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END OF YEAR EXAMINATION 2014

Secondary 3 Express

ADDITIONAL MATHEMATICS

4047/01

Paper 1

1 October 2014

Additional material: Foolscape paper

Time: 12.00 noon – 1.30 p.m.

Duration: 1 hour 30 minutes

INSTRUCTIONS TO STUDENTS:

Write your name, class and register number on all the work you hand in.

Write in blue or black pen on both sides of the paper.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer all questions.

Write your answers in the spaces provided in the question paper.

If working is needed for any question, it must be shown with the answer.

Omission of essential working will result in loss of marks.

You are expected to use a scientific calculator to evaluate explicit numerical expressions.

If the degree of accuracy is not specified in the question and if the answer is not exact, the answer should be given to three significant figures. Answers in degrees should be given to one decimal place.

For π , either use your calculator value or 3.142, unless the question requires the answer in terms of π .

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 60.

At the end of the examination, fasten all your work securely together.

Name of Student: _____ ()

Class: _____

Parent's Signature: _____

Setter: Mr Ng Choon Chooi

For Examiner's Use	
Total	60

This question paper consists of 4 printed pages including the cover page.

[Turn over

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

For the equation $ax^2 + bx + c = 0$,

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

Binomial expansion

$$(a+b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \dots + \binom{n}{r}a^{n-r}b^r + \dots + b^n,$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{r!(n-r)!} = \frac{n(n-1)\dots(n-r+1)}{r!}$

2. TRIGONOMETRY

Identities

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

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

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

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

$$\sin 2A = 2 \sin A \cos A$$

$$\cos 2A = \cos^2 A - \sin^2 A = 2 \cos^2 A - 1 = 1 - 2 \sin^2 A$$

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

Formulae for $\triangle ABC$

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

$$a^2 = b^2 + c^2 - 2bc \cos A$$

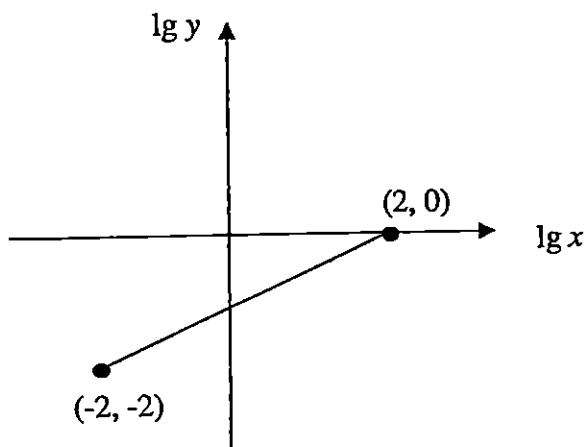
$$\Delta = \frac{1}{2}ab \sin C$$

1. Sketch the graph of $y = \ln \sqrt{2x-1}$ for $x > \frac{1}{2}$. Hence, determine the equation of the straight line that would need to be drawn on the graph of $y = \ln \sqrt{2x-1}$ in order to solve the equation $e^{2x} + e^6 = 2xe^6$ graphically. [4]
2. Find the range of values of m for which the line $y - mx = 3$ meets the curve $y = 4 + 2x + x^2$. [4]
3. A rectangular box has a square base of side $(3 + 2\sqrt{5})$ cm. The volume of the box is $(153 + 80\sqrt{5})$ cm³. Find the height of the box in the form $a + b\sqrt{5}$. [4]
4. Express $\frac{4-2x}{(x-1)(x^2+7)}$ in partial fractions. [6]
5. The expression $ax^3 - 4x^2 + bx - 5$ has a factor of $x+1$ and leaves a remainder of 4 when divided by $x-3$. Find the value of a and of b . [4]
6. Given that $x^2 + 4x - 3 = (x+p)^2 + q$, find the value of p and of q . [2]
Hence, or otherwise,
 - (i) sketch the graph of $y = x^2 + 4x - 3$, indicating clearly its minimum point and y -intercept, [3]
 - (ii) find the range of values of x for which $x^2 + 4x - 3 \leq 9$. [2]
7. (a) Given that $\sin A = \frac{2}{3}$ and A is acute, find
 - (i) $\sin(-A)$,
 - (ii) $\cos(A)$,
 - (iii) $\tan(90^\circ - A)$. [4]
 (b) The curve $y = 2\sin 2x + 1$ is defined for $0^\circ \leq x \leq 360^\circ$.
 - (i) State the amplitude and period of y . [2]
 - (ii) Sketch the graph of $y = 2\sin 2x + 1$ for $0^\circ \leq x \leq 360^\circ$. [4]
8. Solve the following simultaneous equations. [5]

$$9^x(27)^y = 1,$$

$$8^y \div (\sqrt{2})^x = 16\sqrt{2}$$

9. Variables x and y are related such that when $\lg y$ is plotted against $\lg x$, a straight line graph is obtained as shown below.



