2022

YEAR 11 ASSESSMENT TASK 3

Mathematics Advanced

General Instructions

- Reading time – 10 minutes
- Working time – 120 minutes
- Black pen is preferred.
- For questions in Section II, show relevant mathematical reasoning and/or calculations.
- Calculators approved by NESA may be used
- DO NOT USE LIQUID PAPER OR CORRECTION TAPE

Total Marks – 70

Section I: 10 marks

- Attempt questions 1-10, using the answer sheet provided.
- Allow about 15 minutes for this section

Section II: 60 marks

- Attempt questions 11 - 33, answer the questions in the booklets provided.
- Allow about 105 minutes for this section

	Multiple Choice	Section 2 marks		TOTAL
Algebraic Techniques	2(1)	13(2), 27(3), 30(3)	8	9
Functions	1(1)	18(2), 19(2), 25(2), 28(2)	8	9
Linear, quadratics and cubics	3(1)	16(2), 20(3), 21(4), 22(2)	11	12
Trigonometry	9(1)	11(1), 12(1), 14(3), 26(3), 33(2)	10	11
Introduction to Calculus	7(1), 8(1), 10(1)	15(3), 23(3), 24(3)	9	12
Probability	4(1), 5(1), 6(1)	17(2), 29(6), 31(3), 32(3)	14	17
TOTAL	10		60	70

NESA Number: _____ Teacher: _____

Section I

10 marks
Attempt Questions 1 to 10
Use the multiple-choice answer sheet for Questions 1 to 10

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1. Given $f(x) = 3x^2 + 2x$. Calculate the value of $f(2a)$?

A. $6a^2 + 2a$

B. $6a^2 + 4a$

C. $36a^2 + 4a$

D. $12a^2 + 4a$

2. What is 4.09784 correct to three significant figures?

A. 4.09

B. 4.10

C. 4.097

D. 4.098

3. What is the value of the discriminant of the quadratic equation $x^2 + 3x - 10$?

A. -5

B. 5

C. 7

D. 49

4. In a class of thirty Year 10 students, 15 students play piano, 14 play guitar and 7 play both. What is the probability that a randomly chosen student plays guitar, given that they play the piano?

A. $\frac{14}{15}$

B. $\frac{7}{15}$

C. $\frac{7}{29}$

D. $\frac{15}{29}$

5. Given that the random variable X has the probability distribution given in the table

x	1	2	3	4	5	6
$P(X = x)$	0.05	0.23	0.18	0.33	0.14	0.10

Calculate $P(X \geq 5)$.

A. 0.10

B. 0.14

C. 0.24

D. 0.76

6. For two events A and B, $P(A) = \frac{3}{8}$, $P(B) = \frac{4}{7}$ and $P(A \cap B) = \frac{8}{21}$. Calculate $P(A|B)$.

A. $\frac{2}{3}$

B. $\frac{21}{32}$

C. $\frac{3}{14}$

D. $\frac{3}{8}$

7. The function $y = ax^2 - bx$ has a gradient of zero at $x = 2$. The x-axis intercepts of the graph of this function are:

