Students Name:_____ Teachers Code : _____

Saint Ignatius' College, Riverview
Mathematics Assessment Task
2024

Year 11
Advanced Mathematics
Task 3
PRELIMINARY COURSE EXAMINATION
SEPTEMBER 23, 2024

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 booklets provided
- Write **your name** and **your teacher's name** in the positions indicated
- Marks may not be awarded for missing or carelessly arranged working

Teachers:

Mr P Collins	PPC
Mr A Chan	AZC
Mrs J Barlow	JMB
Dr M Furtado	MXF

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: Exponential and Logarithmic Functions
Question 7: Trigonometric Functions

_____

Total **84 Marks**

NSW Education Standards Authority

2020 **HIGHER SCHOOL CERTIFICATE EXAMINATION**

Mathematics Advanced
Mathematics Extension 1
Mathematics Extension 2

REFERENCE SHEET

Measurement

Length

$$l = \frac{\theta}{360} \times 2\pi r$$

Area

$$A = \frac{\theta}{360} \times \pi r^2$$

$$A = \frac{h}{2}\left(a + b\right)$$

Surface area

$$A = 2\pi r^2 + 2\pi rh$$

$$A = 4\pi r^2$$

Volume

$$V = \frac{1}{3}Ah$$

$$V = \frac{4}{3}\pi r^3$$

Functions

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

For $ax^3 + bx^2 + cx + d = 0$:

$$\alpha + \beta + \gamma = -\frac{b}{a}$$

$$\alpha\beta + \alpha\gamma + \beta\gamma = \frac{c}{a}$$

$$\text{and } \alpha\beta\gamma = -\frac{d}{a}$$

Relations

$$\left(x - h\right)^2 + \left(y - k\right)^2 = r^2$$

Financial Mathematics

$$A = P\left(1 + r\right)^n$$

Sequences and series

$$T_n = a + (n-1)d$$

$$S_n = \frac{n}{2}\left[2a + (n-1)d\right] = \frac{n}{2}(a + l)$$

$$T_n = ar^{n-1}$$

$$S_n = \frac{a\left(1 - r^n\right)}{1 - r} = \frac{a\left(r^n - 1\right)}{r - 1},\ r \neq 1$$

$$S = \frac{a}{1 - r},\ |r| < 1$$

Logarithmic and Exponential Functions

$$\log_a a^x = x = a^{\log_a x}$$

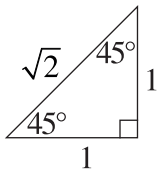
$$\log_a x = \frac{\log_b x}{\log_b a}$$

$$a^x = e^{x \ln a}$$

Trigonometric Functions

$$\sin A = \frac{\text{opp}}{\text{hyp}}, \quad \cos A = \frac{\text{adj}}{\text{hyp}}, \quad \tan A = \frac{\text{opp}}{\text{adj}}$$

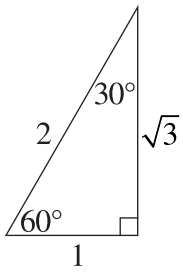
$$A = \frac{1}{2}ab\sin C$$



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

$$c^2 = a^2 + b^2 - 2ab\cos C$$

$$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$$



$$l = r\theta$$

$$A = \frac{1}{2}r^2\theta$$

Trigonometric identities

$$\sec A = \frac{1}{\cos A},\ \cos A \neq 0$$

$$\operatorname{cosec} A = \frac{1}{\sin A},\ \sin A \neq 0$$

$$\cot A = \frac{\cos A}{\sin A},\ \sin A \neq 0$$

$$\cos^2 x + \sin^2 x = 1$$

Compound angles

$$\sin(A + B) = \sin A\cos B + \cos A\sin B$$

$$\cos(A + B) = \cos A\cos B - \sin A\sin B$$

$$\tan(A + B) = \frac{\tan A + \tan B}{1 - \tan A\tan B}$$

If $t = \tan\frac{A}{2}$ then $\sin A = \frac{2t}{1+t^2}$

$$\cos A = \frac{1-t^2}{1+t^2}$$

$$\tan A = \frac{2t}{1-t^2}$$

$$\cos A\cos B = \frac{1}{2}\left[\cos(A - B) + \cos(A + B)\right]$$

$$\sin A\sin B = \frac{1}{2}\left[\cos(A - B) - \cos(A + B)\right]$$

$$\sin A\cos B = \frac{1}{2}\left[\sin(A + B) + \sin(A - B)\right]$$

$$\cos A\sin B = \frac{1}{2}\left[\sin(A + B) - \sin(A - B)\right]$$

$$\sin^2 nx = \frac{1}{2}(1 - \cos 2nx)$$

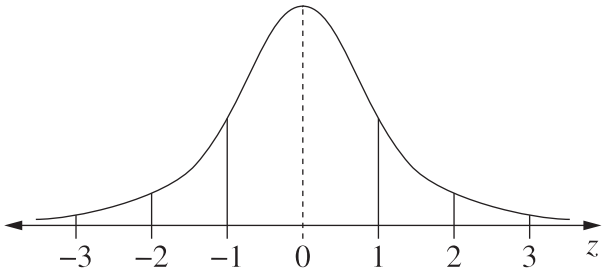
$$\cos^2 nx = \frac{1}{2}(1 + \cos 2nx)$$

Statistical Analysis

$$z = \frac{x - \mu}{\sigma}$$

An outlier is a score
less than $Q_1 - 1.5 \times IQR$
or
more than $Q_3 + 1.5 \times IQR$

Normal distribution



- approximately 68% of scores have z-scores between –1 and 1
- approximately 95% of scores have z-scores between –2 and 2
- approximately 99.7% of scores have z-scores between –3 and 3

$$E(X) = \mu$$

$$\text{Var}(X) = E\left[(X - \mu)^2\right] = E\left(X^2\right) - \mu^2$$

Probability

$$P(A \cap B) = P(A)P(B)$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A|B) = \frac{P(A \cap B)}{P(B)},\ P(B) \neq 0$$

Continuous random variables

$$P(X \leq r) = \int_a^r f(x)\,dx$$

$$P(a < X < b) = \int_a^b f(x)\,dx$$

Binomial distribution

$$P(X = r) = {}^nC_r p^r (1-p)^{n-r}$$

$$X \sim \text{Bin}(n, p)$$

$$\Rightarrow\ P(X = x) = \binom{n}{x} p^x (1-p)^{n-x},\ x = 0, 1, \ldots, n$$

$$E(X) = np$$

$$\text{Var}(X) = np(1-p)$$

Differential Calculus

Function	Derivative
$y = f(x)^n$	$\frac{dy}{dx} = nf'(x)\left[f(x)\right]^{n-1}$
$y = uv$	$\frac{dy}{dx} = u\frac{dv}{dx} + v\frac{du}{dx}$
$y = g(u)$ where $u = f(x)$	$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$
$y = \frac{u}{v}$	$\frac{dy}{dx} = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$
$y = \sin f(x)$	$\frac{dy}{dx} = f'(x)\cos f(x)$
$y = \cos f(x)$	$\frac{dy}{dx} = -f'(x)\sin f(x)$
$y = \tan f(x)$	$\frac{dy}{dx} = f'(x)\sec^2 f(x)$
$y = e^{f(x)}$	$\frac{dy}{dx} = f'(x)e^{f(x)}$
$y = \ln f(x)$	$\frac{dy}{dx} = \frac{f'(x)}{f(x)}$
$y = a^{f(x)}$	$\frac{dy}{dx} = (\ln a)f'(x)a^{f(x)}$
$y = \log_a f(x)$	$\frac{dy}{dx} = \frac{f'(x)}{(\ln a)f(x)}$
$y = \sin^{-1} f(x)$	$\frac{dy}{dx} = \frac{f'(x)}{\sqrt{1-\left[f(x)\right]^2}}$
$y = \cos^{-1} f(x)$	$\frac{dy}{dx} = -\frac{f'(x)}{\sqrt{1-\left[f(x)\right]^2}}$
$y = \tan^{-1} f(x)$	$\frac{dy}{dx} = \frac{f'(x)}{1+\left[f(x)\right]^2}$