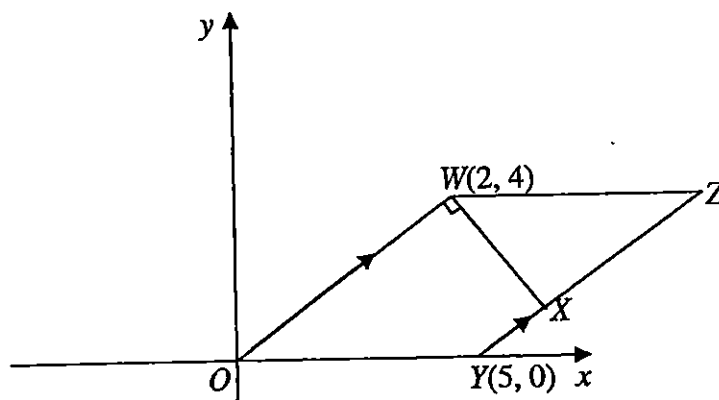
Find

- (i) an expression for y in terms of x ,
 (ii) the value of y when $x = 16$.

[3]

[1]

10. Solutions to this question by accurate drawing will not be accepted.



In the trapezium $OWXY$, the point W has coordinates $(2, 4)$ and the point Y has coordinates $(5, 0)$. The sides OW and YX are parallel, and WX is perpendicular to OW .

- (a) Find the equation of the line YX . [3]
 (b) Find the coordinates of X . [4]
 (c) Find the perimeter of $OWXY$, giving your answer in the form $a + b\sqrt{5}$. [4]
 (d) YX is produced to Z such that $OWZY$ is a parallelogram. Find the coordinates of Z . [1]

---END---

Answer Key

1. $y = x - 3$

2. $m \leq 0, m \geq 4$

3. $4\sqrt{5} - 3$

4. $\frac{1}{4(x-1)} - \frac{x+9}{4(x^2+7)}$

5. $a = 3, b = -12$

6. $p = 2, q = -7,$ (ii) $-6 \leq x \leq 2$

7. (a) (i) $-\frac{2}{3},$ (ii) $\frac{\sqrt{5}}{3}$ (iii) $\frac{\sqrt{5}}{2}$ (b) (ii) $2, 180^\circ$

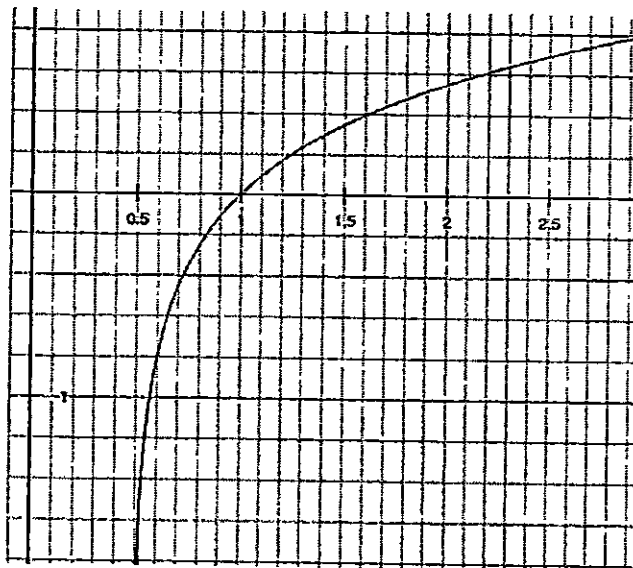
8. $-1\frac{4}{5}, 1\frac{1}{5}$

9. (i) $y = \frac{\sqrt{x}}{10}$ (ii) $\frac{2}{5}$

10. (a) $y = 2x - 10$ (b) $(6, 2)$ (c) $5 + 5\sqrt{5}$ (d) $(7, 4)$

Sec 3E A Maths P1 Marking Scheme

1.



x -intercept.....(B1)

Curve.....(B1) (No mark if the curve crosses $x=0.5$)

$$e^{2x} + e^6 = 2xe^6$$

$$e^{2x-6} + 1 = 2x$$

$$e^{2x-6} = 2x - 1 \dots\dots\dots (M1)$$

$$2x - 6 = \ln(2x - 1)$$

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

$$x - 3 = \ln \sqrt{2x - 1}$$

Draw $y = x - 3$(A1)

2. Subst. $y = mx + 3$ into $y = 4 + 2x + x^2$.

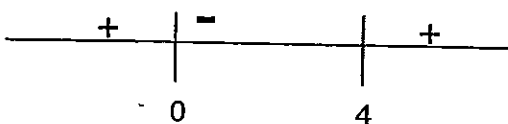
$$mx + 3 = 4 + 2x + x^2 \dots\dots\dots (M1)$$

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

$$(2 - m)^2 - 4(1)(1) \geq 0 \dots\dots\dots (M1)$$

$$m^2 - 4m \geq 0$$

$$m(m - 4) \geq 0 \dots\dots\dots (M1)$$



$$m \leq 0, m \geq 4 \dots\dots\dots (A1)$$

3. Base area $= (3 + 2\sqrt{5})^2 = 9 + 12\sqrt{5} + 20 = 29 + 12\sqrt{5} \dots\dots\dots (M1)$

$$\text{Height} = \frac{153 + 80\sqrt{5}}{29 + 12\sqrt{5}} \dots\dots\dots (M1)$$

$$= \frac{153 + 80\sqrt{5}}{29 + 12\sqrt{5}} \times \frac{29 - 12\sqrt{5}}{29 - 12\sqrt{5}} \dots\dots\dots (M1)$$

