

NAME	CLASS	INDEX NO.
MARKING SCHEME	Sec 4G3/5G2	



ST. PATRICK'S SCHOOL PRELIMINARY EXAMINATION 2024

SUBJECT : Mathematics (Revised)
4052/02

DATE : 14 August 2024

LEVEL : Secondary 4G3 & 5G2

DURATION : 2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your Name, Class, and Index No. 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** 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 of 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.

For Examiner's Use			
Type of Penalties		Question Number	90
Accuracy	-1		
	-2		
Presentation	-1		
	-2		

This paper contains 25 printed pages including this cover 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

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

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

1. (a) Solve the inequality $\frac{3-2x}{5} > \frac{1+x}{4}$.

$$\times 20, \quad 4(3-2x) > 5(1+x)$$

$$12-8x > 5+5x \quad (M1)$$

$$12-5 > 5x+8x$$

$$7 > 13x$$

$$13x < 7$$

$$x < \frac{7}{13} \quad (A1)$$

Accept:

$$\frac{7}{13} > x$$

Answer $x < \frac{7}{13}$ [2]

- (b) It is given that $F = \frac{m(V-k)^2}{r}$.

- (i) Find the value of F when $m = 2023$, $V = 0.14$, $k = -1.08$, $r = 0.348$.

$$F = \frac{2023(0.14 - (-1.08))^2}{0.348}$$

$$= 8652.394 \dots$$

$$= 8650 \text{ (3 sf)}$$

Answer $F = \dots 8650 \quad (B1)$ [1]

- (ii) Express V in terms of F , m , k and r .

$$F = \frac{m(V-k)^2}{r}$$

$$m(V-k)^2 = Fr \quad (M1)$$

$$(V-k)^2 = \frac{Fr}{m}$$

$$V-k = \pm \sqrt{\frac{Fr}{m}} \quad (M1)$$

$$\therefore V = k \pm \sqrt{\frac{Fr}{m}} \quad (A1)$$

Answer $V = \dots k \pm \sqrt{\frac{Fr}{m}} \quad (A1) \quad (A1)$ [3]

- (c) Simplify $\frac{4x^2-6x}{4x^2-9}$.

$$= \frac{2x(2x-3)}{(2x)^2 - (3)^2}$$

$$= \frac{2x(2x-3)}{(2x+3)(2x-3)} \quad (M1)$$

$$= \frac{2x}{2x+3} \quad (A1)$$

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

1

(d) Solve the equation $\frac{3}{x+1} = 5 - \frac{1}{x-2}$.

Give your solutions correct to 2 decimal places.

$$\frac{3}{(x+1)} = 5 - \frac{1}{(x-2)}$$

$$\frac{3}{(x+1)} + \frac{1}{(x-2)} = 5$$

$$\frac{3(x-2) + 1(x+1)}{(x+1)(x-2)} = 5$$

$$5(x+1)(x-2) = 3(x-2) + 1(x+1) \quad (M1)$$

$$5[x^2 - 2x + x - 2] = 3x - 6 + x + 1$$

$$5[x^2 - x - 2] = 4x - 5$$

$$5x^2 - 5x - 10 - 4x + 5 = 0$$

$$5x^2 - 9x - 5 = 0 \quad (M1)$$

$$a = (5), b = (-9), c = (-5)$$

$$x = \frac{-(-9) \pm \sqrt{(-9)^2 - 4(5)(-5)}}{2(5)}$$

$$= \frac{9 \pm \sqrt{81}}{10} \quad (M1)$$

$$x = 2.245 \dots \quad \text{or} \quad x = -0.4453 \dots$$

$$= 2.25 (2dp)$$

$$= -0.45 (2dp)$$

(A1)

Answer $x = 2.25$ or -0.45 [4]

- 2 (a) The selling price of a desktop computer is \$2388.

The hire purchase price is a deposit of \$295 and 18 equal monthly instalments of \$125 per month. Calculate the simple interest rate per annum.

$$SP = \$2388$$

$$\begin{aligned} \text{Hire purchase price} &= \$295 + 18 \times \$125 \\ &= \$2545 \end{aligned}$$

$$\begin{aligned} \text{Interest} &= \$2545 - \$2388 \\ &= \$157 \end{aligned}$$

$$\begin{aligned} \text{Loan Amt} &= \$2388 - \$295 \\ &= \$2093 \quad (M1) \end{aligned}$$

$$\begin{aligned} \text{Interest} &= \frac{PRT}{100} \\ 157 &= \frac{2093 \times R \times 18}{100} \end{aligned}$$

$$\begin{aligned} 3139.5R &= 15700 \\ R &= 5.0007\ldots \\ &= 5.00(3sf) \end{aligned}$$

Answer 5.00 (A1) % [3]

- (b) Peter took a loan of \$5000 at a rate of 0.5% per quarter compound interest.

- (i) He calculated that he will incur an interest of \$100 in the first year. Did he do his calculation correctly? Explain.