Integral Calculus

$$\int f'(x)\left[f(x)\right]^n dx = \frac{1}{n+1}\left[f(x)\right]^{n+1} + c$$

where $n \neq -1$

$$\int f'(x)\sin f(x)\,dx = -\cos f(x) + c$$

$$\int f'(x)\cos f(x)\,dx = \sin f(x) + c$$

$$\int f'(x)\sec^2 f(x)\,dx = \tan f(x) + c$$

$$\int f'(x)e^{f(x)}\,dx = e^{f(x)} + c$$

$$\int \frac{f'(x)}{f(x)}\,dx = \ln\left|f(x)\right| + c$$

$$\int f'(x)a^{f(x)}\,dx = \frac{a^{f(x)}}{\ln a} + c$$

$$\int \frac{f'(x)}{\sqrt{a^2 - \left[f(x)\right]^2}}\,dx = \sin^{-1}\frac{f(x)}{a} + c$$

$$\int \frac{f'(x)}{a^2 + \left[f(x)\right]^2}\,dx = \frac{1}{a}\tan^{-1}\frac{f(x)}{a} + c$$

$$\int u\frac{dv}{dx}\,dx = uv - \int v\frac{du}{dx}\,dx$$

$$\int_a^b f(x)\,dx$$

$$\approx \frac{b-a}{2n}\left\{f(a) + f(b) + 2\left[f\left(x_1\right) + \cdots + f\left(x_{n-1}\right)\right]\right\}$$

where $a = x_0$ and $b = x_n$

Name : Circle Teacher: PPC ADC JMB MXF

Question 1 – Algebra, Equations and Inequalities

Total / 12

a) MULTIPLE CHOICE QUESTION [1]

Which of the following is equivalent to: $\frac{x^6}{y^6} \div x^2y^{-3}$ *(circle one)*

(A) $\frac{x^3}{y^2}$

(B) $\frac{x^4}{y^2}$

(C) $\frac{x^4}{y^3}$

(D) $\frac{x^4}{y^9}$

b) Solve the equation: $\left|\frac{x}{2} - 3\right| = 1$ [2]

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c) Solve the inequality: $8 - 2x \leq x + 4$ [2]

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d) Solve $2x + 3y = 28$ and $3x + 2y = 27$ simultaneously. [2]

e) Rationalise and fully simplify (for $x \neq 4$) [2]

$$\frac{x-4}{\sqrt{x}+2}$$

f) **Fully simplify** the following expression. [3]

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

End Of Question 1

Question 1 extra writing space.
If you use this space, clearly indicate which question you are answering.

Name : Circle Teacher: PPC ADC JMB MXF

Question 2 – Functions and Further Functions

Total / 12

a) MULTIPLE CHOICE QUESTION [1]
If $f(x) = 5x - 2$, which of the following is an expression for $(f(x))^2 - f(x)$? *(circle one)*

(A) $25x^2 - 25x + 2$

(B) $25x^2 - 25x + 6$

(C) $25x^2 - 15x + 2$

(D) $25x^2 - 15x - 2$

b) For the function $y = x^2 + 4x + 6$:

i) Find the value of the discriminant. [1]

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ii) By using i) or otherwise, determine which of the following is correct. *(circle one)* [1]

(A) The function has two real rational roots

(B) The function has two real irrational roots

(C) The function has one real root

(D) The function has no real roots

Question b) continued over page…

iii) Find the coordinates of the vertex of $y = x^2 + 4x + 6$. [1]

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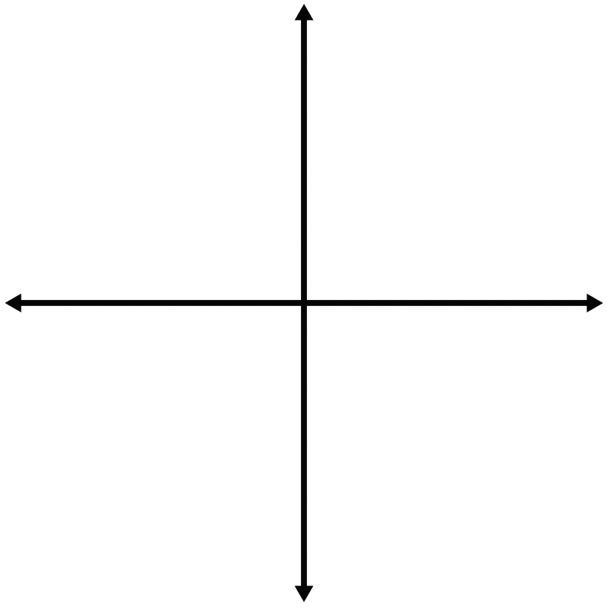
c) Sketch the graph of $y = (x - 1)^3$, clearly indicating any x and y intercepts. [2]



d) A circle on the number plane has equation $x^2 + y^2 - 8x + 6y + 21 = 0$. [2]
Find the centre and radius of the circle.

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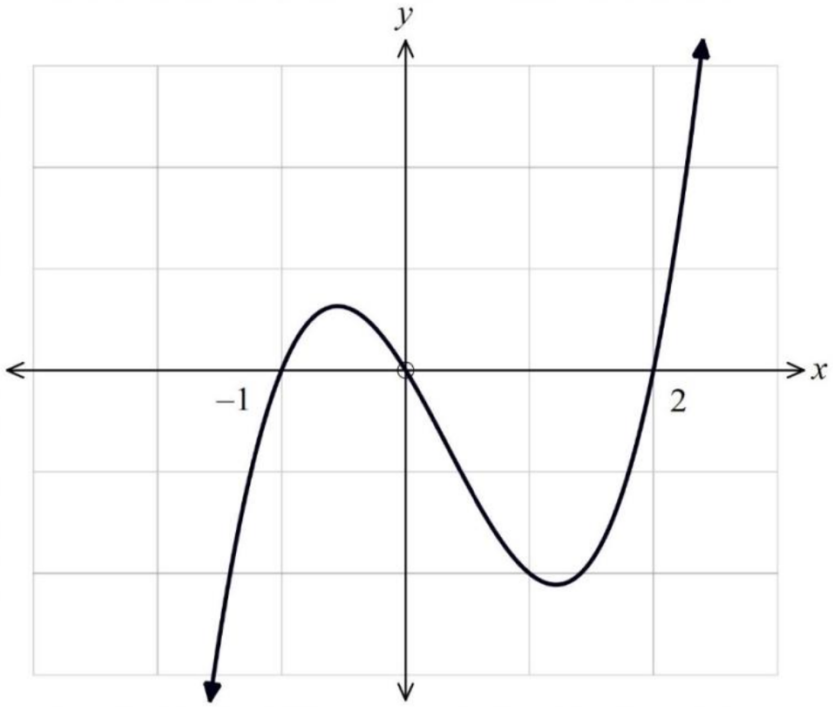
e) The graph of $y = k(x)$ is shown below. [2]

On the same set of axes, draw a neat sketch of $y = k(-x)$. *Clearly show any x and y intercepts.*



f) Find $f(g(x))$ given $f(x) = x^2 - 2x + 3$ and $g(x) = 2x - 1$. [2]
Fully simplify your answer.

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End Of Question 2

Question 2 extra writing space.
If you use this space, clearly indicate which question you are answering.

Name : Circle Teacher: PPC ADC JMB MXF

Question 3 – Trigonometry

Total / 12

a) MULTIPLE CHOICE QUESTION [1]
When simplified, $\sin(90° - \theta) + \cos(180° - \theta)$ becomes: *(circle one)*

(A) 0

(B) 1

(C) 2

(D) $\cos\theta$

b) A sector of a circle with radius 4 cm has an angle of $\frac{\pi}{4}$ radians subtended at the centre. Find the **exact** perimeter of this sector. *Give your answer in cm in exact form.* [2]

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c) In $\triangle ABC$, a = 23 cm, b = 21 cm and c = 18cm. Find the size of $\angle A$. [2]
Give your answer correct to the nearest minute.

