

Student's Name: _____ Teacher's Code: _____



Saint Ignatius' College, Riverview
Mathematics Assessment Task
2025

Year 11
Advanced Mathematics
Task 3
PRELIMINARY COURSE EXAMINATION
Date: Monday 22 nd September

General Instructions: • Reading Time: 5 minutes • Time Allowed: 120 minutes • Write using blue or black pen only • NESA approved calculators may be used • Attempt all questions in the space provided on the paper in the booklets • Write your name and your teacher's code in the positions indicated • Marks may not be awarded for missing or carelessly arranged working Teachers: <table> <tr> <td>• Mr S. Maher</td> <td>SJM</td> </tr> <tr> <td>• Mr J Newey</td> <td>JPN</td> </tr> <tr> <td>• Mr D Reidy</td> <td>DPR</td> </tr> <tr> <td>• Ms K Mullan</td> <td>KXM</td> </tr> <tr> <td>• Ms M Kim</td> <td>MYK</td> </tr> </table>	• Mr S. Maher	SJM	• Mr J Newey	JPN	• Mr D Reidy	DPR	• Ms K Mullan	KXM	• Ms M Kim	MYK	Topics Examined: Question 1: Algebra, Equations and Inequalities Question 2: Functions and Further Functions Question 3: Trigonometry Question 4: Calculus Question 5: Probability Question 6: Trigonometric Functions Six questions each worth 14 marks. Total 84 marks
• Mr S. Maher	SJM										
• Mr J Newey	JPN										
• Mr D Reidy	DPR										
• Ms K Mullan	KXM										
• Ms M Kim	MYK										

Name:

Circle Teacher: SJM KXM MYK DPR

Question 1 – Algebra, Equations and

Total

/14

a) MULTIPLE CHOICE QUESTION

(1)

Which of the following is **equivalent** to $\left(\frac{x+1}{x}\right)^2 - \left(\frac{x-1}{x}\right)^2$? (Circle One)

A. $\frac{2}{x}$

B. $\frac{4}{x}$

C. $\frac{2}{x^2}$

D. $\frac{4}{x^2}$

b) Factorise $ac + bc - ad - bd$.

(1)

c) If $3\sqrt{27} - 2\sqrt{12} = \sqrt{b}$. Find b .

(2)

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[illegible]

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f) Using the **quadratic formula** or by **completing the square**:

Solve for x where $5x^2 + 11x + 3 = 0$. (Answer in Surd Form) **(3)**

g) Solve for x **and** y where:

$$3x - 2y = 14$$

$$2x + 3y = 17$$
 (2)

End Of Question One

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If you use this space, clearly indicate which question you are answering.

[illegible]

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Question 2 – Functions & Further

Total

/14

Functions

- a) MULTIPLE CHOICE QUESTION (1)

What is the **centre of the circle** given by the **equation**: $x^2 - 8x - 9 = -y^2$?

(Circle One Answer)

A. (-4,0)

B. (0,4)

C. (0,-4)

D. (4,0)

- b) If $f(x) = -x^2 - 2x + 3$ and $g(x) = 2x + 1$:

- (i) Write an expression for $f(g(x))$ **fully simplified**. (2)

Question b) continued over page....

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- [illegible]

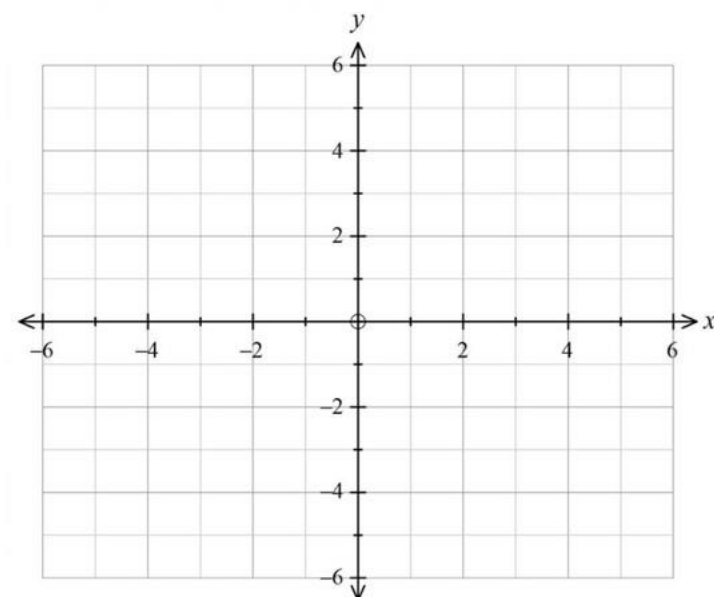
Name:

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d) For the function:

$$f(x) = \begin{cases} -\frac{1}{x+1}, & x < -1 \\ x+1, & x \geq -1 \end{cases}$$

(i) Sketch the graph of $f(x)$ below showing **x and y intercepts** (2)



(ii) State the **range** of $f(x)$. (1)

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- $$2f(x) + 3f\left(\frac{2x+3}{x-2}\right) = 3x + 1 \text{ for all } x, x \neq 2.$$

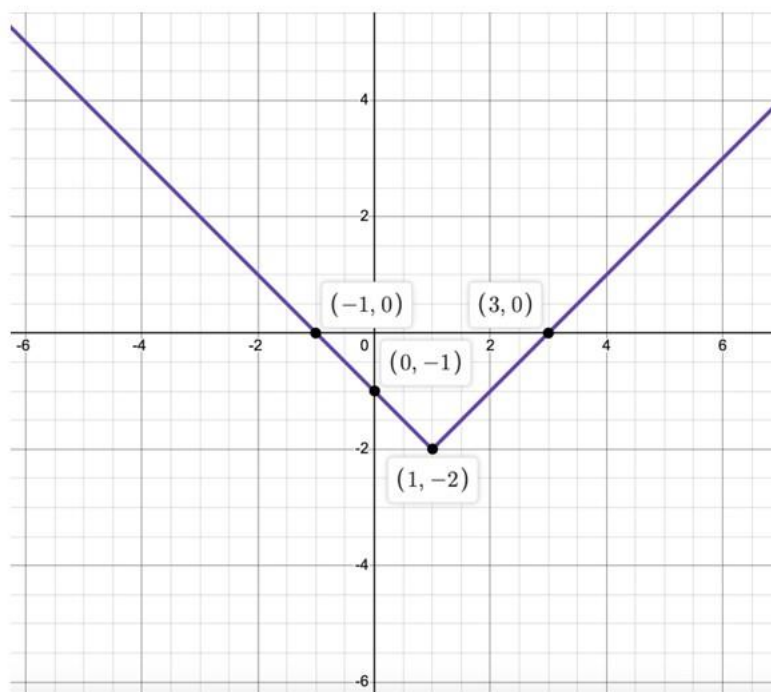
Find the **value of $f(9)$** **(3)**

[illegible]

Name:

