MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
CAMBRIDGE ASSESSMENT INTERNATIONAL EDUCATION
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER | S

INDEX NUMBER

MATHEMATICS

Paper 2

Candidates answer on the Question Paper.

4052/02

October/November 2024

2 hours 15 minutes

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name 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.
DO **NOT** WRITE ON ANY BARCODES.

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.

This document consists of **19** printed pages and **1** blank page.

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

3

1 **(a)** Find all the integers that satisfy the inequality $-4 \leqslant 3 + 2x < 5$.

$$-4 \leqslant 3 + 2x < 5$$

$$-7 \leqslant 2x < 2$$

$$\frac{-7}{2} \leqslant x < 1$$

Answer $-3, -2, -1, 0.$ [3]

(b) Simplify $\dfrac{20p^3q}{7r^2} \div \dfrac{8p^2r}{21q^4}$.

$$\frac{20p^3q}{7r^2} \times \frac{21q^4}{8p^2r}$$

$$= \frac{5pq}{r^2} \times \frac{3q^4}{2r} = \frac{15pq^5}{2r^3}$$

Answer $\dfrac{15pq^5}{2r^3}$ [2]

(c) Simplify $\left(\dfrac{a^9}{64b^{12}}\right)^{-\frac{2}{3}}$.

$$= \left(\frac{64b^{12}}{a^9}\right)^{\frac{2}{3}}$$

$$= \frac{(4^3)^{\frac{2}{3}}(b^{12})^{\frac{2}{3}}}{(a^9)^{\frac{2}{3}}}$$

$$= \frac{4^2 b^8}{a^6}$$

Answer $\dfrac{16b^8}{a^6}$ [2]

(d) Write as a single fraction in its simplest form $\dfrac{x}{x+2} + \dfrac{3}{4-x} - 1$.

$$\frac{x}{x+2} + \frac{3}{4-x} - 1 = \frac{x(4-x) + 3(x+2)}{(x+2)(4-x)} - \frac{(x+2)(4-x)}{(x+2)(4-x)}$$

$$= \frac{4x - x^2 + 3x + 6 - 4x + x^2 - 8 + 2x}{(x+2)(4-x)}$$

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

Answer $\dfrac{5x-2}{(x+2)(4-x)}$ [4]

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4052/02/O/N/24

[Turn over

2   **(a)**   A cinema has three halls.
Each hall has standard seats and premier seats.

Hall 1 has 120 standard seats and 40 premier seats.
Hall 2 has 90 standard seats and 30 premier seats.
Hall 3 has 50 standard seats and 20 premier seats.

This information can be represented by the matrix $\mathbf{C} = \begin{pmatrix} 120 & 40 \\ 90 & 30 \\ 50 & 20 \end{pmatrix}$.

The ticket price for a standard seat is $12.
The ticket price for a premier seat is $15.

(i)   Represent the ticket prices in a 2×1 column matrix $\mathbf{T}$.

$$\text{Answer} \quad \mathbf{T} = \begin{pmatrix} 12 \\ 15 \end{pmatrix}$$ [1]

(ii)   Evaluate the matrix $\mathbf{M} = \mathbf{CT}$.

$$\mathbf{M} = \begin{pmatrix} 120 & 40 \\ 90 & 30 \\ 50 & 20 \end{pmatrix} \begin{pmatrix} 12 \\ 15 \end{pmatrix} = \begin{pmatrix} 120 \times 12 + 40 \times 15 \\ 90 \times 12 + 30 \times 15 \\ 50 \times 12 + 20 \times 15 \end{pmatrix} = \begin{pmatrix} 2040 \\ 1530 \\ 900 \end{pmatrix}$$

$$\text{Answer} \quad \mathbf{M} = \begin{pmatrix} 2040 \\ 1530 \\ 900 \end{pmatrix}$$ [2]

(iii)   The cinema expects to sell $\frac{3}{5}$ of each ticket type in all halls for a Monday night show.

The cinema expects to sell $\frac{9}{10}$ of each ticket type in all halls for a Saturday night show.

There is one film shown in each hall every night.

Calculate the difference between the expected takings for all halls on a Monday night and for all halls on a Saturday night.

$$\frac{9}{10} \begin{pmatrix} 2040 \\ 1530 \\ 900 \end{pmatrix} - \frac{3}{5} \begin{pmatrix} 2040 \\ 1530 \\ 900 \end{pmatrix} = \begin{pmatrix} 612 \\ 459 \\ 270 \end{pmatrix}$$

$$612 + 459 + 270 = \$1341$$

$$\text{Answer} \quad \$ \underline{\quad 1341 \quad}$$ [2]

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(b) In the first week of the month, 5075 tickets were sold.
In the second week of the month, sales decreased by 56%.

Calculate the number of tickets sold in the second week of the month.

$$\frac{44}{100} \times 5075 = 2233$$

Answer ....2233.................. [2]

(c) Each hall shows one film in the afternoon, one film in the evening and one film at night.