A. $x = 0, 4$

B. $x = 0, -4$

C. $x = 0, \frac{1}{2}$

D. $x = 0, -\frac{1}{2}$

8. Given $y = \sqrt{2f(x)}$, calculate $\frac{dy}{dx}$.

A. $\frac{2f'(x)}{\sqrt{2f(x)}}$

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

C. $\frac{f'(x)}{\sqrt{2f(x)}}$

D. $\frac{3}{2(2f'(x))}$

9. Which expression is equivalent to $\frac{1}{\cot^2\theta} + \sec\theta\cos\theta$?

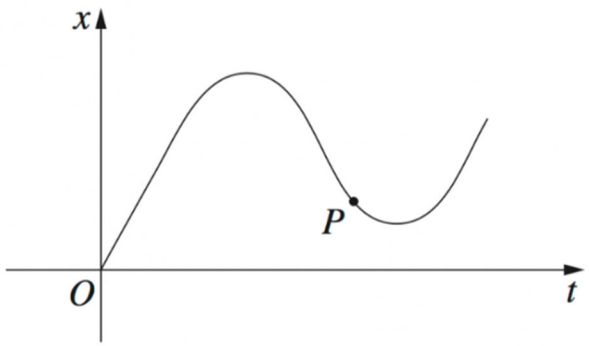
A. 1

B. $\sec^2\theta$

C. $\tan^2\theta$

D. $\operatorname{cosec}^2\theta$

10. The graph shows the displacement x of a particle moving along a straight line as a function of time t, where $t \geq 0$.



Which statement describes the motion of the particle at the point P?

A. The velocity is negative, and acceleration is positive.

B. The velocity is negative, and acceleration is negative.

C. The velocity is positive, and acceleration is positive.

D. The velocity is positive, and acceleration is negative.

End of Section I

Section II

60 marks
Attempt Questions 11 to 33

Answer the questions in the spaces provided.
Your responses should include relevant mathematical reasoning and/or calculations.
All necessary working should be shown in every question.

Question 11 (1 mark)

Express $490°$ in radians in terms of π. **1**

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Question 12 (1 marks)

Calculate $\sin\left(\frac{4\pi}{7}\right)$ to two decimal places. **1**

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Question 13 (2 marks)

Simplify $2a(b^2 - a^3) - 5a^2(b - 3a^2)$

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Question 14 (3 marks)

The area of the sector of a circle formed by the centre angle of $\frac{2\pi}{5}$ is $\frac{33\pi}{4}$ cm^2.

Find the radius of the circle. **3**

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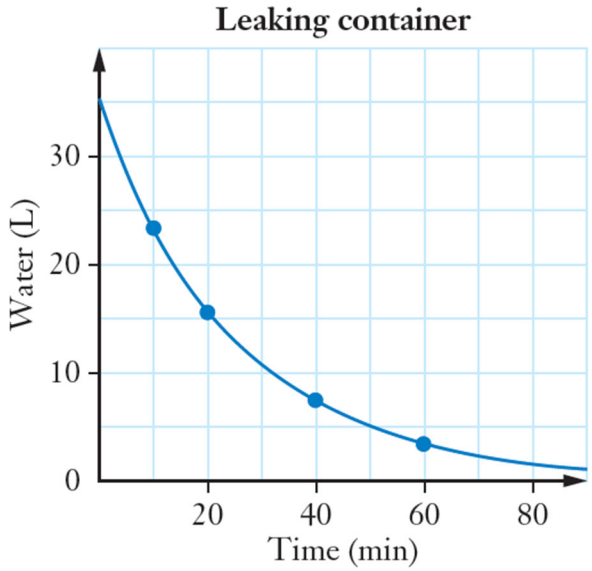
Question 15 (3 marks)

The amount of water in a leaking container is shown in the graph below.



a) Calculate the average rate of loss from 20 minutes to 40 minutes. **1**

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b) Describe how the rate changes over time. **2**

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Question 16 (2 marks)

Two electrical technicians can repair five electrical lines in three hours. After a storm, 50 electrical lines need repairing. How many electrical technicians are needed to repair the electrical lines in one eight hour working day? **2**

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Question 17 (2 marks)

A survey of 950 people were asked to state their favourite team in the NRL competition.

The results are shown in the table below.

