Name: Solution	Register No.:	Class:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2025

MATHEMATICS **4052/02**
Paper 2 **26 August 2025**
2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, register 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.

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

Question	1	2	3	4	5	6	7	8	9	10
Marks	10	8	7	9	9	8	9	10	10	10

Table of Penalties		Question No.		
Presentation	–1			
Accuracy/ Units	–1		Parent's / Guardian's Signature	90

Mathematical Formulae

Compound Interest

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

Mensuration

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

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

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

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

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

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

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

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)** Solve the inequality $2-x<\dfrac{3x+4}{2}<5x-3$.

Solution:

$2-x<\dfrac{3x+4}{2}$ and $\dfrac{3x+4}{2}<5x-3$

$4-2x<3x+4$ $\quad$ $3x+4<10x-6$

$x>0$ $\quad$ $x>\dfrac{10}{7}$

$x>\dfrac{10}{7}$

Answer …………………… [3]

(b) It is given that $F=\dfrac{m(7a-2x^2)}{3a}$, where $m\neq 0$ and $a\neq 0$.

(i) Find, in terms of *a*, the value of *F* when $x=-a$ and $m=3$.

Solution:

$$F=\frac{3(7a-2(-a)^2)}{3a}$$
$$=7-2a$$

Answer $F=$ ………………… [1]

(ii) Express *x* in terms of *F*, *a* and *m*.

Solution:

$$F=\frac{m(7a-2x^2)}{3a}$$
$$7a-2x^2=\frac{3aF}{m}$$
$$x^2=\frac{7a}{2}-\frac{3aF}{2m}$$
$$x=\pm\sqrt{\frac{7a}{2}-\frac{3aF}{2m}}$$
$$=\pm\sqrt{\frac{7am-3aF}{2m}}$$

Answer $x=$ ………………… [2]

(c) Solve the equation $\dfrac{x+2}{x+5}+\dfrac{3x}{x-2}=7$.

Solution:

$$\frac{x+2}{x+5}+\frac{3x}{x-2}=7$$

$$(x+2)(x-2)+3x(x+5)=7(x+5)(x-2)$$

$$x^2-4+3x^2+15x=7(x^2+3x-10)$$

$$4x^2+15x-4=7x^2+21x-70$$

$$3x^2+6x-66=0$$

$$x^2+2x-22=0$$

$$x=\frac{-2\pm\sqrt{2^2-4(1)(-22)}}{2(1)}$$

$$=\frac{-2\pm\sqrt{92}}{2}$$

$$=3.80 \quad \text{or} \quad -5.80 \quad \text{(3sf)}$$

Answer $x =$ ………………… or ………………… [4]

2 A company conducted a survey in a girl's school and found that a user's likelihood of logging into a particular app each day depends on whether she logged in the previous day.

If the user logs in on a particular day, the probability that she logs in again the following day is 0.7.
If the user does not log in on a particular day, the probability that she does not log in the next day is 0.8.

It is given that Emily logs in on Monday.

(a) Find the probability that Emily logs in on Tuesday, Wednesday and Thursday.

Solution:

$$\begin{aligned}\text{probability} &= 0.7\times 0.7\times 0.7\\ &= 0.343\end{aligned}$$

Answer …………………… [2]

(b) Find the probability that Emily does not log in on Wednesday.

Solution:

$$\begin{aligned}\text{probability} &= (0.7\times 0.3)+(0.3\times 0.8)\\ &= 0.45\end{aligned}$$

Answer …………………… [2]

(c) Each time the user logs in, she will earn 10 reward points.
If the user does not log in, no reward points will be given.

(i) Find the probability that Emily earns exactly 20 points by Wednesday.

Solution:

$$\begin{aligned}\text{probability} &= (0.7\times 0.3)+(0.3\times 0.2)\\ &= 0.27\end{aligned}$$

Answer …………………… [2]

(ii) Find the probability that Emily earns more than 10 points by Wednesday.

