

MARK SCHEME

Class Index Number

Name :

METHODIST GIRLS' SCHOOL

Founded in 1887



PRELIMINARY EXAMINATION 2025 Secondary 4

Thursday

22 August 2025

MATHEMATICS Paper 2

4052/02

2 hours 15 minutes

Candidates answer on the Question Paper.

INSTRUCTIONS TO CANDIDATES

Write your name, class and index number in the spaces at the top of this page.

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.

Answer **all** the questions.

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

Omission of essential working will result in loss of marks.

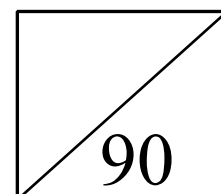
The use of an approved scientific calculator is expected, where appropriate.

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, unless the question requires the answer in terms of π

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

The total of the marks for this paper is 90.



Mathematical Formulae*Compound Interest*

$$\text{Total amount} = P \left(1 + \frac{r}{100} \right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi r l$$

$$\text{Surface area of a sphere} = 4 \pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3} \pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3} \pi r^3$$

$$\text{Area of a triangle } ABC = \frac{1}{2} ab \sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2} r^2 \theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f} \right)^2}$$

1 (a) There are 2 500 sheets of paper of the same thickness in a stack of paper.

- (i) Given that the height of the stack of paper is 25 cm, write down the thickness of a single sheet of paper in metres in standard form.

$\frac{0.25}{2500} = 0.0001$ $= 1 \times 10^{-4}$	B1
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Answer m [1]

- (ii) The stack of paper weighs 13.1 kg, correct to one decimal place. Find the minimum mass of the stack of paper.

13.05	B1
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Answer kg [1]

- (iii) The number 2500 is correct to k significant figures. State a possible value of k .

2, 3 or 4	B1
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Answer $k =$ [1]

- (b) Jim is climbing a mountain that is 4 500 metres high. The temperature at the base of the mountain is 7°C , and as he climbs, the temperature drops at a constant rate.

The temperature at the top of the mountain is 15°C lower than at the base of the mountain.

- (i) Find the temperature at the top of the mountain.

$7^{\circ}\text{C} - 15^{\circ}\text{C} = -8^{\circ}\text{C}$	B1
---	----

Answer $^{\circ}\text{C}$ [1]

- (ii) At what height during his climb does the temperature reach -2°C ?

$\frac{7 - (-2)}{15} \times 4500 = 2700$	B1
--	----

Answer m [1]

- (c) In 2023, Sandra earned 20% less than what she earned in 2022.
In 2024, she earned 15% more than what she earned in 2023.
If she earned \$49 680 in 2024, how much did she earn in 2022?

$49680 \div 1.15 \div 0.8$	M1
$= 54000$	A1

Answer \$ [2]

- 2 (a) (i) Solve the inequality $x - 4 < 5x + 1 \leq \frac{7}{2} - 2x$.

$x - 4 < 5x + 1 \leq \frac{7}{2} - 2x$		
$x - 4 < 5x + 1$	$5x + 1 \leq \frac{7}{2} - 2x$	
$4x > -5$	$7x \leq \frac{5}{2}$	
$x > -\frac{5}{4}$	$x \leq \frac{5}{14}$	M1
$-\frac{5}{4} < x \leq \frac{5}{14}$		A1

Answer [2]

- (ii) List all the integers that satisfy $x - 4 < 5x + 1 \leq \frac{7}{2} - 2x$.

-1, 0	B1
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Answer [1]

(b) $a = \frac{(b+1)^3}{4} - c^2$

(i) Find a when $b = 2$ and $c = -1$.

$a = \frac{(2+1)^3}{4} - (-1)^2$ $= \frac{27}{4} - 1$ $= \frac{23}{4}$	B1
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Answer $a = \dots\dots\dots$ [1]

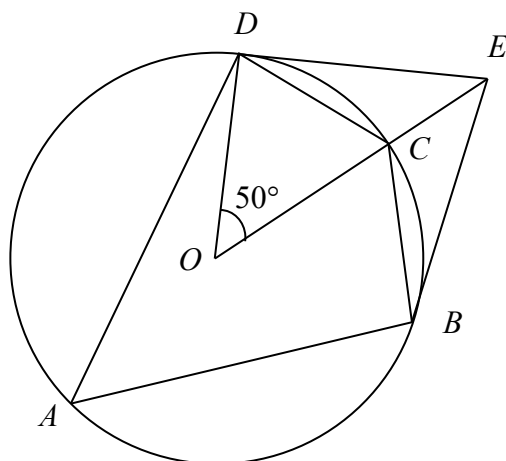
(ii) Arrange the formula to make b the subject.