0.5% per quarter
 $\Rightarrow$ 2% per yr

SIMPLE INTEREST	COMPOUND INTEREST
$\begin{aligned} I &= \frac{PRT}{100} \\ &= \frac{\$5000 \times 2 \times 1}{100} \\ &= \$100 \end{aligned}$	$\begin{aligned} &= 5000(1 + \frac{0.5}{100})^4 - 5000 \\ &= 5100.752 - 5000 \\ &= \$100.752 \\ &> \$100 \end{aligned}$

Answer..... He did his calculation incorrectly. He used simple interest to calculate (A1) [1]

- (ii) Calculate the interest rate that he will be charged in the first year.

$$\begin{aligned} 5100.7525 &= 5000(1 + \frac{r}{100}) \\ \text{Amount} &= P(1 + \frac{r}{100})^n \\ &= 5000(1 + \frac{0.5}{100})^4 \\ &= \$5100.752 \quad (M1) \\ I &= \frac{PRT}{100} \\ 100.752 &= \frac{5000 \times R \times 1}{100} \end{aligned}$$

$$\begin{aligned} R &= 2.01504 \\ &= 2.02(3sf) \end{aligned}$$

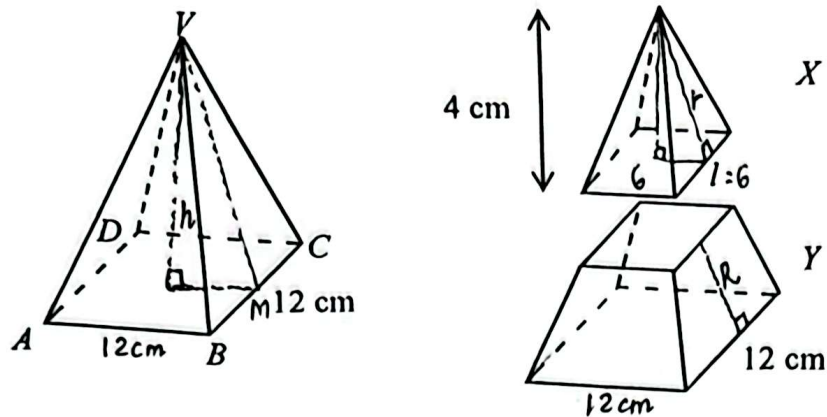
Answer 2.02 (A1) % [2]

Award ECF 1
 ans fr (bi)

3 Solid $VABCD$ is a right pyramid with a square base $ABCD$, where $AB = BC = 12$ cm.

The wooden pyramid is cut into two parts, pyramid X and frustum Y , along a plane parallel to its base.

The ratio of the volume of X to volume of Y is $1 : 7$ while the height of pyramid X is 4 cm.



(a) Show that l , the side of the square base of X is 6 cm long.

Answer:

Pyramid $VABCD$ is similar to pyramid X

$$\left(\frac{l}{12}\right)^3 = \frac{1}{1+7}$$

$$\frac{l}{12} = \sqrt[3]{\frac{1}{8}}$$

$$\frac{l}{12} = \frac{1}{2} \Rightarrow 2l = 12$$

$$l = 6 \text{ cm (shown)} \quad \text{(A1)} \quad [2]$$

(b) Find the volume of frustum Y .

OR

Vol (Big)

$$= \frac{1}{3} \times 12^2 \times 8$$

$$= 384 \text{ cm}^3$$

Vol of frustum

$$= \frac{7}{8} \times 384$$

$$= 336 \text{ cm}^3$$

$$\begin{aligned} \text{Vol of } X &= \frac{1}{3} \times (6 \times 6) \times 4 \\ &= 48 \text{ cm}^3 \quad \text{(M1)} \end{aligned}$$

$$\begin{aligned} \text{Vol } X : \text{Vol } Y \\ 1 : 7 \end{aligned}$$

$$\begin{aligned} \therefore \text{Vol of frustum } Y &= 7 \times 48 \\ &= 336 \text{ cm}^3 \end{aligned}$$

$$\text{Answer } \dots\dots\dots 336 \quad \text{(A1)} \quad \text{cm}^3 [2]$$

- (c) Frustum Y is to be painted on all its sides, at \$0.07 for every square centimetre. Calculate the total cost of painting this frustum.

Since Pyramid VABCD is similar to Pyramid X,

$$\frac{h}{4} = \frac{12}{6}$$

$$6h = 48$$

$$h = 8 \text{ cm}$$

By Pyth. Thm,

$$Vm = \sqrt{8^2 + 6^2}$$

$$= 10 \text{ cm}$$

$$r = \sqrt{3^2 + 4^2}$$

$$= 5 \text{ cm}$$

$$\therefore R = 10 - 5 = 5 \text{ cm} \quad (M)$$

$\therefore$ Total SA of frustum

$$= 4 \left[\frac{1}{2} \times (6 + 12) \times 5 \right] + (6)^2 + (12)^2$$

$$= 360 \text{ cm}^2 \quad (M)$$

$$\text{Total cost} = \$0.07 \times 360$$

$$= \$25.20 \quad (A)$$

Answer \$ 25.20 [3]

-Award 1 mark if never

solve for R and use R as '4' instead of 5

Method must be correct.

• If R is wrong after solving,
method correct & ~~is~~

- 4 The variables x and y are connected by the equation $y = 2x + \frac{16}{x} - 11$.
Some corresponding values of x and y are given in the table below.

x	1	1.5	2	2.5	3	4	5	6
y	7	2.67	1	0.4	p	1	2.2	3.67

- (a) Find the value of p , correct to 2 decimal places.

$$p = 2(3) + \frac{16}{3} - 11$$

$$= 0.3333 \dots$$

$$= 0.33 \text{ (2 dp)}$$

Answer $p = 0.33$ (B1) [1]