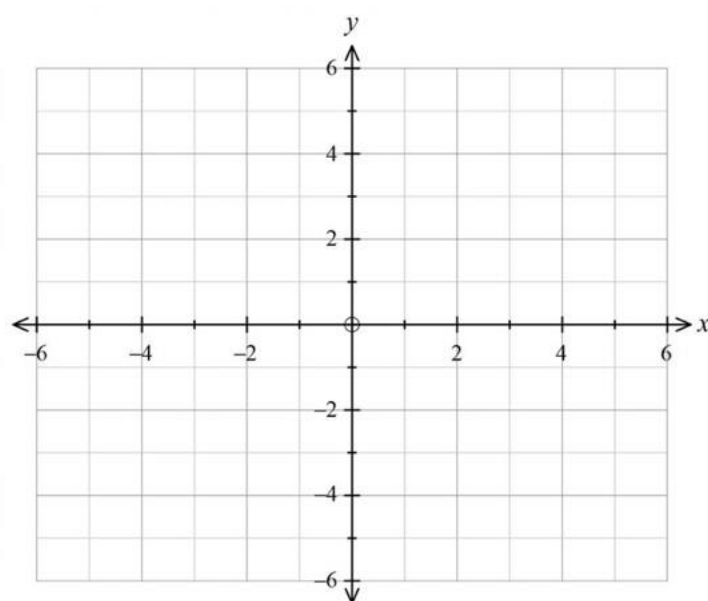
Circle Teacher: SJM KXM MYK DPR

f) The graph of the function $f(x)$ has been shown below.



Sketch the graph of $-f(x) - 2$ below and show **all intercepts**.

(2)



End Of Question Two

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If you use this space, clearly indicate which question you are answering.

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Name:

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Question 3 – Trigonometry

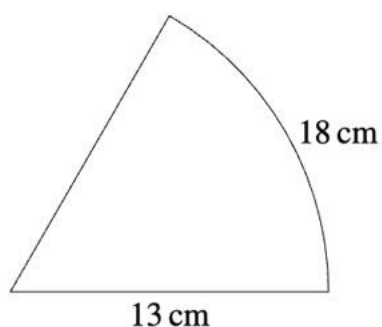
Total

/14

a) MULTIPLE CHOICE QUESTION

(1)

The sector of **radius** 13cm shown below has an arc length of 18cm.



What is the **area of the sector**?

(Circle One Answer)

- A. 84.5cm^2
- B. 117cm^2
- C. 162cm^2
- D. 234cm^2

Name:

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b) The triangle ABC has $AC=32cm$, $BC=45cm$ and $\angle BAC=58^\circ$.

(i) Draw a **labelled diagram** of the **triangle ABC** in the space below **(1)**

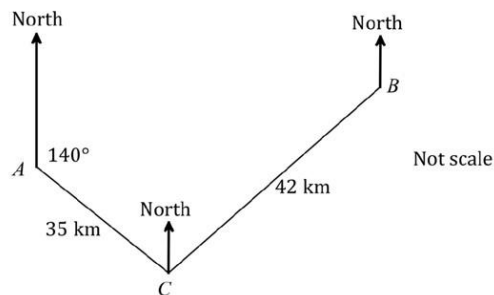


(ii) Find the value of $\angle ABC$, showing your answer to the **nearest degree**. **(2)**

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- c) Tyler drives 35km from town A on a true bearing of $140^\circ T$ to town C .
He then drives 42km on a true bearing of $038^\circ T$ to town B .



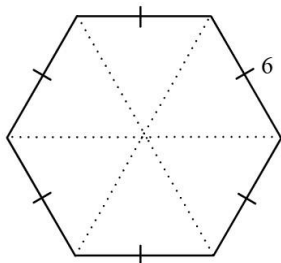
- (i) Calculate the **distance** between A and B and round your answer to **2 decimal places.** (2)

- (ii) Find the **bearing** of A from B to the **nearest degree** (2)

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- d) Find the **area** of the regular hexagon below in **surd form** given it is divided into six equilateral triangles (2)

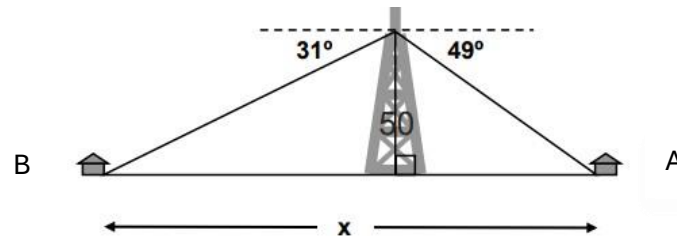


- e) Given that $\cot\beta = -\frac{5}{9}$ and that $\sin\beta < 0$, find the **value of $\cos\beta$** . (2)

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- f) An observer at the top of a **50m high** tower notes that the angle of depression of a house lying due east is 49° and the angle of depression of a house lying due west is 31° .



Find the **distance** between the houses at points *A* and *B* to the **nearest metre**.

(2)

End of Question Three

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If you use this space, clearly indicate which questions you are answering.

[illegible]

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Question 4 – Calculus

Total

/14

a) MULTIPLE CHOICE QUESTION

(1)

Find the **equation of the normal** to the curve $y = -x^2 + 3x - 4$ at the point on the graph **where $x = 2$** . *(circle one answer)*

A. $y = 2x - 1$

B. $y = -x + 2$

C. $y = x$

D. $y = x - 4$

b) Differentiate: $y = -2x^3 - \frac{5x}{2} + 3$.

(1)

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- c) Differentiate: $y = \frac{2x-5}{-x^3+1}$. (2)

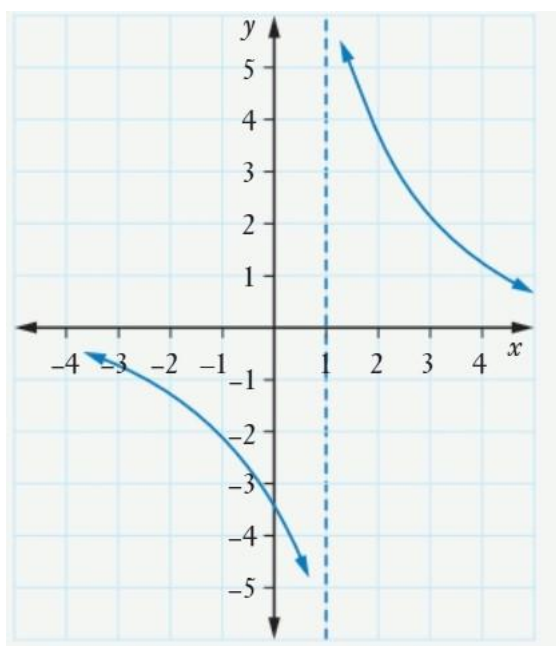
- d) Differentiate: $y = \frac{1}{2}\sqrt{x^3 - 2x}$. (2)

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- e) Find the **gradient function** of $x(t) = 4t^2(t^2 - 10)^4$ in **factored form**. (2)

- f) Consider the graph of the function below:



- Find all the values of x where the function is **not differentiable**. (1)

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- g) The formula for **differentiation by first principles** is:

$$\frac{d(f(x))}{dx} = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}.$$

Given the function $f(x) = x^2 - 2x + 3$, use **differentiation by first principles**

to show that $\frac{d(f(x))}{dx} = 2x - 2$. (3)

- h) A function $f(x)$ satisfies $f(5) = 25$ and $f'(5) = 20$.