	Western Sydney team	Other teams
Lives in Western Sydney	404	254
Lives elsewhere	94	198

Is support for a Western Sydney team independent of where a person lives? Justify your answer. **2**

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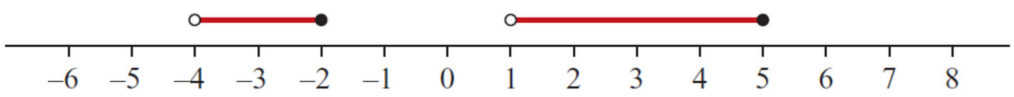
Question 18 (2 marks)

Describe the following solution using interval notation. **2**



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Question 19 (2 marks)

What is the domain and range for the function $f(x) = \sqrt{4 - x}$. **2**

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Question 20 (3 marks)

A group of friends hire a bus for $2100 to take them to a music festival. Seven friends can no longer make the festival and withdraw from the bus hire. The remaining friends must each pay an additional $10 to cover the cost of the bus hire. How many friends originally agreed to go on the bus? **3**

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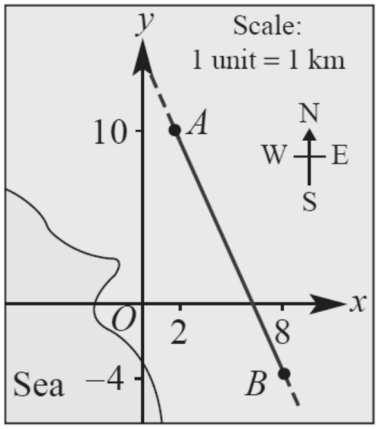
Question 21 (4 marks)

$O(0,0)$ is the position of the air traffic control tower at Sydney Airport. A plane travelling in a straight line is identified at $A(2, 10)$ and again at $B(8, -4)$.



a) What is the equation that describes the flight of the plane? **2**

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b) How far south of O is the aircraft when $x = 15$ km? **2**

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Question 22 (2 marks)

Determine the coordinates of the vertex of the function $f(x) = -(x + 1)^2 + 4$. **2**

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Question 23 (3 marks)

Find the gradient of the curve $y = (x - 1)(3 - 2x)^4$ at the point where $x = -3$. **3**

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Question 24 (3 marks)

Differentiate $f(x) = 3x^2 + 2x + 2$ using the method of first principles. **3**

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Question 25 (2 marks)

Given $f(x) = \frac{1}{x}$ and $g(x) = 3x + 2$. Find the domain and range of the composite function $g(f(x))$. **2**

Question 26 (3 marks)

Solve the equation $\sin(2\theta) = -\frac{\sqrt{3}}{2}$ for the domain $\theta \in [-\pi, \pi]$. **3**

Question 27 (3 marks)

Find the gradient of the normal for the curve $y = \frac{x^2}{1-x}$ when $x = -2$. **3**

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Question 28 (2 marks)

Explain the difference between a one-to-one function and a many-to-one function, provide examples. **2**

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Question 29 (6 marks)

Claire has three packs of lollies. In bag 1 there are three mints and three sour strips, in bag 2 there are three mints and two sour strips, and in bag 3 there are two mints and one sour strip.

Claire selects a bag at random, and then selects a lolly at random. Calculate:

a) The probability she chooses a mint from bag 1. **1**

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b) The probability she chooses a mint. **2**

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c) The probability that Claire chose bag 1, given that she selects a mint. **3**

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Question 30 (3 marks)

A cyclist goes up a long slope at a constant speed of 15km/h. He turns around and comes down the slope at a constant speed of 40km/h. Find his average speed over a full circuit. **3**

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Question 31 (3 marks)

James is a keen runner. He is supposed to attend running training five days per week. **3**

James finds that if he runs one day, the probability that he will run again the next day is $\frac{4}{5}$, and if he does not run one day, the probability that he will not run the next day is $\frac{3}{4}$. Suppose James runs one day, what is the probability that he runs exactly twice in the next three days?

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Question 32 (3 marks)

Athena plays a game in which two coins are tossed. If she throws two heads, she wins \$5. If she throws two tails, she loses \$3. And for one head and one tail, she loses \$2. **3**

Calculate the financial expectation from this game. If the game is not fair, what can be done to make it a fair game?