Solution:

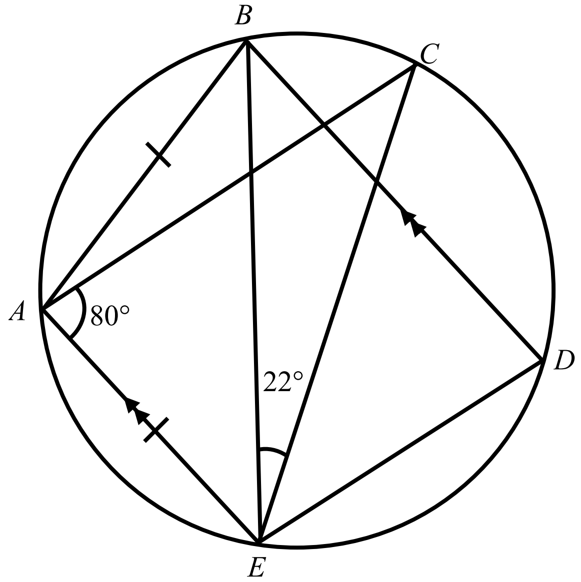
$$\begin{aligned}\text{probability} &= 1-(0.3\times 0.8)\\ &= 0.76\end{aligned}$$

or

$$\begin{aligned}\text{probability} &= 0.27+(0.7\times 0.7)\\ &= 0.76\end{aligned}$$

Answer …………………… [2]

3 A, B, C, D and E are points on a circle.
$AE = AB$, AE is parallel to BD, angle $BEC = 22°$ and angle $EAC = 80°$.



(a) Find angle AEB.

Solution:

$\angle BAC = 22°$ (angles in the same segment)

$\angle BAE = 22° + 80°$

$= 102°$

$\angle AEB = \dfrac{180° - 102°}{2}$ (base angles of isos. triangle)

$= 39°$

Answer Angle AEB = …………………… [2]

(b) Find angle DEC.

Solution:

$\angle BDE = 180° - 102°$ (angles in opp segment)

$= 78°$

$\angle AED = 180° - 78°$ (int angles, $AE // BD$)

$= 102°$

$\angle CED = 102° - 39° - 22°$

$= 41°$

Alternative Solution:

$\angle DBE = \angle BEA$ (alt angles, $AE // BD$)

$= 39°$

$\angle DEC = 180° - 39° \times 3 - 22°$ (angles in opp segment)

$= 41°$

Answer Angle DEC = …………………… [3]

(c) Angle $AFE = 78°$.

Determine the position of point F.

Justify your answer.

Solution:

$\angle ACE = 180° - 39° - 22° - 80°$ (sum of angles in triangle)

$= 39°$

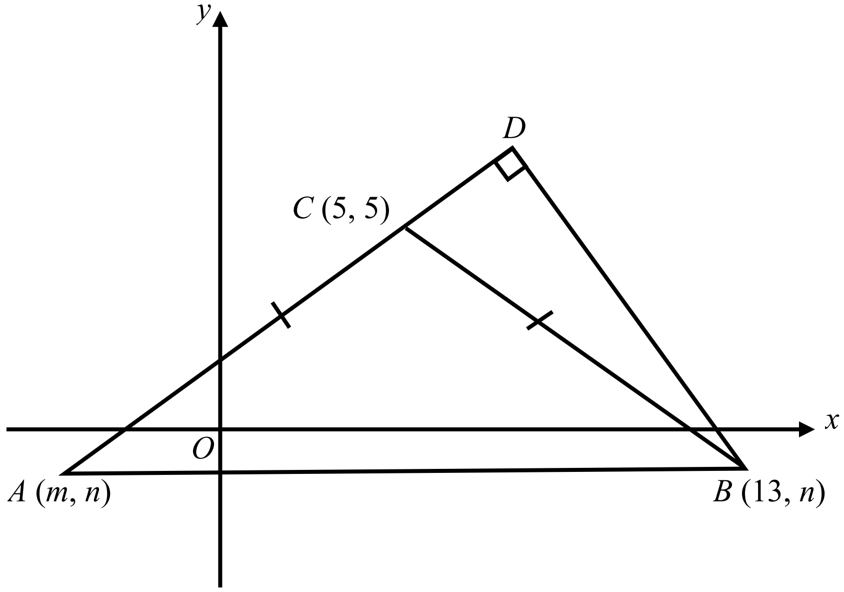
$\angle AFE = 2\angle ACE$

Point F lies on the centre of the circle.

--- [2]

4 In the diagram, BD is perpendicular to AD.

It is given that $AC = BC$ and the gradient of BC is $-\dfrac{3}{4}$.



