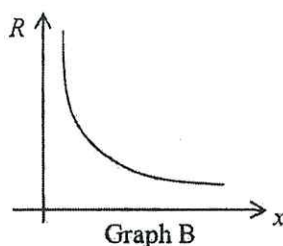
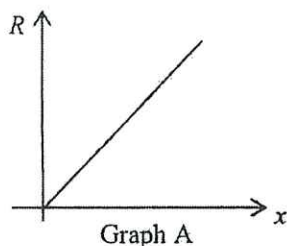
Answerm [2]

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- 14 In an experiment, the resistance R between two particles is known to be inversely proportional to the square of the distance x between them.

- (a) Which of the following graphs could be the representation of the relationship between the resistance R and the distance x ?



Answer Graph [1]

- (b) Given that $R = 10$ when $x = 5$, find an equation connecting R and x .

Answer [2]

- (c) Describe how the value of R changes when x is halved, assuming all other factors remain the same in the experiment.

Answer [1]

~ End of Section A ~

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Section B (45 marks)

Answer **all** the questions in this section.

- 1 The weight of the oranges in a stall are shown in the stem-and-leaf diagram.

Stem	Leaves
14	2 5 5
15	4 4 4 6
16	6 7 8
17	1 3 5
18	
19	
20	5

Key: 17 | 3 means 173 grams

- (a) Find the median weight of the oranges.

Answerg [1]

- (b) State the modal weight of the oranges.

Answerg [1]

- (c) Determine with reason why the mean would not be an appropriate measure of central tendency for the data shown above.

Answer

 [1]

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2 (a) Simplify $\frac{x+1}{x^3} \div \frac{5x^2-5}{10x^2}$.

Answer [2]

(b) (i) Factorise $5x^2 - 6xy + y^2$.

Answer [1]

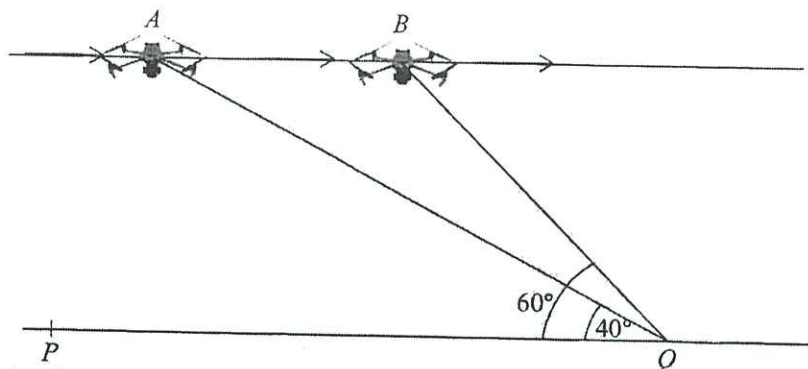
(ii) Hence, find the possible values of $\frac{y}{x}$ when $5x^2 - 6xy + y^2 = 0$.

Answer $\frac{y}{x} = \dots\dots\dots$ or $\dots\dots\dots$ [1]

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- 3 The diagram shows two different positions, A and B , of a drone flying horizontally at a uniform speed of 72 km/h. The drone takes 10 minutes to fly from A to B . P and Q are points on the horizontal ground. Angle $AQP = 40^\circ$ and angle $BQP = 60^\circ$.



- (a) Find the distance AB .

Answerkm [1]

- (b) Show that the height of the drone above the ground is 19.53 km, correct to 4 significant figures.

Answer

[4]

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3 (c) Calculate the distance AQ .

Answerkm [2]

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4 Pipe *A* alone can fill a tank in x minutes.

- (a) Write down an expression, in terms of x , for the fraction of the tank filled by Pipe *A* in 1 minute.

Answer [1]

Pipe *B* alone can fill the same tank in 8 minutes less than time taken for Pipe *A*.

- (b) Write down an expression, in terms of x , for the fraction of the tank filled by Pipe *B* in 1 minute.

Answer [1]

The time taken for Pipe *A* and Pipe *B* to fill the tank together is 7.5 minutes.

- (c) Write down an equation in x to represent this information and show that it reduces to $x^2 - 23x + 60 = 0$.

Answer

[3]

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- 4 (d) Solve the equation $x^2 - 23x + 60 = 0$.

