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**SPRINGFIELD SECONDARY SCHOOL**  
**End-Of-Year Examination 2022**  
**Sec 3 Express**

|                 |  |                    |  |
|-----------------|--|--------------------|--|
| STUDENT<br>NAME |  |                    |  |
| CLASS           |  | REGISTER<br>NUMBER |  |

**ADDITIONAL MATHEMATICS**

**4049**

**4 October 2022**

**2 hours 15 minutes**

Candidates answer on the question paper

**READ THESE INSTRUCTIONS FIRST**

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

Write in dark blue or black pen.

You may use an HB pencil for any diagrams, graphs or rough working.

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

Answer **all** the questions.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

The use of an approved scientific calculator is expected, where appropriate.

You are reminded of the need for clear presentation in your answers.

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 90.

| For Examiner's Use |     |
|--------------------|-----|
| Total              | /90 |

**Do not turn over this question paper until you are told to do so.**

**This question paper consists of 19 printed pages.**

1 (a) Factorise  $x^3 + 8$ . [1]

(b) Does the equation  $x^3 + 8 = 0$  has three real roots? Justify your answer. [2]

2 A triangle has a base of  $(2 + \sqrt{5})$  cm and a perpendicular height of  $h$  cm. The area of the triangle is  $(-8 + 5\sqrt{5}) \text{ cm}^2$ . **Without using a calculator**, show that  $h$  can be expressed, in cm, in the form of  $(a + b\sqrt{5})$ , where  $a$  and  $b$  are integers. [4]

- 3 The curve  $x^2 = xy + 12$  and the line  $x + 2y = 6$  intersect at the points  $A$  and  $B$ .

Find the coordinates of  $A$  and of  $B$ .

[4]

4 (a) Express  $y = -2x^2 - 4x + 1$  in the form  $y = a(x + h)^2 + k$ . [2]

(b) State the coordinates of the turning point of  $y = -2x^2 - 4x + 1$ . [1]

(c) A curve has equation  $y = -2x^2 - 4x + 1 + p$ , where  $p$  is an integer. The  $x$ -axis is a tangent to the curve. Find the value of  $p$ . [1]

5 Find the range of values of  $c$  for which  $3x^2 + cx + 7 > 4$  for all values of  $x$ . [4]

6 Solve the equation  $3^{2x+1} - 28(3^x) + 9 = 0$ .

[4]

- 7 The population of a type of insect was observed in an experimental environment. After  $t$  days, the number of insects was given by the equation  $N = 500 + 3000e^{kt}$ , where  $k$  is a constant.

(a) Find the initial population of the insects. [1]

(b) Find the value of  $k$  given that the population of the insects decreased to 3000 after 5 days. [2]

(c) The population of the insects approaches a particular value  $A$  after a long period of time.

(i) Find the value of  $A$ . [1]

(ii) Explain why the population of the insects can never reach  $A$ . [1]

8 Express  $\frac{4-x}{x(x+2)^2}$  in partial fractions.

[6]

- 9 (a) Given that  $\sin A = \frac{4}{5}$ , where  $A$  is acute, find the exact value of

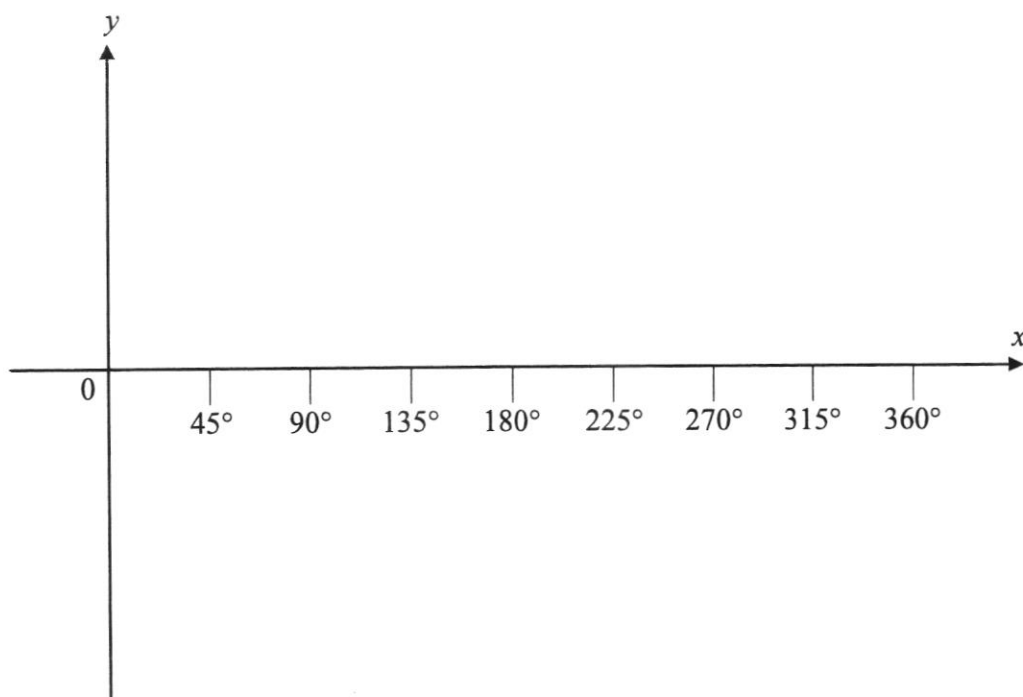
(i)  $\sec A$ , [2]