(a) Find the equation of line BC.

Solution:

$$y - 5 = -\frac{3}{4}(x - 5)$$
$$y = -\frac{3}{4}x + \frac{35}{4}$$

Answer …………………… [2]

(b) Find the value of n.

Solution:

$$n = -\frac{3}{4}(13) + \frac{35}{4}$$
$$= -1$$

Alternative Solution:

$$\frac{5-n}{5-13} = -\frac{3}{4}$$
$$n = -1$$

Answer $n =$ ………………… [1]

(c) Show that $m = -3$.

Solution:

ΔABC is isosceles.

Points A and B are symmetrical about the vertical through C.

$$\frac{m+13}{2} = 5$$

$$m = -3$$

[1]

(d) Find the area of triangle *ABC*.

Solution:

$$\text{area of triangle } ABC = \frac{1}{2} \times 16 \times 6$$
$$= 48 \text{ units}^2$$

Answer ………………… units^2 [2]

(e) Hence, find the length of *BD*.

Solution:

$$AC = \sqrt{(5-(-3))^2 + (5-(-1))^2}$$
$$= 10 \text{ units}$$

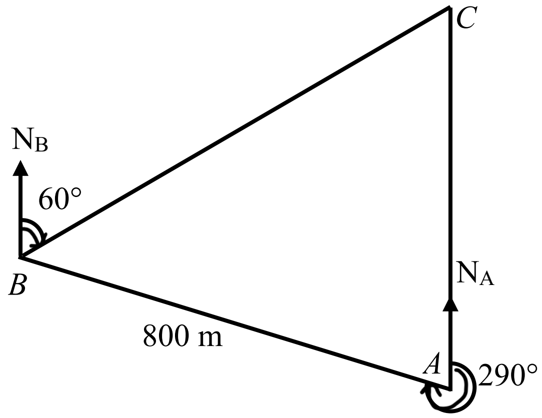
$$\frac{1}{2} \times 10 \times BD = 48$$
$$BD = 9.6 \text{ units}$$

Answer ………………… units [3]

5 A, B and C are points on the horizontal ground.
B is at a bearing of 290° and 800 m away from A.
C is due north of A and at a bearing of 60° from B.

(a) Find BC.

Solution:



$\angle BCA = 60°$ (alternate angles)

$$\frac{BC}{\sin 70°} = \frac{800}{\sin 60°}$$

$$BC = \frac{800}{\sin 60°} \times \sin 70°$$
$$= 868.05$$
$$= 868 \text{ m (3sf)}$$

Answer …………………… m [2]

(b) Show that AC is approximately 707.64 m.

Answer
Solution:

$\angle CBA = 180° - 60° - (360° - 290°)$ (sum of angles in a triangle)
$= 50°$

$$\frac{AC}{\sin 50°} = \frac{800}{\sin 60°}$$

$$AC = \frac{800}{\sin 60°} \times \sin 50°$$
$$= 707.64 \text{ m (5sf) (shown)}$$

Alternative Solution:

$\angle CBA = 180° - 60° - (360° - 290°)$ (sum of angles in a triangle)

$= 50°$

$AC = \sqrt{800^2 + 868.05^2 - 2(800)(868.05)\cos 50°}$

$= 707.64$ m (5sf) (shown)

[2]

CT is a vertical tower at C.
When Betty is at A, the angle of elevation of the top of the tower, T, is 20°.

(c) Find CT.

Solution:

$$\tan 20° = \frac{CT}{707.64}$$

$$CT = 707.64 \times \tan 20°$$

$$= 257.56 \text{ m (5sf)}$$

$$= 258 \text{ m (3sf)}$$

Answer ……………………. m [2]

(d) Find the largest angle of elevation of T as Betty walks from A to B.

Solution:

Let the perpendicular distance from C to AB be x.

$$\sin 70° = \frac{x}{707.64}$$

$$x = 707.64 \times \sin 70°$$

$$= 664.96 \text{ m (5sf)}$$

Let the largest angle of elevation of T be θ.