$$= \frac{484\sqrt{5} - 363}{121}$$

$$= 4\sqrt{5} - 3 \dots\dots\dots (A1)$$

4. Let $\frac{4-2x}{(x-1)(x^2+7)} = \frac{A}{x-1} + \frac{Bx+C}{x^2+7} \dots\dots\dots (M1)$

$$4 - 2x = A(x^2 + 7) + (Bx + C)(x - 1) \dots\dots\dots (M1)$$

$$\text{Let } x = 1, 2 = A(1 + 7)$$

$$A = \frac{1}{4} \dots\dots\dots (A1)$$

$$\text{Let } x = 0, 4 = A(7) + C(-1)$$

$$4 = \left(\frac{1}{4}\right)(7) - C$$

$$C = -\frac{9}{4} \dots\dots\dots (A1)$$

$$\text{Let } x = 2, 0 = A(4 + 7) + (2B + C)(1)$$

$$0 = \left(\frac{1}{4}\right)(11) + 2B + \left(-\frac{9}{4}\right)$$

$$B = -\frac{1}{4} \dots\dots\dots (A1)$$

$$\therefore \frac{4-2x}{(x-1)(x^2+7)} = \frac{1}{4(x-1)} - \frac{x+9}{4(x^2+7)} \dots\dots\dots (A1) \quad \text{or} \quad \frac{1}{4(x-1)} + \frac{-x-9}{4(x^2+7)}$$

5. Let $f(x) = ax^3 - 4x^2 + bx - 5$

$$f(-1) = a(-1)^3 - 4(-1)^2 + b(-1) - 5 = 0 \dots\dots\dots (M1)$$

$$a + b = -9 \dots\dots\dots (1)$$

$$f(3) = a(3)^3 - 4(3)^2 + b(3) - 5 = 4 \dots\dots\dots (M1)$$

$$9a + b = 15 \dots\dots\dots (2)$$

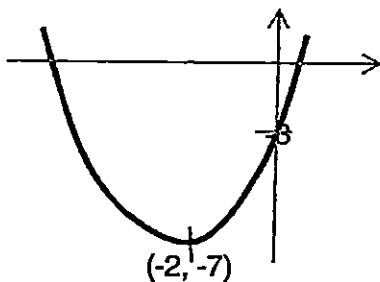
$$(2) - (1), \quad 8a = 24$$

$$a = 3 \dots\dots\dots (A1)$$

$$b = -12 \dots\dots\dots (A1)$$

6. $x^2 + 4x - 3 = x^2 + 4x + (2)^2 - 3 - (2)^2 \dots\dots\dots (M1)$
 $= (x+2)^2 - 7$
 $p = 2, q = -7 \dots\dots\dots (A1)$

(a)



Curve..... 1 mark
y-intercept..... 1 mark
Min. point..... 1 mark

(b) $x^2 + 4x - 3 \leq 9$

$x^2 + 4x - 12 \leq 0$

$(x+6)(x-2) \leq 0 \dots\dots\dots (M1)$

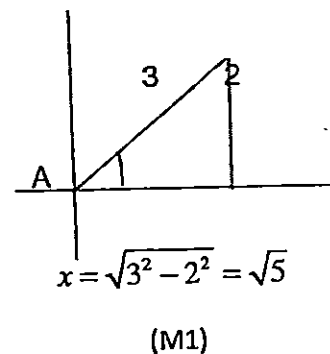


$-6 \leq x \leq 2 \dots\dots\dots (A1)$

7. (a)(i) $\sin(-A) = -\sin A = -\frac{2}{3}$(A1)

(ii) $\cos(A) = \frac{\sqrt{5}}{3}$(A1)

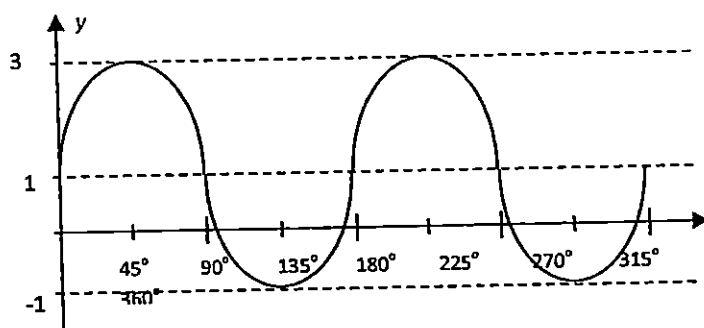
(iii) $\tan(90^\circ - A) = \cot A = \frac{\sqrt{5}}{2}$(A1)



(b) (i) *Amplitude* = 2.....(B1)

Period = $\frac{360^\circ}{2} = 180^\circ$(B1)

(ii)



y-intercept.....1 mark

curve.....1 mark

max& min pts....2 marks

$$8. \quad 9^x(27^y)=1$$

$$3^{2x}(3^{3y})=3^0$$

$$3^{2x+3y}=3^0 \dots\dots\dots (M1)$$

$$2x+3y=0 \dots\dots\dots (1)$$

$$8^y \div (\sqrt{2})^x = 16\sqrt{2}$$

$$2^{3y-\frac{x}{2}} = 2^{4\frac{1}{2}} \dots\dots\dots (M1)$$

$$3y - \frac{x}{2} = 4\frac{1}{2}$$

$$6y - x = 9 \dots\dots\dots (2)$$

From (2), $x + 6y - 9$

Subst. $x = 6y - 9$ into (1)

$$2(6y - 9) + 3y = 0 \dots\dots\dots (M1)$$

$$y = 1\frac{1}{5} \dots\dots\dots (A1)$$

$$x = 6(1\frac{1}{5}) - 9 = -1\frac{4}{5} \dots\dots\dots (A1)$$

$$9. \quad (i) \quad m = \frac{0 - (-2)}{2 - (-2)} = \frac{1}{2} \dots\dots\dots (M1)$$