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Question 33 (2 marks)

Prove that

$$\frac{1-\sin^2 x\cos^2 x}{\sin^2 x}=\cot^2 x+\sin^2 x$$ **2**

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END OF EXAMINATION

Section II

60 marks
Attempt Questions 11 to 33

Answer the questions in the spaces provided.
Your responses should include relevant mathematical reasoning and/or calculations.
All necessary working should be shown in every question.

Question 11 (1 mark)

Express 490° in radians in terms of π.

1

$\frac{490\pi}{180} = \frac{49\pi}{18}$ 2.72π

Question 12 (1 marks)

Calculate $\sin\left(\frac{4\pi}{7}\right)$ to two decimal places.

$= 0.97\,49279122$
$= 0.97$ (1)

Question 13 (2 marks)

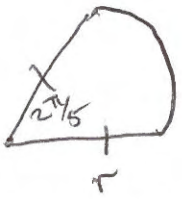
Simplify $2a(b^2 - a^3) - 5a^2(b - 3a^2)$

$= 2ab^2 - 2a^4 - 5a^2b + 15a^4 = 2ab^2 + 13a^4 - 5a^2b$ (1)
$= a(2b^2 + 13a^3 - 5ab)$ (1)

Question 14 (3 marks)

The area of the sector of a circle formed by the centre angle of $\frac{2\pi}{5}$ is $\frac{33\pi}{4}$ cm^2.

Find the radius of the circle.



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

$\frac{33\pi}{4} = \frac{1}{2}r^2\frac{2\pi}{5}$ (1)

$\frac{165}{4} = r^2$

$r = \pm\frac{\sqrt{165}}{2}$ (1)

but $r > 0$

$\therefore r = \frac{\sqrt{165}}{2}$ cm (1)

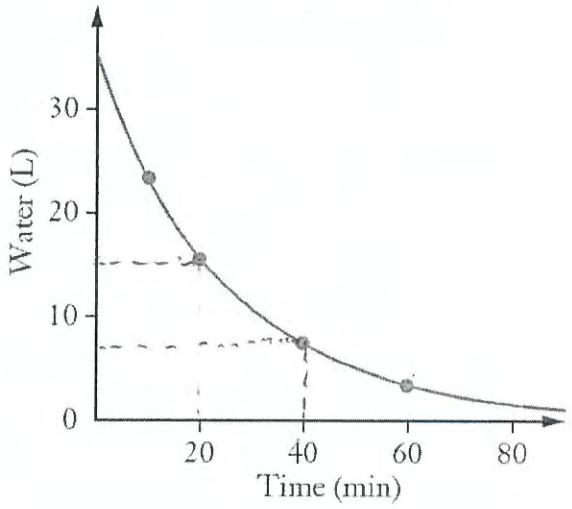
* students had equations in terms of degrees and radians. ☹
* some students changed the area to an angle in degrees!!! ☹

or $r = 6.422616289$ cm

Question 15 (3 marks)

The amount of water in a leaking container is shown in the graph below.

Leaking container



a) Calculate the average rate of loss from 20 minutes to 40 minutes.

rate $= 15\text{L} - 8\text{L} = -7\text{L}$ in 20 mins

$20 - 40 = -\frac{7}{20}$ L/min (1)

decreases at $\frac{7}{20}$ L/min

b) Describe how the rate changes over time.

as time increases the water level is going down at a decreasing rate, ie reducing at a decreasing rate. (1) (1)

* you needed mention 3 things to get the two marks; most students didn't talk about time.

Question 16 (2 marks)

Two electrical technicians can repair five electrical lines in three hours. After a storm, 50 electrical lines need repairing. How many electrical technicians are needed to repair the electrical lines in one eight hour working day?