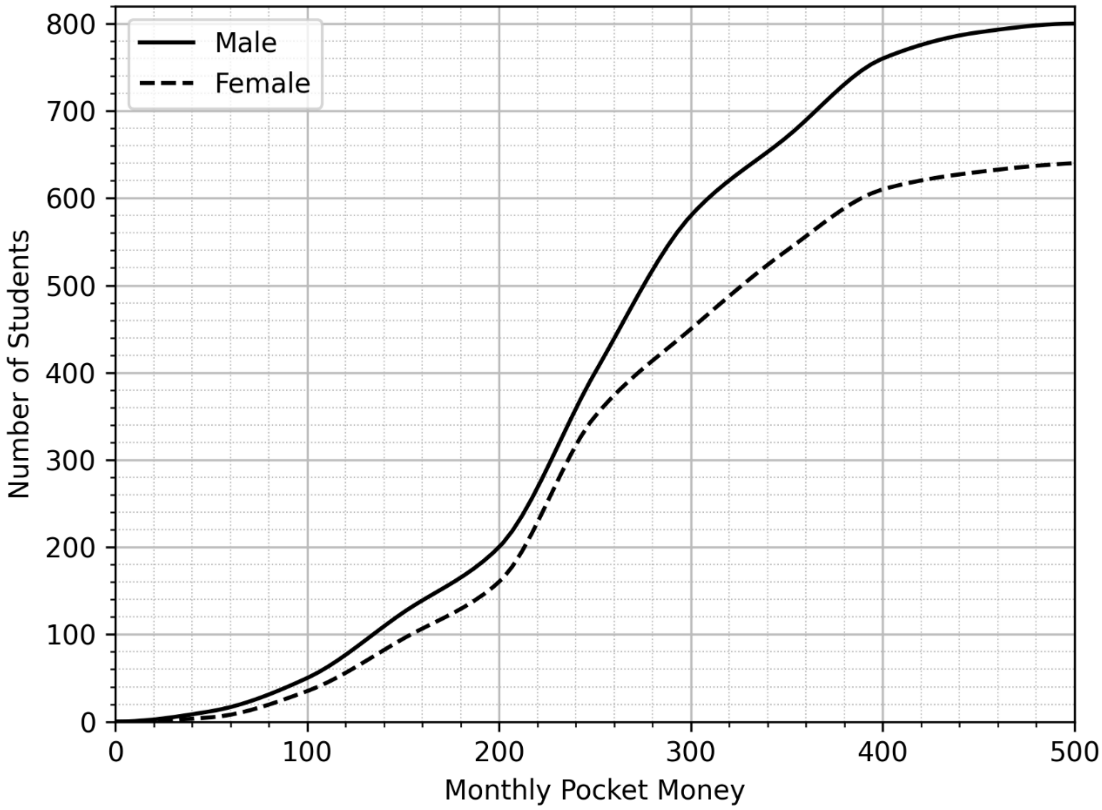
$$\tan\theta = \frac{257.56}{664.96}$$

$$\theta = \tan^{-1}\left(\frac{257.56}{664.96}\right)$$

$$\theta = 21.2°$$

Answer ……………………. [3]

6 A secondary school conducted a survey on the amount of pocket money male and female students received each month.
The cumulative frequency curves below represent the distributions of the amounts received by each group.



(a) Use the curve to estimate

(i) the median monthly pocket money the male students received,

Solution:
Median = \$250

Answer \$ ………………… [1]

(ii) the interquartile range of the monthly pocket money the male students received.

Solution:
Interquartile range = \$310 − \$200
= \$110

Answer \$ ………………… [2]

(b) Find the number of students who received more than \$300 of pocket money each month.

Solution:

Number of male students = (800 – 580) + (640 – 450)
= 410

Answer ………………… [2]

(c) Amy said, "In this survey, the percentage of male students who received above \$300 of pocket money each month is higher than the percentage of female students who received above \$300 of pocket money each month."
Do you agree with this statement?
Justify your answer.

Answer

Solution:

$$\text{Percentage of male students} = \frac{800-580}{800} \times 100\%$$
$$= 27.5\%$$
$$\text{Percentage of female students} = \frac{640-450}{640} \times 100\%$$
$$= 29.6875\%$$

I do not agree with the statement.