$$Y = \frac{1}{2}X + c$$

Subst. $Y = 0, X = 2, c = -1 \dots\dots\dots (M1)$

$$\therefore Y = \frac{1}{2}X - 1$$

$$\lg y = \frac{1}{2} \lg x - 1$$

$$\lg y = \lg \sqrt{x} - \lg 10$$

$$\lg y = \lg \frac{\sqrt{x}}{10}$$

$$y = \frac{\sqrt{x}}{10} \dots\dots\dots (A1)$$

$$\text{When } x = 16, y = \frac{\sqrt{16}}{10} = \frac{2}{5} \dots\dots\dots (A1)$$

10. (a) Gradient of $OW = \frac{4-0}{2-0} = 2 \dots\dots\dots (M1)$

Equation of XY is

$y-0 = 2(x-5) \dots\dots\dots (M1)$

$y = 2x-10 \dots\dots\dots (A1)$

(b) Gradient of $WX = -\frac{1}{2} \dots\dots\dots (M1)$

Equation of WX is

$y-4 = -\frac{1}{2}(x-2)$

$y = -\frac{1}{2}x + 5 \dots\dots\dots (A1)$

$2x-10 = -\frac{1}{2}x + 5 \dots\dots\dots (M1)$

$x = 6$

$y = 2(6)-10 = 2 \dots\dots\dots (A1)$

$\therefore$ coordinates of X is $(6, 2)$

(c) $OW = \sqrt{(2-0)^2 + (4-0)^2} = 2\sqrt{5} \dots\dots\dots (M1)$

$XY = \sqrt{(6-5)^2 + (2-0)^2} = \sqrt{5} \dots\dots\dots (M1)$

$WX = \sqrt{(6-2)^2 + (2-4)^2} = 2\sqrt{5} \dots\dots\dots (M1)$

Perimeter $= 5 + 2\sqrt{5} + \sqrt{5} + 2\sqrt{5} = 5 + 5\sqrt{5} \dots\dots (A1)$

(d) Z is $(7, 4) \dots\dots\dots (B1)$

END OF YEAR EXAMINATION 2014

Secondary 3 Express

ADDITIONAL MATHEMATICS

4047/02

Paper 2

25 September 2014

Additional material: Foolscap paper, Graph paper

Time: 10.30 a.m. – 12.30 p.m.

Duration: 2 hours

INSTRUCTIONS TO STUDENTS:

Write your name, class and register number on all the work you hand in.

Write in blue or black pen on both sides of the paper.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer all questions.

Write your answers in the spaces provided in the question paper.

If working is needed for any question, it must be shown with the answer.

Omission of essential working will result in loss of marks.

You are expected to use a scientific calculator to evaluate explicit numerical expressions.

If the degree of accuracy is not specified in the question and if the answer is not exact, the answer should be given to three significant figures. Answers in degrees should be given to one decimal place.

For π , either use your calculator value or 3.142, unless the question requires the answer in terms of π .

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 80.

At the end of the examination, fasten all your work securely together.

Name of Student: _____ ()

Class: _____

Parent's Signature: _____

Setter: Mr Ng Choon Chooi

For Examiner's Use	
Total	80

This question paper consists of 5 printed pages including the cover page.

[Turn over

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

For the equation $ax^2 + bx + c = 0$,

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

Binomial expansion

$$(a+b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \dots + \binom{n}{r}a^{n-r}b^r + \dots + b^n,$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{r!(n-r)!} = \frac{n(n-1)\dots(n-r+1)}{r!}$

2. TRIGONOMETRY

Identities

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

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

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

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

$$\sin 2A = 2 \sin A \cos A$$

$$\cos 2A = \cos^2 A - \sin^2 A = 2 \cos^2 A - 1 = 1 - 2 \sin^2 A$$

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

Formulae for $\triangle ABC$

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

$$a^2 = b^2 + c^2 - 2bc \cos A$$

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

1. The equation $2x^2 = 1 - 4x$ has roots α and β . Form an equation whose roots are $\frac{1}{\alpha^2}$ and $\frac{1}{\beta^2}$. [6]

2. (a) Write down and simplify, in ascending powers of x , the first three terms of the expansion of

(i) $(1+2x)^5$ (ii) $(1-x)^7$

Hence find the coefficient of x^2 in the expansion of $(1+2x)^5(1-x)^7$. [4]

- (b) Evaluate the term which is independent of x in the expansion of

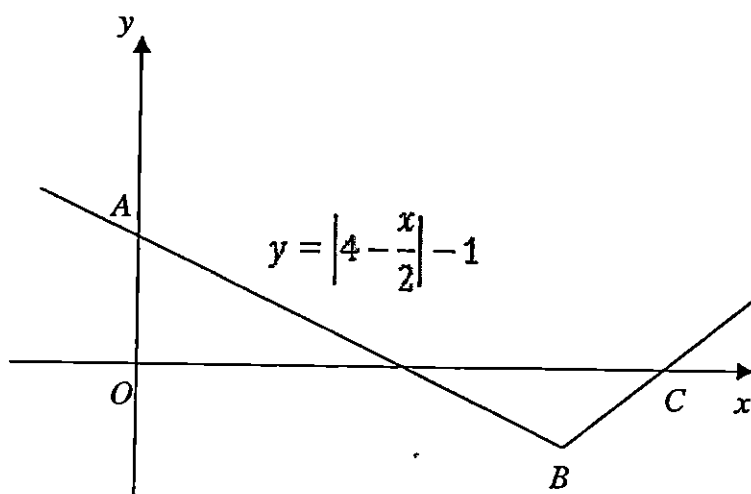
$\left(x^2 - \frac{1}{2x^6}\right)^{16}$. [4]