2

2 Electricians → 5 lines → 3 hours
→ 40 lines → 24 hours
8 Electricians → 160 lines → 24 hours
→ 53 1/3 lines → 8 hours.

OR

Electricians	Lines	Time
2	5	3
x	50	8

$2 \times 50 \times 3 = x \times 5 \times 8$

$300 = 40x$

$x = 7.5$

∴ 8 electricians

Question 17 (2 marks)

A survey of 950 people were asked to state their favourite team in the NRL competition.

The results are shown in the table below.

	Western Sydney team	Other teams
Lives in Western Sydney	404	254
Lives elsewhere	94	198

Is support for a Western Sydney team independent of where a person lives? Justify your answer.

2

- Western Sydney reside and supporter $\frac{404}{658} = \frac{202}{329} = 0.$
- If events A and B are independent then $P(A \text{ and } B) = P(A) \times P($
- lives elsewhere and supports Western Sydney team $\frac{94}{292} = 0.32$

or $P(A|B) = P(A)$ $P(B|A) = P(B)$

LHS $\frac{404}{658} = \frac{202}{329}$ RHS $= \frac{498}{950} = \frac{249}{475}$

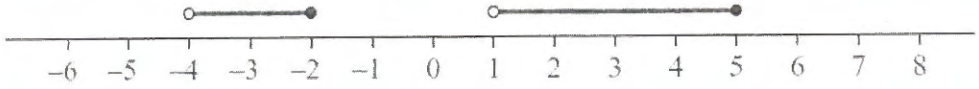
LHS ≠ RHS ∴ not independent.

* words only but no justification is 1 mark only. You had to either use the table or do the math

Question 18 (2 marks)

Describe the following solution using interval notation.

2



$(-4, -2] \cup (1, 5]$

or

① for correct interval notation

① for "∪"

Question 19 (2 marks)

What is the domain and range for the function $f(x) = \sqrt{4-x}$. 2

$4 - x \geq 0$

domain: $x \leq 4$ or $(-\infty, 4]$ ✓

$f(x)$ can't be negative

range: $y \geq 0$ or $[0, \infty)$ ✓

Some students thought that this is a semicircle which is not.

Question 20 (3 marks)

A group of friends hire a bus for $2100 to take them to a music festival. Seven friends can no longer make the festival and withdraw from the bus hire. The remaining friends must each pay an additional $10 to cover the cost of the bus hire. How many friends originally agreed to go on the bus? 3

let x be the number of original friends

y be the amount each friend contributed

$xy = 2100$

$y = \frac{2100}{x}$

$(x-7)(y+10) = 2100$ ✓

$xy + 10x - 7y - 70 = 2100$

substituting values

$2100 + 10x - 7\left(\frac{2100}{x}\right) - 70 = 2100$

$\left(10x - \frac{14700}{x} - 70 = 0\right) \times x$

$\left(10x^2 - 70x - 14700 = 0\right) \div 10$

$x^2 - 7x - 1470 = 0$

$(x-42)(x+35) = 0$

$x = 42, x = -35$ but $x > 0$ ✓

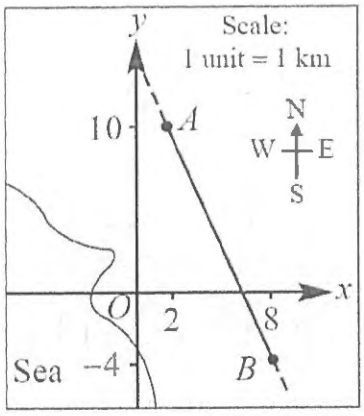
$\therefore x = 42$ friends ✓

$\therefore$ There were 42 friends originally

- Algebraic techniques req'd to gain full marks.
- Need to show both values of the quadratic equation and indicate that $x > 0$.
- 1 mark only for students who only wrote the answer using guess-and-check.

Question 21 (4 marks)

$O(0,0)$ is the position of the air traffic control tower at Sydney Airport. A plane travelling in a straight line is identified at $A(2,10)$ and again at $B(8,-4)$.