(ii)  $\tan(-A)$ . [1]

- (b) It is given that  $f(x) = 2 \cos 2x + 1$ .

(i) State the period of  $f(x)$ . [1]

(ii) Sketch the graph of  $y = f(x)$  for  $0^\circ \leq x \leq 360^\circ$ . [2]



**10** The equation of a circle is  $x^2 + y^2 - 10x + 4y + 25 = 0$ .

- (a)** Find the radius of the circle and the coordinates of its centre. [4]

The point  $P(3, -2)$  lies on the circle.

- (b)** Explain why the tangent to the circle at  $P$  is parallel to the  $y$ -axis. [2]

**11 (a)** It is given that  $1 - \ln y = \ln(x + y)$ . Express  $x$  in terms of  $y$ . [3]

**(b)** Solve the equation  $6 \log_y 2 = 5 - \log_2 y$ . [5]

- 12** The polynomial  $f(x)$  where  $f(x) = 3x^3 - 4x^2 + qx + 6$  where  $q$  is a constant, leaves a remainder of  $-12$  when divided by  $x - 1$ .

**(a)** Show that  $q = -17$ . [2]

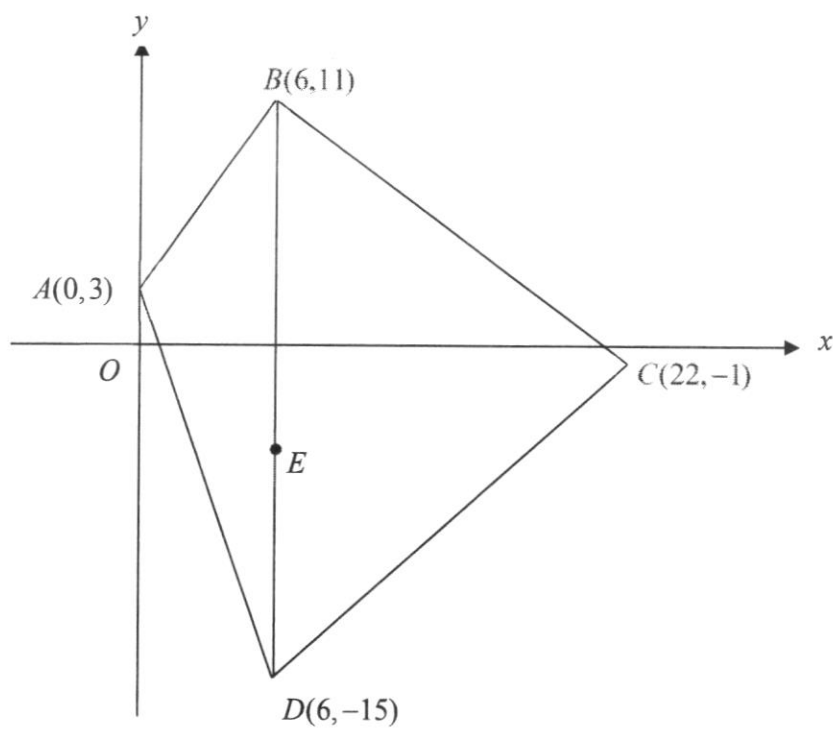
**(b)** Solve the equation  $f(x) = 0$ . [4]