$a = \frac{(b+1)^3}{4} - c^2$	
$a + c^2 = \frac{(b+1)^3}{4}$	M1
$4(a + c^2) = (b+1)^3$	M1
$b = \sqrt[3]{4(a + c^2)} - 1$	A1

Answer $b = \dots\dots\dots$ [3]

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3 (a)



A, B, C and D are points on a circle, centre O .
 EB and ED are tangents to the circle.
 Angle $DOC = 50^\circ$.

Find, giving reasons for each answer,
 (i) angle OEB ,

$\angle ODE = 90^\circ$ (tan $\perp$ rad)	M1
$\angle DEO = 180^\circ - 90^\circ - 50^\circ$ ($\angle$ sum in a Δ)	M1
$= 40^\circ$	
$\angle OEB = 40^\circ$ (tangents from ext point)	A1

Answer $^\circ$ [3]

(ii) angle DAB ,

$\angle COB = 50^\circ$ (tangents from ext. pt)	M1
$\angle DOB = 100^\circ$	
$\angle DAB = 50^\circ$ ($\angle$ at centre $= 2 \times \angle$ at circumference)	A1

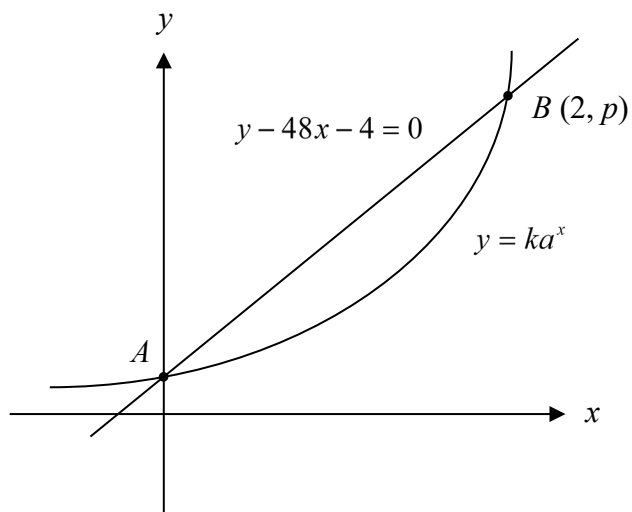
Answer $^\circ$ [2]

(iii) angle EBC .

$\angle OBC = \frac{180^\circ - 50^\circ}{2}$ (base $\angle$ s of isos Δ)	
$= 65^\circ$	
$\angle EBC = 90^\circ - 65^\circ$	
$= 25^\circ$	B1

Answer $^\circ$ [1]

(b)



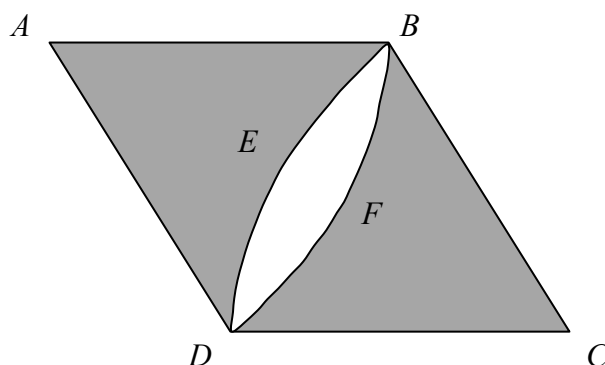
The diagram shows the graphs of $y - 48x - 4 = 0$ and $y = ka^x$. They intersect at the points A and B. A is a point on the y-axis. Find the values of k and of a .