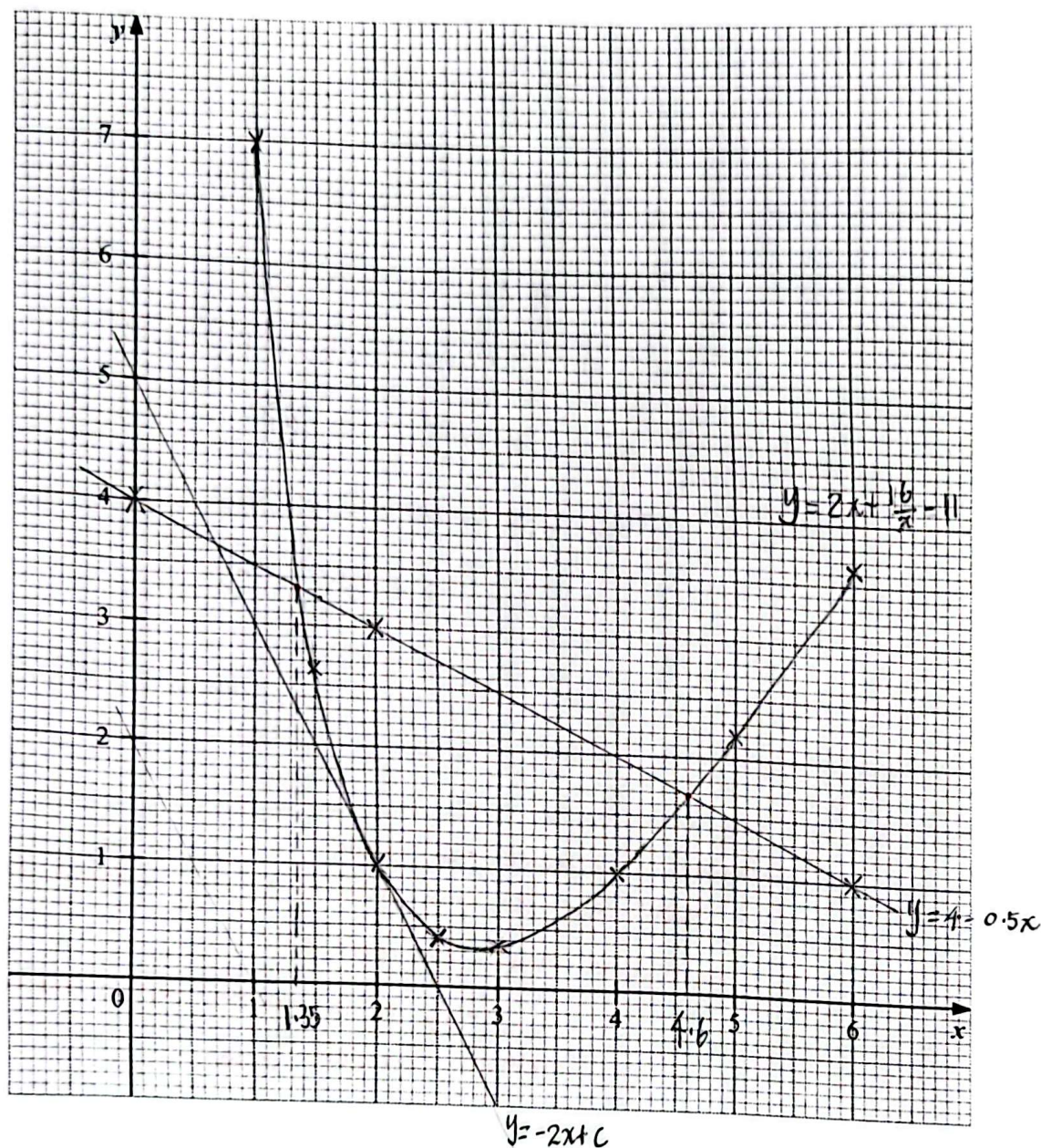
- (b) On your axes, plot the points given in the table and join them with a smooth curve. [3]

All correct points — (m1)

Smooth curve — (m1)

Label — (m1)

↓
represent curve
& line
(tangent not included)



- (c) The line $y = -2x + c$ is a tangent to the curve at T .

Use your graph to estimate the x -coordinate of T and the value of c .

tangent must be -2 (A1)
 Answer $x = 2$ (A1)
 $c = 5$ (A2) must be from the tangent line. [2]

- (d) (i) On the same axes, draw the graph of $y = 4 - 0.5x$ for $0 \leq x \leq 6$. [1]

x	0	2	6
y	4	3	1

- (ii) The x -coordinates of the points of intersection of the curve $y = 2x + \frac{16}{x} - 11$ and the line $y = 4 - 0.5x$ are the solutions of the equation $5x^2 + Ax + 32 = 0$. Find the value of A .

$$\begin{aligned}
 2x + \frac{16}{x} - 11 &= 4 - 0.5x \\
 \times x, \quad 2x^2 + 16 - 11x &= 4x - 0.5x^2 \\
 2.5x^2 - 15x + 16 &= 0 \\
 \times 2, \quad 5x^2 - 30x + 32 &= 0 \quad (M1) \\
 5x^2 + Ax + 32 &= 0
 \end{aligned}$$

By comparison, $A = -30$

Answer $A = -30$ (A1) [2]

- (iii) Hence, use your graph to solve the equation $5x^2 + Ax + 32 = 0$.