- (c) Use your answer to part (b) to solve the equation

$$3(4^x)^3 - 4(4^x)^2 - 17(4^x) + 6 = 0 . \quad [2]$$

- (d) Explain why there are only two solutions for  $x$ . [1]

13



The diagram shows a quadrilateral  $ABCD$  with vertices  $A(0, 3)$ ,  $B(6, 11)$ ,  $C(22, -1)$  and  $D(6, -15)$ . The point  $E$  lies on  $BD$  and the perpendicular bisector of  $BC$ .

(a) Find the coordinates of  $E$ .

[5]

(b) Find the area of the quadrilateral  $ABCD$ .

[2]

(c) Is quadrilateral  $ABCD$  a trapezium?

[2]

- 14** A rectangle has an area of  $y \text{ m}^2$ , width  $x \text{ m}$  and length  $(Ax + B) \text{ m}$ , where  $A$  and  $B$  are constants. Corresponding values of  $x$  and  $y$  are shown in the table below.

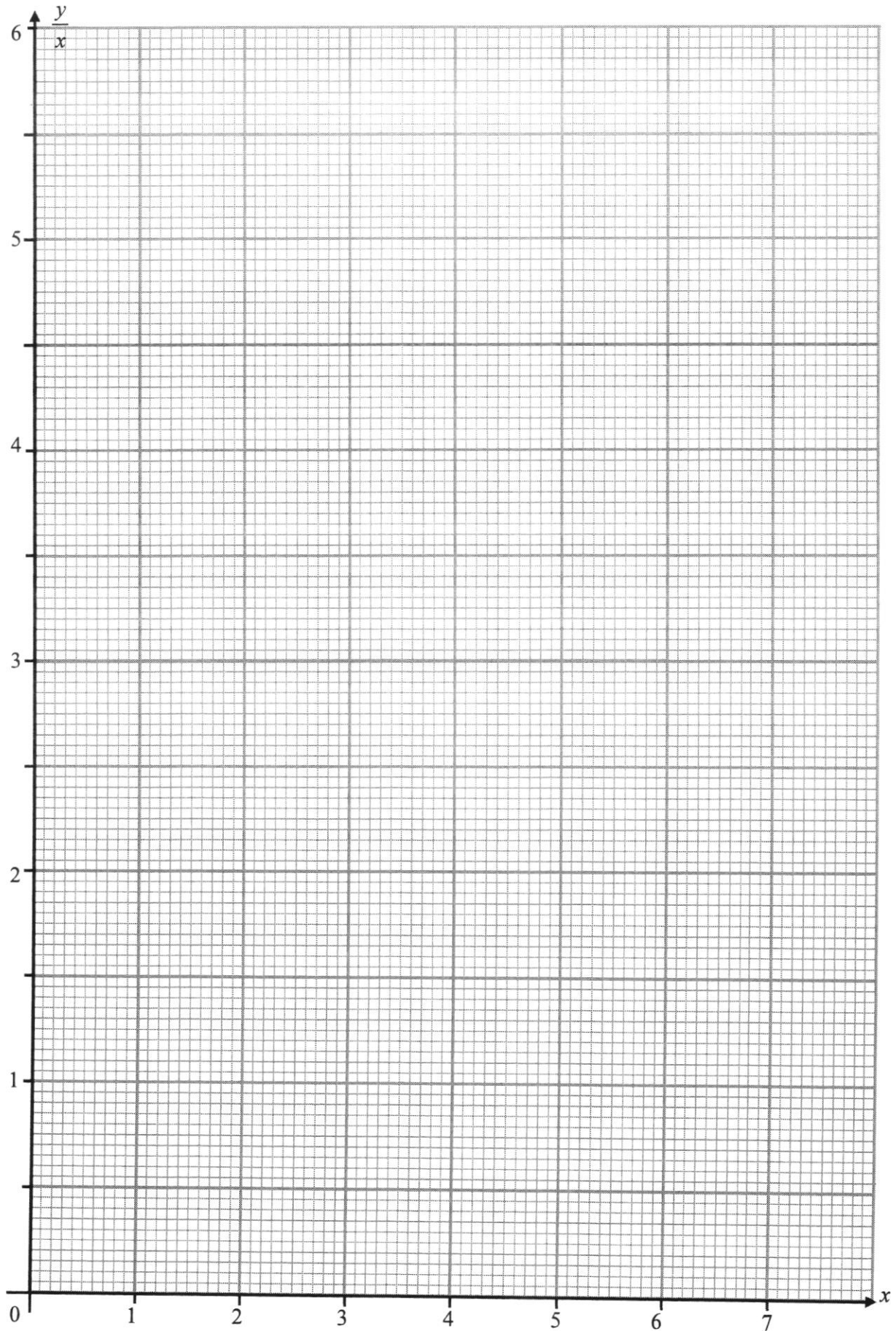
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|-----|---|----|----|----|
| $x$ | 1 | 3  | 5  | 7  |
| $y$ | 3 | 12 | 25 | 42 |