[2]

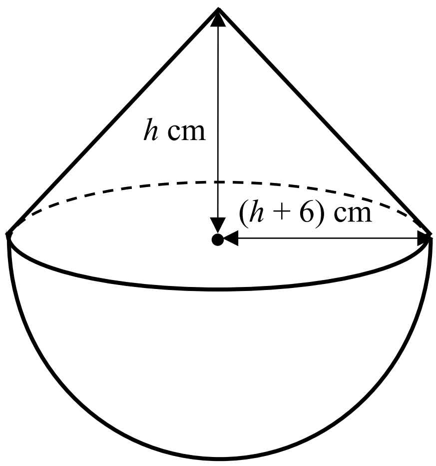
(d) The school realised that there is a mistake in the data.
One of the male student's monthly pocket money should be \$300 instead of \$250.
How does this affect the accuracy of the interquartile range of the male students' monthly pocket money?

Solution:

Upper Quartile = \$310 Lower Quartile = \$200
Both \$250 and \$300 lies within lower and upper quartiles.
This does not affect the interquartile range.

[1]

7 The figure shows a solid consisting of a right circular cone and a hemisphere.
The height and the base radius of the circular cone are h cm and $(h + 6)$ cm respectively.
The volume of the hemisphere is three times the volume of the cone.



(a) Show that $h = 12$.

Solution:

$$\frac{2}{3}\pi(h+6)^3 = 3\times\frac{1}{3}\pi(h+6)^2 h$$

$$2\pi(h+6)^3 - 3\pi(h+6)^2 h = 0$$

$$\pi(h+6)^2\left(2h+12-3h\right) = 0$$

$$\pi(h+6)^2\left(12-h\right) = 0$$

$$h = -6 \text{ (NA)} \quad \text{or} \quad 12 \text{ (shown)}$$

Answer [3]

(b) Find the total surface area of the solid giving your answer correct to the nearest cm^2.

Solution:

$$\text{slant height} = \sqrt{12^2+(12+6)^2}$$

$$= \sqrt{468}$$

$$\text{total surface area of solid} = \pi(18)\sqrt{468} + 2\pi(18)^2$$

$$= 3259 \text{ cm}^2$$

Answer ………………… cm^2 [3]

(c) Cathy buys a tin of paint that can cover a surface area of 0.5 m^2.
She cuts the solid into 2 identical parts and plans to paint all surfaces of the two parts with the can of paint.
Does she have enough paint?
Explain your answer.

Answer
Solution:

$$\text{new total surface area of solid} = \pi(18)\sqrt{468} + 2\pi(18)^2 + 2\left(\frac{36\times12}{2} + \frac{\pi(18)^2}{2}\right)$$
$$= 4709 \text{ cm}^2$$
$$= 0.4709 \text{ m}^2$$

She has enough paint.

[3]

8 A cuboid has a square base of sides x cm.
Its height is h cm and its volume is 150 cm^3.

(a) Show that the total surface area of the cuboid, $A = 2x^2 + \dfrac{600}{x}$.

Answer
Solution:

$$x^2 h = 150$$
$$h = \frac{150}{x^2}$$
$$A = 2x^2 + 4xh$$
$$= 2x^2 + 4x\left(\frac{150}{x^2}\right)$$
$$= 2x^2 + \frac{600}{x}$$