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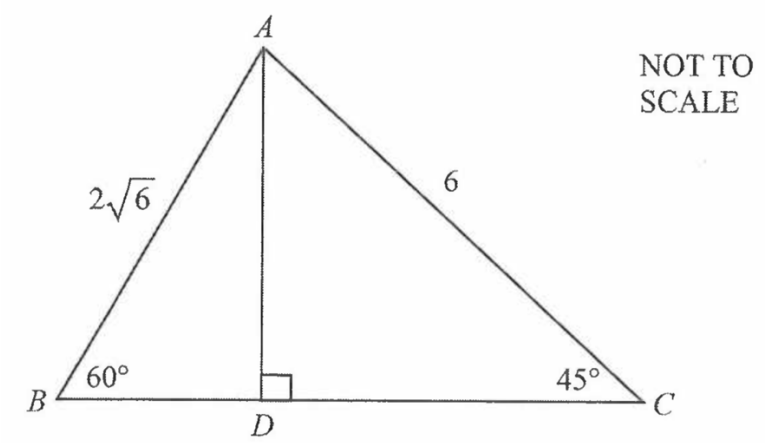
d) In the diagram, below ABC is a triangle in which $AB = 2\sqrt{6}$, $AC = 6$, $\angle ABC = 60^o$, and $\angle ACB = 45^o$. AD is the perpendicular from A to BC.



i) Find BD. *Give your answer in exact form.* [1]

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ii) Hence, or otherwise show that $BC = \sqrt{6} + 3\sqrt{2}$. [1]

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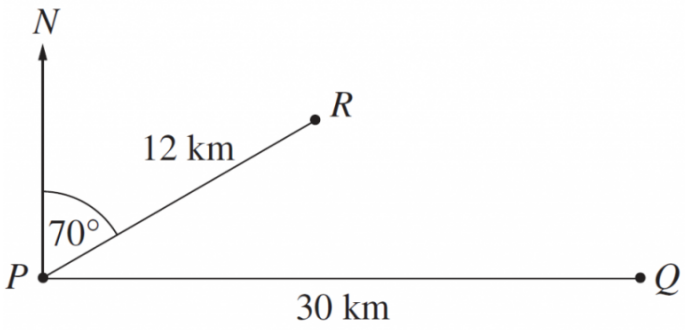
e) The diagram shows a point P which is 30 km due west of the point Q.
The point R is 12 km from P and has a bearing from P of 070°.

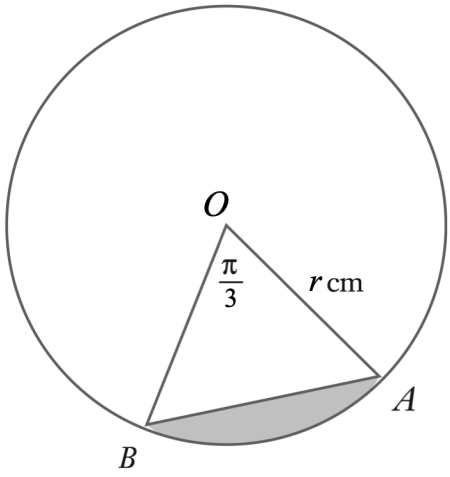


NOT TO SCALE

i) Find the distance of R from Q. *Give your answer in km to 1 decimal place.* [1]

ii) Find the true bearing of R from Q. [2]

f) Consider the following circle with centre O and chord AB subtended by an angle of $\frac{\pi}{3}$ at the centre.



NOT TO SCALE

Given the area of the shaded minor segment cut off by chord AB is $54\pi - 81\sqrt{3}\ cm^2$, find the value of the radius of the circle, r cm. [2]

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End Of Question 3

Question 3 extra writing space.
If you use this space, clearly indicate which question you are answering.

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Name : Circle Teacher: PPC ADC JMB MXF

Question 4 – Calculus

Total / 12

a) MULTIPLE CHOICE QUESTION [1]

If $y = \sqrt{2x}$, which of the following is an expression for $\frac{dy}{dx}$ *(circle one)*

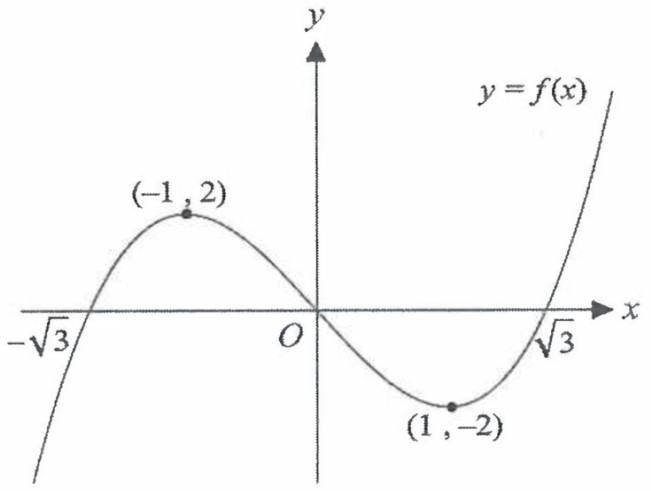
(A) $\frac{1}{\sqrt{x}}$

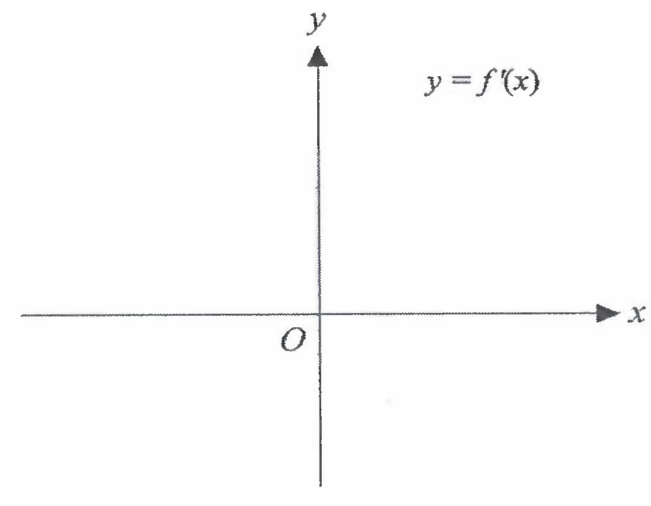
(B) $\frac{1}{\sqrt{2x}}$

(C) $\frac{1}{2\sqrt{x}}$

(D) $\frac{1}{2\sqrt{2x}}$

b) The diagram below shows the graph of the curve. $y = f(x)$. On the set of axes on the underneath, sketch the graph of the curve.$y = f'(x)$ showing the shape of the curve and its x intercepts. [2]





c) Find the equation of the **normal** to the curve $y = x^3 + 4x + 7$ at the point where $x = 1$. [2]

d) The position (in metres) of an object along a straight line after t seconds is modelled by $x(t) = 3t^2 + 5t + 2 \quad (t \geq 0)$. [1]

Calculate the **velocity** of the object when $t = 4$ *s*.

e) Differentiate the following with respect to x: [2]

i) $y = \sqrt{x^2 - 5}$

Question e) continues over page…

ii) $f(x) = \frac{1+x^2}{5x+1}$ [2]

iii) $y = x^2(2x+1)^5$. *Fully factorise your answer.* [2]

End Of Question 4

Question 4 extra writing space.
If you use this space, clearly indicate which question you are answering.

Name : Circle Teacher: PPC ADC JMB MXF

Question 5 – Probability

Total / 12

a) MULTIPLE CHOICE QUESTION [1]
Four cards, labelled 2, 3, 5 and 7, are placed on a table to form a four-digit number.
How many different numbers greater than 3000 can be formed?

(A) 6

(B) 12

(C) 18

(D) 24

b) A packet contains 12 red, 8 green, 7 yellow and 3 black jellybeans. [1]
One jellybean is selected from the packet at random.

What is the probability that the selected jellybean is red or yellow?

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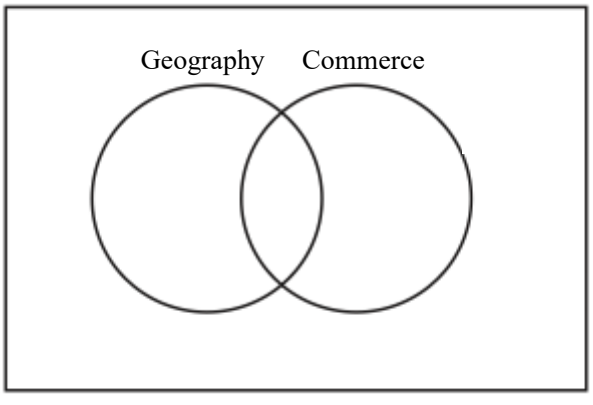
c) A class has 25 students. 20 of them study at least one of Geography and Commerce. [2]
7 students study Geography and 17 study Commerce.

i) Complete the Venn diagram to represent the class breakdown.



Question c) continues over page…

ii) Two students are chosen at random from the class. Find the probability that both students chose to study exactly one of either Geography or Commerce. [1]
Give your answer in simplest fraction form.

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d) Neil tries to connect to his internet service provider. The probability that he connects on any single attempt is 0.8.

i) What is the probability that he connects for the first time on his second attempt? [1]

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ii) What is the probability that he is still not connected after his third attempt? [1]

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e) In a box there are 4 milk chocolates, 2 white chocolates and 2 dark chocolates.
Three chocolates are chosen at random without replacement.