- (a) On the grid on page 17, plot  $\frac{y}{x}$  against  $x$  and draw a straight line. [2]
- (b) Use your graph to estimate the value of  $A$  and of  $B$ . [3]

- (c) Using your values of  $A$  and  $B$ , write down an expression, in terms of  $x$ , for the area of the rectangle. [1]

- (d) (i) Explain how another straight line drawn on your graph, can lead to an estimate of the value of  $x$  for which the rectangle is a square. [1]

- (ii) Draw this line and find this value of  $x$ . [2]



- 15 (a) Find the term independent of  $x$  in the binomial expansion of  $\left(x - \frac{1}{x^2}\right)^6$ . [3]

- (b) (i) Write down, and simplify, the first 3 terms in the expansion of  $(2 - 3x)^5$  in ascending powers of  $x$ . [2]

- (ii) Given that the first three terms in the expansion of  $(a + bx)(2 - 3x)^5$  are  $32 + cx + 660x^2$  where  $a$ ,  $b$  and  $c$  are constants, find the value of  $a$ , of  $b$  and of  $c$ . [4]

***THE END***

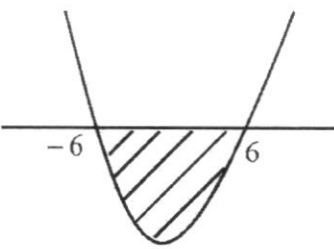


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Mathematics Department  
Marking Scheme**

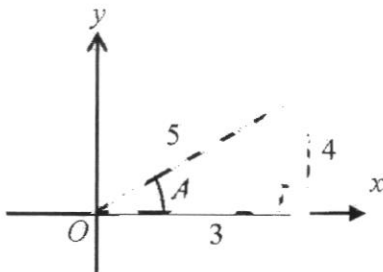
|                         |                                                   |
|-------------------------|---------------------------------------------------|
| <b>Year</b>             | <b>2022</b>                                       |
| <b>Examination:</b>     | <b>End of Year Examination</b>                    |
| <b>Format of Paper:</b> | <b>Secondary 3 Express Additional Mathematics</b> |
| <b>Paper:</b>           | <b>1</b>                                          |
| <b>Setter:</b>          | <b>Leung Yong Kang</b>                            |