1 mark for correct gradient.

1 mark for correct equation of the line whether in $y=mx+c$ or $ax+by+c=0$ form.

a) What is the equation that describes the flight of the plane? 2

$m = \frac{-4-10}{8-2} = \frac{-7}{3}$ ✓

$y-10 = \frac{-7}{3}(x-2)$

$y-10 = \frac{-7}{3}x + \frac{14}{3}$

$y = \frac{-7}{3}x + \frac{44}{3}$ ✓

or $7x+3y-44=0$

b) How far south of O is the aircraft when $x = 15$ km? 2

$y = \frac{-7}{3}(15) + \frac{44}{3}$ ✓

$y = \frac{-61}{3}$ or $-20\frac{1}{3}$

∴ the aircraft is $20\frac{1}{3}$ km south of O. ✓

1 mark for the line of substitution.

1 mark for the answer.

Question 22 (2 marks)

Determine the coordinates of the vertex of the function $f(x) = -(x+1)^2 + 4$. 2

$f(x) = a(x-h)^2 + k$ ✓

the vertex is at $(-1, 4)$ ✓

1 mark for x-coordinate

1 mark for y-coordinate

Question 23 (3 marks)

Find the gradient of the curve $y = (x-1)(3-2x)^4$ at the point where $x = -3$. **3**

$u = (x-1)$ | $v = (3-2x)^4$

$u' = 1$ | $v' = 4(3-2x)^3(-2)$ ✓

$v' = -8(3-2x)^3$

$y' = u'v + v'u$

$y' = (3-2x)^4 - 8(3-2x)^3(x-1)$ ✓ or $(3-2x)^3(11-10x)$ ← not required to show.

at $x = -3$

$y' = (3-2(-3))^4 - 8(3-2(-3))^3(-3-1)$

$y' = 29889$

$\therefore$ the gradient is 29889 ✓

2 marks for correct derivate using product rule.

1 mark for gradient

Question 24 (3 marks)

Differentiate $f(x) = 3x^2 + 2x + 2$ using the method of first principles. **3**

Question 23 (3 marks)

Find the gradient of the curve $y = (x-1)(3-2x)^4$ at the point where $x = -3$. **3**

Question 24 (3 marks)

Differentiate $f(x) = 3x^2 + 2x + 2$ using the method of first principles. **3**

Use the reference sheet!

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

$= 3(x^2+2xh+h^2) + 2x + 2h + 2$

$= 3x^2 + 6xh + 3h^2 + 2x + 2h + 2$ } 1 mark

$f'(x) = \lim_{h\to 0} \frac{f(x+h) - f(x)}{h}$ } 1 mark

$= \lim_{h\to 0} \frac{3x^2 + 6xh + 3h^2 + 2x + 2h + 2 - (3x^2+2x+2)}{h}$

$= \lim_{h\to 0} \frac{3x^2 + 6xh + 3h^2 + 2x + 2h + 2 - 3x^2 - 2x - 2}{h}$ } 1 mark.

$= \lim_{h\to 0} \frac{6xh + 3h^2 + 2h}{h}$

$= \lim_{h\to 0} \frac{h(6x + 3h + 2)}{h}$

$= \lim_{h\to 0} 6x + 3h + 2$

$= 6x + 3(0) + 2$

$= 6x + 2$ } 1 mark.

lost 1 mark for $3h + 6x + 2$

Question 25 (2 marks)

Given $f(x) = \frac{1}{x}$ and $g(x) = 3x + 2$. Find the domain and range of the composite function $g(f(x))$. 2

$g(f(x)) = g\left(\frac{1}{x}\right) = 3\left(\frac{1}{x}\right) + 2$

$g(f(x)) = \frac{3}{x} + 2$

(1 mark)

Domain: all real, $x \neq 0$ or $(-\infty, 0) \cup (0, \infty)$ (1 mark for ...)