Determine the probability that: [1]

i) All 3 are milk chocolate?

ii) One of each type of chocolate is chosen? [2]

f) Alpine Air operates a daily a daily flight from Jindabyne to Sydney. The probability of the flight departing on time, given there is fine weather in Jindabyne is 0.8, and the probability of the flight departing on time given that the weather is not fine is 0.5. [2]

In August, the probability of a day being fine is 0.4.

Find the probability that on a particular day in August that the weather is fine in Jindabyne, given that the flight departs on time. *Give your answer as a simplified fraction.*

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End Of Question 5

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Name : Circle Teacher: PPC ADC JMB MXF

Question 6 – Exponential and Logarithmic Functions

Total / 12

a) MULTIPLE CHOICE QUESTION [1]
Simplify $2ln10 - ln5$ and choose the correct answer

(A) $ln4$

(B) $ln15$

(C) $ln20$

(D) $ln95$

b) Given $\log_b 2 = 0.43$ and $\log_b 3 = 0.68$, evaluate $\log_b 1.5$ [1]

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c) If $\log_x 7 + \log_x m = \log_x(m + 12)$, find the value of m. [2]

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d) Differentiate with respect to x: $y = e^{3x} + 2e^{-2x}$ [2]

e) Solve for x: $3^{-4x} = 9^{6-x}$ [2]

f) A radioactive substance with a mass of 150 grams decays according to the equation [2]
$A = 150e^{\left(\frac{-t}{20}\right)}$, where A (grams) is the amount remaining after t days.

Find, correct to the nearest whole day, the time taken for the substance to decay to half of it's original mass.

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g) Solve for x: $e^{2\ln x} = 5x + 24$ [2]

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End Of Question 6

Question 6 extra writing space.
If you use this space, clearly indicate which question you are answering.

Name : Circle Teacher: PPC ADC JMB MXF

Question 7 – Trigonometric Functions

Total / 12

a) MULTIPLE CHOICE QUESTION [1]
What is $255°$ in radians? *(circle one)*

(A) $\frac{7\pi}{5}$

(B) $\frac{17\pi}{12}$

(C) $\frac{11\pi}{8}$

(D) $\frac{13\pi}{9}$

b) What is the exact value of $sin\frac{2\pi}{3}$? [1]

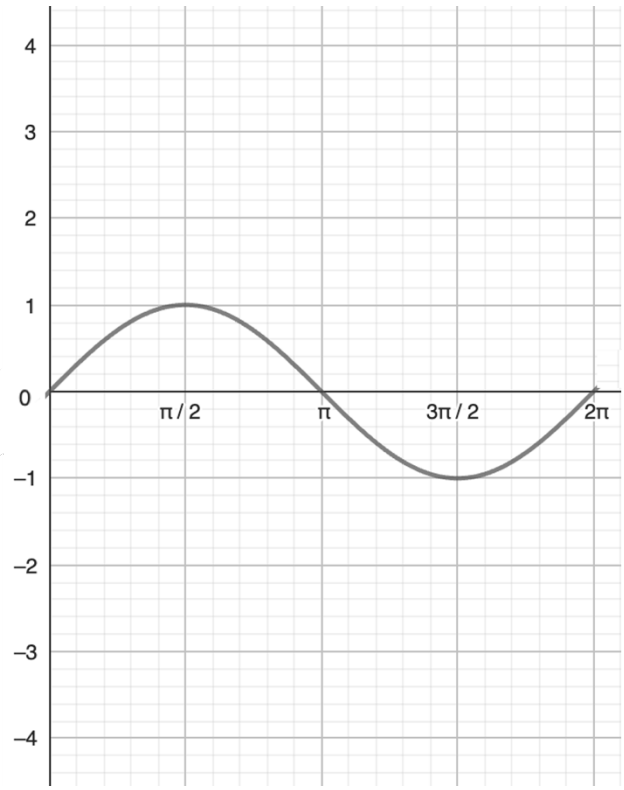
c) Solve the following equation for $[0, 360°]$: $2sin2\theta - 1 = 0$ [2]

d) Given that $cot\beta = -\frac{5}{12}$ and that $sin\beta < 0$, find the value of $cos\beta$. [2]

e) Fully simplify: $cot\theta sec\theta$ [2]

f) Below is the graph of $f(x) = sinx$. [2]

On the axes below, sketch the graph of $f(x) = 2sinx - 1$ for $[0, 2\pi]$.



g) Show that $2sec^2\theta + \frac{sin^2\theta - 2cos^2\theta}{cos^2\theta} = 3tan^2\theta$ [2]

End Of Question 7

Question 7 extra writing space.
If you use this space, clearly indicate which question you are answering.

END OF PAPER

Students Name:_____ Teachers Code : _____

Marker's Comments
Question 1.
SUGGESTED SOLUTIONS

Saint Ignatius' College, Riverview
Mathematics Assessment Task
2024

Year 11
Advanced Mathematics
Task 3
PRELIMINARY COURSE EXAMINATION
SEPTEMBER 23, 2024

General Instructions:

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- **Time Allowed: 120 Minutes**
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Question 6: Exponential and Logarithmic Functions
Question 7: Trigonometric Functions

Total **84 Marks**

Name : Circle Teacher: PPC ADC JMB MXF

Question 1 – Algebra, Equations and Inequalities

Total / 12

a) MULTIPLE CHOICE QUESTION [1]

Which of the following is equivalent to: $\frac{x^6}{y^6} \div x^2y^{-3}$ *(circle one)*

(A) $\frac{x^3}{y^2}$

(B) $\frac{x^4}{y^2}$

(C) $\frac{x^4}{y^3}$

(D) $\frac{x^4}{y^9}$

$= \frac{x^6}{y^6} \times \frac{1}{x^2y^{-3}}$

$= \frac{x^6}{y^6} \times \frac{y^3}{x^2}$

$= \frac{x^4}{y^3}$ C ✓

b) Solve the equation: $\left|\frac{x}{2} - 3\right| = 1$ [2]

$\frac{x}{2} - 3 = 1$ or $\frac{x}{2} - 3 = -1$

$\frac{x}{2} = 4$ $\frac{x}{2} = 2$

$x = 8$ $x = 4$

$x = 8, x = 4$

Both answers 2 marks

any - one 1 mark.

c) Solve the inequality: $8 - 2x \leq x + 4$ [2]

$8 - 3x \leq 4$

$-3x \leq -4$

$x \geq \frac{4}{3}$

Inequality sign, Value 2 M.

any - one right 1 M.

d) Solve $2x + 3y = 28$ and $3x + 2y = 27$ simultaneously. [2]

$2x + 3y = 28$ (1)

$3x + 2y = 27$ (2)

(1) $\times 2$: $4x + 6y = 56$ (3)

(2) $\times 3$: $-9x - 6y = -81$ (4)

(3) + (4): $-5x = -25$

$x = 5$

Sub $x = 5$ into (1):

$2(5) + 3y = 28$

$10 + 3y = 28$

$3y = 18$

$y = 6$

$\boxed{x = 5,\ y = 6}$

Both x, y values 2M
any one right 1M.
None right 0M.

e) Rationalise and fully simplify (for $x \neq 4$) [2]

$\dfrac{x-4}{\sqrt{x}+2}$

$= \dfrac{x-4}{\sqrt{x}+2} \times \dfrac{\sqrt{x}-2}{\sqrt{x}-2}$

$= \dfrac{(x-4)(\sqrt{x}-2)}{(\sqrt{x}+2)(\sqrt{x}-2)}$

$= \dfrac{(x-4)(\sqrt{x}-2)}{x-4}$

$= \sqrt{x} - 2$

$\boxed{\sqrt{x} - 2}$

Or $\dfrac{(\sqrt{x}-2)(\sqrt{x}+2)}{(\sqrt{x}+2)}$

$= \sqrt{x} - 2.$

Many got this wrong.

NO Marks if tried to expand Numerator.

f) **Fully simplify** the following expression. [3]

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

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

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

$= \frac{1-x}{(x+1)(x-1)}$ ✓

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

$= \frac{-1}{x+1}$ ✓

Fully simplified: $\boxed{\frac{-1}{x+1}}$

OR.

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

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

$= \frac{-(x-1)}{(x+1)(x-1)}$ ✓

$= \frac{-1}{(x+1)}$ ✓

All steps with right answer 3M

Some process to " " 1M

Once again quite a few errors

End Of Question 1

Question 1 extra writing space.
If you use this space, clearly indicate which question you are answering.