1.3 -1.4 (A2) 4.55 4.65
 Answer $x = 1.35$ or 4.6 [2]

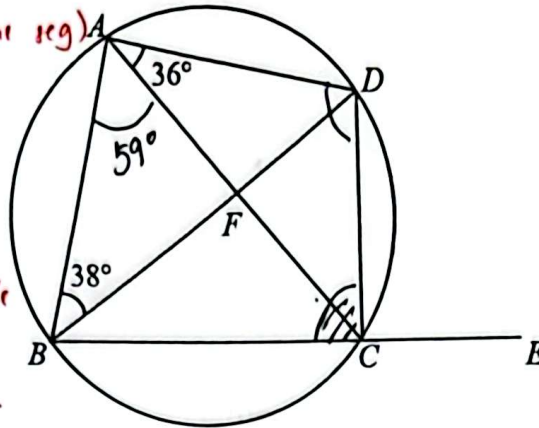
Half a small square.

OR

$$\angle DBC = 36^\circ \text{ (Is in same seg)}$$

$$\therefore \angle ABC = 38^\circ + 36^\circ \\ = 74^\circ$$

Since $\angle ABC$ is not 90° ,
using right angle in the semi circle
property, ~~can~~ AC is not
the diameter of the circle.



- (a) A, B, C and D are points on the circle. BC produced to E and BFD is a straight line. Angle ABD = 38° and angle CAD = 36° .

- (i) Justify with reasons why AC is not a diameter of the circle, ABCD.

Answer

$$\angle ACD = 38^\circ \text{ (}\angle\text{s in the same segment)}$$

$$\angle ADC = 180^\circ - 36^\circ - 38^\circ \text{ (}\angle\text{ sum of } \triangle)$$

$$= 106^\circ$$

$$\neq 90^\circ \quad (m)$$

By the property of Right angle in the semi-circle,
 AC is not a diameter of the circle, ABCD. (A1)

[2]

- (ii) Given that angle BAC = 59° , find angle DCB.

$$\angle DCB = 180^\circ - 59^\circ - 36^\circ \text{ (opp. } \angle\text{s in a cyclic quad)}$$

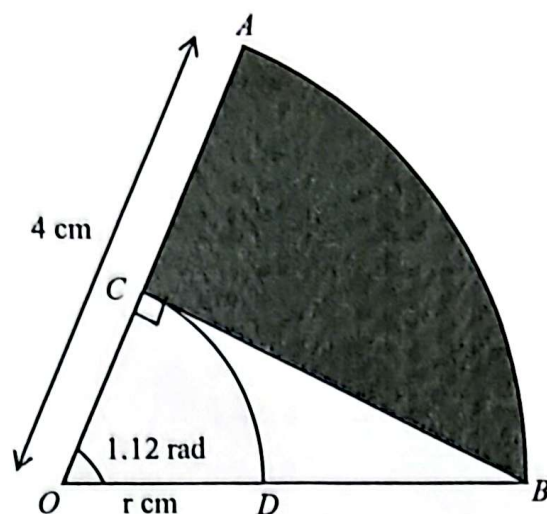
$$= 85^\circ$$

(A1)

$\angle\text{s in opp. segment}$

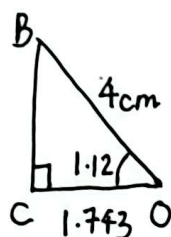
$$\text{Answer Angle DCB} = \dots\dots\dots 85^\circ [1]$$

- (b) The diagram shows two arcs AB and CD of two circles with centre O . Arc CD has radius r cm and arc AB has radius 4 cm. C and D lie on OA and OB respectively. BC is tangent to the arc CD at C and angle AOB is 1.12 radians.



- (i) Show that the value of r is 1.743 cm, correct to 4 significant figures.

Answer



$$\angle OCB = 90^\circ \text{ (tan } \perp \text{ radius) } \quad (M1)$$

$$\cos 1.12 = \frac{OC}{4}$$

$$OC = 4 \cos 1.12$$

$$= 1.7427 \dots$$

$$= 1.743 \text{ cm (4 sf)} \quad (A1)$$

[2]

- (ii) Find the perimeter of the shaded region, ABC .

$$= \widehat{AB} + AC + BC$$

$$= 4(1.12) + (4 - 1.743) + \sqrt{(4)^2 - 1.743^2} \quad (M2)$$

$$= 4.48 + 2.257 + 3.60027$$

$$= 10.33027 \dots$$

$$= 10.3 \text{ cm (3 sf)} \quad (A1)$$

Answer 10.3 cm [3]

Award 1 mark:

All steps correct but

Sub in 1 value wrongly.

- 5 (b) (iii) Find the area of the shaded region, ABC.

$$= \text{Area of sector } OAB - \text{Area of } \triangle OCB$$

$$= \frac{1}{2} r^2 \theta - \frac{1}{2} \times OC \times BC$$

$$= \frac{1}{2} (4)^2 (1.12) - \frac{1}{2} \times 1.743 \times 3.60027$$

$$= 5.82236 \dots$$

$$= 5.82 \text{ cm}^2 (3 \text{ sf})$$

Answer 5.82 cm² [3]

6. (a) A is the point $(3, -7)$ and B is the point $(5, 3)$.