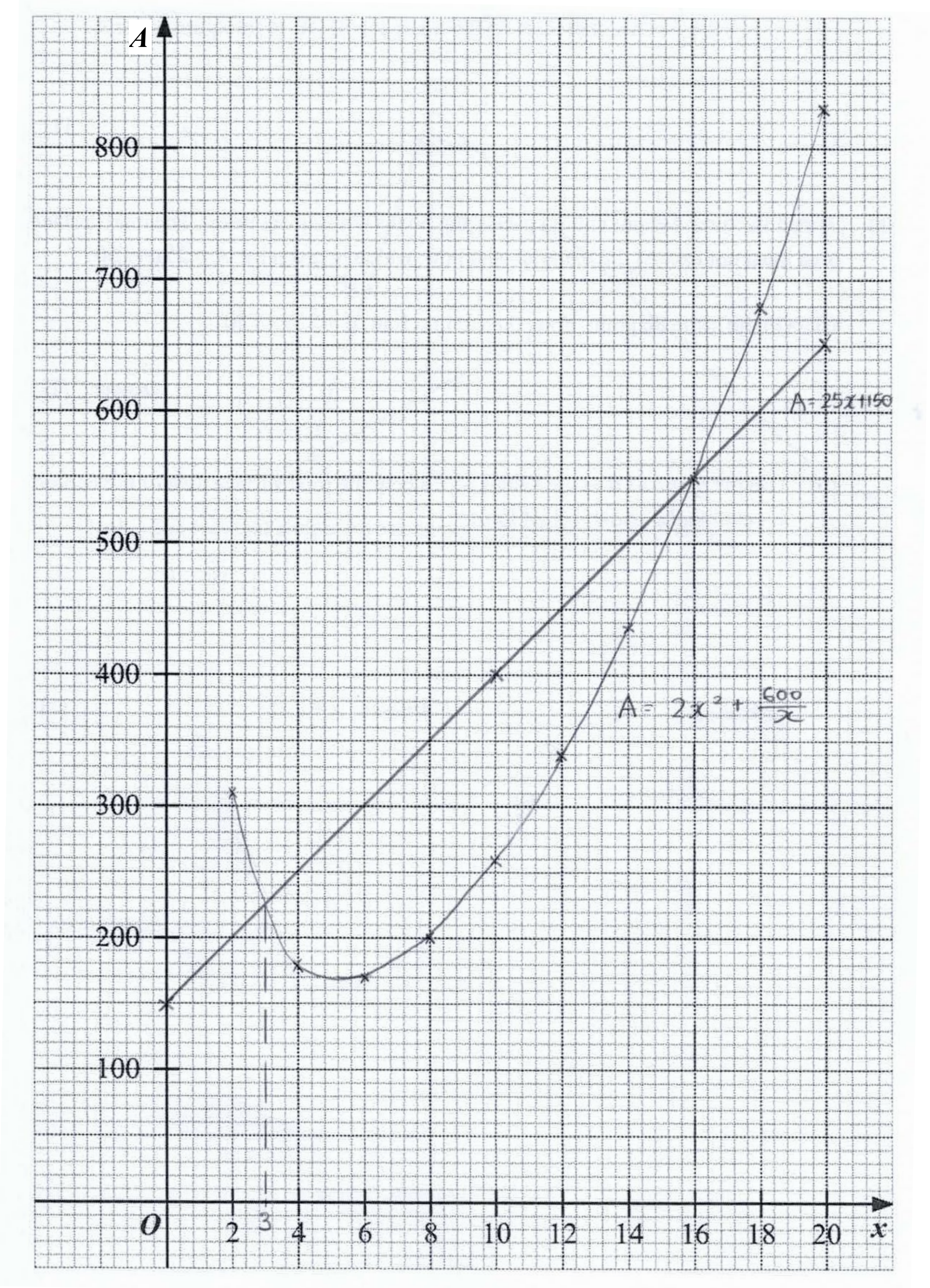
[2]

(b) Complete the table of values for $A = 2x^2 + \dfrac{600}{x}$.

x	2	4	6	8	10	12	14	16	18	20
A	308	182	172	203	260	338	435	550	681	830

[1]

(c) On the grid, draw the graph of $A = 2x^2 + \dfrac{600}{x}$ for $2 \le x \le 20$.



[3]

(d) Can the total surface area of the cuboid be 150 cm^2?
Explain your answer.

Solution:
From graph, minimum y is 170 cm^2.

Total surface area of the cuboid cannot be 150 cm^2.

--- [1]

(e) A manufacturer designs cuboid packaging boxes with square bases. The total surface area must not exceed the material cost limit which is given by $A = 25x + 150$.

(i) On the same grid, draw the straight line $A = 25x + 150$ for $2 \le x \le 20$.

Answer [1]

(ii) Use the graph to find the possible lengths of the sides of the cuboid where the material cost is maximised.