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Question 2 – Functions and Further Functions

Total / 12

a) MULTIPLE CHOICE QUESTION [1]

If $f(x) = 5x - 2$, which of the following is an expression for $(f(x))^2 - f(x)$? *(circle one)*

(A) $25x^2 - 25x + 2$

(B) $25x^2 - 25x + 6$

(C) $25x^2 - 15x + 2$

(D) $25x^2 - 15x - 2$

$= (5x-2)^2 - (5x-2)$

$= 25x^2 - 20x + 4 - 5x + 2$

$= 25x^2 - 25x + 6$

$=$ B

b) For the function $y = x^2 + 4x + 6$:

i) Find the value of the discriminant. [1]

$\Delta = b^2 - 4ac$

$= 4^2 - 4 \times 1 \times 6$

$= 16 - 24$

$= -8$

$\Delta = -8$

ii) By using i) or otherwise, determine which of the following is correct. *(circle one)* [1]

(A) The function has two real rational roots

(B) The function has two real irrational roots

(C) The function has one real root

(D) The function has no real roots

as $\Delta < 0$, no real roots.

$\therefore$ D

Question b) continued over page...

iii) Find the coordinates of the vertex of $y = x^2 + 4x + 6$. [1]

$x = \frac{-b}{2a}$ at $x = -2$: $y = (-2)^2 + 4(-2) + 6$

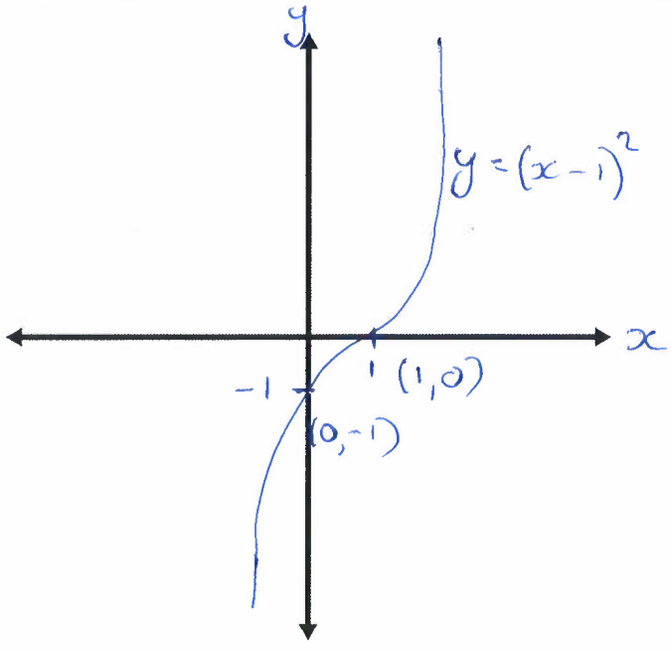
$y = 4 - 8 + 6$

$x = \frac{-4}{2}$ $y = 2$ other methods possible.

$x = -2$

$\therefore$ vertex at $(-2, 2)$

c) Sketch the graph of $y = (x-1)^3$, clearly indicating any x and y intercepts. [2]



→ many need to practise sketching shape accurately.

d) A circle on the number plane has equation $x^2 + y^2 - 8x + 6y + 21 = 0$. [2]
Find the centre and radius of the circle.

$x^2 - 8x + 4^2 + y^2 + 6y + 3^2 = -21 + 16 + 9$

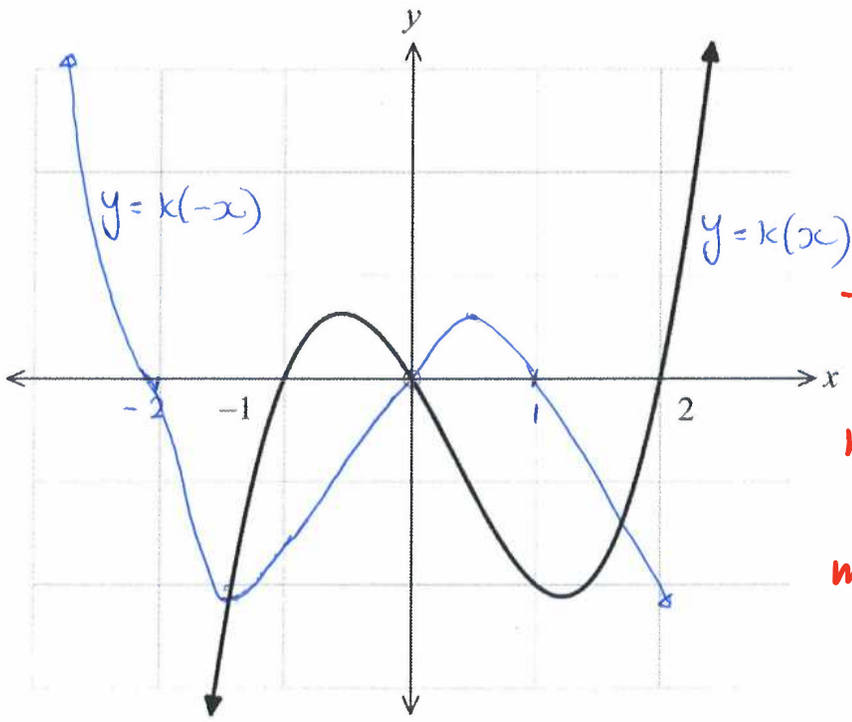
$(x-4)^2 + (y+3)^2 = 4$

centre: $(4, -3)$

radius = 2

e) The graph of $y = k(x)$ is shown below. [2]

On the same set of axes, draw a neat sketch of $y = k(-x)$. *Clearly show any x and y intercepts.*



→ hit and miss; try making use of the coordinates move!

f) Find $f(g(x))$ given $f(x) = x^2 - 2x + 3$ and $g(x) = 2x - 1$. [2]
Fully simplify your answer.

$f(g(x)) = f(2x-1)$

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

$= 4x^2 - 4x + 1 - 4x + 2 + 3$

$= 4x^2 - 8x + 6$

$\boxed{f(g(x)) = 4x^2 - 8x + 6}$

→ easy marks lost due to poor algebra.

End Of Question 2

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Question 3 – Trigonometry

Total / 12

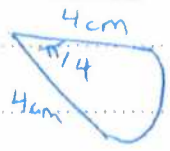
a) MULTIPLE CHOICE QUESTION [1]
When simplified, $\sin(90° - \theta) + \cos(180° - \theta)$ becomes: *(circle one)*

(A) 0
(B) 1
(C) 2
(D) $\cos\theta$

$\sin(90-\theta) + \cos(180-\theta)$
$= \cos\theta - \cos\theta$
$= 0$
$= A$ CAO

1

b) A sector of a circle with radius 4 cm has an angle of $\frac{\pi}{4}$ radians subtended at the centre. Find the **exact** perimeter of this sector. *Give your answer in cm in exact form.* [2]



$l = r\theta$
$= 4 \times \frac{\pi}{4}$
$= \frac{4\pi}{4}$
$= \pi$ ✓

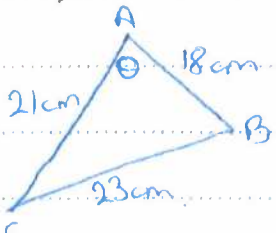
∴ Perimeter $= 4 + 4 + \pi$
$= 8 + \pi$ cm ✓

Perimeter $= 8 + \pi$ cm

2

Many neglected the second step.

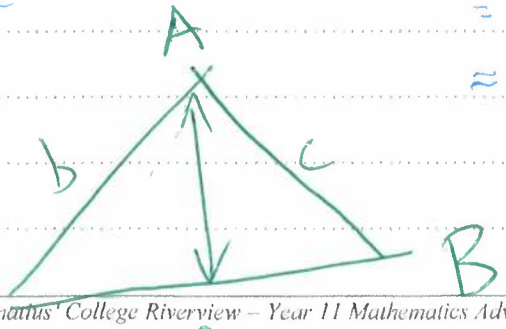
c) In $\triangle ABC$, $a = 23$ cm, $b = 21$ cm and $c = 18$cm. Find the size of $\angle A$. [2]
Give your answer correct to the nearest minute.