On a Sunday, tickets were sold in the following ratios:
afternoon tickets : evening tickets = 3 : 8
evening tickets : night tickets = 6 : 11

Find the ratio   afternoon tickets : night tickets   sold that Sunday.
Give your answer in its simplest form.

3 : 8   6 : 11
= 9 : 24   = 24 : 44

∴ afternoon : evening : night
  tickets   : tickets : tickets

9 : 24 : 44

Answer ....9......... : ....44......... [2]

3 **(a)** The equation of line L is $4y = 3x - 2$.
The equation of line M is $2y = kx + 13$, where k is a constant.
Line L and line M intersect at the point $(-4, p)$, where p is a constant.

Find the value of k and the value of p.

Since $(-4, p)$ lies on $4y = 3x - 2$,
$$4p = 3(-4) - 2$$
$$p = -3.5$$

Also, $(-4, -3.5)$ lies on $2y = kx + 13$
$$\therefore -7 = -4k + 13$$
$$4k = 20$$
$$k = 5$$

Answer $k =$ .... **5** ....

$p =$ .... **-3.5** ....

[3]

(b) X is the point $(-3, 7)$.
$$\overrightarrow{XY} = \begin{pmatrix} 5 \\ -2 \end{pmatrix}.$$

Find the equation of the line XY.

$(-3, 7)$

5 units

X

2 units

Y
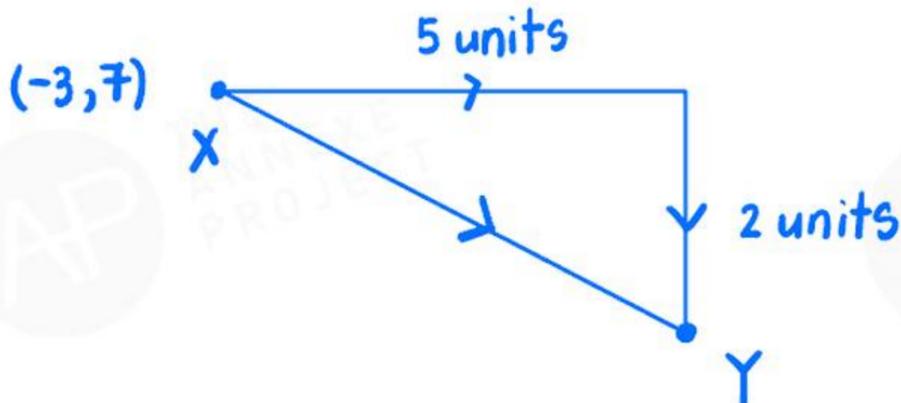
gradient of $XY = \dfrac{\text{rise}}{\text{run}}$

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

Equation of line:
$$y - 7 = -\frac{2}{5}(x + 3)$$
$$y = -\frac{2}{5}x + \frac{29}{5}$$

Answer   .... [3]

AP

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(c) A is the point $(8, a)$, where $a < 0$.
B is the point $(15, 11)$.
The length of line AB is 25 units.

Find the value of a.

$$25 = \sqrt{(15-8)^2 + (11-a)^2}$$

$$25^2 = 7^2 + (11-a)^2$$

$$(11-a)^2 = 576$$

$$11-a = \pm\sqrt{576}$$

$$11-a = \pm 24$$

$$\therefore a = -13 \text{ or } 35$$
$$\text{(rej.)}$$

Answer $a =$ ....-13.......... [3]

AP

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The suggested solutions are prepared by Mr Alvin Yeo. Mr Yeo will hold no liability for any errors.

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

x	−2	−1	0	1	2	3	4
y	**8**	−1.5	−4	−2.5	0	0.5	−4

When $x = -2$, $y = 2(-2)^2 - \dfrac{(-2)^3}{2} - 4$

$= 8$

[1]