- (c) Given that the first three terms in the expansion of $\left(2 - \frac{x}{2}\right)^5(1+ax)$ are $32 - 16x + bx^2$, find the value of a and of b . [4]

3. (a) Solve the equation $2y^3 - 7y^2 = 10y - 24$. [4]

- (b) Hence, find the values of x , such that $e^{3x} + 12 - 3\frac{1}{2}e^{2x} - 5e^x = 0$. [2]

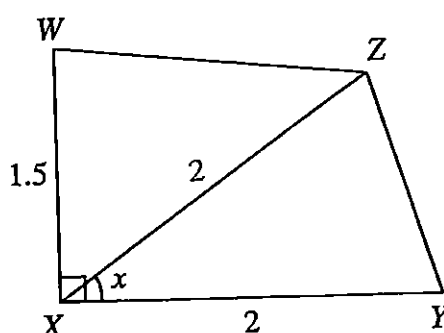
4. The following diagram shows part of the graph of $y = \left|4 - \frac{x}{2}\right| - 1$. Find the coordinates of the points A , B and C . [5]



5. Find the equation of the circle whose centre lies in the line $2x + y - 1 = 0$ and passes through the points $D(-2, 0)$ and $E(5, 1)$. [9]

6. A certain radioactive substance is known to decay with time such that its mass, m grams, after t hours is given by $m = 100e^{-kt}$, where k is a positive constant. A sample of this substance having an original mass of 100 g is taken for observation. After 40 hours, its mass is reduced to 90 g. Find
- (a) the value of the constant k , [2]
- (b) the mass of the substance after 100 hours, [2]
- (c) the time taken for the block to decay to less than half of its original mass. [2]

7. The figure $WXYZ$ is formed by two triangles, $\triangle WXZ$ and $\triangle XYZ$ where $WX = 1.5$ cm and $XZ = XY = 2$ cm. $\angle WXY = 90^\circ$ and $\angle ZXY = x$. The area of the figure $WXYZ$ is A cm².



- (a) Show that $A = 2\sin x + 1.5\cos x$. [2]
- (b) Express A in the form $R\sin(x + \alpha)$, stating the value of R and of α . [2]
- (c) Hence, find the maximum value of A and the corresponding value of x . [2]
8. (a) Solve the following equations.
- (i) $2\log_2 x = 2 + \log_2(2x - 3)$, [4]
- (ii) $\log_2 y + \log_4 y = 9$. [4]
- (b) Given that $\log_3 x = p$, express $\log_9(27\sqrt{x})$ in terms of p . [3]

9. (a) Solve the equation $3\sin 2x + 2 = 0$ for $0^\circ \leq x \leq 360^\circ$. [4]

(b) Solve the equation $2\sin x = \tan x$ for $0 \leq x \leq 2\pi$. [4]

10. Prove that $\frac{1 + \cos 2A + \sin 2A}{1 - \cos 2A + \sin 2A} = \cot A$ [3]

11. **Answer this part of the question on a piece of graph paper.**

The table shows experimental values of two variables x and y .

x	1	2	3	4	5
y	0.32	2.08	-2.96	-1.34	-1.00

It is known that x and y are related by the equation of the form $x = axy + by$, where a and b are constants.

Plot $\frac{x}{y}$ against x and obtain a straight line graph. [4]

Use your graph to estimate

(a) the value of a and of b , [2]

(b) the value of x when $y = 2x$. [2]

---END---

Answer Key

1. $x^2 - 20x + 4 = 0$
2. (a)(i) $1 + 10x + 40x^2 + \dots$, (ii) $1 - 7x + 21x^2 + \dots$, -9
(b) $113\frac{3}{4}$ (c) $a = \frac{3}{4}$, $b = -10$
3. (a) $-2, 1\frac{1}{2}, 4$ (b) $x = \ln 1\frac{1}{2} = 0.405$, $x = \ln 4 = 1.39$
4. $A = (0, 3)$, $B = (8, -1)$, $C = (10, 0)$
5. $(x-2)^2 + (y+3)^2 = 25$
6. (a) 0.00263 (b) 76.8 (c) 264 hours
7. (b) $2.5 \sin(x + 36.9^\circ)$ (c) *Max. value* = 2.5, $x = 53.1^\circ$
8. (a)(i) $x = 2$ or $x = 6$ (ii) 64 (b) $\frac{3}{2} + \frac{p}{4}$
9. (a) $110.9^\circ, 159.1^\circ, 290.9^\circ, 339.1^\circ$ (b) $0, \frac{\pi}{3}, \pi, \frac{5\pi}{3}, 2\pi$
11. (a) $a = -2, b = 5$ (b) $x = 2.25$