$y - 48x - 4 = 0$	
$x = 0, y = 4$	
$A(0, 4)$	M1
$x = 2, y = 100$	
$B(2, 100)$	M1
$y = ka^x$	
$x = 0, y = 4 \quad 4 = ka^0$	
$k = 4$	A1
$x = 2, y = 100 \quad 100 = 4a^2$	
$a = 5$	A1

Answer $k = \dots\dots\dots$

$a = \dots\dots\dots$ [4]

- (c) The diagram shows a rhombus $ABCD$ such that $AB = BD = 18$ cm.
 $ABFD$ and $CBED$ are sectors of circles with centre A and C respectively.



- (i) Explain why angle $BCD = \frac{\pi}{3}$ radians.

$AB = BC = DC$ (sides of rhombus) $AB = BD$ (given) $BC = BD$ triangle BCD is an equilateral triangle $\angle BCD = \pi \div 3$ $= \frac{\pi}{3}$ radians	B1
--	----

[1]

- (ii) Calculate the area of the shaded region.

Area of rhombus $= 2 \left[\frac{1}{2} (18)^2 \sin \frac{\pi}{3} \right]$ $= 290.59$ (5 s.f.) Shaded area $= 2 \times \left[290.59 - \frac{1}{2} (18)^2 \frac{\pi}{3} \right]$ $= 222 \text{ cm}^2$ (3 s.f.)	M1 M1 A1
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Answer cm^2 [3]

- 4 (a) Complete the table of values for $y = \frac{x^2}{3} + \frac{3}{x} - 4$.

Values are given to two decimal places where appropriate.

x	0.5	1	1.5	2	3	4	5	6
y	2.08	-0.67	-1.25		0	2.08	4.93	8.5

[1]

-1.17	B1
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- (b) On the grid opposite, draw the graph of $y = \frac{x^2}{3} + \frac{3}{x} - 4$ for $0.5 \leq x \leq 6$. [3]

- (c) By drawing a tangent, find the gradient of the curve at (3,0).

Correct tangent drawn	M1
1.65, accept 1.32 to 1.98	A1

Answer [2]

- (d) (i) On the same axes, draw the line with gradient $\frac{4}{3}$ that passes through (3,2). [2]

gradient of $\frac{4}{3}$,	B1
passes through (3,2)	B1

- (ii) Write down the x -coordinate(s) of the point(s) where the line intersects the curve.

$1 \pm 0.1, 4.85 \pm 0.1$	B1
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Answer [1]