$\cos\theta = \frac{21^2 + 18^2 - 23^2}{2 \times 21 \times 18}$ ✓
$\theta = 71.8099\ldots$
$= 71°48'35.96''$
$\approx 71°49'$ ✓

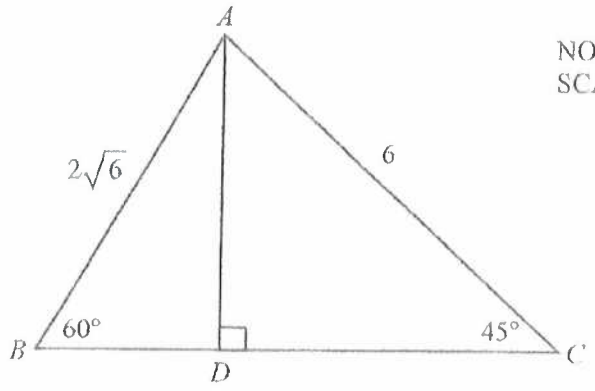
$\angle A \approx 71°49'$ nearest minute

2



C a generally well done
Side a opposite Angle A etc. IF diagram drawn correctly.

d) In the diagram, below ABC is a triangle in which $AB = 2\sqrt{6}$, $AC = 6$, $\angle ABC = 60^o$, and $\angle ACB = 45^o$. AD is the perpendicular from A to BC.



i) Find BD. *Give your answer in exact form.* [1]

$\frac{BD}{2\sqrt{6}} = \cos 60$

$\frac{BD}{2\sqrt{6}} = \frac{1}{2}$

$BD = \frac{2\sqrt{6}}{2}$ ✓ $\boxed{BD = \sqrt{6}}$ | 1

Means its probably easiest to use the same process again.

ii) Hence, or otherwise show that $BC = \sqrt{6} + 3\sqrt{2}$. [1]

was very difficult.

$\frac{DC}{6} = \cos 45$

$\frac{DC}{6} = \frac{1}{\sqrt{2}}$

$DC = \frac{6}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}}$

$= \frac{6\sqrt{2}}{2}$

$= 3\sqrt{2}$ ✓

$BC = BD + DC$

$BC = \sqrt{6} + \frac{6}{\sqrt{2}}$ ✓

$BC = \sqrt{6} + \frac{6}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}}$

$BC = \sqrt{6} + \frac{6\sqrt{2}}{2}$

$BC = \sqrt{6} + 3\sqrt{2}$

as required | 1

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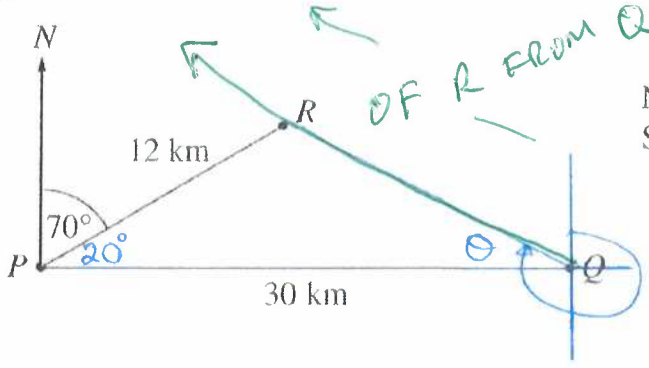
e) The diagram shows a point P which is 30 km due west of the point Q.
The point R is 12 km from P and has a bearing from P of 070°.



OF R FROM Q

START AT Q, GO TO R.

i) Find the distance of R from Q. *Give your answer in km to 1 decimal place.* [1]

$RQ^2 = PR^2 + PQ^2 - 2 \times PR \times PQ \times \cos\angle RPQ$

$= 12^2 + 30^2 - 2 \times 12 \times 30 \times \cos 20$

$= 367.421\ldots$

$RQ = 19.168\ldots$

$= 19.2$ km ✓

$RQ = 19.2$ km (1 dp)

1

ii) Find the true bearing of R from Q. [2]

$\frac{\sin\theta}{12} = \frac{\sin 20}{19.2}$ SINE RULE EASIER!

$\sin\theta = \frac{12\sin 20}{19.2}$

$\theta = 12.342\ldots$ ✓

$\theta = 12°$ (nearest degree)

Bearing $= 270° + 12°$
$= 282°$ ✓

2

Alt: $\cos\theta = \frac{19.2^2 + 30^2 - 12^2}{2 \times 19.2 \times 30}$

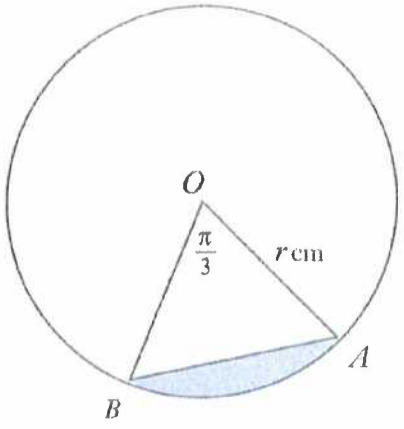
$= \frac{781}{800}$

$\therefore \theta = 12.512.$
$= 13°$ (nearest degree)

$\therefore$ Bearing $= 270° + 13°$
$= 282.$

[slight difference caused by rounding 19.168... to 19.2]

f) Consider the following circle with centre O and chord AB subtended by an angle of $\frac{\pi}{3}$ at the centre.



NOT TO SCALE

Given the area of the shaded minor segment cut off by chord AB is $54\pi - 81\sqrt{3}\ cm^2$, find the value of the radius of the circle, r cm. [2]

$A_{sector} = \frac{1}{2}r^2\theta$

$= \frac{1}{2}r^2 \times \frac{\pi}{3}$

$= \frac{\pi r^2}{3}$

$A_{triangle} = \frac{1}{2}ab\sin C$

$= \frac{1}{2} \times r^2 \times \sin\frac{\pi}{3}$

$= \frac{1}{2} \times r^2 \times \frac{\sqrt{3}}{2}$

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

$A_{sector} = A_{triangle} + A_{segment}$

$\frac{\pi r^2}{6} = \frac{r^2\sqrt{3}}{4} + 54\pi - 81\sqrt{3}$ $(\times 12)$

$2\pi r^2 = 3r^2\sqrt{3} + 648\pi - 972\sqrt{3}$

$2\pi r^2 - 3r^2\sqrt{3} = 648\pi - 972\sqrt{3}$ ✓

$r^2(2\pi - 3\sqrt{3}) = 324(2\pi - 3\sqrt{3})$

$r^2 = \frac{324(2\pi - 3\sqrt{3})}{2\pi - 3\sqrt{3}}$

$r^2 = 324$

$r = 18\text{cm}$ ✓

2.

Other methods possible

End Of Question 3

Alternate method.

Question 3 extra writing space.

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

(f) Many correctly assumed that $\frac{\pi r^2}{3} = 54\pi$ ✓
(Larger of two terms, with no $\sqrt{3}$ in it also.)

$\therefore r^2 = 54 \times 3$

$= 324$

$\therefore r = 18$ ✓

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Question 4 – Calculus

Total / 12

a) MULTIPLE CHOICE QUESTION [1]

If $y = \sqrt{2x}$, which of the following is an expression for $\frac{dy}{dx}$ *(circle one)*

(A) $\frac{1}{\sqrt{x}}$

(B) $\frac{1}{\sqrt{2x}}$

(C) $\frac{1}{2\sqrt{x}}$

(D) $\frac{1}{2\sqrt{2x}}$

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

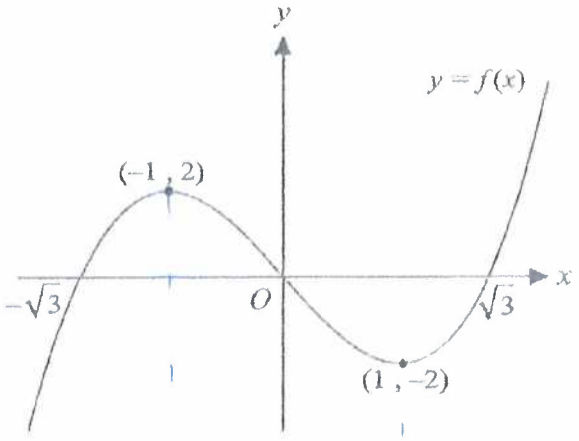
$\frac{dy}{dx} = \frac{1}{2}(2x)^{-\frac{1}{2}} \times 2$

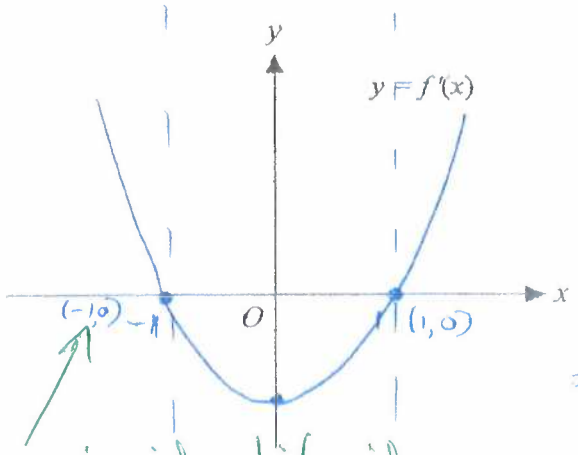
$= (2x)^{-\frac{1}{2}}$

$= \frac{1}{\sqrt{2x}}$ (B) ✓

1

b) The diagram below shows the graph of the curve. $y = f(x)$. On the set of axes on the underneath, sketch the graph of the curve.$y = f'(x)$ showing the shape of the curve and its x intercepts. [2]





concave up parabola across y axis. ✓
x-intercepts at -1 and 1 ✓

May mis-identified the x intercepts. eg. (-1, 2).