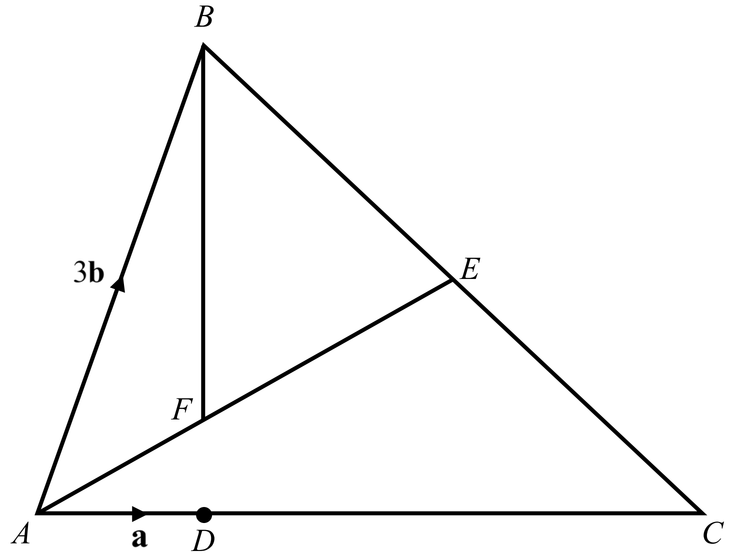
Solution:
3 or 16 [accept 2.6 – 3.4, 15.6 – 16.4]

Answer $x =$ ………… cm or ………… cm [2]

9 In the diagram, $\overrightarrow{AD} = \mathbf{a}$, $\overrightarrow{AB} = 3\mathbf{b}$ and $AD = \frac{1}{4}AC$.

E is the midpoint of BC.

F is a point on AE such that $AF = \frac{2}{3}FE$.



(a) Express and simplify your answers in terms of $\mathbf{a}$ and $\mathbf{b}$,

(i) $\overrightarrow{BC}$,

Solution:

$\overrightarrow{AC} = 4\overrightarrow{AD}$

$= 4\mathbf{a}$

$\overrightarrow{BC} = \overrightarrow{AC} + \overrightarrow{BA}$

$= 4\mathbf{a} - 3\mathbf{b}$

Answer $\overrightarrow{BC} =$ …………………… [1]

(ii) $\overrightarrow{AF}$,

Solution:

$$\overrightarrow{AE} = \overrightarrow{AB} + \overrightarrow{BE}$$
$$= 3\mathbf{b} + \frac{1}{2}(4\mathbf{a} - 3\mathbf{b})$$
$$= 2\mathbf{a} + \frac{3}{2}\mathbf{b}$$
$$\overrightarrow{AF} = \frac{2}{5}\overrightarrow{AE}$$
$$= \frac{4}{5}\mathbf{a} + \frac{3}{5}\mathbf{b}$$

Answer $\overrightarrow{AF}$ = …………………… [2]

(iii) $\overrightarrow{BF}$.

Solution:

$$\overrightarrow{BF} = \overrightarrow{BA} + \overrightarrow{AF}$$
$$= -3\mathbf{b} + \left(\frac{4}{5}\mathbf{a} + \frac{3}{5}\mathbf{b}\right)$$
$$= \frac{4}{5}\mathbf{a} - \frac{12}{5}\mathbf{b}$$

Answer $\overrightarrow{BF}$ = …………………… [1]

(b) Explain if BF produced will meet AC at D.

Answer
Solution:

$$\overrightarrow{BF} = \frac{4}{5}\mathbf{a} - \frac{12}{5}\mathbf{b} = \frac{4}{5}(\mathbf{a} - 3\mathbf{b})$$

$$\overrightarrow{BD} = \overrightarrow{BA} + \overrightarrow{AD}$$
$$= -3\mathbf{b} + \mathbf{a}$$

$$\overrightarrow{BF} = \frac{4}{5}\overrightarrow{BD}$$

The points B, F and D are collinear with common point B.
Hence, BF produced will meet AC at D.

[3]

(c) Find the value of

(i) $\dfrac{\text{area of } \Delta ABF}{\text{area of } \Delta ABE}$,

Solution:

$$\frac{\text{area of } \Delta ABF}{\text{area of } \Delta ABE} = \frac{AF}{AE}$$
$$= \frac{2}{5}$$

Answer …………………… [1]

(ii) $\dfrac{\text{area of } \Delta BEF}{\text{area of } \Delta ABC}$.