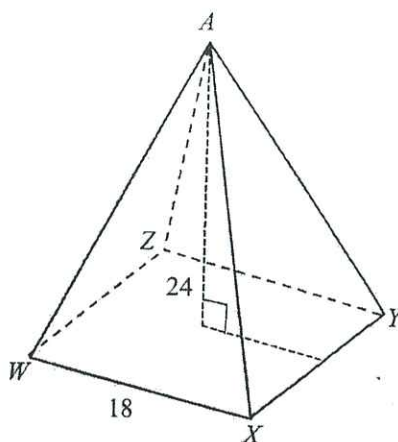
Hence, calculate the time taken to fill the tank using Pipe B alone.

Answer min [2]

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5



The diagram shows a pyramid $AWXYZ$.
 The base of the pyramid is a square of side 18 cm.
 A is vertically above the centre of the square base.
 The vertical height of the pyramid is 24 cm.

- (a) Show that height of the triangle in one of the lateral faces is 25.6 cm, correct to three significant figures.

Answer

- (b) Calculate the total surface area of the pyramid.

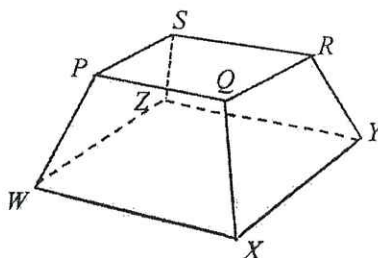
[2]

Answercm³ [3]

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- 5 (c) A smaller, similar pyramid is removed from the top of the original pyramid. The diagram below shows the solid remaining.



The vertical height of the solid remaining is 6 cm.

- (i) Show that $PQ = 13.5$ cm.

Answer

[1]

- (ii) Hence, calculate the volume of the remaining solid.

Answercm² [2]

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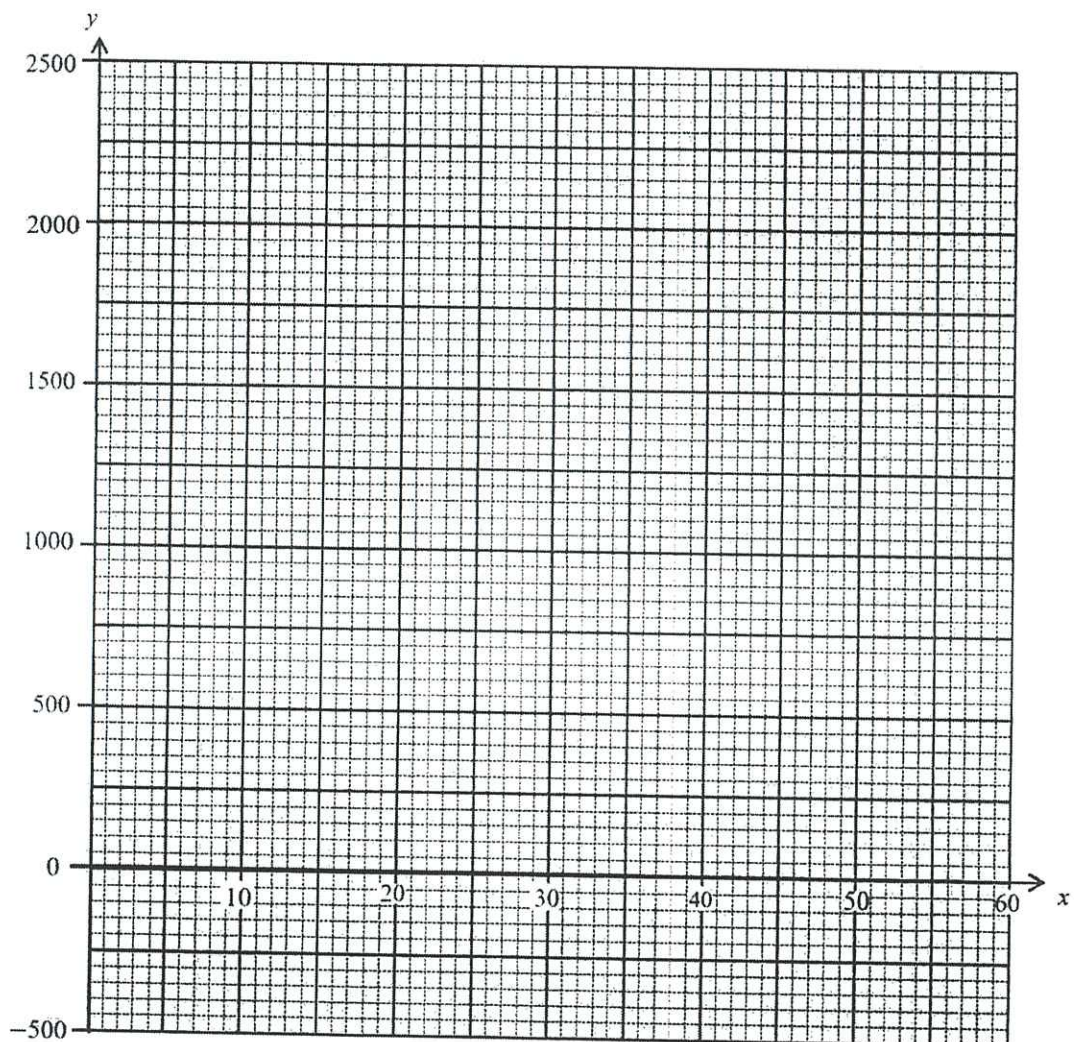
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- 6 The variables x and y are connected by equation $y = 750 + 100x - 2x^2$.
The table below shows some corresponding values of x and y .