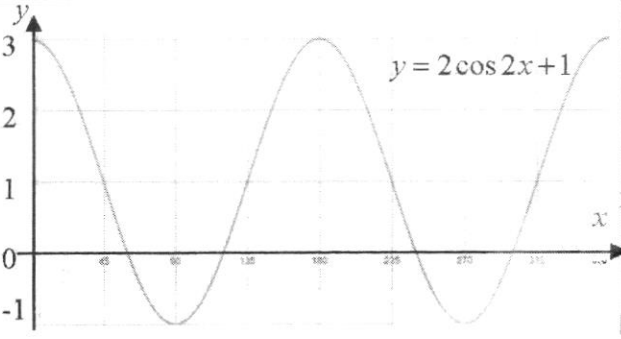
| S/N            | Solutions                                                                                                                                                                                                                                                                                                                                                                  | Marks                                                    | Remarks                                                                                                 | AOs |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------|-----|
| 1(a)           | $x^3 + 8 = (x+2)(x^2 - 2x + 4)$                                                                                                                                                                                                                                                                                                                                            | B1                                                       |                                                                                                         | AO1 |
| 1(b)           | $x^3 + 8 = 0$ $(x+2)(x^2 - 2x + 4) = 0$ <p><math>x+2=0</math> or <math>x^2-2x+4=0</math></p> $x=-2$<br>Discriminant $= (-2)^2 - 4(1)(4)$<br>$= -12 < 0$<br>Therefore, $x^2 - 2x + 4$ has no real roots. Hence,<br>the equation $x^3 + 8 = 0$ , <b>does not</b> have three real<br>roots. $x = -2$ is the only real root of the equation<br>$x^3 + 8 = 0$ .                 | <br><br><br><br><br><br><br><br><br>M1<br><br><br><br>A1 |                                                                                                         | AO3 |
| <b>3 MARKS</b> |                                                                                                                                                                                                                                                                                                                                                                            |                                                          |                                                                                                         |     |
| 2              | Area of triangle $= \frac{1}{2} \times (2+\sqrt{5}) \times h$<br><br>$-8+5\sqrt{5} = \frac{1}{2} \times (2+\sqrt{5}) \times h$<br><br>$h = \frac{2(-8+5\sqrt{5})}{2+\sqrt{5}}$ $= \frac{(-16+10\sqrt{5})(2-\sqrt{5})}{(2+\sqrt{5})(2-\sqrt{5})}$ $= \frac{(-16)(2)+16\sqrt{5}+20\sqrt{5}-10(5)}{4-5}$ $= 82-36\sqrt{5}$<br>The height of the triangle is $82-36\sqrt{5}$ . | <br><br><br>M1<br><br><br>M1<br><br><br>M1<br><br>A1     | <br><br><br>$2-\sqrt{5}$ is multiplied to both the numerator and denominator.<br><br>Correct expansion. | AO2 |
| <b>4 MARKS</b> |                                                                                                                                                                                                                                                                                                                                                                            |                                                          |                                                                                                         |     |

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                         |                                                                                   |            |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-----------------------------------------------------------------------------------|------------|
| <p><b>3</b></p>    | <p><math>x^2 = xy + 12 \dots (1)</math><br/> <math>x = 6 - 2y \dots (2)</math></p> <p>Sub (2) into (1):</p> <p><math>(6 - 2y)^2 = (6 - 2y)y + 12</math><br/> <math>36 - 24y + 4y^2 = 6y - 2y^2 + 12</math><br/> <math>6y^2 - 30y + 24 = 0</math><br/> <math>y^2 - 5y + 4 = 0</math><br/> <math>(y - 4)(y - 1) = 0</math><br/> <math>y - 4 = 0</math> or <math>y - 1 = 0</math><br/> <math>y = 4</math> or <math>y = 1</math><br/> <math>x = -2</math> or <math>x = 4</math></p> <p>Hence the coordinates of <math>A</math> and <math>B</math> are <math>(-2, 4)</math> and <math>(4, 1)</math> respectively. OR</p> <p>Hence the coordinates of <math>A</math> and <math>B</math> are <math>(4, 1)</math> and <math>(-2, 4)</math> respectively.</p> | <p>M1</p> <p>M1</p> <p>M1</p> <p>A1</p> | <p>For correct substitution</p> <p>For both correct values of <math>y</math>.</p> | <p>AO2</p> |
| <p>4 MARKS</p>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                         |                                                                                   |            |
| <p><b>4(a)</b></p> | <p><math>y = -2x^2 - 4x + 1</math><br/> <math>= -2(x^2 + 2x) + 1</math><br/> <math>= -2[(x + 1)^2 - (1)^2] + 1</math><br/> <math>= -2(x + 1)^2 + 2 + 1</math><br/> <math>= -2(x + 1)^2 + 3</math></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <p>M1</p> <p>A1<br/>or B2</p>           |                                                                                   | <p>AO1</p> |
| <p><b>4(b)</b></p> | <p><math>(-1, 3)</math></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <p>B1</p>                               |                                                                                   | <p>AO1</p> |
| <p><b>4(c)</b></p> | <p><math>p = -3</math></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p>B1</p>                               |                                                                                   | <p>AO2</p> |
| <p>4 MARKS</p>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                         |                                                                                   |            |
|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                         |                                                                                   |            |