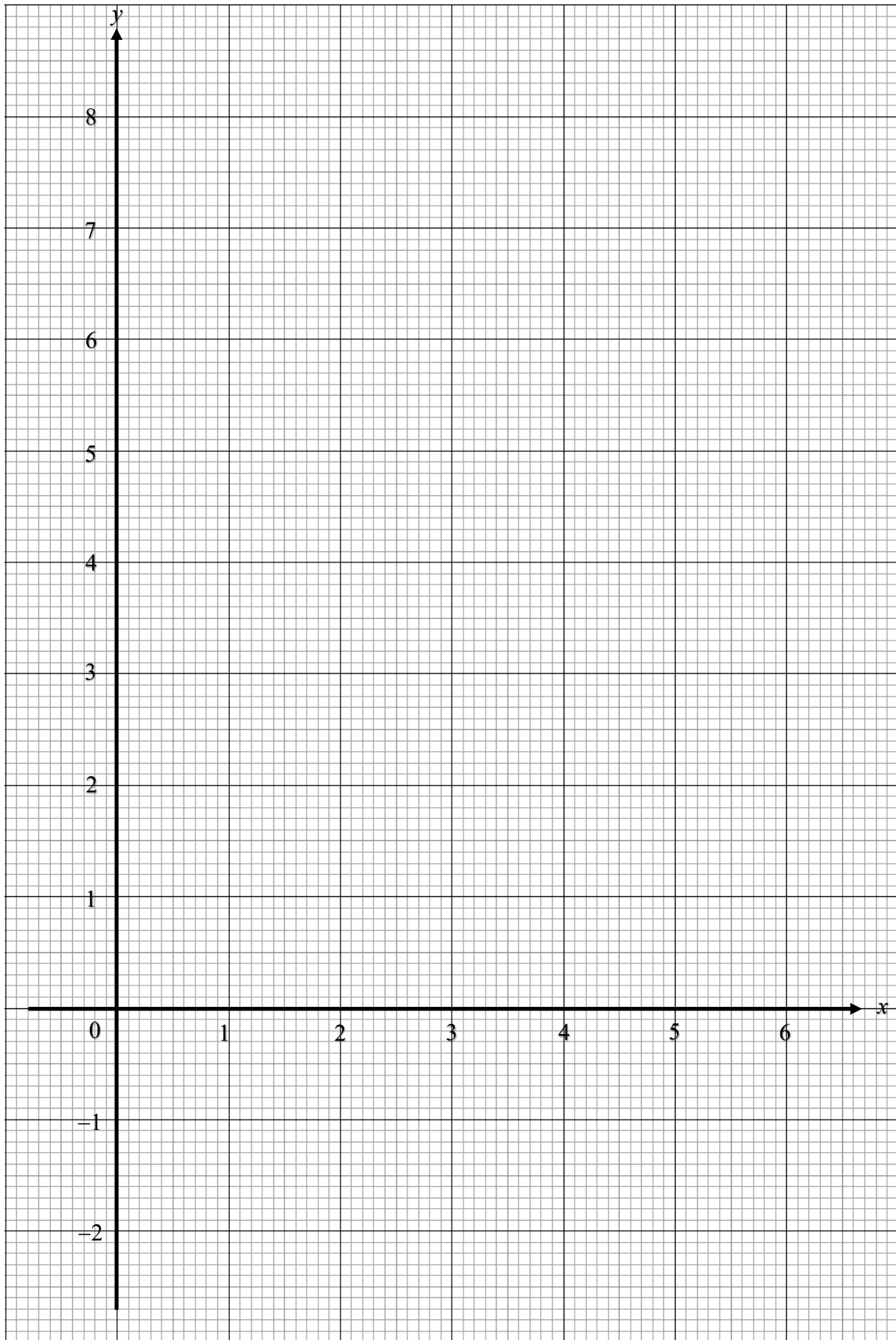
- (iii) The x -coordinate(s) of the point(s) of intersection satisfy the equation $x^3 + Ax^2 + Bx + C = 0$.
Find the values of A , B and C .

$y = \frac{x^2}{3} + \frac{3}{x} - 4$	
$y = \frac{4}{3}x - 2$	
$\frac{x^2}{3} + \frac{3}{x} - 4 = \frac{4}{3}x - 2$	M1
$x^3 + 9 - 12x = 4x^2 - 6x$	
$x^3 - 4x^2 - 6x + 9 = 0$	M1
$A = -4, B = -6, C = 9$	A1

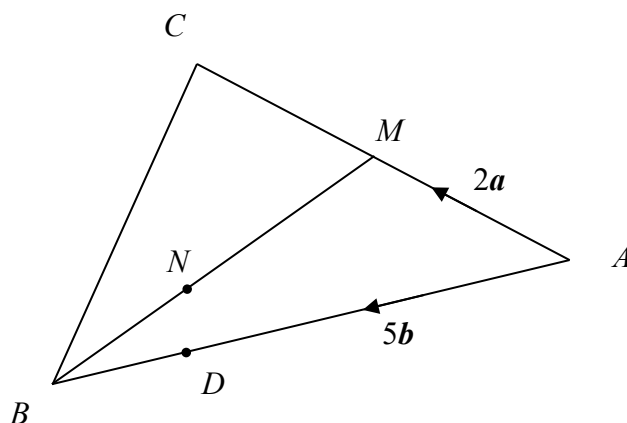
Answer $A =$

$B =$

$C =$ [3]



5 (a)



In the diagram, ABC is a triangle such that $\overrightarrow{AB} = 5b$ and $\overrightarrow{AC} = 2a$.

It is given that $\frac{BD}{DA} = \frac{1}{4}$, $\overrightarrow{BN} = \frac{1}{3}\overrightarrow{BM}$ and M is the midpoint of AC .