Range: all real, $y \neq 2$ or $(-\infty, 2) \cup (2, \infty)$

Question 26 (3 marks)

Solve the equation $\sin(2\theta) = -\frac{\sqrt{3}}{2}$ for the domain $\theta \in [-\pi, \pi]$. 3

$\sin 2\theta = -\frac{\sqrt{3}}{2}$ $\quad -\pi \leq \theta \leq \pi$

$-2\pi \leq 2\theta \leq 2\pi$

related angle is $\frac{\pi}{3}$.

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

$2\theta = \frac{4\pi}{3}, \frac{5\pi}{3}, -\frac{\pi}{3}, -\frac{2\pi}{3}$

(1 mark for related angle.)

$\theta = \frac{4\pi}{6}, \frac{5\pi}{6}, -\frac{\pi}{6}, -\frac{2\pi}{6}$

$= \frac{2\pi}{3}, \frac{5\pi}{6}, -\frac{\pi}{6}, -\frac{\pi}{3}$

$\therefore \theta = -\frac{\pi}{6}, -\frac{\pi}{3}, \frac{2\pi}{3}, \frac{5\pi}{6}$ } have two marks.

1 mark 1 mark.

Question 27 (3 marks)

Find the gradient of the normal for the curve $y = \frac{x^2}{1-x}$ when $x = -2$. 3

Using the quotient rule $y' = \frac{vu' - uv'}{v^2}$

$u = x^2 \quad v = 1-x$

$u' = 2x \quad v' = -1$

Lots not differentiating using m.

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

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

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

Not done well.

$y'(-2) = -2\left(\frac{2-(-2)}{(1-(-2))^2}\right)$ 1 mark

$= \frac{-2(4)}{3^2}$

$= \frac{-8}{9}$

$\therefore m = -\frac{8}{9}$ 1 mark

→ gradient of normal is $\frac{9}{8}$, since $m_1 \times m_2 = -1$.

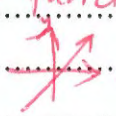
missing examples

Question 28 (2 marks)

Explain the difference between a one-to-one function and a many-to-one function, provide examples. 2

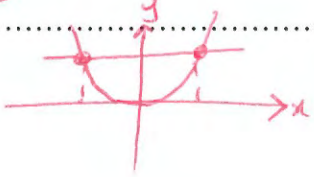
One-to-one function means each x value has a one y-value

Eg various -



many to one function means each x value has a/d a y-value. Many x values have the same value.

Eg parabola



Done well. Well explained

Question 29 (6 marks)

Claire has three packs of lollies. In bag 1 there are three mints and three sour strips, in bag 2 there are three mints and two sour strips, and in bag 3 there are two mints and one sour strip.

Claire selects a bag at random, and then selects a lolly at random. Calculate:

a) The probability she chooses a mint from bag 1. 1

$P(\text{mint from bag 1}) = \frac{1}{3} \times \frac{1}{2} = \frac{1}{6}$ poorly done.

b) The probability she chooses a mint. 2

Bag 1 Bag 2 Bag 3

$P(\text{mint}) = \left(\frac{1}{3} \times \frac{1}{2}\right) + \left(\frac{1}{3} \times \frac{3}{5}\right) + \left(\frac{1}{3} \times \frac{2}{3}\right)$

$= \frac{1}{6} + \frac{1}{5} + \frac{2}{9}$

$= \frac{53}{90}$

c) The probability that Claire chose bag 1, given that she selects a mint. 3

$P(\text{Bag 1} / \text{mint}) = \frac{P(\text{mint} \wedge \text{Bag 1})}{P(M)}$

$= \frac{\left(\frac{1}{6}\right)}{\left(\frac{53}{90}\right)}$ from part a / from part b

$= \frac{15}{53}$

Question 30 (3 marks)

A cyclist goes up a long slope at a constant speed of 15km/h. He turns around and comes down the slope at a constant speed of 40km/h. Find his average speed over a full circuit. 3

let x be length of slope in km.