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c) Find the equation of the **normal** to the curve $y = x^3 + 4x + 7$ at the point where $x = 1$. [2]

$y' = 3x^2 + 4$

at $x = 1$: $y' = 3(1)^2 + 4$

$= 3 + 4$

$= 7$

$m_T = 7$

$m_N = -\frac{1}{7}$ ✓

when $x = 1$, $y = 1^3 + 4(1) + 7$

$= 1 + 4 + 7$

$= 12$ $(1, 12)$

$y - 12 = -\frac{1}{7}(x - 1)$

$7y - 84 = -x + 1$

$x + 7y - 85 = 0$ ✓

$ax + by + c = 0$

$y = -\frac{x}{7} + \frac{85}{7}$

2

d) The position (in metres) of an object along a straight line after t seconds is modelled by $x(t) = 3t^2 + 5t + 2 \quad (t \geq 0)$. [1]

Calculate the **velocity** of the object when $t = 4$ s.

$x(t) = 3t^2 + 5t + 2$

$v(t) = 6t + 5$

at $t = 4$: $v(4) = 6(4) + 5$

$= 24 + 5$

$= 29 \text{ m/s}$

$v(4) = 29 \text{ m/s}$ ✓

generally well done.

1

e) Differentiate the following with respect to x: [2]

i) $y = \sqrt{x^2 - 5}$

$y = (x^2 - 5)^{\frac{1}{2}}$

$y' = \frac{1}{2}(x^2 - 5)^{-\frac{1}{2}} \times 2x$ ✓

$= x(x^2 - 5)^{-1/2}$ ✓

$= \frac{x}{\sqrt{x^2 - 5}}$

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

Errors below were penalised

2

Question e) continues over page...

ii) $f(x) = \frac{1+x^2}{5x+1}$ [2]

FAR TOO MANY CANNOT WRITE THE QUOTIENT RULE CORRECTLY - IT IS ON THE REF. SHEET.

$u = 1+x^2 \qquad v = 5x+1$

$u' = 2x \qquad v' = 5$

$f'(x) = \frac{vu' - uv'}{v^2}$ ✓

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

$= \frac{10x^2 + 2x - 5 - 5x^2}{(5x+1)^2}$

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

$f'(x) = \frac{5x^2+2x-5}{(5x+1)^2}$ ✓ 2

iii) $y = x^2(2x+1)^5$. *Fully factorise your answer.* [2]

Product rule primarily, with v' requiring function of function.

$u = x^2 \qquad v = (2x+1)^5$

$u' = 2x \qquad v' = 5(2x+1)^4 \times 2$

$= 10(2x+1)^4$

$y' = vu' + uv'$

$= 2x \times (2x+1)^5 + x^2 \times 10(2x+1)^4$ ✓

$= 2x(2x+1)^5 + 10x^2(2x+1)^4$

$= 2x(2x+1)^4[(2x+1) + 5x]$

$= 2x(2x+1)^4(7x+1)$

$= 2x(7x+1)(2x+1)^4$

$y' = 2x(7x+1)(2x+1)^4$ ✓ 2

End Of Question 4

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Question 5 – Probability

Total / 12

a) MULTIPLE CHOICE QUESTION [1]
Four cards, labelled 2, 3, 5 and 7, are placed on a table to form a four-digit number.
How many different numbers greater than 3000 can be formed?

(A) 6
(B) 12
(C) 18
(D) 24

$= 3 \times 3 \times 2 \times 1$
$= 18$
C

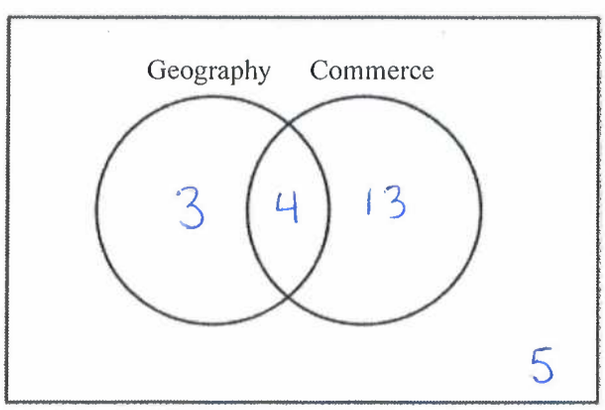
b) A packet contains 12 red, 8 green, 7 yellow and 3 black jellybeans. [1]
One jellybean is selected from the packet at random.

What is the probability that the selected jellybean is red or yellow?

$P(\text{red or yellow}) = \frac{19}{30}$.

c) A class has 25 students. 20 of them study at least one of Geography and Commerce. [2]
7 students study Geography and 17 study Commerce.

i) Complete the Venn diagram to represent the class breakdown.



Question c) continues over page...

ii) Two students are chosen at random from the class. Find the probability that both students chose to study exactly one of either Geography or Commerce. [1]
Give your answer in simplest fraction form.

$P(\text{2 students exactly one subject}) = \frac{16}{25} \times \frac{15}{24}$

$= \frac{2}{5}$

$\frac{2}{5}$

---

d) Neil tries to connect to his internet service provider. The probability that he connects on any single attempt is 0.8.

i) What is the probability that he connects for the first time on his second attempt? [1]

$P(\text{connect on second attempt}) = 0.2 \times 0.8$

$= 0.16 \quad \left(\frac{4}{25}\right)$

Very poorly done! Consider using a tree diagram.

0.16

ii) What is the probability that he is still not connected after his third attempt? [1]

$P(\text{not connected after 3 attempts})$

$= 0.2 \times 0.2 \times 0.2$

$= 0.008 \quad \left(\frac{1}{125}\right)$

0.008

e) In a box there are 4 milk chocolates, 2 white chocolates and 2 dark chocolates.
Three chocolates are chosen at random without replacement.

Determine the probability that: [1]

Very poorly done! Consider using a tree diagram.

i) All 3 are milk chocolate?

$P(MMM) = \frac{4}{8} \times \frac{3}{7} \times \frac{2}{6}$

$= \frac{24}{336}$

$= \frac{1}{14}$

$P(MMM) = \frac{1}{14}$

ii) One of each type of chocolate is chosen? [2]

$P(MWD, \text{in that order}) = \frac{4}{8} \times \frac{2}{7} \times \frac{2}{6}$

$= \frac{1}{21}$

MWD can be arranged in 6 ways, each with same chance

$\therefore P(MWD, \text{any order}) = 6 \times \frac{1}{21}$

$= \frac{6}{21}$

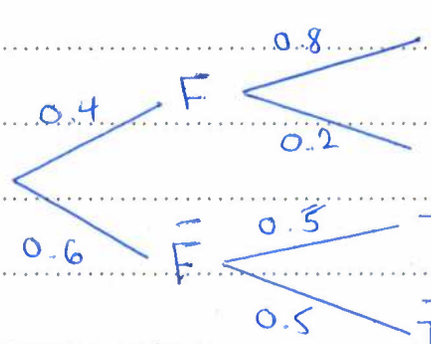
$P(\text{one of each}) = \frac{6}{21}$

f) Alpine Air operates a daily a daily flight from Jindabyne to Sydney. The probability of the flight departing on time, given there is fine weather in Jindabyne is 0.8, and the probability of the flight departing on time given that the weather is not fine is 0.5. [2]

In August, the probability of a day being fine is 0.4.

Find the probability that on a particular day in August that the weather is fine in Jindabyne, given that the flight departs on time. *Give your answer as a simplified fraction.*

Weather On time



$P(\text{on time}) = FT + \bar{F}T$

$= 0.4 \times 0.8 + 0.6 \times 0.5$

$= 0.32 + 0.30$

$= 0.62$

$P(F|T) = \frac{0.4 \times 0.8}{0.62}$

$= \frac{0.32}{0.62}$

$= \frac{16}{31}$

$\frac{16}{31}$

→ Done BADLY. need much more practice

End Of Question 5

Question 5 extra writing space
If you use this space, clearly indicate which question you are answering.