Find

- (i) the length of AB ,

$$= \sqrt{(5-3)^2 + (3+7)^2}$$

$$= \sqrt{4 + 100}$$

$$= \sqrt{104}$$

$$= 10.198 \dots$$

$$= 10.2 \text{ units (3 s.f.)} \quad \text{Answer } 10.2 \text{ (A1) units [1]}$$

- (ii) the equation of line AB ,

$$\text{grad}_{AB} = \frac{-7-3}{3-5}$$

$$= \frac{-10}{-2} = 5 \quad \text{(M1)}$$

$$\text{Eqn of } AB: y = mx + c$$

$$(5, 3) \quad y = 5x + c$$

$$3 = 5(5) + c$$

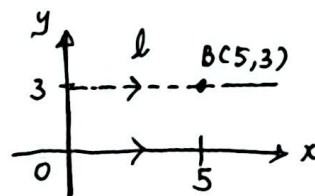
$$c = 3 - 25$$

$$= -22$$

$$\therefore y = 5x - 22$$

$$\text{Answer } y = 5x - 22 \quad \text{(A1) [2]}$$

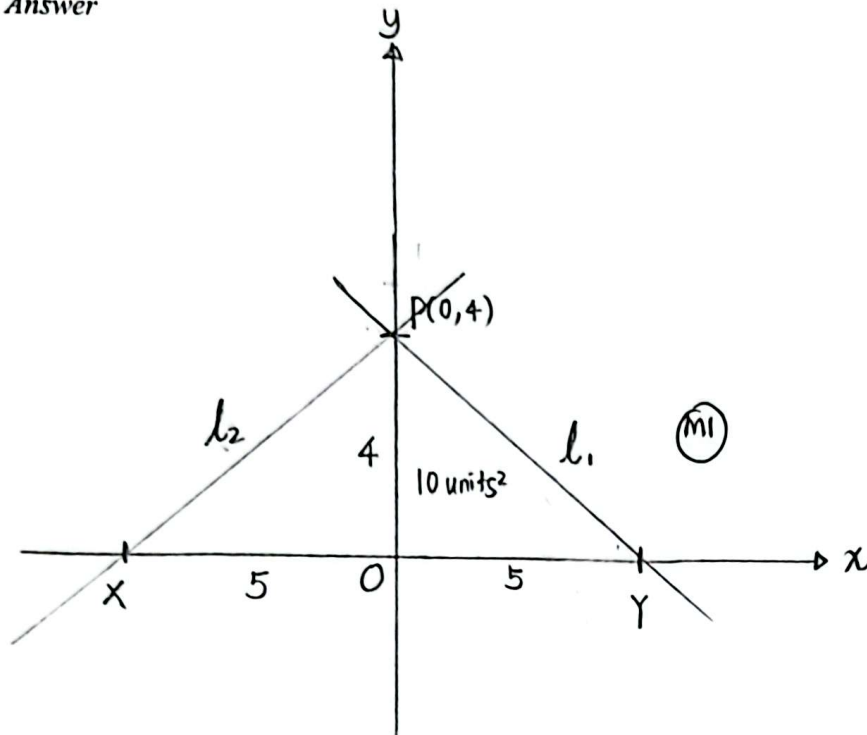
- (iii) the equation of the line l which passes through B and is parallel to the x -axis.



$$\text{Answer } y = 3 \quad \text{(B1) [1]}$$

- 6 (b) The area bounded by a line and the axes has an area of 10 square units.
 The line passes through the point $P(0,4)$.
 Max claims that there are 2 possible equations of the lines, and their gradients are the negatives of each other.
 Do you agree with Max's claim?
 Justify your answer showing your calculations.

Answer



$$\text{Area} = 10 \text{ units}^2$$

$$\frac{1}{2} \times OY \times 4 = 10$$

$$OY = 5 \text{ units}$$

OR Diagram (M1)

$$\text{grad}_{l_1} = -\frac{4}{5}$$

$$\text{grad}_{l_2} = \frac{4}{5}$$

(M1) must show working (if n/o diagram)

$\therefore$ Yes, I agree with Max's claim (A1)

- (c) The position vector of point R is $\begin{pmatrix} -5 \\ -1 \end{pmatrix}$ and the coordinates of point S are $(7, 2)$.

- (i) Find the magnitude of $\overrightarrow{RS}$.

$$\begin{aligned}\overrightarrow{RS} &= \overrightarrow{OS} - \overrightarrow{OR} \\ &= \begin{pmatrix} 7 \\ 2 \end{pmatrix} - \begin{pmatrix} -5 \\ -1 \end{pmatrix} \\ &= \begin{pmatrix} 12 \\ 3 \end{pmatrix} \quad (M1)\end{aligned}$$

$$|\overrightarrow{RS}| = \sqrt{(12)^2 + (3)^2}$$

$$= \sqrt{153}$$

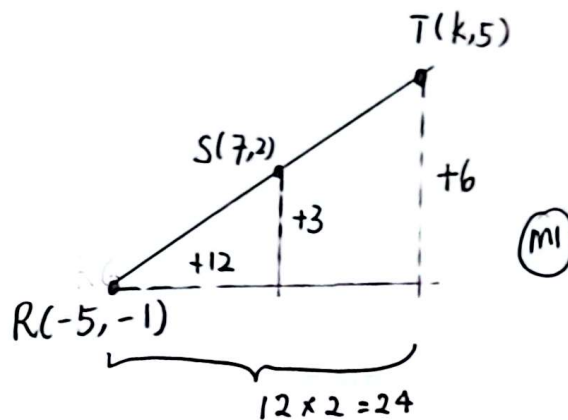
$$= 12.369$$

$$= 12.4 \text{ units (3sf)} \quad \text{Answer} \dots\dots\dots 12.4 \quad (A1) \dots\dots\dots \text{units [2]}$$

OR

$$\begin{aligned}|\overrightarrow{RS}| &= \sqrt{(-5-7)^2 + (-1-2)^2} \\ &= \sqrt{144+9} \\ &= \sqrt{153} \\ &= 12.369\end{aligned}$$

- (ii) T is the point on RS produced with coordinate $(k, 5)$. Find the value of k .