(a) Write each of the following as simply as possible in terms of a and b ,

(i) $\overrightarrow{AD}$,

$\overrightarrow{AD} = 4b$	B1
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Answer [1]

(ii) $\overrightarrow{BM}$,

$\overrightarrow{BM} = a - 5b$	B1
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Answer [1]

(iii) $\overrightarrow{CD}$.

$\overrightarrow{CD} = -2a + 4b$	B1
----------------------------------	----

Answer [1]

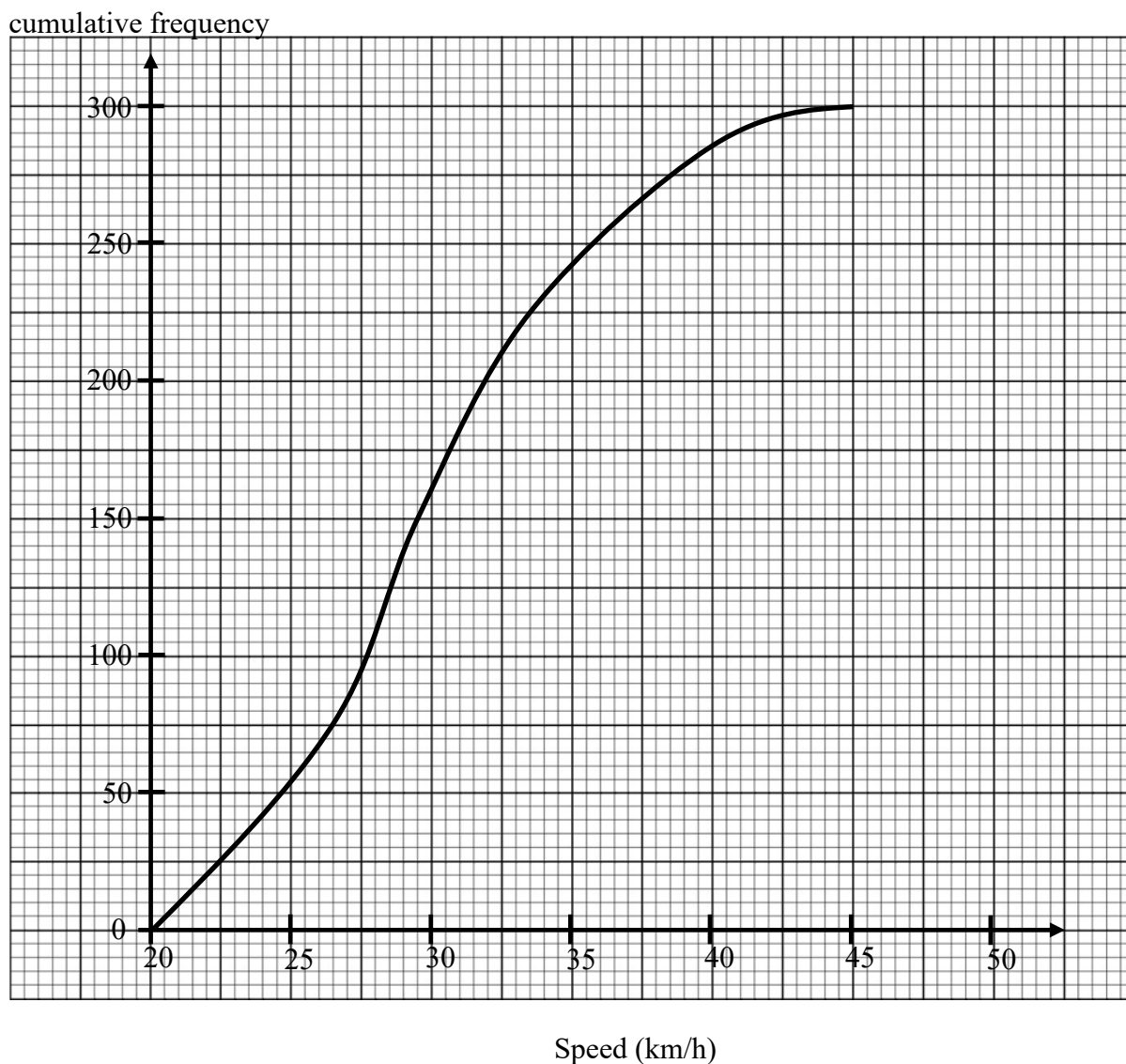
- (b) Show that $\overrightarrow{CN} = \frac{5}{3}(2b - a)$. [2]