Sec 3E A Maths P2 Marking Scheme

1. $2x^2 + 4x - 1 = 0$

$\alpha + \beta = \frac{-4}{2} = -2 \dots\dots\dots (B1)$

$\alpha\beta = -\frac{1}{2} \dots\dots\dots (B1)$

$$\begin{aligned} \text{Sum of roots} &= \frac{1}{\alpha^2} + \frac{1}{\beta^2} \\ &= \frac{\beta^2 + \alpha^2}{\alpha^2 \beta^2} \\ &= \frac{(\alpha + \beta)^2 - 2\alpha\beta}{(\alpha\beta)^2} \dots\dots\dots (M1) \end{aligned}$$

$$= \frac{(-2)^2 - 2(-\frac{1}{2})}{(-\frac{1}{2})^2} = 20 \dots\dots\dots (A1)$$

$$\begin{aligned} \text{Product of roots} &= (\frac{1}{\alpha^2})(\frac{1}{\beta^2}) \\ &= \frac{1}{(\alpha\beta)^2} = \frac{1}{(-\frac{1}{2})^2} = 4 \dots\dots\dots (A1) \end{aligned}$$

New equation is $x^2 - 20x + 4 = 0 \dots\dots\dots (A1)$

2. (a) (i) $(1+2x)^5 = 1+10x+40x^2 + \dots$ (M1)

(ii) $(1-x)^7 = 1-7x+21x^2 + \dots$ (M1)

$(1+2x)^5(1-x)^7 = (1+10x+40x^2)(1-7x+21x^2) \dots$ (M1)

Coeff of $x^2 = 40+10(-7)+21 = -9 \dots$ (A1)

(b) General term $= \binom{16}{r} (x^2)^{16-r} \left(-\frac{1}{2x^6}\right)^r \dots$ (M1)
 $= \binom{16}{r} \left(-\frac{1}{2}\right)^r x^{32-8r}$

Let $32-8r=0$

$r=4 \dots$ (A1)

$\therefore$ term independent of x

$= \binom{16}{4} \left(-\frac{1}{2}\right)^4 \dots$ (M1)

$= 113\frac{3}{4} \dots$ (A1)

(c) $\left(2-\frac{x}{2}\right)^5 = 2^5 - 5(2)^4\left(\frac{x}{2}\right) + 10(2)^3\left(\frac{x}{2}\right)^2 + \dots$ (M1)

$= 32-40x+20x^2 + \dots$

$\left(2-\frac{x}{2}\right)^5 (1+ax) = (32-40x+20x^2)(1+ax)$

$= 32+(32a-40)x+(20-40a)x^2 \dots$ (M1)

$\therefore 32a-40=-16$

$a = \frac{3}{4} \dots$ (A1)

$b = 20-40a = -10 \dots$ (A1)

3. (a) $2y^3 - 7y^2 = 10y - 24$

$$2y^3 - 7y^2 - 10y + 24 = 0$$

Try $y = -2$, $2(-2)^3 - 7(-2)^2 - 10(-2) + 24 = 0$(M1)

$\therefore (y+2)$ is a factor.

$$\begin{array}{r} 2y^2 - 11y + 12 \\ y+2 \overline{) 2y^3 - 7y^2 - 10y + 24} \end{array} \quad \text{.....(M1)}$$

$$\begin{array}{r} 2y^3 + 4y^2 \\ \underline{2y^3 + 4y^2} \\ -11y^2 - 10y + 24 \\ -11y^2 - 22y \\ \underline{-11y^2 - 22y} \\ 12y + 24 \\ 12y + 24 \\ \underline{12y + 24} \\ 0 \end{array}$$

$$\begin{aligned} & (y+2)(2y^2 - 11y + 12) \\ &= (y+2)(2y-3)(y-4) = 0 \text{.....(M1)} \end{aligned}$$

$\therefore y = -2, 1\frac{1}{2}, 4$(A1)

(b) $e^{3x} + 12 - 3\frac{1}{2}e^{2x} - 5e^x = 0$

$$2e^{3x} - 7e^{2x} - 10e^x + 24 = 0 \text{.....(M1)}$$

$$e^x = 1\frac{1}{2}, e^x = 4, e^x = -2 \text{ (N.A)}$$

$$x = \ln 1\frac{1}{2} = 0.405, x = \ln 4 = 1.39 \text{.....(A1) (Accept both answers)}$$

$$4. \quad y = \left| 4 - \frac{x}{2} \right| - 1$$

$$\text{subst. } x=0, y = \left| 4 - \frac{0}{2} \right| - 1 = 3$$

$$\therefore A = (0, 3) \dots \dots \dots (A1)$$

$$\text{Min. } y = -1, \therefore \left| 4 - \frac{x}{2} \right| = 0 \dots \dots \dots (M1)$$

$$x = 8$$

$$B = (8, -1) \dots \dots \dots (A1)$$

$$\text{Subst. } y=0, \left| 4 - \frac{x}{2} \right| = 1$$

$$4 - \frac{x}{2} = 1 \quad \text{or} \quad 4 - \frac{x}{2} = -1 \dots \dots \dots (M1)$$

$$x = 6(\text{rej}) \quad \text{or} \quad x = 10$$

$$\therefore C = (10, 0) \dots \dots \dots (A1)$$

$$5. \quad \text{Gradient of } DE = \frac{1-0}{5-(-2)} = \frac{1}{7} \dots \dots \dots (M1)$$

$$\text{Gradient of perpendicular bisector} = -7 \dots \dots \dots (M1)$$

$$\text{Mid-point of } DE = \left(\frac{-2+5}{2}, \frac{0+1}{2} \right) = \left(1\frac{1}{2}, \frac{1}{2} \right) \dots \dots \dots (B1)$$