$$\begin{aligned}\therefore k &= -5 + 24 \\ &= 19\end{aligned}$$

OR

gradients = gradients

$$\begin{aligned}\hookrightarrow \frac{2+1}{7+5} &= \frac{3}{12} \\ &= \frac{1}{4} \quad (M1)\end{aligned}$$

$$\frac{5-2}{k-7} = \frac{1}{4}$$

$$k = 19 \quad (A1)$$

OR

$$y = \frac{1}{4}x + \frac{1}{4} \quad (M1)$$

Sub $(k, 5)$ into Eqⁿ

$$5 = \frac{1}{4}(k) + \frac{1}{4}$$

$$k = 19 \quad (A1)$$

19 A

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

- 7 (a) The height, in centimetres, of 20 boys and 15 girls from Class 2A were recorded. The results are shown in the stem-and-leaf diagram.

Boys						Girls		
					11	8		
			4	2	12	3	5	9
	9	5	3	3	13	5	6	8
9	7	6	2	1	14	2	3	6
	8	5	4	0	15	4	4	5
x	8	5	5	3	16	2	4	

Key (Boys)		Key (Girls)	
2	12 means 122 cm	11	8 means 118 cm

- (i) Write down the median ^{height} of the girls.

$$\begin{aligned}
 \text{Median pos}^n &= \frac{n+1}{2} \\
 &= \frac{15+1}{2} \\
 &= 8^{\text{th}}
 \end{aligned}$$

Answer 142 (B1) cm [1]

- (ii) The range of the heights for the boys is 47 cm. Find x .

$$\begin{aligned}
 160 + x - 122 &= 47 \\
 38 + x &= 47 \\
 x &= 9
 \end{aligned}$$

Answer $x =$ 9 (B1) [1]

- (b) (i) Summarise the heights of the 15 girls from Class 2A in the frequency table below.

	120	140	160
Height (h cm)	$110 \leq h < 130$	$130 \leq h < 150$	$150 \leq h < 170$
Frequency	4	6	5

1 wrong
= zero

(B1) [1]

- (ii) Calculate an estimate of the mean height and the standard deviation of the heights.

$$\text{Mean height} = \frac{4(120) + 6(140) + 5(160)}{4 + 6 + 5}$$

$$= 141.33 \dots$$

$$= 141 \text{ cm (3 sf)} \quad (A1)$$

Standard deviation

$$= \sqrt{\frac{\sum fx^2}{\sum f} - (\bar{x})^2}$$

$$= \sqrt{\frac{303200}{15} - \left(\frac{2120}{15}\right)^2}$$

$$= 15.434 \dots$$

$$= 15.4 \text{ cm (3 sf)} \quad (A1)$$

Answer mean = 141 cm

Standard deviation = 15.4 cm [2]

- (c) The mean height for girls from Class 2B is 135 cm and the standard deviation was 13.5 cm.

Make two comparisons between the heights for the girls in Class A and Class B.

1. On average, the girls from class 2A are taller than girls from 2B as $\text{mean}_{2A} (141 \text{ cm}) > \text{mean}_{2B} (135 \text{ cm})$ (A1)

2. The height for girls from class 2B is more consistent as $\text{standard deviation}_{2B} (13.5 \text{ cm}) < \text{standard deviation}_{2A} (15.4 \text{ cm})$ (A1) [2]

- 8 A bag contains 17 red marbles and 8 green marbles.
Two marbles are taken from the bag without replacement.

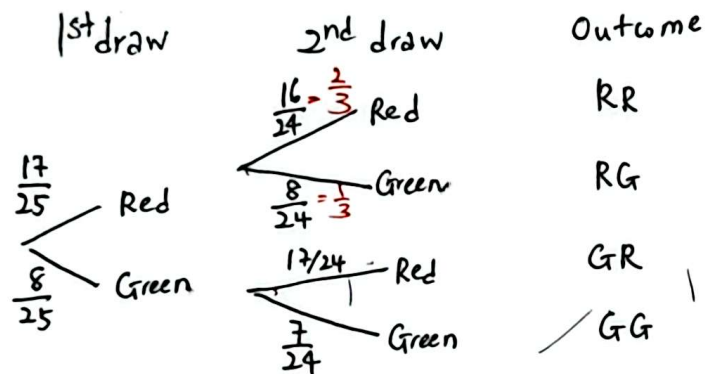
(a) Sally says the probability that both marbles are green is $\frac{64}{125}$.
Explain what she has done wrong.

Answer:

Sally calculated the probability based on replacement of the 1st marble. [numerator] & [denominator] ie. $\frac{8}{25} \times \frac{8}{25} = \frac{64}{625}$ he made an error
P(both marbles are green) = $\frac{8}{25} \times \frac{7}{24} = \frac{7}{75}$ (A1) (A2) (1) she has done wrongly if mention, did with replacement (2)

- (b) Draw a tree diagram to show the probabilities of the possible outcomes.