Solution:

$$\frac{\text{area of } \Delta BEF}{\text{area of } \Delta ABC} = \frac{\text{area of } \Delta BEF}{\text{area of } \Delta ABE} \times \frac{\text{area of } \Delta ABE}{\text{area of } \Delta ABC}$$
$$= \frac{FE}{AE} \times \frac{BE}{BC}$$
$$= \frac{3}{5} \times \frac{1}{2}$$
$$= \frac{3}{10}$$

…………………
Answer … [2]

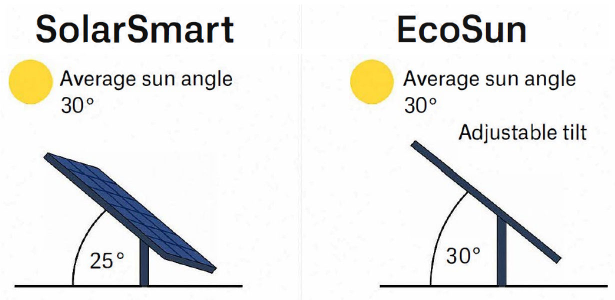
10 A secondary school is planning a major upgrade by setting up a solar panel system. The goal is to choose the system that offers the best financial value over its entire lifespan.
The school is evaluating two solar panel providers, SolarSmart and EcoSun.

School's current electricity usage:
- School uses an average of 17 000 kilowatt hours (kWh) of electricity per year.
- The cost of electricity is \$0.30 per kWh.

Information on the solar panel providers:

Company	Number of Panels	Type of Panel	Total Installation Cost	Annual Maintenance Cost
SolarSmart	50	Fixed tilt at 25°	\$66 000	\$340
EcoSun	45	Adjustable tilt	\$64 000	\$360

- Each panel's wattage is 320 Watts (W) at 100% efficiency.
- The average sun angle at the school's location is 30°.
- For every 1° difference between the panel tilt and the sun angle, the panel's efficiency drops by 1%.
- Both solar panel systems are guaranteed to last for 25 years.



Additional information:
- Singapore gets an average of 4.2 hours of peak sunlight per day.
- Solar panel output in daily watt hours = solar panel wattage × peak sunlight hours × 75%.
- The school can sell any extra energy it does not use back to the grid for \$0.20 per kWh.

(a) Calculate, in watt hours, the daily power output per panel for SolarSmart.

Solution:

daily power output per panel for SolarSmart $= \frac{95}{100} \times 320 \times 4.2 \times \frac{75}{100}$ [M1]

$= 957.6\text{Wh}$ [A1]

Answer ………………… Wh [2]

(b) Find the total daily power output from each company, leaving your answer in kilowatt hours (kWh).

Solution:

daily power output for SolarSmart $= 957.6 \times 50$

$= 47880 \text{ Wh}$

$= 47.88 \text{ kWh}$ [B1]

daily power output for EcoSun $= 320 \times 4.2 \times \frac{75}{100} \times 45$

$= 45360 \text{ Wh}$

$= 45.36 \text{ kWh}$ [B1]

Answer Daily power output for SolarSmart = ………………… kWh

Daily power output for EcoSun = ………………… kWh [2]

(c) Recommend which company the school should choose.
Justify your decision and show your calculations clearly.

Solution:

SolarSmart:

$$\begin{aligned}\text{Annual energy } &= 47.88 \text{ kW} \times 365 \\ &= 17\ 476.2 \text{ kWh}\end{aligned}$$

$$\begin{aligned}\text{net savings per year} &= 17\ 000 \times \$0.30 + 476.2 \times \$0.20 - \$340 \\ &= \$4855.24\end{aligned}$$

$$\begin{aligned}\text{total savings over 25 years} &= \$4855.24 \times 25 - \$66\ 000 \\ &= \$55\ 381\end{aligned}$$

EcoSun:

$$\begin{aligned}\text{Annual energy } &= 45.36 \text{ kW} \times 365 \\ &= 16\ 556.4 \text{ kWh}\end{aligned}$$

$$\begin{aligned}\text{net savings per year} &= 16\ 556.4 \times \$0.30 - \$360 \\ &= \$4606.92\end{aligned}$$

$$\begin{aligned}\text{total savings over 25 years} &= \$4606.92 \times 25 - \$64\ 000 \\ &= \$51\ 173\end{aligned}$$

The total savings over 25 years for SolarSmart is more than
for EcoSun.
The school should choose SolarSmart.

[5]

(d) State one assumption made in your calculation in **(c)**.

Solution:

Solar panel generates the same amount of energy every day. / 365 days in a year. / No degradation in panel performance over time / Electricity prices does not change. / Peak sunlight hours remain constant over 25 years… etc. [1]

END OF PAPER