Equation of perpendicular bisector is

$$y - \frac{1}{2} = -7\left(x - 1\frac{1}{2}\right) \dots \dots \dots (M1)$$

$$y = -7x + 11 \dots \dots \dots (M1)$$

$$\text{Subst. } y = -7x + 11 \text{ into } 2x + y - 1 = 0$$

$$2x + (-7x + 11) - 1 = 0 \dots \dots \dots (M1)$$

$$x = 2$$

$$y = -3$$

$$\therefore \text{centre} = (2, -3) \dots \dots \dots (A1)$$

$$r = \sqrt{(5-2)^2 + (1-(-3))^2} = 5 \dots \dots \dots (A1)$$

$\therefore$ equation of circle is

$$(x-2)^2 + (y+3)^2 = 25 \dots \dots \dots (A1)$$

6. (a) $90 = 100e^{-k(40)} \dots\dots\dots (M1)$

$$0.9 = e^{-40k}$$

$$-40k = \ln 0.9$$

$$k = \frac{\ln 0.9}{-40} = 0.002634 \approx 0.00263 \dots\dots\dots (A1)$$

(b) $m = 100e^{-(0.002634)(100)} \dots\dots\dots (M1)$

$$m = 100e^{-0.2634} = 76.8 \dots\dots\dots (A1)$$

(a) $100e^{-0.002634t} < 50 \dots\dots\dots (M1)$

$$e^{-0.002634t} < 0.5$$

$$-0.002634t < \ln 0.5$$

$$t > \frac{\ln 0.5}{-0.002634} = 263.15$$

$$t = 264 \text{ hours} \dots\dots\dots (A1)$$

7. (a) $\text{Area of } \triangle ZXY = \frac{1}{2} \times 2 \times 2 \times \sin x = 2 \sin x \quad \text{Or}$

$$\text{Area of } \triangle WXZ = \frac{1}{2} \times 1.5 \times 2 \times \sin(90^\circ - x) = 1.5 \cos x \dots\dots\dots (M1) \quad (\text{Any one correct})$$

$$\therefore A = 2 \sin x + 1.5 \cos x \dots\dots\dots (A1)$$

(b) Let $2 \sin x + 1.5 \cos x = R \sin(x + \alpha)$

$$2 \sin x + 1.5 \cos x = R \sin x \cos \alpha + R \cos x \sin \alpha$$

$$\therefore R \cos \alpha = 2$$

$$R \sin \alpha = 1.5$$

$$R = \sqrt{2^2 + 1.5^2} = 2.5, \tan \alpha = \frac{1.5}{2}, \alpha = 36.9^\circ \dots\dots\dots (M1)$$

$$\therefore 2 \sin x + 1.5 \cos x = 2.5 \sin(x + 36.9^\circ) \dots\dots\dots (A1)$$

(c) $\text{Max. value} = 2.5 \dots\dots\dots (B1)$

$$\text{When } \sin(x + 36.9^\circ) = 1$$

$$(x + 36.9^\circ) = 90^\circ$$

$$x = 53.1^\circ \dots\dots\dots (A1)$$

8. (a) (i) $2\log_2 x = 2 + \log_2(2x-3)$

$$\log_2 x^2 - \log_2(2x-3) = 2$$

$$\log_2 \frac{x^2}{(2x-3)} = 2 \dots\dots\dots (M1)$$

$$\frac{x^2}{(2x-3)} = 2^2 \dots\dots\dots (M1)$$

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

$$x^2 - 8x + 12 = 0$$

$$(x-2)(x-6) = 0 \dots\dots\dots (M1)$$

$$x = 2 \text{ or } x = 6 \dots\dots\dots (A1)$$

(ii) $\log_2 y + \log_4 y = 9$

$$\log_2 y + \frac{\log_2 y}{\log_2 4} = 9 \dots\dots\dots (M1)$$

$$\log_2 y + \frac{\log_2 y}{2} = 9 \dots\dots\dots (M1)$$

$$\frac{3}{2} \log_2 y = 9$$

$$\log_2 y = 9 \times \frac{2}{3} = 6 \dots\dots\dots (M1)$$

$$y = 2^6 = 64 \dots\dots\dots (A1)$$

(b) $\log_9(27\sqrt{x}) = \frac{\log_3(27\sqrt{x})}{\log_3 9} \dots\dots\dots (M1)$

$$= \frac{\log_3 27 + \log_3 \sqrt{x}}{2} \dots\dots\dots (M1)$$

$$= \frac{3}{2} + \frac{p}{4} \dots\dots\dots (A1)$$

9. (a) $3\sin 2x + 2 = 0$

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

basic $\angle = 41.8^\circ \dots\dots\dots (M1)$

$2x = (180^\circ + 41.8^\circ), (360^\circ - 41.8^\circ), (540^\circ + 41.8^\circ), (720^\circ - 41.8^\circ) \dots\dots (M1)$