time up $= \frac{x}{15}$

time down $= \frac{x}{40}$

total time $= \frac{x}{15} + \frac{x}{40}$

$= \frac{11x}{120}$

Average speed $= \frac{\text{distance}}{\text{time}}$

$= \frac{2x}{\left(\frac{11x}{120}\right)}$

$= 2x \times \frac{120}{11x}$

$= \frac{240}{11}$

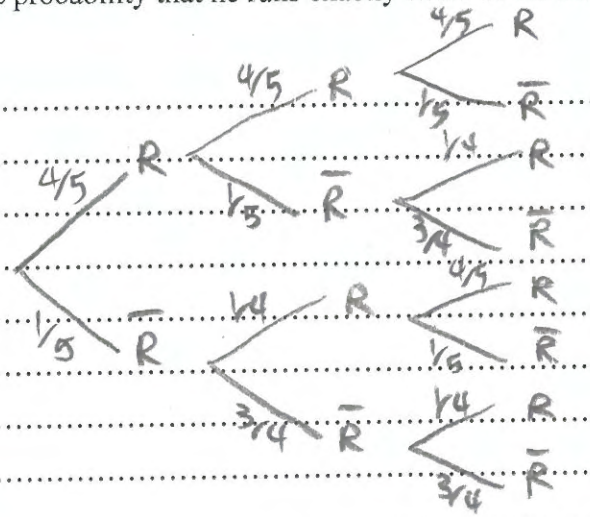
$= 21.82$ km/hr.

very poorly done!

Question 31 (3 marks)

James is a keen runner. He is supposed to attend running training five days per week. 3

James finds that if he runs one day, the probability that he will run again the next day is $\frac{4}{5}$, and if he does not run one day, the probability that he will not run the next day is $\frac{3}{4}$. Suppose James runs one day, what is the probability that he runs exactly twice in the next three days?



$RR\bar{R}$ $\left(\frac{4}{5} \times \frac{4}{5} \times \frac{1}{5}\right) = \frac{16}{125}$

$R\bar{R}R$ $\left(\frac{4}{5} \times \frac{1}{5} \times \frac{1}{4}\right) = \frac{4}{100}$

$\bar{R}RR$ $\left(\frac{1}{5} \times \frac{1}{4} \times \frac{4}{5}\right) = \frac{4}{100}$

total $= \frac{26}{125}$

Question 32 (3 marks)

Athena plays a game in which two coins are tossed. If she throws two heads, she wins \$5. If she throws two tails, she loses \$3. And for one head and one tail, she loses \$2. 3

Calculate the financial expectation from this game. If the game is not fair, what can be done to make it a fair game?

$E(X) = \frac{1}{4}(5) + \frac{1}{4}(-3) + \frac{1}{2}(-2)$

$= -0.5$

$\therefore$ not fair

If Athena wins \$7, the game will be fair.

Feedback: Students commented on the probability being not fair and awarded no marks.

Question 33 (2 marks)

Prove that 2

$$\frac{1 - \sin^2 x \cos^2 x}{\sin^2 x} = \cot^2 x + \sin^2 x$$

$LHS = \frac{1 - \sin^2 x \cos^2 x}{\sin^2 x}$

$= \frac{1}{\sin^2 x} - \frac{\sin^2 x \cos^2 x}{\sin^2 x}$

$= \operatorname{cosec}^2 x - \cos^2 x$

$= (1 + \cot^2 x) - (1 - \sin^2 x)$

$= \cot^2 x + \sin^2 x$

$= RHS$

Feedback:

→ Many students did this!

$\frac{1 - \sin^2 x \cos^2 x}{\sin^2 x}$

$= \frac{\cos^2 x \cos^2 x}{\sin^2 x}$

→ RHS to LHS was a little easier.

END OF EXAMINATION