x	0	10	20	30	40	50	60
y	750	1550	1950	1950	1550	750	-450

- (a) Using the grid below, draw the graph $y = 750 + 100x - 2x^2$ for $0 \leq x \leq 60$. [3]

Answer



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- 6 (b) Use your graph, find
 (i) the value of y when $x = 45$,

Answer $y =$ [1]

- (ii) the values of x when $y = 1750$.

Answer $x =$ or [1]

- (c) Write down the equation of the line of symmetry of the graph.

Answer [1]

-
- 7 (a) A piece of chocolate in the shape of a sphere has a volume of 38.8 cm^3 .
 Show that the radius of the chocolate is 2.10 cm , correct to 3 significant figures.
 Answer

[2]

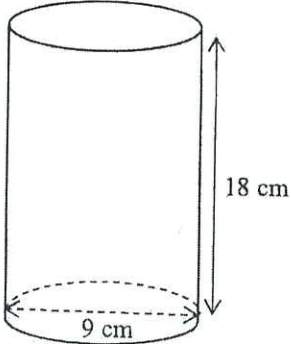
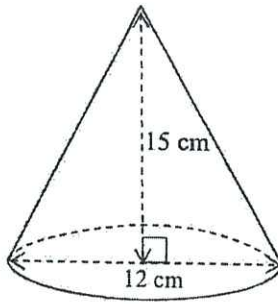
- (b) (i) The chocolate has only one layer of wrapping.
 The wrapping costs $\$0.01$ per cm^2 , find the estimated cost of wrapping a
 chocolate.

Answer \$ [2]

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- 7 (b) (ii) A supplier is given two options to pack 12 such chocolate pieces in one container. The manufacturing cost includes cost of ingredients, cost of wrapping and the material cost of the container.
The supplier wants to minimize the manufacturing cost. Suggest which option of the container should he use and find the manufacturing cost. Justify your answer with working.

Option 1: Cylindrical shape container	Option 2: Conical shape container
	
Cost of container = 0.08 cents per cm^2	Cost of container = 0.11 cents per cm^2
Cost of ingredients for one chocolate = 13 cents	

Answer

~ End of Section B ~

[6]

Fairfield Methodist School (Secondary)
Mathematics
Secondary 2 Express
Marking Scheme Section A

No	Workings	Description	Marks allocation	AO
1	$4(3-x)^2 - x(2-3x)$ $= 4(9-6x+x^2) - 2x+3x^2$ $= 36-24x+4x^2-2x+3x^2$ $= 7x^2-26x+36$	Expand $(3-x)^2$ correctly	M1 A1	AO1
2	$PQ^2 + QR^2 = 11^2 + 59^2$ $= 3602$ $PR^2 = 61^2$ $= 3721$ Since $PQ^2 + QR^2 \neq PR^2$, ΔPQR is not a right-angled triangle.	M1 for working out $PQ^2 + QR^2$ and PR^2 separately A1 Conclusion (no A1 mark if they write (Converse of Pythagoras Theorem))	M1 A1	AO3
3a	$\text{Percentage} = \frac{4}{16} \times 100\%$ $= 25\%$		B1	AO2
3b	- There is a gap between 5 and 8 story books. - The highest value of 8 story books deviates considerably from other values in the distribution. Hence, 8 story books is an outlier, which will increase the mean number of story books.	Any one of these points [B1]	B1	AO3
4a	$10 - 5x \leq -14 + 3x$ $-5x - 3x \leq -14 - 10$ $-8x \leq -24$ $x \geq \frac{-24}{-8}$ $x \geq 3$		M1 A1	AO1
4b	Smallest integer that is a perfect square and a perfect cube = 64		B1	AO2
5a	$\text{Mean} = \frac{50 \times 10 + 150 \times 10 + 250 \times 30 + 350 \times 36 + 450 \times 14}{100}$ $= \frac{28400}{100}$ $= 284$		M1 A1	AO1
5b	$\frac{30+36+14}{100} = \frac{4}{5}$		B1	AO2