Find the **equation of the tangent to $y = \sqrt{f(x)}$ at $x = 5$** . (2)

End of Question Four

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Question 5 – Probability**Total****/14****a) MULTIPLE CHOICE QUESTION (1)**

One letter is chosen randomly from each of the two words ‘THIRTY’ and ‘EIGHTY’. What is the probability that the **two letters chosen are the same?** *(circle one answer)*

A. $\frac{1}{12}$

B. $\frac{1}{9}$

C. $\frac{5}{36}$

D. $\frac{1}{6}$

b) A standard deck of 52 cards is placed on the table after being shuffled. Two cards are picked **with replacement.**

What is the probability that the first card is a **Heart** and the second card is a **King**?

(Note: A deck of cards, has four suits, hearts, diamonds, clubs and spades.

Each suit comprises 13 cards with numbers from 1-10 and picture cards

king, queen and jack.) **(2)**

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- c) Two numbers are chosen randomly from the set $\{1,2,3,4,5\}$ **with replacement**.

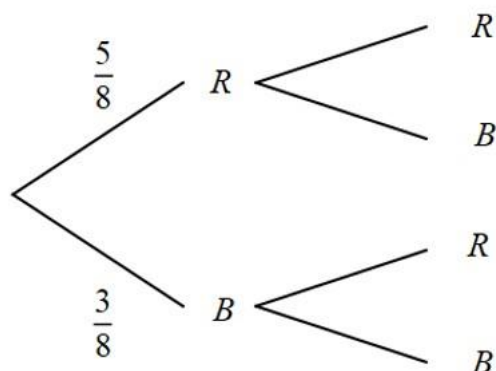
What is the probability that **multiplication** of the two numbers results in a **multiple of 3**?

(3)

- d) A bag contains **5 red marbles and 3 blue marbles**. Two marbles are drawn **without replacement**.

- (i) Complete the probability tree diagram below.

(1)



- (ii) Find the probability that both marbles are the same colour.

(1)

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- e) A country could have a president, a queen, both a president, and a queen or be self-governed. 60 countries were surveyed, and their results can be categorized into three groups: 35 have a **President**, 27 have a **Queen**, and 8 are **self-governed**.

- (i) Using the information above complete the two-way table below:

	President	No President	Total
Queen			
No Queen			
Total			60

(2)

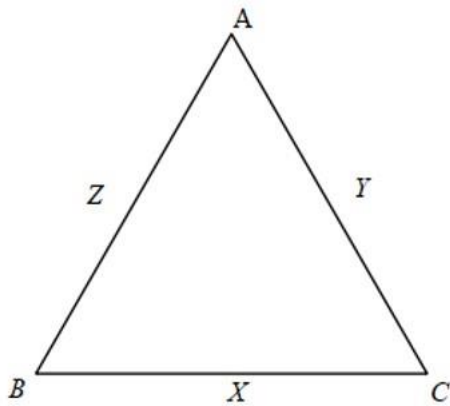
- (ii) What is the probability that a country will have a **President** only? (1)

- (iii) What is the probability that a country will have a **President if we know it has a Queen**? (1)

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- f) Three telecommunications towers, A, B , and C are connected via cables X, Y , and Z as shown below. A and B remain in contact only if Z is operative or if both cables X and Y are operative. Cables X, Y , and Z are subject to failure in any one day with probabilities of failure 0.01, 0.025 and 0.03 respectively. Such failures occur independently.



Find the probability that towers A and B are unable to make contact on a given day. (Do Not Round Off Your Answer At The End) (2)

End of Question Five

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If you use this space, clearly indicate which question you are answering.

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**Question 6 – Trigonometric
Functions**

Total

/14

- a) MULTIPLE CHOICE QUESTION (1)

What is the **correct expression** for $(\sin \theta + \cos \theta)^2 - 1$. (*circle one answer*)

- A. 0
- B. $2\cos^2 \theta$
- C. $2\sin^2 \theta$
- D. $2 \sin \theta \cos \theta$

- b) Given $-\pi \leq x \leq \pi$: find all **suitable solutions** to the equation:

$$2\cos(2x) - 0.5 = 0.5. \quad (2)$$

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c) Show that $\frac{1+\sin\theta}{1-\sin\theta} + \frac{1-\sin\theta}{1+\sin\theta} = 2(\sec^2\theta + \tan^2\theta)$. (3)

d) Given $0 \leq \theta \leq 2\pi$
solve the equation $2\cos^2\theta + \cos\theta - 1 = 0$, giving answers in **terms of π** . (2)

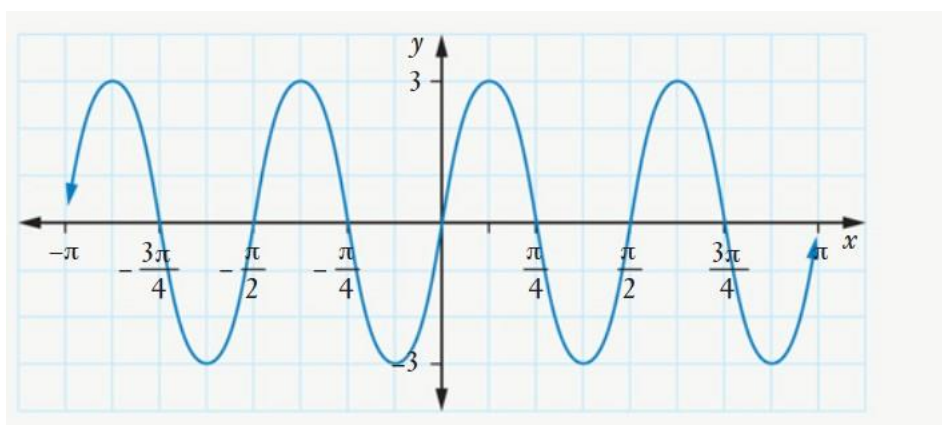
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- e) Consider the function $f(x) = 2\sin\left(\frac{2}{3}x - \frac{\pi}{3}\right)$:

What are the **amplitude, period and phase** of this function? (3)

- f) What is the equation of the graph below: (2)



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[illegible]

Page 34 of 36

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If you use this space, clearly indicate which question you are answering.