$\overrightarrow{CN} = \overrightarrow{CM} + \overrightarrow{MN}$	
$= -a + \frac{2}{3}(5b - a)$	M1
$= -a + \frac{10}{3}b - \frac{2}{3}a$	
$= -\frac{5}{3}a + \frac{10}{3}b$	
$= \frac{5}{3}(2b - a)$	A1

- (c) Explain why C , N and D lie in a straight line. [2]

$\overrightarrow{CD} = 2(2b - a)$	
$\overrightarrow{CN} = \frac{5}{3}(2b - a)$	
$\overrightarrow{CN} = \frac{5}{3} \left[\frac{1}{2}(2b - a) \right]$	
$= \frac{5}{6}(2b - a)$	
$= \frac{5}{6}\overrightarrow{CD}$	M1
Since $\overrightarrow{CN} = \frac{5}{6}\overrightarrow{CD}$, and C is a common point,	
$\therefore C, N$ and D lie in a straight line.	A1

- 6 (a) The cumulative frequency curve shows the distribution of the speeds of 300 cars passing a road on a particular morning.



- (i) Use the curve to estimate

- (a) the median speed,

29.5	B1
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Answer km/h [1]

- (b) the interquartile range of the speeds,

33.5 – 26.5	M1
= 7	A1

Answer km/h [2]

(c) 70th percentile.

32.5	B1
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Answer km/h [1]

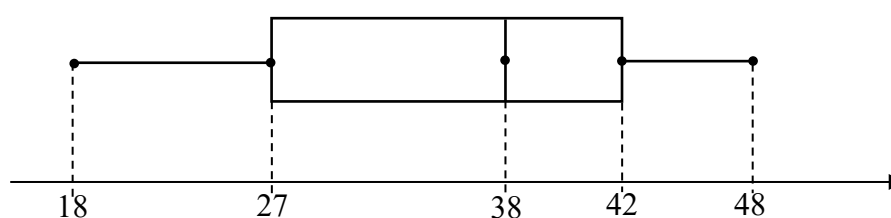
(ii) Given that 10% of the cars have a speed of more than p km/h, find the value of p .

38	B1
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Answer $p =$ [1]

(iii) The speeds of 300 cars passing the same road in the afternoon were also recorded.

The box-and-whiskers plot shows the distribution of the speeds, in km/h.



Make two comments comparing the speeds of the cars in the morning and in the afternoon.

Median speed in the morning = 29.5 km/h	B1
Median speed in the afternoon = 38 km/h	
The cars in the morning travel at a lower speed as the median speed in the lower in the morning	B1
Interquartile range in the morning = 7 km/h	
Interquartile range in the afternoon = 15 km/h	
The speeds of the cars in the morning are more consistent as the interquartile range in the morning is smaller.	

Answer

..... [2]

- (b) Ten identical cards are labelled 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 respectively. Two cards are drawn at random, one after the other, without replacement. Find the probability that

- (i) both cards picked have a number that is odd,

$\frac{5}{10} \times \frac{4}{9} = \frac{2}{9}$	B1
---	----

Answer [1]

- (ii) one card picked has a number that is odd and the other card has a number that is even,

$\frac{5}{10} \times \frac{5}{9} \times 2$	M1
$= \frac{5}{9}$	A1

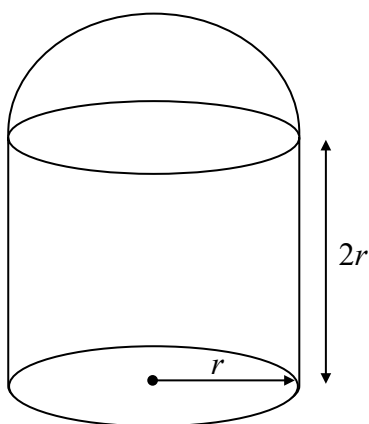
Answer [2]

- (iii) the product of the numbers on both cards is even.