(ii) On the grid, draw the graph of $y = 2x^2 - \dfrac{x^3}{2} - 4$ for $-2 \leqslant x \leqslant 4$.
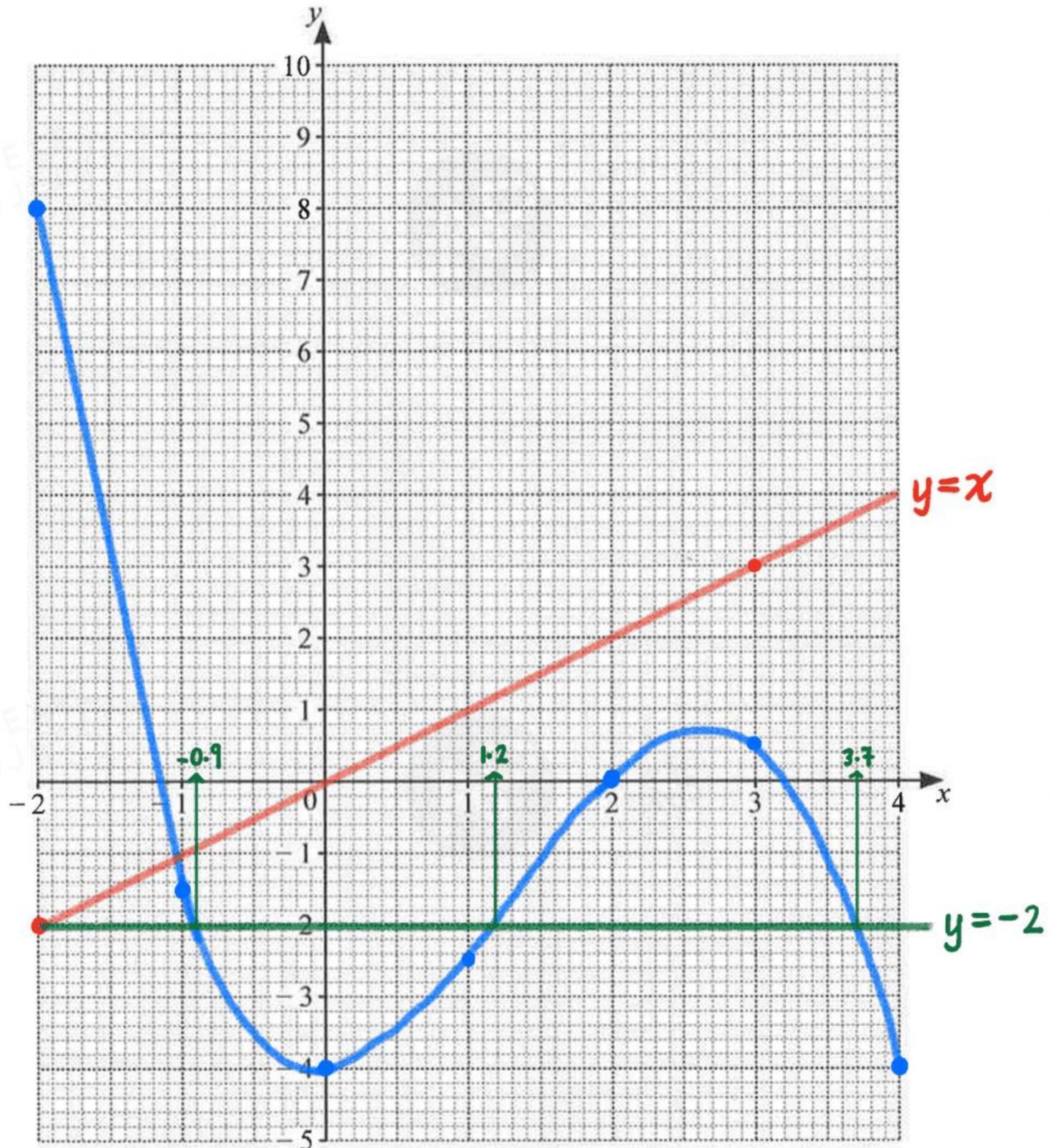
[3]

(iii) Use your graph to explain why the equation $2x^2 - \dfrac{x^3}{2} - 4 = x$ has only one solution.

The graph of $y = 2x^2 - \dfrac{x^3}{2} - 4$ and $y = x$ intersect once only.

[1]

(iv) By drawing a suitable straight line on the grid, solve the equation $4x^2 - x^3 - 4 = 0$.

$$4x^2 - x^3 - 4 = 0$$
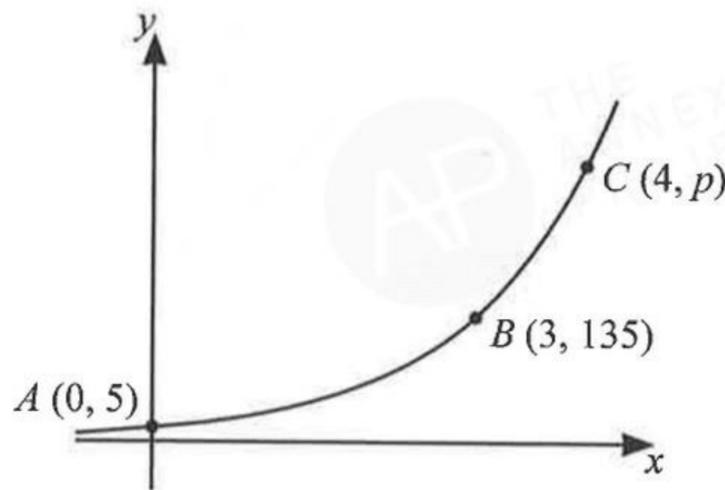$$2x^2 - \frac{x^3}{2} - 2 = 0$$
$$2x^2 - \frac{x^3}{2} - 4 + 2 = 0$$
$$2x^2 - \frac{x^3}{2} - 4 = -2$$

Draw the line $y = -2$,

Answer ......$x = -0.9,\ 1.2\ \text{and}\ 3.7$.............. [3]

(b)

The sketch shows the graph of $y = ka^x$, where $a > 0$.
The graph passes through the points $A(0, 5)$, $B(3, 135)$ and $C(4, p)$.