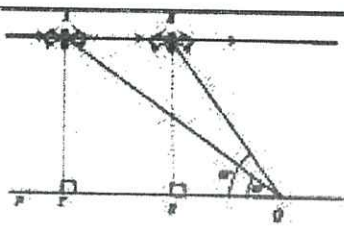
No	Workings	Description	Marks allocation	AO
6	$\frac{u}{\sqrt{v}} = w^2 + u$ $\frac{\sqrt{v}}{u} = \frac{1}{w^2 + u}$ $\sqrt{v} = \frac{u}{w^2 + u}$ $v = \left(\frac{u}{w^2 + u} \right)^2$ Alternative Method: $\sqrt{v} (w^2 + u) = u$ $\sqrt{v} = \frac{u}{w^2 + u}$ $v = \left(\frac{u}{w^2 + u} \right)^2$ Alternative Method: Square both sides, $\frac{u^2}{v} = (w^2 + u)^2$ $\frac{v}{u^2} = \frac{1}{(w^2 + u)^2}$ $v = \frac{u^2}{(w^2 + u)^2}$		M1 A1 M1 A1 M1 A1	AO1
7	$(x+2)(3-x) = 0$ $(x+2) = 0 \text{ or } (3-x) = 0$ $x = -2 \text{ or } x = 3$ $\therefore a = -2$ $x\text{-coordinate of maximum point} = \frac{-2+3}{2} = 0.5$ $y\text{-coordinate of maximum point, } b = (0.5+2)(3-0.5)$ $= 6.25$		B1 B1 B1	AO2

No	Workings	Description	Marks allocation	AO
8a	Reduction Scale factor = $\frac{8}{12} = \frac{2}{3}$		B1	AO1
8b	$\frac{CD}{AB} = \frac{2}{3}$ $\frac{12}{AB} = \frac{2}{3}$ $2AB = 36$ $AB = 18\text{ cm}$		B1	AO1
9a	P (green ring) = 0		B1	AO1
9b	P (blue ring) = $\frac{8}{36} = \frac{2}{9}$ P (not a blue ring) = $1 - \frac{2}{9} = \frac{7}{9}$ <u>Alternative Method:</u> Yellow rings = 6; Blue rings = 8; Red rings = 22 P (not blue ring) = $\frac{28}{36} = \frac{7}{9}$		B1 or B1	AO1
9c	$\frac{x+8}{x+36} = \frac{3}{10}$ $10(x+8) = 3(x+36)$ $10x+80 = 3x+108$ $10x-3x = 108-80$ $7x = 28$ $x = 4$		M1 A1	AO2
10ai	$BC = DE = 8\text{ cm}$		B1	AO1
10aii	$BD = AB = 15\text{ cm}$ $CD = 15 - 8$ $= 7\text{ cm}$		B1	AO1
10b	Area of triangle BDE = 45 cm^2 Let shortest distance between point E and BD be $h\text{ cm}$. $\frac{1}{2} \times b \times h = 45$ $\frac{1}{2} \times 15 \times h = 45$ $h = \frac{45}{7.5}$ $= 6\text{ cm}$		M1 A1	AO2

No	Workings	Description	Marks allocation	AO
11a	1 cm rep 20,000 cm 1 cm rep 0.2 km 157 cm rep 157×0.2 km = 31.4 km	Convert to km for scale	M1 A1	AO1
11b	0.2 km rep 1 cm $0.2 \times 0.2 = 0.04$ km ² rep 1 cm ² 5 km ² rep $\frac{5}{0.04} = 125$ cm ² Area of farm on map is 125 cm ²	Area scale	M1 A1	AO2
12a	$6xy - 21y + 8x^2 - 28x$ $= 3y(2x - 7) + 4x(2x - 7)$ $= (2x - 7)(3y + 4x)$	[M1] 1 st grouping	M1 A1	AO1
12b	$\frac{4x^2 - 49}{6xy - 21y + 8x^2 - 28x}$ $= \frac{(2x + 7)(2x - 7)}{(2x - 7)(3y + 4x)}$ $= \frac{2x + 7}{3y + 4x}$	M1 for factorise numerator	M1 A1	AO1