|         |                                                                                                                                                                                                                                                                                   |                                              |                                                                                                                                                              |     |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 5       | $3x^2 + cx + 7 > 4$ $3x^2 + cx + 3 > 0$ $b^2 - 4ac < 0$ $c^2 - 4(3)(3) < 0$ $c^2 - 6^2 < 0$ $(c + 6)(c - 6) < 0$  $\therefore -6 < c < 6$                                                        | M1, M1<br><br>M1<br><br><br><br><br><br>A1   | 1M for correct discriminant<br>1M for correct inequality sign, <<br><br>Give M1 if student is able to factorise even if inequality sign from above is wrong. | AO2 |
| 4 MARKS |                                                                                                                                                                                                                                                                                   |                                              |                                                                                                                                                              |     |
| 6       | $3^{2x+1} - 28(3^x) + 9 = 0$ $3(3^x)^2 - 28(3^x) + 9 = 0$ <p>Let <math>u = 3^x</math>,</p> $3u^2 - 28u + 9 = 0$ $(3u - 1)(u - 9) = 0$ $3u - 1 = 0 \text{ or } u - 9 = 0$ $u = \frac{1}{3} \text{ or } u = 9$ $3^x = \frac{1}{3} \text{ or } 3^x = 3^2$ $x = -1 \text{ or } x = 2$ | M1<br><br><br><br>M1<br><br><br>M1<br><br>A1 | For expressing $3^{2x+1}$ as $3(3^x)^2$ .                                                                                                                    | AO2 |
| 4 MARKS |                                                                                                                                                                                                                                                                                   |                                              |                                                                                                                                                              |     |
|         |                                                                                                                                                                                                                                                                                   |                                              |                                                                                                                                                              |     |

|           |                                                                                                                                                                                                                                                                                                                    |                                              |  |     |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|--|-----|
| 7(a)      | When $t = 0$<br>$N = 500 + 3000e^0$<br>$= 3500$                                                                                                                                                                                                                                                                    | B1                                           |  | AO2 |
| 7(b)      | When $N = 3000$ , $t = 5$<br>$3000 = 500 + 3000e^{5k}$<br>$2500 = 3000e^{5k}$<br>$\frac{5}{6} = e^{5k}$<br>$\ln\left(\frac{5}{6}\right) = 5k$<br>$k = -0.036464$<br>$\approx -0.0365$ (3s.f.)                                                                                                                      | M1<br><br><br><br><br><br><br><br><br><br>A1 |  | AO2 |
| 7(c)(i)   | $A = 500$                                                                                                                                                                                                                                                                                                          | B1                                           |  | AO1 |
| 7(c) (ii) | As $t \rightarrow \infty$ , $3000e^{-0.36464t} \rightarrow 0$<br>$N \rightarrow 500$<br>$N$ will only approaches 500 and hence can never reach 500.<br><br>OR<br><br>$N = 500$ is the asymptote for the exponential graph of $N = 500 + 3000e^{-0.36464t}$ . Hence, population of the insects can never reach 500. | B1<br><br><br><br><br><br><br>[B1]           |  | AO3 |
| 5 MARKS   |                                                                                                                                                                                                                                                                                                                    |                                              |  |     |
|           |                                                                                                                                                                                                                                                                                                                    |                                              |  |     |

|          |                                                                                                                                                                                                                                                                                                                                                                                                        |                                            |                           |     |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------------------|-----|
| 8        | $\frac{4-x}{x(x+2)^2} = \frac{A}{x} + \frac{B}{(x+2)} + \frac{C}{(x+2)^2}$ $4-x = A(x+2)^2 + B(x)(x+2) + C(x)$ <p>When <math>x = 0</math>,</p> $4 = A(2)^2$ $A = 1$ <p>When <math>x = -2</math></p> $6 = -2C$ $C = -3$ <p>When <math>x = 1</math>,</p> $3 = 9A + B(1)(3) + C(1)$ $3 = 9 + 3B - 3$ $3B = -3$ $B = -1$ $\frac{4-x}{x^3 + 4x^2 + 4x} = \frac{1}{x} - \frac{1}{(x+2)} - \frac{3}{(x+2)^2}$ | M1<br><br>M1<br><br>M1<br><br>M1<br><br>A1 |                           | AO1 |
| 6 MARKS  |                                                                                                                                                                                                                                                                                                                                                                                                        |                                            |                           |     |
| 9(a)(i)  |  $\sec A = \frac{1}{\cos A}$ $= \frac{1}{\left(\frac{3}{5}\right)}$ $= \frac{5}{3}$                                                                                                                                                                                                                                 | M1<br><br>A1                               | For $\frac{3}{5}$<br>o.e. | AO1 |
| 9(a)(ii) | $\tan(-A) = -\tan A$ $= -\frac{4}{3}$                                                                                                                                                                                                                                                                                                                                                                  | B1                                         | o.e.                      | AO1 |