$1 - \frac{2}{9}$	
$= \frac{7}{9}$	B1

Answer [1]

- 7 The diagram shows a cylindrical solid with a hemispherical top with the same radius r cm. The height of the cylinder is $2r$ cm and the volume of the solid is $576\pi \text{ cm}^3$.



- (a) Show that $r = 6$.

$\frac{2}{3}\pi r^3 + \pi r^2(2r) = 576\pi$	M1
$\frac{8}{3}r^3 = 576$	
$r^3 = 216$	M1
$r = 6$	A1

[3]

- (b) If the solid is melted to form a solid cone such that its radius and height are the same, find the total surface area of the cone.

$\frac{1}{3}\pi r_c^2(r_c) = 576\pi$	M1
$\frac{1}{3}r^3 = 576$	
$r_c^3 = 1728$	
$r_c = 12$	M1
$\pi r_c l + \pi r_c^2 = \pi(12)\sqrt{12^2 + 12^2} + \pi(12)^2$	M1
$= 1090 \text{ cm}^2$	A1

Answer cm^2 [4]

8 A water heater is programmed to heat up water in a tank to a temperature of 38°C .

- (a) In the morning, the temperature of the water before heating is 25°C .
The water heater heats up water at an average rate of $x^{\circ}\text{C}$ per minute.

Write down an expression, in terms of x , for the time taken to heat up the water.

$\frac{38-25}{x} = \frac{13}{x}$	B1
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Answer min [1]

- (b) In the afternoon, the temperature of the water before heating is 28°C .
The water heater heats up water at an average rate of $(x+2)^{\circ}\text{C}$ per minute.

Write down an expression, in terms of x , for the time taken to heat up the water.

$\frac{38-28}{x+2} = \frac{10}{x+2}$	B1
--------------------------------------	----

Answer min [1]

- (c) The difference between the time taken to heat up the water in the morning and in the afternoon is 2 minutes.

Write down an equation in x to represent this information, and show that it reduces to

$$2x^2 + x - 26 = 0.$$

$\frac{13}{x} - \frac{10}{x+2} = 2$	M1
$13(x+2) - 10x = 2x^2 + 4x$	M1
$13x + 26 - 10x = 2x^2 + 4x$	
$2x^2 + x - 26 = 0$	A1

[3]

- (d) Solve the equation $2x^2 + x - 26 = 0$, giving your answers to two decimal places.

$2x^2 + x - 26 = 0$	
$x = \frac{-1 \pm \sqrt{1^2 - 4(2)(-26)}}{2(2)}$	M2
$= 3.36 \text{ or } -3.86$	A1

Answer [3]

- (e) Find the time taken to heat up the water in the morning.
Give your answer in minutes and seconds, correct to the nearest second.

$\frac{13}{3.36} = 3.869 \text{ min} \times 60 \text{ s}$ $= 3 \text{ min } 0.869 \times 60 \text{ s}$ $= 3 \text{ min } 52 \text{ s (nearest second)}$	B1
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Answer min s [1]

- 9 A is the point $(-3, -1)$ and B is the point $(5, -7)$.

Find

- (a) the equation of the line AB ,

$m = \frac{-1 - (-7)}{-3 - 5}$ $= -\frac{3}{4}$ $y - (-1) = -\frac{3}{4}[x - (-3)]$ $y = -\frac{3}{4}x - \frac{9}{4} - 1$ $y = -\frac{3}{4}x - \frac{13}{4}$	M1 A1
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Answer [2]

- (b) the value of k if the point $(k, 3k)$ lies on the line AB ,

$3k = -\frac{3}{4}k - \frac{13}{4}$ $\frac{15}{4}k = -\frac{13}{4}$ $k = -\frac{13}{15}$	M1 A1
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Answer $k =$ [2]

- (c) the value of a if the line $4y = 3ax + 4$ is parallel to the line AB .