Find the value of p.

Sub $A(0, 5)$: $5 = ka^0$
$$\therefore k = 5$$

Sub $B(3, 135)$: $135 = 5a^3$
$$a^3 = 27$$
$$\therefore a = 3$$

Sub $C(4, p)$: $p = 5(3)^4$
$$= 405$$

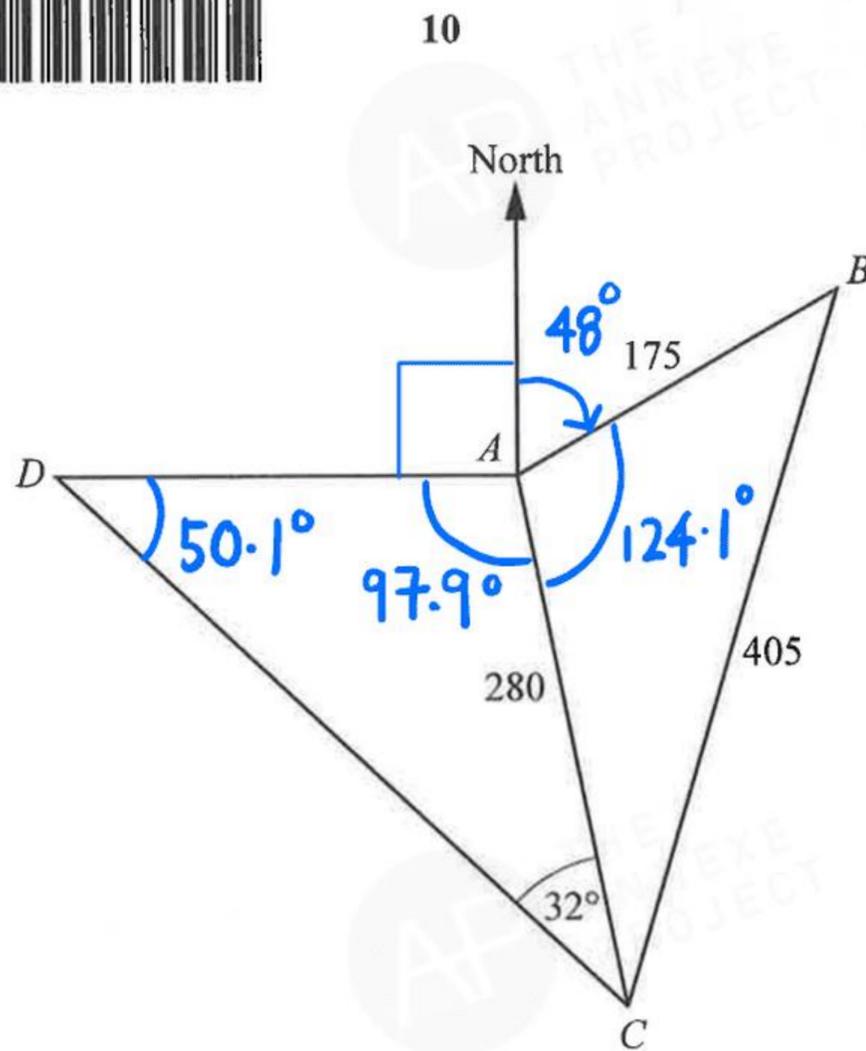*Answer* $p =$ ....**405**........... [3]

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The suggested solutions are prepared by Mr Alvin Yeo. Mr Yeo will hold no liability for any errors.

North

48° 175

B

A

D

50.1°

97.9°

124.1°

280

405

32°

C

Points A, B, C and D are on horizontal ground.
$AB = 175\,\text{m}$, $AC = 280\,\text{m}$, $BC = 405\,\text{m}$ and angle $ACD = 32°$.

B is on a bearing of $048°$ from A.
D is due west of A.

(a) Show that angle $BAC = 124.1°$, correct to one decimal place.

Answer

Cosine Rule :

$$405^2 = 280^2 + 175^2 - 2(280)(175)\cos BAC$$

$$\cos BAC = -\frac{55}{98}$$

$$\angle BAC = 124.1405$$
$$= 124.1° \quad (\text{shown})$$

[3]

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(b) Calculate *AD*.

$$\angle DAC = 360° - 90° - 48° - 124.1°$$
$$= 97.9° \text{ (sum of } \triangle)$$
$$\therefore \angle ADC = 180° - 97.9° - 32° = 50.1°$$