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Student's Name: _____ Teacher's Code: _____



SUGGESTED SOLUTIONS

Saint Ignatius' College, Riverview

Mathematics Assessment Task

2025

Year 11
Advanced Mathematics
Task 3
PRELIMINARY COURSE EXAMINATION
Date: Monday 22 nd September

General Instructions: • Reading Time: 5 minutes • Time Allowed: 120 minutes • Write using blue or black pen only • NESA approved calculators may be used • Attempt all questions in the space provided on the paper in the booklets • Write your name and your teacher's code in the positions indicated • Marks may not be awarded for missing or carelessly arranged working Teachers: • Mr S. Maher SJM • Mr J Newey JPN • Mr D Reidy DPR • Ms K Mullan KXM • Ms M Kim MYK	Topics Examined: Question 1: Algebra, Equations and Inequalities Question 2: Functions and Further Functions Question 3: Trigonometry Question 4: Calculus Question 5: Probability Question 6: Trigonometric Functions Six questions each worth 14 marks. Total 84 marks
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Question 1 – Algebra, Equations and**Total****/14****a) MULTIPLE CHOICE QUESTION****(1)**Which of the following is **equivalent** to $\left(\frac{x+1}{x}\right)^2 - \left(\frac{x-1}{x}\right)^2$? (Circle One)

A. $\frac{2}{x}$

B. $\frac{4}{x}$

C. $\frac{2}{x^2}$

D. $\frac{4}{x^2}$

b) Factorise $ac + bc - ad - bd$.**(1)**

$$c(a+b) - d(a+b) = (a+b)(c-d) \checkmark$$

c) If $3\sqrt{27} - 2\sqrt{12} = \sqrt{b}$. Find b .**(2)**

$$3\sqrt{9}\sqrt{3} - 2\sqrt{4}\sqrt{3} = 9\sqrt{3} - 4\sqrt{3} = 5\sqrt{3} \checkmark$$

$$= \sqrt{25} \times \sqrt{3} = \sqrt{75}$$

$$b = 75 \checkmark$$

- d) Solve for x where $|2x + 1| = |x|$. (2)

$2x + 1 = x$ $x = -1 \quad \checkmark$	$2x + 1 = -x$ $3x = -1$ $x = -\frac{1}{3} \quad \checkmark$
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- e) Solve for x where $\frac{3x-5}{4} + 1 = \frac{x-7}{3}$ (3)

$$12\left(\frac{3x-5}{4}\right) + 12\left(\frac{1}{1}\right) = 12\left(\frac{x-7}{3}\right) \quad \checkmark$$

$$3(3x-5) + 12 = 4(x-7)$$

$$9x - 15 + 12 = 4x - 28 \quad \checkmark$$

$$5x = -25$$

$$x = -5 \quad \checkmark$$

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- d) Solve for x where $|2x + 1| = |x|$. (2)

$2x+1 = x$	$2x+1 = -x$
$x = -1$ ✓	$3x = -1$
	$x = -\frac{1}{3}$ ✓

- e) Solve for x where $\frac{3x-5}{4} + 1 = \frac{x-7}{3}$ (3)

$$\frac{3(3x-5)}{12} + 12\left(\frac{1}{1}\right) =$$

f) Using the **quadratic formula** or by **completing the square**:Solve for x where $5x^2 + 11x + 3 = 0$. (Answer in Surd Form)

(3)

$$\begin{array}{l}
 x = \frac{-11 \pm \sqrt{121 - 60}}{10} \checkmark \\
 x = \frac{-11 \pm \sqrt{61}}{10} \checkmark \\
 x = \frac{-11 + \sqrt{61}}{10}, \frac{-11 - \sqrt{61}}{10} \checkmark
 \end{array}
 \quad
 \begin{array}{l}
 5\left(x^2 + \frac{11}{5}x + \frac{3}{5}\right) = 0 \\
 x^2 + \frac{11}{5}x + \frac{3}{5} = 0 \checkmark \\
 \left(x^2 + \frac{11}{5}x + \frac{121}{100}\right) = -\frac{3}{5} + \frac{121}{100} \\
 \left(x + \frac{11}{10}\right)^2 = \frac{61}{100} \checkmark \\
 x + \frac{11}{10} = \pm \sqrt{\frac{61}{100}} \\
 x = \frac{-11}{10} \pm \frac{\sqrt{61}}{10} \checkmark
 \end{array}$$

g) Solve for x and y where:

$$3x - 2y = 14 \quad (1)$$

$$2x + 3y = 17 \quad (2)$$

(2)

$$\begin{array}{l}
 9x - 6y = 42 \quad (1) \times 3 \\
 4x + 6y = 34 \quad (2) \times 2 \\
 \hline
 13x = 76 \\
 x = \frac{76}{13}
 \end{array}
 \quad
 \begin{array}{l}
 \text{Add} \quad \left| \begin{array}{l} 3\left(\frac{76}{13}\right) - 2y = 14 \\ \frac{228}{13} - 14 = 2y \\ \frac{228 - 182}{13} = 2y \\ \frac{46}{26} = y \\ \frac{23}{13} = y \end{array} \right.
 \end{array}$$

End Of Question One

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Question 2 – Functions & Further**Total****/14****Functions****a) MULTIPLE CHOICE QUESTION****(1)**What is the **centre of the circle** given by the **equation**: $x^2 - 8x - 9 = -y^2$?*(Circle One Answer)*

A. (-4,0)

B. (0,4)

C. (0,-4)

D. (4,0)

b) If $f(x) = -x^2 - 2x + 3$ and $g(x) = 2x + 1$:**(i) Write an expression for $f(g(x))$ fully simplified.****(2)**

$$f(g(x)) = -(2x+1)^2 - 2(2x+1) + 3$$

$$f(g(x)) = -(4x^2 + 4x + 1) - 4x - 2 + 3 \checkmark$$

$$= -4x^2 - 8x$$

$$= -4x(x+2) \checkmark$$

Question b) continued over page...

- b) (ii) What is the **axis of symmetry** of $f(g(x))$? (1)

$$f(g(x)) = -4x^2 - 8x$$

$$x = \frac{-b}{2a} = \frac{-(-8)}{-8} = -1$$

$$x = -1 \checkmark$$

- c) Consider the two functions: $y = x^2 - 2x - 3$, and $y = 2x - 6$.
Find the **points of intersection** between the two functions. (2)

$$y = x^2 - 2x - 3 \quad y = 2x - 6$$

$$x^2 - 2x - 3 = 2x - 6$$

$$x^2 - 4x + 3 = 0$$

$$(x - 3)(x - 1) = 0$$

$$x = 3$$

$$x = 1 \checkmark$$

$$y = 6 - 6$$

$$y = 2 - 6$$

$$y = 0$$

$$y = -4 \checkmark$$

$$(3, 0) \text{ and } (1, -4) \text{ are the}$$

points of intersection.

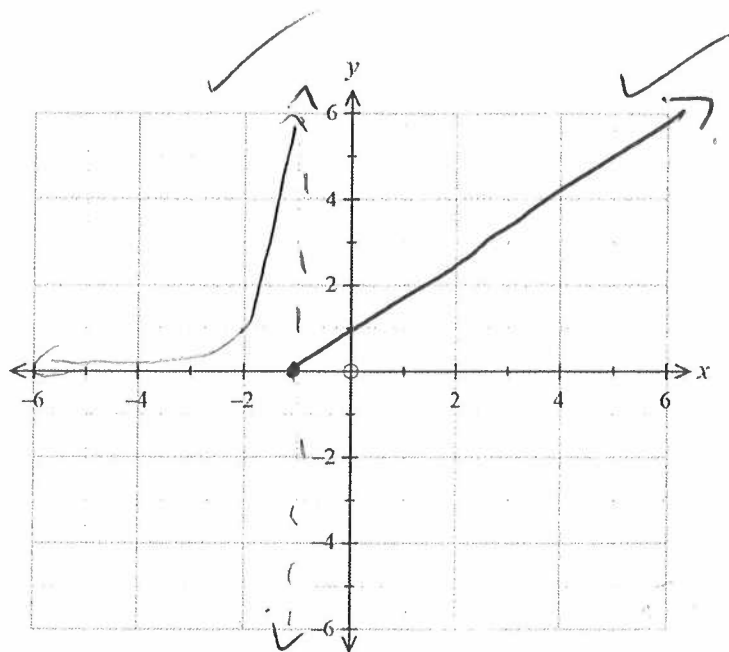
Name:

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d) For the function:

$$f(x) = \begin{cases} -\frac{1}{x+1}, & x < -1 \\ x+1, & x \geq -1 \end{cases}$$

(i) Sketch the graph of $f(x)$ below showing x and y intercepts (2)



(ii) State the **range** of $f(x)$. (1)

$y \geq 0$ or $y \in [0, \infty)$

- e) The function $f(x)$ satisfies the condition:

$$2f(x) + 3f\left(\frac{2x+3}{x-2}\right) = 3x + 1 \text{ for all } x, x \neq 2.$$

Find the value of $f(9)$.