$x = 110.9^\circ, 159.1^\circ, 290.9^\circ, 339.1^\circ \dots\dots\dots (A2)$

(b) $2\sin x = \tan x$

$$2\sin x = \frac{\sin x}{\cos x} \dots\dots\dots (M1)$$

$$2\sin x \cos x - \sin x = 0$$

$$\sin x(2\cos x - 1) = 0 \dots\dots\dots (M1)$$

$$\sin x = 0$$

$$x = 0, \pi, 2\pi \dots\dots\dots (A1)$$

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

$$x = \frac{\pi}{3}, \frac{5\pi}{3} \dots\dots\dots (A1)$$

10. $L.H.S. = \frac{1 + \cos 2A + \sin 2A}{1 - \cos 2A + \sin 2A}$

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

$$= \frac{2\cos^2 A + 2\sin A \cos A}{2\sin^2 A + 2\sin A \cos A} \dots\dots\dots (M1)$$

$$= \frac{2\cos A(\cos A + \sin A)}{2\sin A(\sin A + \cos A)} \dots\dots\dots (M1)$$

$$= \cot A = R.H.S. \dots\dots\dots (A1)$$

11. $x = axy + by$

$\frac{x}{y} = ax + b \dots\dots\dots (M1)$

(B1)

x	1	2	3	4	5
$\frac{x}{y}$	3.13	0.96	-1.01	-2.99	-5

Correct plotting of points (B1)

Drawing of straight line (B1)

(a) $a = \frac{-10}{5} = -2 \quad (\pm 0.3) \dots\dots\dots (M1)$

$b = 5 \quad (\pm 0.1) \dots\dots\dots (A1)$

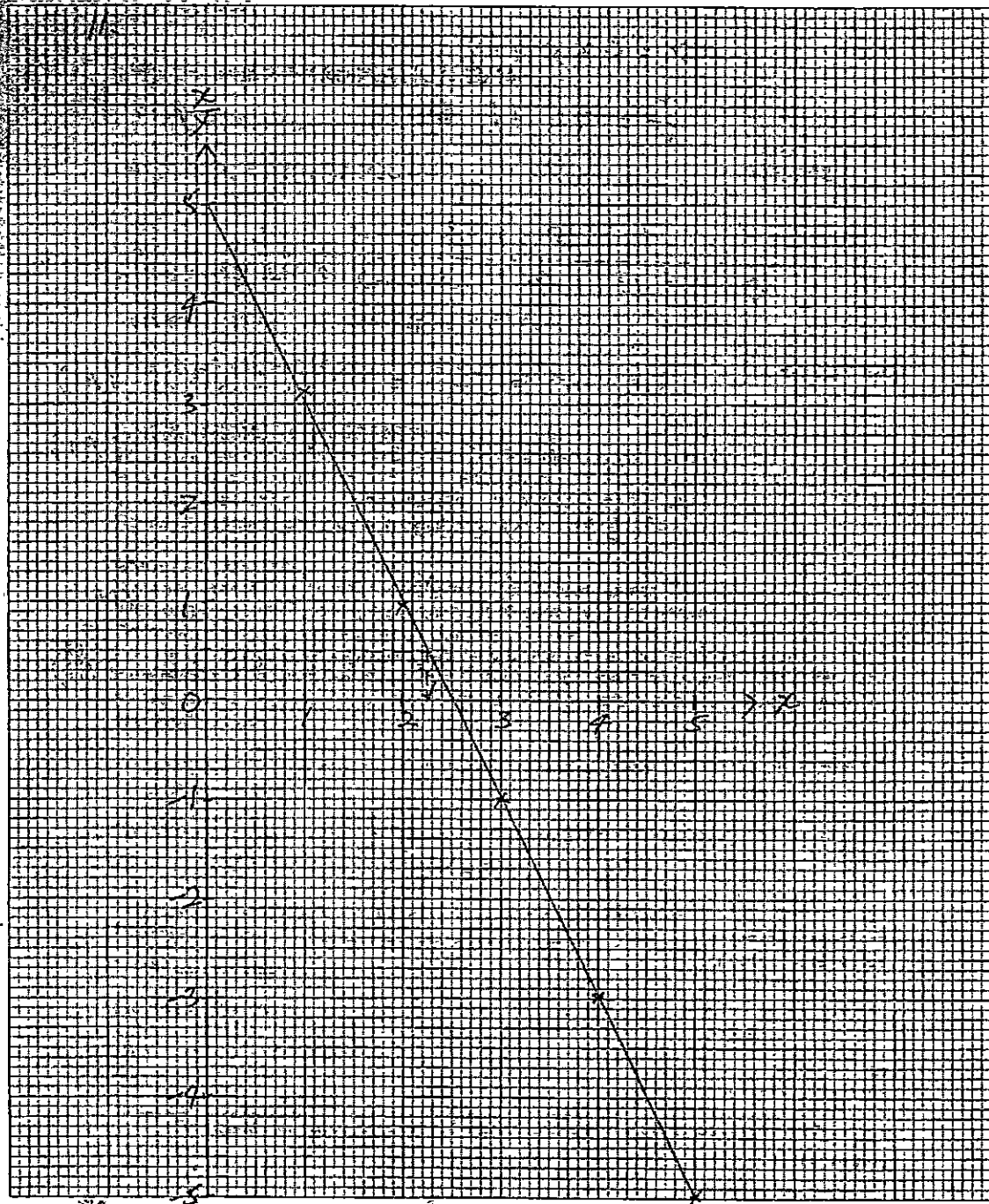
(b) $y = 2x$

$\frac{1}{2} = \frac{x}{y} \dots\dots\dots (M1)$

$x = 2.25 \quad (\pm 0.05) \dots\dots\dots (A1)$

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20 cm x 24 cm
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