Sine Rule: $\dfrac{AD}{\sin 32°} = \dfrac{280}{\sin 50.1°}$

$$AD = 193.41 = 193 \text{ m (3 s.f.)}$$

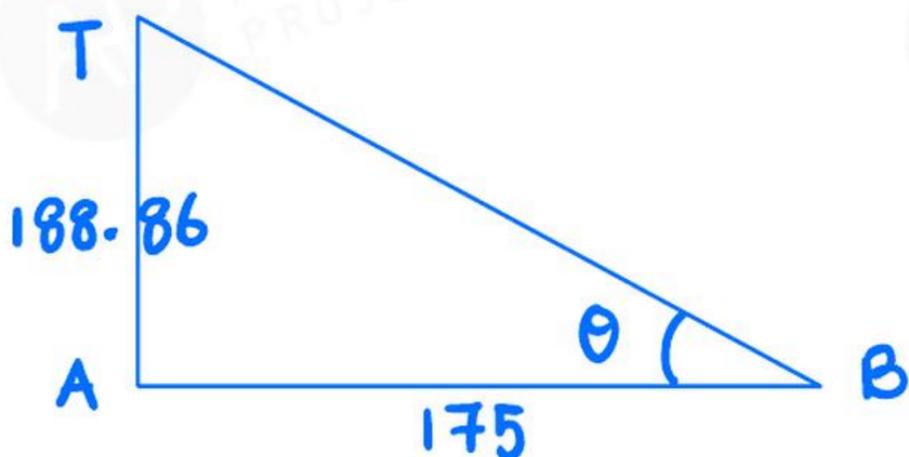Answer ....193.................... m [3]

(c) Point *A* is the base of a vertical mast *AT*.
The angle of elevation of *T* from *C* is 34°.

Calculate the angle of elevation of *T* from *B*.
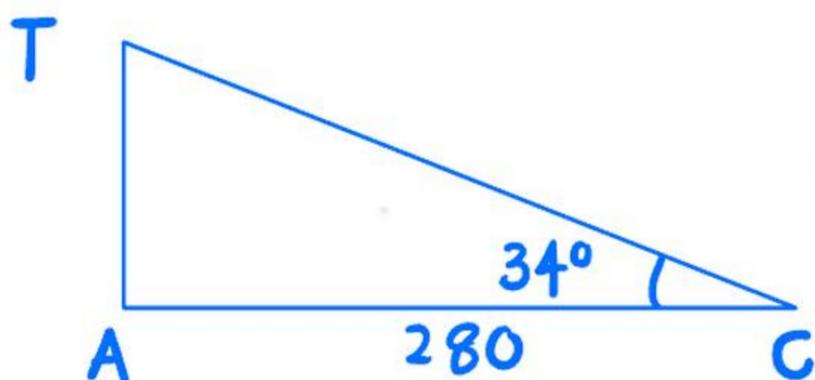
$$\tan 34° = \frac{AT}{280}$$
$$\therefore AT = 280 \tan 34°$$
$$= 188.86 \text{ m}$$

Answer ....47.2°............ [3]

$$\tan\theta = \frac{188.86}{175}$$

$$\theta = 47.2°$$

The suggested solutions are prepared by Mr Alvin Yeo. Mr Yeo will hold no liability for any errors.

6 Nadia drives the first 40 km of a journey on an expressway and the remaining 20 km on local roads.
She drives on the expressway at an average speed of x km/h.
Her average speed on the local roads is 30 km/h slower than her average speed on the expressway.

The journey takes Nadia a total of 50 minutes.

(a) Show that $x^2 - 102x + 1440 = 0$.

Answer

$$\frac{40}{x} + \frac{20}{(x-30)} = \frac{50}{60}$$

$$\frac{40(x-30) + 20x}{x(x-30)} = \frac{5}{6}$$

$$6(60x - 1200) = 5(x^2 - 30x)$$

$$360x - 7200 = 5x^2 - 150x$$

$$5x^2 - 510x + 7200 = 0$$

$$x^2 - 102x + 1440 = 0 \quad (\text{shown})$$

[5]

(b) Solve the equation $x^2 - 102x + 1440 = 0$.

Give your solutions correct to two decimal places.

$$x = \frac{-(-102) \pm \sqrt{(-102)^2 - 4(1440)}}{2}$$

$$= \frac{102 \pm \sqrt{4644}}{2}$$

$$= 16.93 \quad \text{or} \quad 85.07$$

Answer $x =$ ...**16.93**... or $x =$ ...**85.07**... [3]

The suggested solutions are prepared by Mr Alvin Yeo. Mr Yeo will hold no liability for any errors.

(c) Explain why one of the solutions in **part (b)** must be rejected.

$x = 16.93$ has to be rejected, because if $x = 16.93$ km/h, then Nadia's speed on the local roads will be a negative. [1]

(d) Calculate the difference between the times Nadia spent driving on the expressway and driving on local roads.
Give your answer in minutes and seconds, correct to the nearest second.

time on expressway $= \dfrac{40}{85.07} = 0.470$ h

time on local roads $= \dfrac{20}{85.07 - 30} = 0.363$ h

$0.470 - 0.363 = 0.107$ h
$= 6.4216$ min
$= 6$ mins 25 s

*Answer* ....**6**........ minutes ....**25**.... seconds [2]

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The suggested solutions are prepared by Mr Alvin Yeo. Mr Yeo will hold no liability for any errors.