(3)

$$2f(9) + 3f\left(\frac{21}{7}\right) = 28$$

$$2f(9) + 3f(3) = 28 \quad \checkmark$$

$$2f(3) + 3f(9) = 10 \quad \checkmark \quad (x=3)$$

$$2f(9) + 3f(3) = 28 \quad (x=2)$$

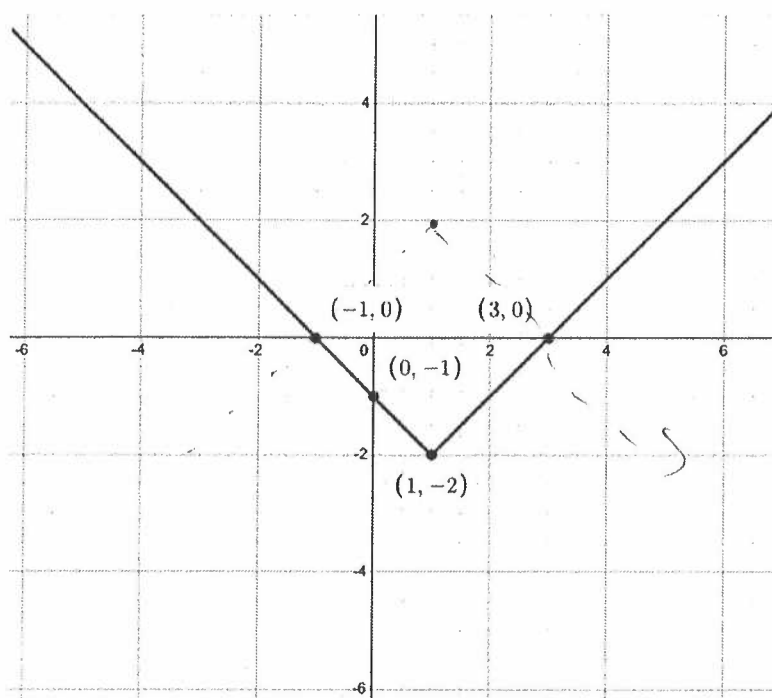
$$6f(3) + 9f(9) = 30 \quad \left. \begin{array}{l} \\ \end{array} \right\} \text{Add}$$

$$-6f(3) - 4f(9) = -56 \quad \left. \begin{array}{l} \\ \end{array} \right\}$$

$$5f(9) = -26$$

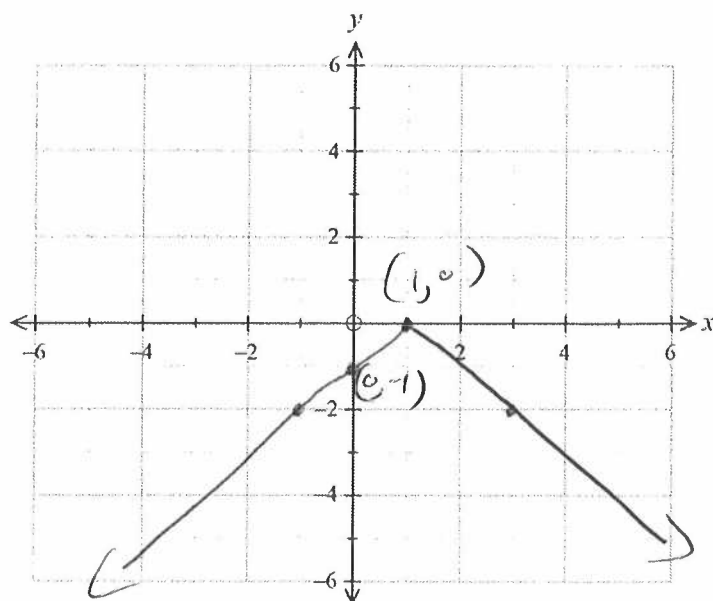
$$f(9) = \frac{-26}{5} \quad \checkmark$$

- f) The graph of the function $f(x)$ has been shown below.



Sketch the graph of $-f(x) - 2$ below and show **all intercepts**.

(2)



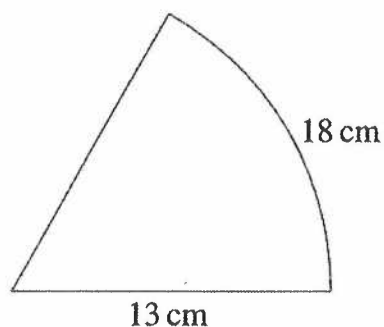
End Of Question Two

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Question 3 – Trigonometry**Total****/14****a) MULTIPLE CHOICE QUESTION****(1)**

The sector of **radius** 13cm shown below has an arc length of 18cm.



What is the **area of the sector**?

(Circle One Answer)

A. 84.5cm^2

B. 117cm^2

C. 162cm^2

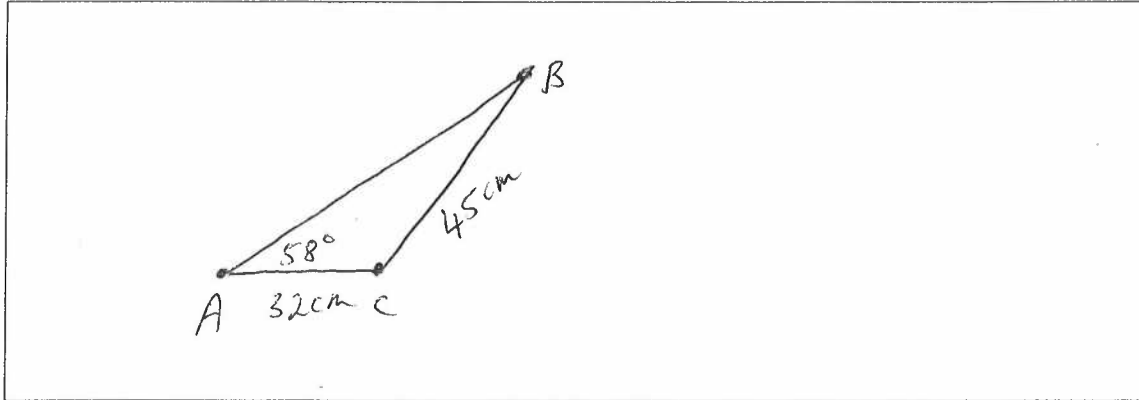
D. 234cm^2

Name:

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b) The triangle ABC has $AC=32\text{cm}$, $BC=45\text{cm}$ and $\angle BAC=58^\circ$.