No	Workings	Description	Marks allocation	AO
14a	Graph B		B1	AO2
14b	$R = \frac{k}{x^2}$, where k is a constant and $k \neq 0$ when $x=5$, $R = 10$, $10 = \frac{k}{5^2}$ $k = 250$ $\therefore R = \frac{250}{x^2}$		B1 B1	AO1
14c	When x is halved, • R will increase to 4 times of its original value • R will increase by 300% or percentage increase = 300% • R will increase to 400% of its original value.	Any one of the following answer	B1	AO2

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Marking Scheme Section B

No	Workings	Description	Marks allocation	AO	
1(a)	Median = $\frac{156+166}{2} = 161$		B1	AO1	
1(b)	Modal weight = 154 g		B1	AO1	
1(c)	There is an <u>outlier weight</u> of an orange of 205 g which <u>will increase/change/affect</u> the mean weight of oranges. This result in the mean being inaccurate. OR The distribution of the data shows that most oranges weigh between 142g and 175g, with no oranges weighing between 180g and 200g. <u>This suggests the data is skewed</u>, which also makes the mean less representative.	Must indicate outlier 205 g and how it affects the mean	B1	AO2	
2(a)	$\frac{x+1}{x^3} \div \frac{5x^2-5}{10x^2}$ $= \frac{x+1}{x^3} \times \frac{10x^2}{5(x^2-1)}$ $= \frac{x+1}{x^3} \times \frac{10x^2}{5(x-1)(x+1)}$ $= \frac{2}{x(x-1)}$	M1 fully factorisation $5x^2-5$ $= 5(x-1)(x+1)$	M1 A1	AO1	
2(bi)	$(5x-y)(x-y)$		B1	AO1	
2(bii)	$(5x-y)(x-y) = 0$ $5x-y = 0$ or $x-y = 0$ $y = 5x$ or $y = x$ $\frac{y}{x} = 5$ or $\frac{y}{x} = 1$	For both answer	B1	AO2	
3(a)	Distance of $AB = 72 \text{ km/h} \times \frac{10}{60} h$ $= 12 \text{ km}$		B1	AO1	
3(b)	$AB = TR = 12 \text{ km}$ Let $x \text{ km}$ be the distance RQ. Let $h \text{ km}$ be the height BR and AT. In $\triangle QBR$, $\tan 60^\circ = \frac{h}{x} \rightarrow h = x \tan 60^\circ \text{ ----- (1)}$ In $\triangle AQT$, $\tan 40^\circ = \frac{h}{(12+x)} \rightarrow h = (12+x) \tan 40^\circ \text{ ----- (2)}$		M1 form either eqn (1) or eqn 2	M1	AO3

No	Workings	Description	Marks allocation	AO
	$(1) = (2),$ $(12 + x) \tan 40^\circ = x \tan 60^\circ$ $12 \tan 40^\circ + x \tan 40^\circ = x \tan 60^\circ$ $10.069 + 0.8390x = 1.73205x$ $0.8390x = 10.069$ $x = 11.275$ <i>Sub</i> $x = 11.275$ into (1) $h = 11.275 \tan 60^\circ$ $h = 19.528$ $h = 19.53$ (correct to 4 s.f)	Solve equation Make x the subject	M1 M1 AG1	
3(b) Alt. soln	$AB = TR = 12$ km Let x km be the distance RQ . Let h km be the height BR and AT . In $\triangle QBR$, $\tan 60^\circ = \frac{h}{x} \rightarrow x = \frac{h}{\tan 60^\circ}$ ----- (1) In $\triangle AQT$, $12 + x = \frac{h}{\tan 40^\circ}$ ----- (2) (2) - (1): $12 = \frac{h}{\tan 40^\circ} - \frac{h}{\tan 60^\circ}$ $12 = 1.19175h - 0.57735h$ $0.61435 h = 12$ $h = \frac{12}{0.61435}$ $h = 19.5328$ $h = 19.53$ (4 s.f.)	M1 form either eqn (1) or eqn 2 Solve equation Make h the subject	M1 M1 A1	
3(c)	In $\triangle AQT$, $\sin 40^\circ = \frac{19.53}{AQ}$ $AQ = \frac{19.53}{\sin 40^\circ}$ $= 30.383$ $= 30.4$ km (3 s.f.)	Make AQ the subject with correct trigo ratio	M1 A1	AO1
4(a)	$\frac{1}{x}$		B1	AO2
4(b)	$\frac{1}{x-8}$		B1	AO2
4(c)	1 minute can fill $\frac{1}{x-8} + \frac{1}{x}$ tank 7.5 minutes can fill 1 tank $\frac{1}{x-8} + \frac{1}{x} = \frac{1}{7.5}$	M1 form equation	M1	AO3