7 **(a)** There are 120 apples in a box.
The table shows the distribution of the masses of these apples.

Mass (m g)	$60 < m \leqslant 80$	$80 < m \leqslant 100$	$100 < m \leqslant 120$	$120 < m \leqslant 140$	$140 < m \leqslant 160$
Frequency	8	21	27	46	18

(i) Find the interval that contains the median mass.

Answer ...120... $< m \leqslant$ ...140... [1]

(ii) Calculate an estimate of the mean mass.

$$\frac{(8 \times 70) + (21 \times 90) + (27 \times 110) + (46 \times 130) + (18 \times 150)}{120} = 117.5$$

Answer ...117.5... g [1]

(iii) Calculate an estimate of the standard deviation of the masses.

Answer ...22.7... g [1]

(iv) Another 80 apples are added to the box.
The estimated mean mass of the apples in the box is now 110 g.

Explain what this tells you about the masses of the apples added to the box.

They have an estimated mean mass of less than 110g.

.... [1]

(b) The histogram shows the distribution of the masses of 150 tomatoes.

Frequency

Mass (g)
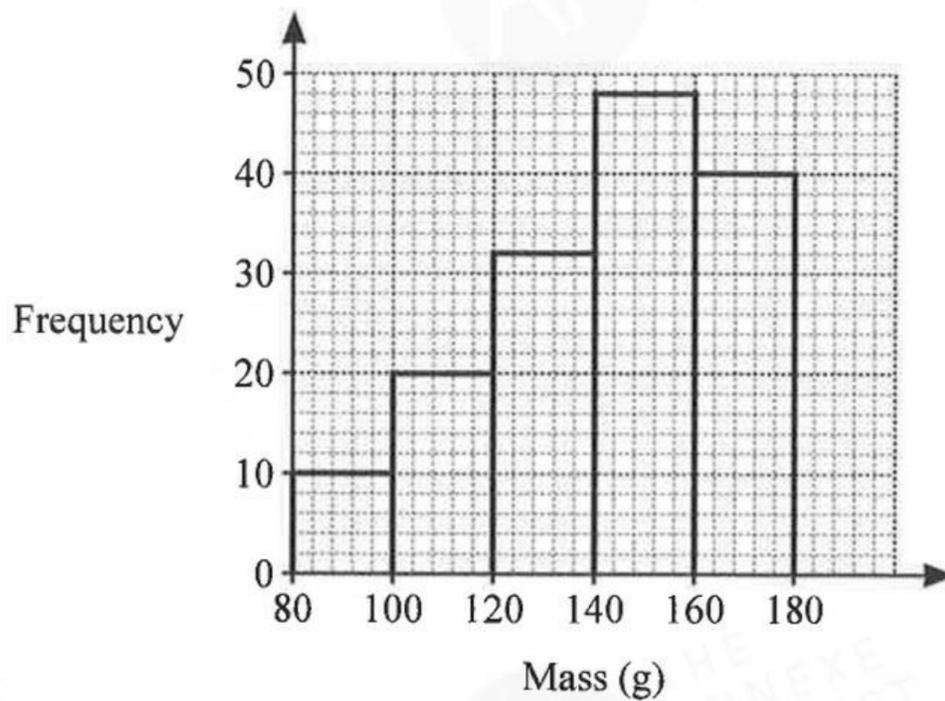
(i) Explain why the range of masses of tomatoes may not be 100 g.

It is assumed that the least mass of the tomatoes is 80kg and the maximum mass of the tomatoes is 180kg, [1] which may not be true.

(ii) One of the tomatoes is selected at random.

Find the probability that it has a mass between 120 g and 160 g.

$$\frac{32 + 48}{150} = 0.533 \text{ or } \frac{8}{15}$$

Answer .... $\frac{8}{15}$ .... [1]

(iii) Three of the 150 tomatoes are selected at random without replacement.

Find the probability that two have a mass less than 120 g and one has a mass greater than 160 g.

$$\left(\frac{30}{150} \times \frac{29}{149} \times \frac{40}{148}\right) + \left(\frac{30}{150} \times \frac{40}{149} \times \frac{29}{148}\right) + \left(\frac{40}{150} \times \frac{30}{149} \times \frac{29}{148}\right)$$