(i) Draw a **labelled diagram** of the triangle ABC in the space below (1)



(ii) Find the value of $\angle ABC$, showing your answer to the **nearest degree**. (2)

$$\text{Let } \angle ABC = \theta$$

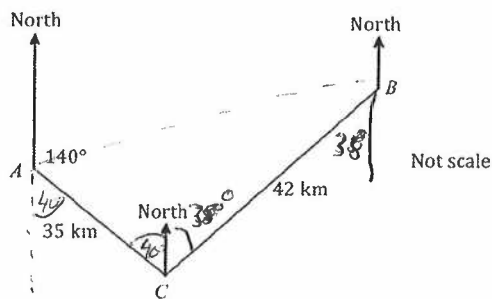
$$\frac{\sin \theta}{32} = \frac{\sin 58^\circ}{45}$$

$$\sin \theta = \frac{32 \times \sin 58^\circ}{45} \checkmark$$

$$\theta = \sin^{-1} \left(\frac{32 \times \sin 58^\circ}{45} \right)$$

$$\theta \approx 37^\circ \checkmark$$

- c) Tyler drives 35km from town A on a true bearing of $140^\circ T$ to town C .
He then drives 42km on a true bearing of $038^\circ T$ to town B .



- (i) Calculate the **distance** between A and B and round your answer to **2 decimal places**. (2)

$$\angle ACB = 38 + 40 = 78^\circ$$

$$|AB|^2 = 35^2 + 42^2 - 2(35)(42)\cos 78^\circ \checkmark$$

$$= 2377.739 \dots$$

$$AB \approx 49 \text{ km} \checkmark$$

- (ii) Find the **bearing** of A from B to the **nearest degree** (2)

$$\cos \angle ABC = \frac{2377.739 + 42^2 - 35^2}{2 \times 49 \times 42} = 0.708 \dots$$

$$2 \times 49 \times 42$$

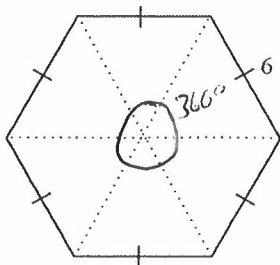
$$\angle ABC = \cos^{-1} 0.708 \dots \approx 45^\circ \checkmark$$

$$\text{Bearing} \approx 180^\circ + 38^\circ + 45^\circ = 263^\circ T \checkmark$$

Name:

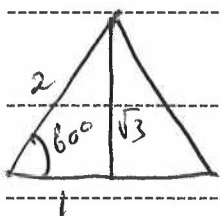
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- d) Find the **area** of the regular hexagon below in **surd form** given it is divided into six equilateral triangles (2)



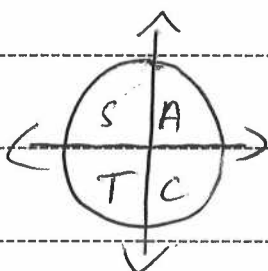
$$\text{Area of one equilateral triangle} = \frac{1}{2} \times 6^2 \times \sin 60^\circ$$

$$= 18 \times \frac{\sqrt{3}}{2} = 9\sqrt{3} u^2$$



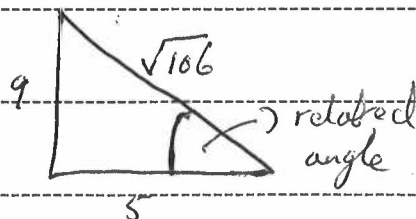
$$\text{Area of hexagon} = 6 \times 9\sqrt{3} u^2 = 54\sqrt{3} u^2$$

- e) Given that $\cot \beta = -\frac{5}{9}$ and that $\sin \beta < 0$, find the **value of $\cos \beta$** . (2)



$$\tan \beta = -\frac{9}{5} < 0 \quad \left. \begin{array}{l} \text{ } \\ \text{ } \end{array} \right\} \text{4th quad}$$

$$\sin \beta < 0$$

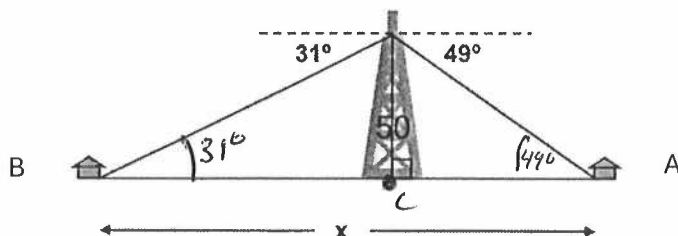


$$\cos \beta = \frac{5}{\sqrt{106}}$$

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- f) An observer at the top of a **50m high** tower notes that the angle of depression of a house lying due east is 49° and the angle of depression of a house lying due west is 31° .



Find the **distance** between the houses at points *A* and *B* to the **nearest metre**. (2)

$$\tan 31^\circ = \frac{50}{|BC|}$$

$$|BC| = \frac{50}{\tan 31^\circ}$$

$$|BC| = \frac{50}{\tan 31^\circ}$$

$$|BC| = \frac{50}{\tan 31^\circ}$$

$$\tan 49^\circ = \frac{50}{|AC|}$$

$$|AC| = \frac{50}{\tan 49^\circ}$$

$$|AC| = \frac{50}{\tan 49^\circ}$$

$$|AC| = \frac{50}{\tan 49^\circ}$$

$$\text{Ans} = \frac{50}{\tan 31^\circ} + \frac{50}{\tan 49^\circ} \approx 127\text{m.}$$

End of Question Three

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If you use this space, clearly indicate which questions you are answering.

[illegible]

Question 4 – Calculus

Total

/14

a) MULTIPLE CHOICE QUESTION

(1)

Find the **equation of the normal** to the curve $y = -x^2 + 3x - 4$ at the point on the graph **where $x = 2$** . (circle one answer)

A. $y = 2x - 1$

B. $y = -x + 2$

C. $y = x$

D. $y = x - 4$

b) Differentiate: $y = -2x^3 - \frac{5x}{2} + 3$.