No	Workings	Description	Marks allocation	AO
	$\frac{x+x-8}{x(x-8)} = \frac{2}{15}$ $15(2x-8) = 2(x)(x-8)$ $30x-120 = 2x^2-16x$ $2x^2-46x+120 = 0$ $2(x^2-23x+60) = 0$ $x^2-23x+60 = 0 \text{ (Shown)}$	M1 simplify and form a quadratic equation	M1 AG1	
4(d)	$(x-20)(x-3) = 0$ $x = 20 \text{ or } x = 3$ Time taken for Pipe B = 20 - 8 = 12 minutes	M1 factorisation	M1 A1	AO2
5(a)	Height of triangle $\sqrt{24^2 + 9^2}$ $= 25.632$ $= 25.6 \text{ cm (3 s.f.)}$		M1 AG1	AO3
5(b)	Base area = $18 \times 18 = 324 \text{ cm}^2$ Area of 4 triangles/lateral faces $= \left(\frac{1}{2} \times 18 \times 25.632 \right) \times 4$ $= 922.752$ Total surface area $= 324 + 922.752$ $= 1246.752$ $= 1250 \text{ cm}^2 \text{ (3 s.f.)}$		M1 M1 A1	AO1
5(c)	<i>l</i> is the length of <i>PQ</i> $\frac{18}{24} = \frac{l}{18} \text{ (ratio of corr. sides)}$ $l = \frac{18^2}{24}$ $l = 13.5$		AG1	AO3
5(cii)	Vol. of remaining solid $= \frac{1}{3} \times (18 \times 18) \times 24 - \frac{1}{3} \times (13.5 \times 13.5) \times 18$ $= 1498.5 \text{ cm}^3$	Vol. of big cone – vol. of small cone with correct formula for vol.	M1 A1	AO1
6(a)	See last page		P2 C1	AO1
6(bi)	1200	smooth curve	B1	AO1
6(bii)	14 or 36		B1	AO1
6(c)	$x = 25$		B1	AO1

No	Workings	Description	Marks allocation	AO
7(a)	Volume of sphere = 38.8 $\frac{4}{3}\pi r^3 = 38.8$ $r = \sqrt[3]{38.8 \div \frac{4}{3} \div \pi}$ $r = 2.100$ $r = 2.10(3 \text{ s.f.})$		M1 AG1	AO3
7(b)(i)	$4\pi r^2 = 4\pi(2.100)^2$ $= 17.64\pi \text{ cm}^2$ Cost = $17.64\pi \times \\$0.01$ $= \$0.55417$ $= \$0.55 (2 \text{ d.p.})$		M1 A1	AO1
7(b)(ii)	<u>Option 1:</u> Cylindrical shape container Total surface area = $2\pi(4.5)^2 + 2\pi(4.5)(18)$ $= 202.5\pi \text{ or } 636.17$ Cost of container (Option 1) = 0.08×636.17 $= 50.89 \text{ cents} = \0.5089 <u>Option 2:</u> Conical container Slanted height = $\sqrt{15^2 + 6^2}$ $= \sqrt{261} \text{ cm or } 16.155 \text{ cm}$ Total surface area of conical container $= (\pi \times 6^2) + (\pi \times 6 \times \sqrt{261})$ $= 417.62 = 417.6 \text{ cm}^2 (4 \text{ s.f.})$ Cost of container (option 2) $= 0.11 \times 417.62$ $= 45.94 \text{ cents}$ $= \$0.4594$ Since cost of container in option 2 < cost of container in option 1, supplier choose option 2. Cost of ingredients = $12 \times 13 \text{ cent}$ $= 156 \text{ cents} = \$1.56$ Wrapping cost = 12×0.55417 $= \$6.60$ Manufacturing cost (options) $= \$1.56 + \$6.60 + \$0.4594$ $= \$8.62 (2 \text{ d.p.})$	Calculate TSA of cylinder with correct formula For cost for option 1 or option 2 Calculate TSA for cone with correct slant height and curved surface area formula Statement that is supported by reason. Calculate cost of ingredients / wrapping cost With correct conversion unit	Cy1 M1 Co1 B1 I1 Mf1	AO2

Answer 6(b)