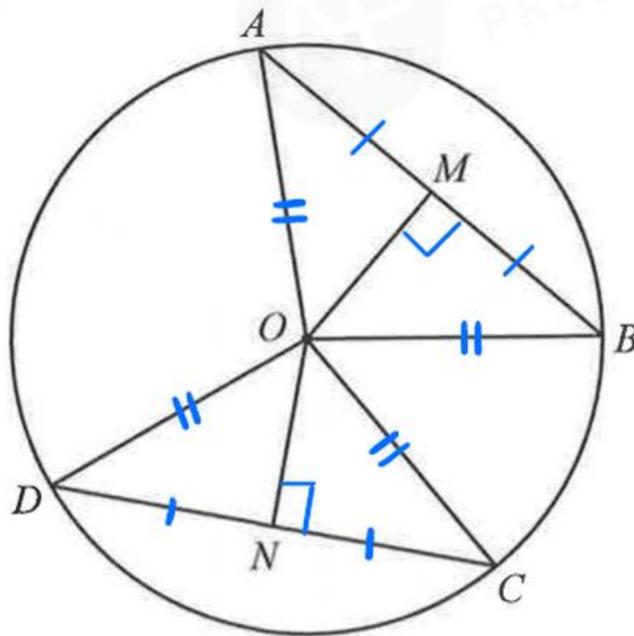$$= 0.0316 \text{ or } \frac{174}{5513}$$

Answer .... $\frac{174}{5513}$ .... [3]

The suggested solutions are prepared by Mr Alvin Yeo. Mr Yeo will hold no liability for any errors.

8 **(a)**

A, B, C and D are points on the circle, centre O.
M is the midpoint of AB and N is the midpoint of CD.
$AB = CD$.

(i) Show that triangle BMO is congruent to triangle CNO.
Give a reason for each statement you make.

$\angle OMB = \angle ONC = 90°$ (perp. bisector of chord)

$OB = OC = $ radius of circle.

Given $AB = CD$, M is midpoint of AB,

N is midpoint of CD, hence $MB = NC$

By RHS congruency test, $\triangle BMO \equiv \triangle CNO$. [3]

(ii) The radius of the circle is 4 cm and angle $COD = 1.8$ radians.

Calculate the length of the major arc AB.

$\angle COD = \angle BOA = 1.8$ rad.
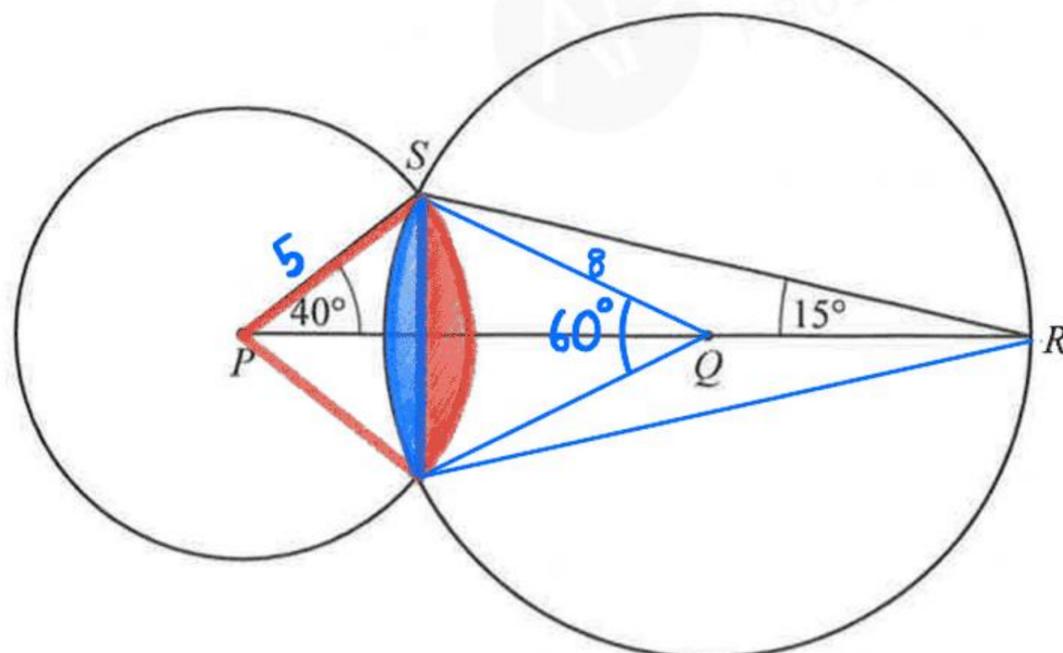
reflex $\angle BOA = 2\pi - 1.8 = 4.48$ rad.

$\overset{\frown}{AB} = 4 \times 4.48$

$= 17.9$ cm

Answer ....17.9............ cm [2]

The suggested solutions are prepared by Mr Alvin Yeo. Mr Yeo will hold no liability for any errors.

(b)

The diagram shows two circles, centres P and Q.
S is a point of intersection of the circles and PQR is a straight line.
Angle $RPS = 40°$ and angle $PRS = 15°$.
The radius of the larger circle is 8 cm and the radius of the smaller circle is 5 cm.

Calculate the shaded area.