Name : Circle Teacher: PPC ADC JMB MXF

Question 6 – Exponential and Logarithmic Functions

Total / 12

a) MULTIPLE CHOICE QUESTION [1]
Simplify $2ln10 - ln5$ and choose the correct answer

(A) $ln4$
(B) $ln15$
(C) $ln20$
(D) $ln95$

$= \ln 10^2 - \ln 5$
$= \ln 100 - \ln 5$
$= \ln 20$
(C)

Done well

b) Given $\log_b 2 = 0.43$ and $\log_b 3 = 0.68$, evaluate $\log_b 1.5$ [1]

$\log_b 1.5 = \log_b \frac{3}{2}$
$= \log_b 3 - \log_b 2$
$= 0.68 - 0.43$
$= 0.25$

Always use the logs you are given!

$\log_b 1.5 = 0.25$

c) If $\log_x 7 + \log_x m = \log_x(m + 12)$, find the value of m. [2]

$\log_x 7m = \log_x(m + 12)$
$7m = m + 12$
$6m = 12$
$m = 2$

$m = 2$

Done well.

d) Differentiate with respect to x: $y = e^{3x} + 2e^{-2x}$ [2]

$y = e^{3x} + 2e^{-2x}$

$y' = 3e^{3x} - 4e^{-2x}$

$\boxed{y' = 3e^{3x} - 4e^{-2x}}$

Done well.

e) Solve for x: $3^{-4x} = 9^{6-x}$ [2]

$3^{-4x} = (3^2)^{6-x}$

$3^{-4x} = 3^{2(6-x)}$

$3^{-4x} = 3^{12-2x}$

$-4x = 12 - 2x$

$-2x = 12$

$x = -6$

$\boxed{x = -6}$

* Done better using exponentials as bags were trickier.
* -18 was the most incorrect answer (from basic $3^3 = 9$ instead of $3^2 = 9$)

other methods possible

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f) A radioactive substance with a mass of 150 grams decays according to the equation $A = 150e^{\left(\frac{-t}{20}\right)}$, where A (grams) is the amount remaining after t days. [2]

Find, correct to the nearest whole day, the time taken for the substance to decay to half of it's original mass.

$A = 150e^{-t/20}$

$75 = 150e^{-t/20}$

$\frac{1}{2} = e^{-t/20}$

$\ln\left(\frac{1}{2}\right) = \ln\left(e^{-t/20}\right)$

$\ln\frac{1}{2} = \frac{-t}{20}$ ✓

$20\ln\frac{1}{2} = -t$

$20\ln 2^{-1} = -t$

$20\ln 2 = t$

$t = 13.86$

$t = 14$ days ✓

Overall done well. Some students failed to recognise that $A = 75$.

g) Solve for x: $e^{2\ln x} = 5x + 24$ [2]

$e^{\ln x^2} = 5x + 24$

$x^2 = 5x + 24$

$x^2 - 5x - 24 = 0$

$(x - 8)(x + 3) = 0$

$x - 8 = 0, \quad x + 3 = 0$

$x = 8, \quad x = -3$

x cannot be negative

$\therefore x = 8$

Many students solved the quadratic correctly, however did not specify x could not be negative and provided both answers.

$x = 8$

End Of Question 6

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Question 7 – Trigonometric Functions

Total / 12

Question 7 MXF.
Marker's Comments.

a) MULTIPLE CHOICE QUESTION [1]
What is 255° in radians? *(circle one)*

(A) $\frac{7\pi}{5}$

(B) $\frac{17\pi}{12}$

(C) $\frac{11\pi}{8}$

(D) $\frac{13\pi}{9}$

$= \frac{255 \times \pi}{180}$

$= \frac{17\pi}{12}$

(B) ✓

b) What is the exact value of $sin\frac{2\pi}{3}$? [1]

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

$= \sin\pi - \sin\frac{\pi}{3}$ (2nd quad)

$= \sin\frac{\pi}{3}$

$= \frac{\sqrt{3}}{2}$ ✓

$\boxed{\frac{\sqrt{3}}{2}}$

c) Solve the following equation for $[0, 360°]$: $2sin2\theta - 1 = 0$ [2]

$\sin 2\theta = \frac{1}{2}$ $0 \leq 2\theta \leq 720$

$2\theta = 30°, 180° - 30°, 360° + 30°, 540° - 30°$

$2\theta = 30°, 150°, 390°, 510°$

$\theta = 15°, 75°, 195°, 255°$

$\boxed{\theta = 15°, 75°, 195°, 255°}$

All 4 right answers 2 marks
any other 1 mark.

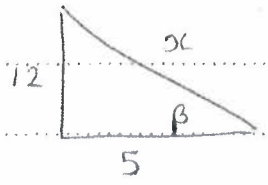
d) Given that $cot\beta = -\frac{5}{12}$ and that $sin\beta < 0$, find the value of $cos\beta$. [2]

$\cot\beta = \frac{-5}{12}$

$\tan\beta = \frac{-12}{5}$

S	A
T	C ✓

If $\tan\beta$ is negative and $\sin\beta$ is negative then in 4th quadrant, so $\cos\beta$ is positive'



$x^2 = 5^2 + 12^2$

$x^2 = 169$

$x = 13$

$\therefore \cos\beta = \frac{5}{13}$

$\boxed{\cos\beta = \frac{5}{13}}$

1 Mark ratio
1 " sign.

e) Fully simplify: $cot\theta sec\theta$ [2]

$= \frac{\cos\theta}{\sin\theta} \times \frac{1}{\cos\theta}$

$= \frac{1}{\sin\theta}$

accepted $\frac{1}{\sin\theta}$ for 2 marks.

$= \text{cosec}\,\theta$

$\boxed{\text{cosec}\,\theta}$

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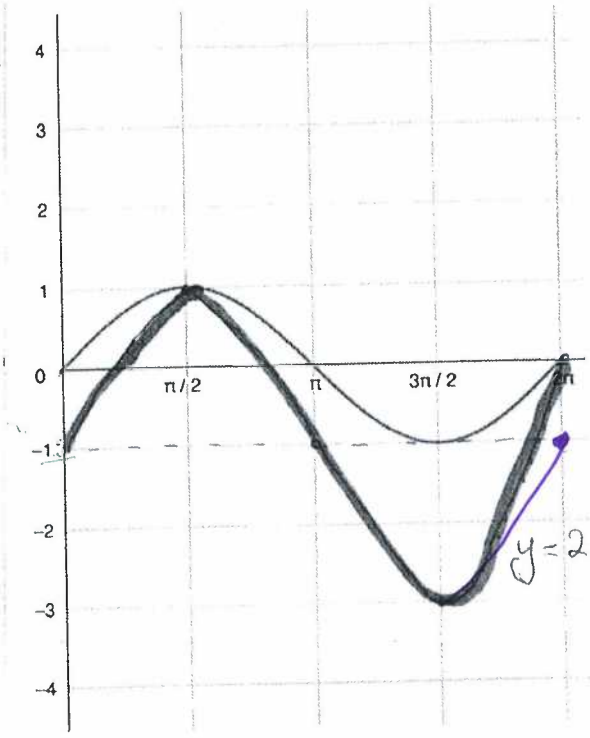
f) Below is the graph of $f(x) = sinx$. [2]

On the axes below, sketch the graph of $f(x) = 2sinx - 1$ for $[0, 2\pi]$.



Proper Domain and Range 2 marks.

Any-one right 1 Mark.

Mostly well done.

g) Show that $2sec^2\theta + \frac{sin^2\theta - 2cos^2\theta}{cos^2\theta} = 3tan^2\theta$ [2]

$LHS = \frac{2}{\cos^2\theta} + \frac{\sin^2\theta - 2\cos^2\theta}{\cos^2\theta}$

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

$= \frac{2(1 - \cos^2\theta) + \sin^2\theta}{\cos^2\theta}$

$= \frac{2(\sin^2\theta) + \sin^2\theta}{\cos^2\theta}$

$= \frac{3\sin^2\theta}{\cos^2\theta}$

$= 3\tan^2\theta$

$= RHS$ as required

OR.

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

$2\sec^2\theta + \tan^2\theta - 2$

$2(\tan^2\theta + 1) + \tan^2\theta - 2$

$2\tan^2\theta + 2 + \tan^2\theta - 2$

$= 3\tan^2\theta = RHS$.

* Lots of bluffing, where some right working shown 1 Mark otherwise zero.

End Of Question 7

END OF PAPER