(1)

$$y' = -6x^2 - \frac{5}{2}$$

c) Differentiate: $y = \frac{2x-5}{-x^3+1}$. $\frac{u}{v}$ (2)

$$y' = \frac{v u' - u v'}{v^2}$$

$$u = 2x - 5 \quad u' = 2$$

$$v = -x^3 + 1 \quad v' = -3x^2$$

$$y' = \frac{(-x^3+1)(2) + 3x^2(2x-5)}{(-x^3+1)^2} = \frac{4x^3 - 15x^2 + 2}{(1-x^3)^2}$$

d) Differentiate: $y = \frac{1}{2}\sqrt{x^3 - 2x}$. (2)

$$y = \frac{1}{2}(x^3 - 2x)^{\frac{1}{2}}$$

$$y' = \frac{1}{2} \times \frac{1}{2} (x^3 - 2x)^{-\frac{1}{2}} (3x^2 - 2)$$

$$y' = \frac{3x^2 - 2}{4\sqrt{x^3 - 2x}}$$

Name:

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- e) Find the **gradient function** of $x(t) = 4t^2(t^2 - 10)^4$ in **factored form**. (2)

$$u = 4t^2 \quad v = (t^2 - 10)^4$$

$$u' = 8t \quad v' = 4(t^2 - 10)^3(2t)$$

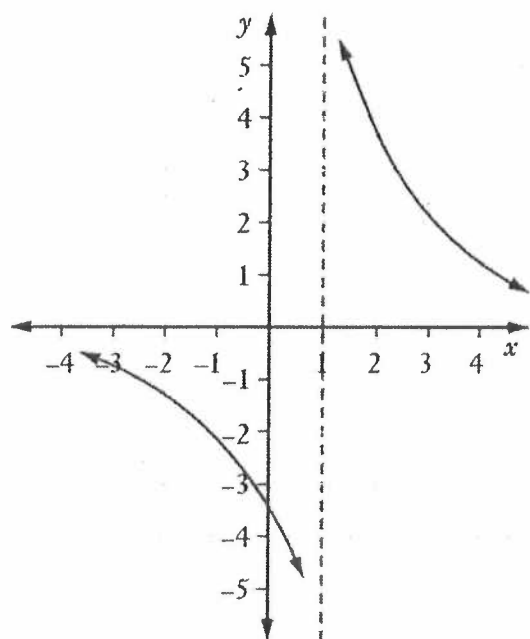
$$x'(t) = 32t^3(t^2 - 10)^3 + 8t(t^2 - 10)^4 \checkmark$$

$$x'(t) = 8t(t^2 - 10)^3(4t^2 + t^2 - 10)$$

$$x'(t) = 8t(t^2 - 10)^3(5t^2 - 10)$$

$$x'(t) = 40t(t^2 - 10)^3(t^2 - 2) \checkmark$$

- f) Consider the graph of the function below:



- Find all the values of x where the function is **not differentiable**. (1)

$$x = 1 \text{ (discontinuous)} \checkmark$$

- g) The formula for **differentiation by first principles** is:

$$\frac{d(f(x))}{dx} = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

Given the function $f(x) = x^2 - 2x + 3$, use **differentiation by first principles**

to show that $\frac{d(f(x))}{dx} = 2x - 2$. (3)

$$f(x) = x^2 - 2x + 3$$

$$f(x+h) = (x+h)^2 - 2(x+h) + 3 = x^2 + 2hx + h^2 - 2x - 2h + 3$$

$$f(x+h) - f(x) = x^2 + 2hx + h^2 - 2x - 2h + 3 - x^2 + 2x - 3$$

$$f(x+h) - f(x) = 2hx + h^2 - 2h$$

$$\frac{f(x+h) - f(x)}{h} = 2x - 2 + h$$

$$\lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h} = 2x - 2 + 0 = 2x - 2$$

- h) A function $f(x)$ satisfies $f(5) = 25$ and $f'(5) = 20$.

Find the **equation of the tangent** to $y = \sqrt{f(x)}$ at $x = 5$. (2)

$$y' = \frac{1}{2} f(x)^{-\frac{1}{2}} (f'(x))$$

$$x=5 \quad y = \sqrt{f(5)} = \sqrt{25} = 5$$

$$y' \text{ @ } x=5 =$$

(5, 5) point on graph.

$$\frac{1}{2} \times \frac{1}{\sqrt{25}} \times 20 = 2$$

$$\text{equation} = y - 5 = 2(x - 5)$$

$$y = 2x - 5$$

End of Question Four

If you use this space, clearly indicate which question you are answering.

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Question 5 – Probability**Total****/14****a) MULTIPLE CHOICE QUESTION****(1)**

One letter is chosen randomly from each of the two words 'THIRTY' and 'EIGHTY'. What is the probability that the **two letters chosen are the same?** *(circle one answer)*

A. $\frac{1}{12}$

B. $\frac{1}{9}$

C. $\frac{5}{36}$

D. $\frac{1}{6}$

b) A standard deck of 52 cards is placed on the table after being shuffled. Two cards are picked **with replacement.**

What is the probability that the first card is a **Heart** and the second card is a **King**?

(Note: A deck of cards, has four suits, hearts, diamonds, clubs and spades.

Each suit comprises 13 cards with numbers from 1-10 and picture cards

king, queen and jack.)

(2)

$$\frac{13}{52} \times \frac{4}{52} = \frac{1}{4} \times \frac{1}{13} = \frac{1}{52}$$

✓

- c) Two numbers are chosen randomly from the set $\{1,2,3,4,5\}$ **with replacement**.

What is the probability that **multiplication** of the two numbers results in a **multiple of 3**?

Pick 2

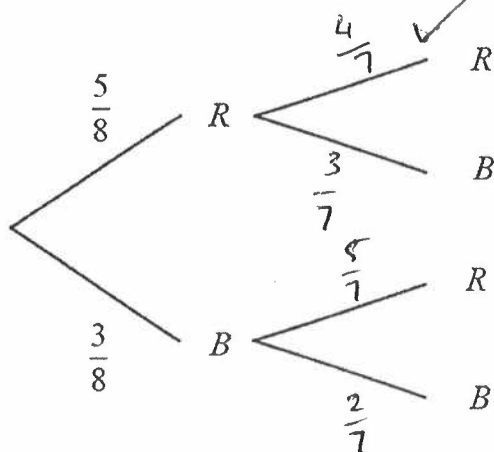
(3)

	X	1	2	3	4	5	
	1	1	2	3	4	5	✓
Pick 2	2	2	4	6	8	10	✓
1	3	3	6	9	12	15	$\frac{9}{25}$ ✓
	4	4	8	12	16	20	
	5	5	10	15	20	25	

- d) A bag contains 5 red marbles and 3 blue marbles. Two marbles are drawn **without replacement**.

- (i) Complete the probability tree diagram below.

(1)



- (ii) Find the probability that both marbles are the same colour.

(1)

$$P(R, R) = \frac{5}{8} \times \frac{4}{7} = \frac{5}{14}$$

$$P(B, B) = \frac{3}{8} \times \frac{2}{7} = \frac{3}{28}$$

$$Ans = \frac{5}{14} + \frac{3}{28} = \frac{13}{28}$$

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- e) A country could have a president, a queen, both a president, and a queen or be self-governed. 60 countries were surveyed, and their results can be categorized into three groups: 35 have a **President**, 27 have a **Queen**, and 8 are **self-governed**.

- (i) Using the information above complete the two-way table below:

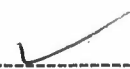
	President	No President	Total
Queen	10	17	27
No Queen	25	8	33
Total	35	25	60



(2)

- (ii) What is the probability that a country will have a **President** only? (1)

$$\frac{25}{60} = \frac{5}{12}$$

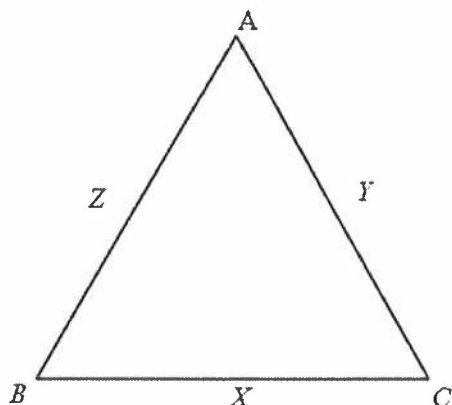


- (iii) What is the probability that a country will have a **President** if we know it has a **Queen**? (1)

$$\frac{10}{27}$$



- f) Three telecommunications towers, A , B , and C are connected via cables X , Y , and Z as shown below. A and B remain in contact only if Z is operative or if both cables X and Y are operative. Cables X , Y , and Z are subject to failure in any one day with probabilities of failure 0.01, 0.025 and 0.03 respectively. Such failures occur independently.