Area of Red Segment:

$$\frac{80°}{360°} \times \pi(5)^2 - \frac{1}{2}(5)(5)\sin 80° = 5.1432 \text{ cm}^2$$

Area of Blue Segment:

$$\frac{60°}{360°} \times \pi(8)^2 - \frac{1}{2}(8)(8)\sin 60° = 5.7975 \text{ cm}^2$$

Total shaded area $= 5.1432 + 5.7975$
$$= 10.9 \text{ cm}^2$$

Answer ....10.9................ cm² [5]

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18

9   Wei starts a small business making candles.
    He makes the candles by pouring wax and fragrance oil into a mould.
    He uses a length of string as the wick.
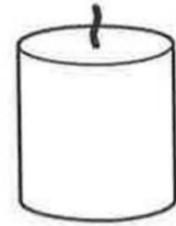
The tables below show information Wei uses to calculate the materials he needs.

Calculating materials for a candle

- Total mass of candle in grams = 0.765 × volume of mould in cubic centimetres

- Total mass of candle = mass of wax + mass of fragrance oil

- Mass of fragrance oil = 8% of mass of wax

- 1 ml of fragrance oil has a mass of 1 gram

- The wick is 5 mm longer than the height of the candle

- All masses are calculated correct to the nearest gram

Candle supplies

Item	Size	Cost
Wax	500 g	$16
	1 kg	$26
Fragrance oil	30 ml	$12
	60 ml	$22
Candle wick	10 pieces, each 15 cm long	$8

(a) Wei makes a candle using a mould in the shape of a cube with side length 5 cm.

Calculate the total mass of the candle.

$0.765 \times 5^3 = 95.625\,g$

Answer .... 95.625 .... g [2]

(b) The total mass of another candle is 150 g.

Show that the mass of wax used for this candle is 139 g.

Answer

Mass of candle = mass of wax + 8% of mass of wax

150 = 108% of mass of wax

∴ mass of wax = $\frac{150}{1.08}$ = 138.89

= 139 g (shown).

[2]

(c) Wei makes two sizes of candle using cylindrical moulds.
The cylinders are geometrically similar with diameters of 4 cm and 6 cm.
The height of the smaller cylinder is 8 cm.

Wei wants to make a small profit when he sells these candles.

Suggest a suitable amount for him to charge for each size of candle.
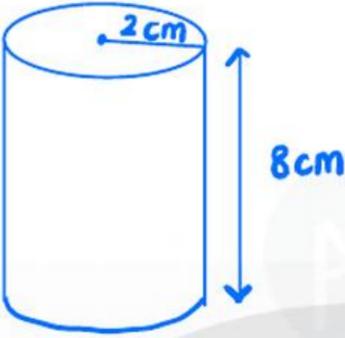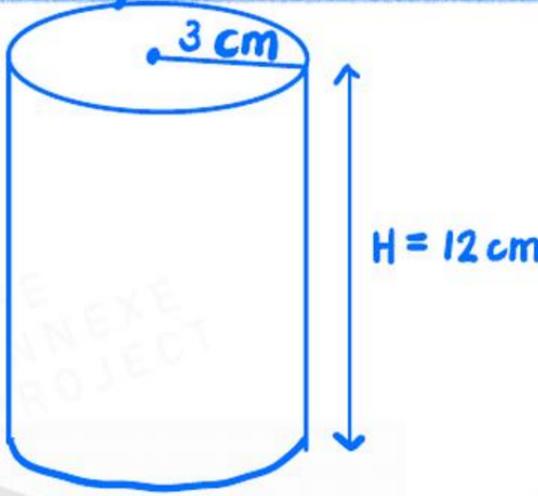Justify the decisions you make and show your calculations clearly.

(boxed note)
since the
candles are similar,
$$\frac{2}{3} = \frac{8}{H}$$
$$2H = 24$$
$$H = 12$$

Assuming Wei makes 1 of each candle only:

smaller candle — 2 cm, 8 cm

bigger candle — 3 cm, H = 12 cm

	smaller candle	bigger candle
volume of cylinder	$\pi(2)^2(8) = 32\pi$ cm^3	$\pi(3)^2(12) = 108\pi$ cm^3
mass of candle	$0.765 \times 32\pi = 76.9$ g	$0.765 \times 108\pi = 259.558$ g
mass of wax	$\frac{76.9}{108} \times 100 = 71.209$ g	$\frac{259.558}{108} \times 100 = 240.332$ g
mass of fragrance oil	$76.9 - 71.209$ $= 5.691$ g	$259.558 - 240.332$ $= 19.226$ g
length of wick	8.5 cm	12.5 cm

Cost of wax = $16   (311.54 g required)
Cost of fragrance oil = $12   (24.9 ml required)
Cost of wick = $8   (2 pieces required)

Total cost of materials to make the = $16 + $12 + $8
above 2 candles   = $36

Assuming Wei wants to make a small profit of $4, the
total selling price for both candles should be $40.   [7]

By Volume ratio, $2^3 : 3^3 = 8 : 27$

selling price of small candle = $\frac{8}{35} \times \$40 = \underline{\$9}$

selling price of big candle = $\frac{27}{35} \times \$40 = \underline{\$31}$
(nearest dollar)

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