$4y = 3ax + 4$	
$y = \frac{3a}{4} + 1$	M1
$\frac{3a}{4} = -\frac{3}{4}$	
$a = -1$	A1

Answer $a = \dots\dots\dots$ [2]

- 10 Caroline is interested to buy a new car. She has shortlisted 2 cars, which she intends to drive for 10 years. The following tables show the details of the specifications, car loans, applicable road taxes and expenditure of owning the cars.

Car	Model A	Model B
Engine Capacity (EC)/ cc	1598	1798
Power Rating (PR)/ kW	96	72
Fuel Type	Petrol	Petrol-Electric
Fuel consumption (km/L)	15.6	27
Cost	\$180 888	\$189 300
Annual maintenance fee	\$463	\$389
Car loan: Simple interest rate per annum	1.88%	2.18%

Road Tax (For Petrol Cars)	
Engine Capacity (EC) in cc	Annual Road Tax Formula
$EC \leq 600$	$\text{S\$}400 \times 0.782$
$600 < EC \leq 1,000$	$[\text{S\$}400 + \text{S\$}0.25(EC - 600)] \times 0.782$
$1,000 < EC \leq 1,600$	$[\text{S\$}500 + \text{S\$}0.75(EC - 1,000)] \times 0.782$
$1,600 < EC \leq 3,000$	$[\text{S\$}950 + \text{S\$}1.5(EC - 1,600)] \times 0.782$
Road Tax (For Electric Cars)	
Power Rating (PR) in kW	Annual Road Tax Formula
$PR \leq 7.5$	$\text{S\$}400 \times 0.782$
$7.5 < PR \leq 30$	$[\text{S\$}400 + \text{S\$}4(PR - 7.5)] \times 0.782$
$30 < PR \leq 230$	$[\text{S\$}500 + \text{S\$}7.5(PR - 30)] \times 0.782$

Road Tax (For Petrol-Electric Cars)
To find out your road tax, calculate road tax twice: first based on your car's engine capacity, then based on its Power Rating (PR). The higher amount will be the road tax you have to pay.

- a) Calculate the annual road tax payable for Model A.

$[500 + 0.75 \times (1598 - 1000)] \times 0.782$ $= 741.727$ $= 741.73 \text{ (2d.p.)}$	B1
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Answer \$ [1]

- b) Show that annual road tax payable for Model *B* is \$975.15 correct to two decimal places.

$[950 + 1.5 \times (1798 - 1600)] \times 0.782$ $= 975.154$	
$[500 + 7.5 \times (72 - 30)] \times 0.782$ $= 637.33$	M1
$975.154 > 637.33$	
Hence, road tax for Model <i>B</i> is \$975.15 (2d.p.).	A1

[2]

- c) Caroline estimates that she will travel approximately 20 000 km per year and petrol prices are at \$2.57 per litre.

Caroline owns a credit card which gives her a discount of 21% off petrol prices.
She will pay \$60 000 cash for the downpayment for the car and take a car loan for 7 years.

Assuming both car models offer comparable performance over 10 years, which car model offers better value? Justify your answer with clear working.

Model A	
$180\,888 - 60\,000 = 120\,888$	
interest = $\frac{120\,888 \times 1.88 \times 7}{100}$	M1
$= 15\,908.8608$	
$180\,888 + 15\,908.8608 = 196\,796.8608$	
petrol	
$\frac{20\,000}{15.6} \times 2.57 \times 79\% = 2\,602.948\,718$	M1
road tax and maintenance	
$741.727 + 463 = 1\,204.727$	
Total cost = $196\,796.8608 + 2\,602.948\,718 \times 10 + 1\,204.727 \times 10$	M1
$= 234\,873.618$	
$= 234\,873.62$	

For Model B	
$189300 - 60000 = 129300$ $\text{interest} = \frac{129300 \times 2.18 \times 7}{100}$ $= 19731.18$ $189300 + 19731.18 = 209031.18$	M1
petrol $\frac{20000}{27} \times 2.57 \times 79\% = 1503.925926$	M1
$975.154 + 389 = 1364.154$ Total cost = $209031.18 + 1503.925926 \times 10 + 1364.154 \times 10$ $= 237711.9793$	M1
$234873.62 < 237711.9793$ Model A offers better value	A1

Continued from previous page

End of Paper

[7]