|          |                                                                                                                                                                                                                                                                            |                              |                                                                                                                     |     |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------------------------------------------------------------------------------------------------------|-----|
| 9(b)(i)  | $\text{Period} = \frac{360^\circ}{b} \text{ or } \frac{2\pi}{b}$ $= \frac{360^\circ}{2} \text{ or } \frac{2\pi}{2}$ $= 180^\circ \text{ or } \pi$                                                                                                                          | B1                           |                                                                                                                     | AO1 |
| 9(b)(ii) |                                                                                                                                                                                           | B1<br><br>B1                 | Correct Shape with 2 cycles<br><br>Maximum points, minimum points and points on the axis of the curves are correct. | AO1 |
| 6 MARKS  |                                                                                                                                                                                                                                                                            |                              |                                                                                                                     |     |
| 10(a)    | $x^2 + y^2 - 10x + 4y + 25 = 0$ $2g = -10, 2f = 4, c = 25$ $g = -5, f = 2, c = 25$ $\text{Centre } C \text{ of circle} = (-g, -f)$ $= (5, -2)$ $\text{Radius of circle} = \sqrt{g^2 + f^2 - c}$ $= \sqrt{(-5)^2 + (2)^2 - (25)}$ $= 2 \text{ units}$                       | M1<br><br>A1<br><br>M1<br>A1 | For 2g and 2f                                                                                                       | AO1 |
| 10(b)    | $C(5, -2), P(3, -2)$ <p>The radius <math>CP</math> is a horizontal line. Since the <b>radius is perpendicular to the tangent</b>, then the tangent to the circle at <math>P</math> is a <b>vertical line</b>.<br/>Therefore it is parallel to the <math>y</math>-axis.</p> | M1<br><br>A1                 |                                                                                                                     | AO3 |
| 6 MARKS  |                                                                                                                                                                                                                                                                            |                              |                                                                                                                     |     |

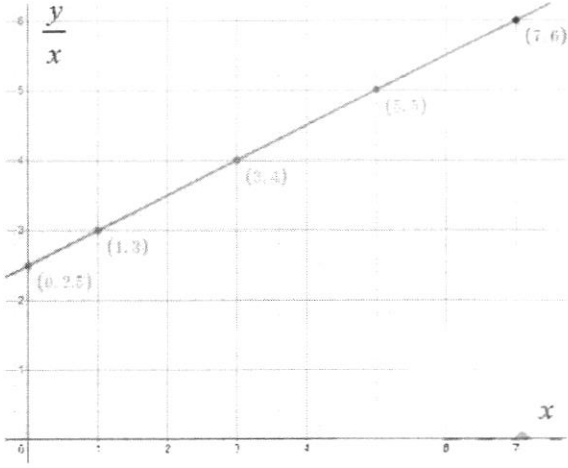
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| <b>11(a)</b> | $1 - \ln y = \ln(x + y)$<br>$\ln(e) - \ln y = \ln(x + y)$<br>$\ln\left(\frac{e}{y}\right) = \ln(x + y)$<br>$\frac{e}{y} = x + y$<br>$x = \frac{e}{y} - y$                                                                                                                                                                                             | M1<br><br>M1<br><br>A1                     | For<br>$1 = \ln(e)$                       | AO2 |
| <b>11(b)</b> | $6\log_y 2 = 5 - \log_2 y$<br>$\frac{6\log_2 2}{\log_2 y} = 5 - \log_2 y$<br>Let $u = \log_2 y$<br>$\frac{6}{u} = 5 - u$<br>$6 = 5u - u^2$<br>$u^2 - 5u + 6 = 0$<br>$(u - 2)(u - 3) = 0$<br>$u = 2$ or $u = 3$<br>$\log_2 y = 2$ or $\log_2 y = 3$<br>$y = 4$ or $y = 8$                                                                              | M1<br><br>M1<br><br>M1<br><br>M1<br><br>A1 | For both<br>correct<br>values of<br>$y$ . | AO2 |
| 8 MARKS      |                                                                                                                                                                                                                                                                                                                                                       |                                            |                                           |     |
| <b>12(a)</b> | $f(x) = 3x^3 - 4x^2 + qx + 6$<br><br>Using remainder theorem,<br>$f(1) = 3 - 4 + q + 6$<br>$3 - 4 + q + 6 = -12$<br>$q = -17$ (Shown)                                                                                                                                                                                                                 | M1<br><br>A1                               |                                           | AO2 |
| <b>12(b)</b> | $f(x) = 3x^3 - 4x^2 - 17x + 6$<br>$f(-2) = 3(-2)^3 - 4(-2)^2 - 17(-2) + 6$<br>$= 0$<br>Therefore by the factor theorem, $x + 2$ is a factor of $f(x)$ .<br><br>$3x^3 - 4x^2 - 17x + 6 = (x + 2)(ax^2 + bx + c)$<br>By observation, $a = 3$ and $c = 3$<br>$3x^3 - 4x^2 - 17x + 6 = (x + 2)(3x^2 + bx + 3)$<br><br>Equating the coefficient of $x^2$ : | M1                                         |                                           | AO1 |