Find the probability that towers A and B are unable to make contact on a given day. (Do Not Round Off Your Answer At The End) (2)

$$P(Z \text{ fail and } X \text{ or } Y \text{ fail})$$

$$= P(Z \text{ fail}) \times (1 - P(\text{neither } X \text{ or } Y \text{ fail})) \checkmark$$

$$= 0.03 \times (1 - (0.99 \times 0.975))$$

$$= 0.0010425 \checkmark$$

End of Question Five

Question 5 extra writing space.

If you use this space, clearly indicate which question you are answering.

or $P(Z \text{ fails and } x \text{ fails})$

or

$P(Z \text{ fails and } x \text{ passes, and } y \text{ fails}) =$

$$(0.03 \times 0.01) + (0.03 \times 0.99 \times 0.025) =$$

$$0.0010425.$$

Question 6 – Trigonometric Functions

Total

/14

a) MULTIPLE CHOICE QUESTION

(1)

What is the **correct expression** for $(\sin \theta + \cos \theta)^2 - 1$. (circle one answer)

A. 0

B. $2\cos^2 \theta$ C. $2\sin^2 \theta$ D. $2 \sin \theta \cos \theta$ b) Given $-\pi \leq x \leq \pi$: find all **suitable solutions** to the equation:

(2)

$$2\cos(2x) - 0.5 = 0.5.$$

$$2\cos 2x = 1$$

$$\cos 2x = \frac{1}{2}$$

$$-2\pi \leq 2x \leq 2\pi.$$

$$2x = \frac{\pi}{3}, \frac{5\pi}{3}, -\frac{\pi}{3}, -\frac{5\pi}{3}$$

$$x = \frac{\pi}{6}, \frac{5\pi}{6}, -\frac{\pi}{6}, -\frac{5\pi}{6}$$

- c) Show that $\frac{1+\sin\theta}{1-\sin\theta} + \frac{1-\sin\theta}{1+\sin\theta} = 2(\sec^2\theta + \tan^2\theta)$. (3)

$$L.H.S = \frac{(1+\sin\theta)^2 + (1-\sin\theta)^2}{(1-\sin\theta)(1+\sin\theta)}$$

$$\frac{2 + 2\sin^2\theta}{1 - \sin^2\theta} = \frac{2 + 2\sin^2\theta}{\cos^2\theta} \quad \checkmark$$

$$= \frac{2}{\cos^2\theta} + \frac{2\sin^2\theta}{\cos^2\theta} = 2\sec^2\theta + 2\tan^2\theta$$

$$= 2(\sec^2\theta + \tan^2\theta) \quad \checkmark$$

- d) Given $0 \leq \theta \leq 2\pi$

solve the equation $2\cos^2\theta + \cos\theta - 1 = 0$, giving answers in terms of π . (2)

$$\text{let } \cos\theta = m$$

$$2m^2 + m - 1 = 0$$

$$(2m - 1)(m + 1) = 0$$

$$m = \frac{1}{2} \quad m = -1 \quad \checkmark$$

$$\cos\theta = \frac{1}{2} \quad \cos\theta = -1$$

$$\theta = \pi$$

$$\theta = \frac{\pi}{3}, \frac{5\pi}{3} \quad \checkmark$$

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- e) Consider the function $f(x) = 2\sin\left(\frac{2}{3}x - \frac{\pi}{3}\right)$:

What are the **amplitude, period and phase** of this function?

(3)

Amplitude = 2 ✓

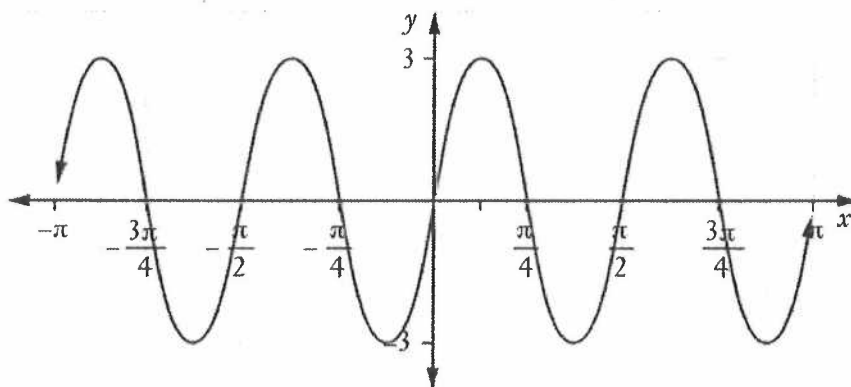
Period = $2\pi \div \frac{2}{3} = \frac{2\pi}{1} \times \frac{3}{2} = 3\pi$ ✓

Phase: $f(x) = 2\sin\frac{2}{3}\left(x - \frac{\pi}{2}\right)$

Phase = $-\frac{\pi}{2}$ or $\frac{\pi}{2}$ works both right ✓

- f) What is the equation of the graph below:

(2)



Amplitude = 3

$y = 3\sin 4x$ ✓

Centre of motion = 0.

sine function

Period = $\frac{\pi}{2}$ ✓

$\frac{2\pi}{n} = \frac{\pi}{2} \quad 2 \cdot \left. \begin{matrix} 4\pi = n\pi \\ 4 = n \end{matrix} \right\}$

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g) Solve $\sin \theta = \cos \frac{2\pi}{3}$ for $-\pi \leq \theta \leq \pi$. (1)

$$\sin \theta = \sin \left(\frac{\pi}{2} - \frac{2\pi}{3} \right)$$

$$\sin \theta = \sin \left(\frac{3\pi}{6} - \frac{4\pi}{6} \right)$$

$$\sin \theta = \sin \left(-\frac{\pi}{6} \right)$$

$$\theta = -\frac{\pi}{6}$$

$$\left(\sin \frac{5\pi}{6} = \sin \frac{\pi}{6} = \cos \frac{\pi}{3} \neq \cos \frac{2\pi}{3} \right)$$

6 discarded

$$\sin(\pi - \theta) = \sin \theta$$

$$\pi - \theta = \frac{\pi}{2} - \frac{2\pi}{3}$$

$$\pi - \frac{\pi}{2} + \frac{2\pi}{3} = \theta$$

$$\frac{\pi}{2} + \frac{2\pi}{3} = \theta$$

$$\frac{3\pi + 4\pi}{6} = \theta$$

$$\frac{7\pi}{6} = \theta$$

$$\frac{-5\pi}{6} = \theta$$

$$\text{Ans} = -\frac{\pi}{6}, -\frac{5\pi}{6} \quad \checkmark$$

End of Examination

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If you use this space, clearly indicate which question you are answering.

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