Answer:



- Probability number wrong = zero mark
- Label correctly (A1) (A2) (1) mark probability number (A1) (A2) (2)

- (c) Find, as a fraction in its simplest form, the probability that only one of the marbles is red.

$$P(\text{only 1 marble is red})$$

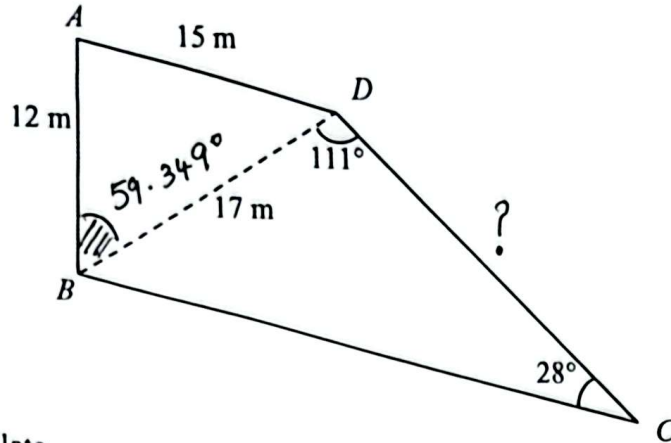
$$= P(RG) + P(GR)$$

$$= \frac{17}{25} \times \frac{8}{24} + \frac{8}{25} \times \frac{17}{24}$$

$$= \frac{34}{75}$$

Answer $\frac{34}{75}$ (A1) [1]

- 9 The diagram shows a plot of land $ABCD$ on horizontal ground, consisting of two triangles ABD and BDC .
- $AB = 12$ m, $BD = 17$ m and $AD = 15$ m.
- Angle $BDC = 111^\circ$ and angle $BCD = 28^\circ$.



- (a) Calculate
- (i) the length of CD ,

$$\angle DBC = 180^\circ - 111^\circ - 28^\circ \text{ (sum of } \triangle)$$

$$= 41^\circ \quad (\text{M1})$$

Using Sine Rule,

$$\frac{CD}{\sin 41^\circ} = \frac{17}{\sin 28^\circ} \quad (\text{M1})$$

$$CD = \frac{17 \sin 41^\circ}{\sin 28^\circ}$$

$$= 23.756 \dots \text{ Answer } 23.8 \dots \text{ m [3]}$$

$$= 23.8 \text{ m (3 sf)} \quad (\text{A1})$$

- (ii) the angle ABD .

Using Cosine Rule,

$$\cos \angle ABD = \frac{12^2 + 17^2 - 15^2}{2(12)(17)} \quad (\text{M1})$$

$$\angle ABD = \cos^{-1}\left(\frac{26}{51}\right)$$

$$= 59.349 \dots$$

$$= 59.3^\circ \text{ (1 dp)} \quad (\text{A1})$$

$$\text{Answer } 59.3 \dots^\circ \text{ [2]}$$

9

- (b) The land is used to plant some trees.

If each tree needs 36 square metres of space to grow, what is the greatest number of trees that can be planted in the plot of land $ABCD$?

Area of land

$$= \frac{1}{2}(12)(17) \sin 59.3492^\circ + \frac{1}{2}(17)(23.756) \sin 111^\circ$$

$$= 276.26377 \dots \quad (M1)$$

$$\text{No. of trees} = \frac{276.26377 \dots}{36}$$

$$= 7.67$$

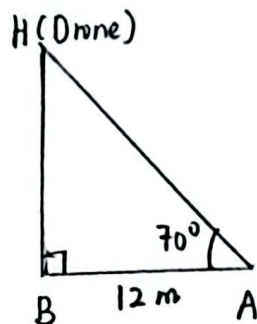
$\therefore$ greatest no. of trees = 7

Answer 7 (A1) [2]

- (c) A drone is hovering vertically above
- B
- .

The angle of elevation of the drone from A is 70° .

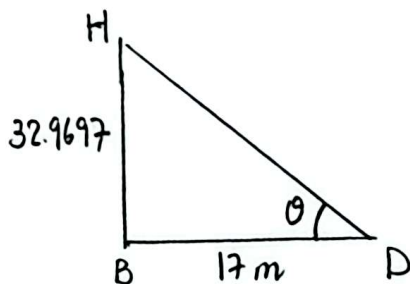
Find the angle of elevation of the drone from D .



$$\tan 70^\circ = \frac{BH}{12}$$

$$BH = 12 \tan 70^\circ \quad (M1)$$

$$= 32.9697 \dots$$



$$\tan \theta = \frac{32.9697}{17} \quad (M1) \rightarrow ECF1$$

$$\theta = \tan^{-1}\left(\frac{32.9697}{17}\right)$$

$$= 62.7232$$

$$= 62.7^\circ (1dp)$$

Answer 62.7 (A1) [3]

- 10 Electronic Road Pricing System (ERP) is used in managing road congestion. Based on a pay-as-you-use principle, motorists are charged when they use priced roads during peak hours.

The tables show the time periods and respective ERP rates of some roads for passenger cars, taxis and light goods vehicles in Singapore in a certain year.

ERP Rates		
Time period	KPE Southbound after Defu Flyover	PIE slip to Bendemeer Road
7:30 – 7:35	\$2.00	-
7:35 – 8:30	✓ \$3.00	-
8:30 – 8:35	\$4.50	\$1.00
8:35 – 8:55	\$6.00	\$2.00
8:55 – 9:00	\$4.00	\$1.50

ERP Rates		
Time period	CTE slip road to PIE (Changi) / Serangoon Road	AYE to City before Alexandra Road
7:30 – 7:35	-	-
7:35 – 8:00	-	-
8:00 – 8:05	\$2.50	\$0.50
8:05 – 8:30	\$3.00	✓ \$1.00
8:30 – 8:35	-	\$1.50

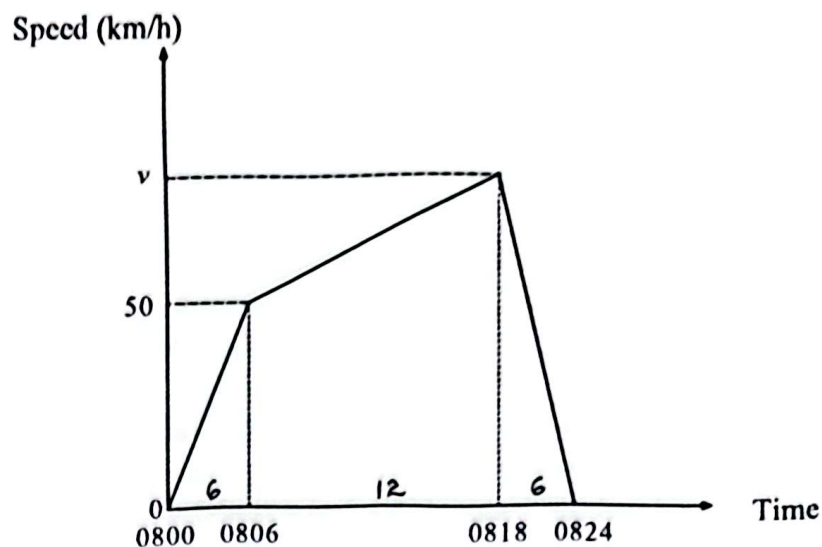
- (a) The distance between Mr Lim's home and workplace is 31 km. Mr Lim drives to work. One day, to cut down on travelling time, Mr Lim travelled through the KPE gantry at 7:50 and passed the AYE gantry at 8:22. Calculate the total ERP charges paid by Mr Lim.

$$= \$3 + \$1$$

$$= \$4$$

Answer \$.....4..... (BI) [1]

- (b) On some days, Mr Lim travels from home to Town using alternative routes to avoid all the ERP charges. His speed-time graph is shown below.



- (i) The total distance travelled by Mr Lim to Town is 19.5 km. Find the value of v .

$$\text{Distance travelled} = 19.5 \text{ km}$$

$$\frac{1}{2} \times \frac{6}{60} \times 50 + \frac{1}{2} [50 + v] \times \frac{12}{60} + \frac{1}{2} \times \frac{6}{60} \times v = 19.5 \quad (\text{M2})$$

$$2.5 + 5 + 0.1v + 0.05v = 19.5$$

$$0.15v = 12$$

$$v = 80$$

Answer $v = \dots\dots\dots 80 \dots\dots\dots (\text{A1}) \dots\dots\dots [3]$

- (ii) Calculate the acceleration between 0800 and 0803.

$$= \frac{50 \text{ km/h}}{\frac{6}{60} \text{ h}}$$

$$= 500 \text{ km/h}^2$$

~~(A1)~~ (B1)

Answer $\dots\dots\dots \text{km/h}^2 [1]$

- 10 (c) The cost of fuel from Shell is shown below

Company	Diesel cost per litre	Regular petrol cost per litre	Premium petrol cost per litre
Shell	\$2.40	\$2.79	\$3.50

The fuel consumption of Mr Lim's car was 8 litres/100 km and his car uses regular petrol.

Mr Lim decided to fetch a colleague, Mr Goh, on his way to work.

Mr Lim drove for an additional 4 km and travelled through both the KPE gantry and AYE gantry 10 minutes later than his usual timing.
8:00
8:32

To cut down on his transport expenses, Mr Lim decided to charge Mr Goh 30% of his total transport expenses to work, which consist of the ERP charges and fuel cost incurred based on a 20-day work month.

If Mr Goh took public transport in the morning, he would have to pay \$3.89.

Which is a cheaper transport option for Mr Goh based on a 20-day work month? Justify your decision and show your method clearly.

Answer

Total distance
to workplace

$$\begin{array}{l} \text{1 day} \\ 31 + 4 = 35 \text{ km} \end{array}$$

Petrol used

$$\begin{array}{l} 8 \text{ l} / 100 \text{ km} \\ 0.08 \text{ l} / 1 \text{ km} \\ 0.08 \times 35 = 2.8 \text{ l} \end{array} \quad (\text{M1})$$

cost of petrol

$$\begin{array}{l} \text{Regular petrol} = \$2.79/\text{l} \\ \text{Total cost} = 2.8 \times \$2.79 \\ = \$7.812 \end{array} \quad (\text{M1})$$

ERP
KPE
8:00

+ AYE
8:32

$$— \$3 + \$1.50 = \$4.50$$

24

$$\begin{array}{l} \text{Total transport cost} \\ = \$7.812 + \$4.50 \\ = \$12.312 \end{array} \quad (\text{M1})$$

$$\text{Total transport cost} = \$12.312$$

30% of total transport cost

$$= \frac{30}{100} \times 12.312$$

$$= \$3.6936 \quad (M1)$$

$$< \$3.89$$

$\therefore$ Mr Goh should take Mr Lim's car as it is cheaper. (A1)

$$\left[\begin{array}{l} \text{cost(Mr Lim)} = \$3.69 \\ < \text{cost(Mr Goh)} = \$3.89 \end{array} \right]$$

$$\begin{array}{l} 20 \text{ days : } \square \text{ Mr Lim : } \$73.872 \\ \text{by public : } \$77.80 \end{array} \quad \left. \vphantom{\begin{array}{l} 20 \text{ days : } \square \text{ Mr Lim : } \$73.872 \\ \text{by public : } \$77.80 \end{array}} \right\} \text{diff} = \$3.928$$

.....
M1 $\rightarrow$ Public [5]

M3 $\rightarrow$ Mr Lim.

A1 $\rightarrow$ conclusion.

End of Paper