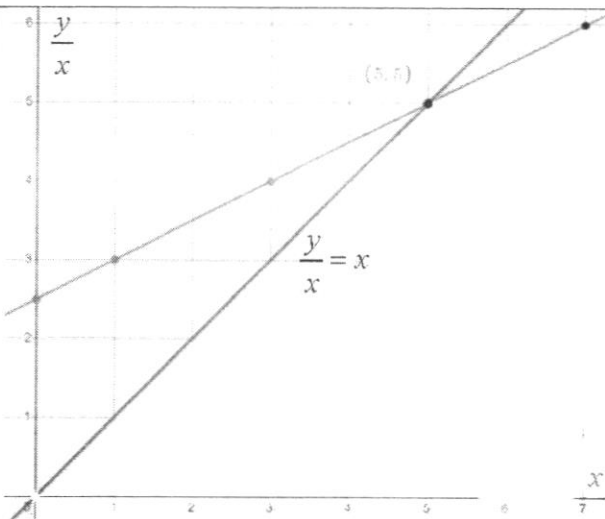




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|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-----|
| 13(a) | <p>Gradient of line <math>BC = \frac{11 - (-1)}{6 - 22}</math></p> $= \frac{12}{-16}$ $= -\frac{3}{4}$ <p>Gradient of perpendicular bisector <math>= -\frac{1}{\left(-\frac{3}{4}\right)}</math></p> $= \frac{4}{3}$ <p><math>M</math> is the midpoint of line <math>BC</math>, then</p> $M = \left( \frac{6+22}{2}, \frac{11+(-1)}{2} \right)$ $= (14, 5)$ <p>Equation of perpendicular bisector of <math>BC</math>:</p> $5 = \frac{4}{3}(14) + C$ $C = -\frac{41}{3}$ <p>Hence, <math>y = 1\frac{1}{3}x - \frac{41}{3}</math>.</p> <p>Since <math>E</math> lies on <math>BD</math>, then the <math>x</math>-coordinate of <math>E</math> is 6.</p> <p>When <math>x = 6</math>,</p> $y = 1\frac{1}{3}(6) - 13\frac{2}{3}$ $= -\frac{17}{3}$ <p>Hence the coordinates of <math>E</math> is <math>\left(6, -\frac{17}{3}\right)</math>.</p> | <p>M1</p> <p>M1</p> <p>M1</p> <p>M1</p> <p>A1</p> | <p>o.e.</p> <p>For substituting <math>x = 6</math> into the equation of perpendicular bisector.</p> <p>o.e.</p> | AO2 |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-----|



|               |                                                                                                                                                                                                                                                                                                         |                        |   |     |   |   |               |   |   |   |   |              |                                                                                                                            |     |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---|-----|---|---|---------------|---|---|---|---|--------------|----------------------------------------------------------------------------------------------------------------------------|-----|
| 14(a)         | <table border="1" data-bbox="432 219 895 353"> <tr> <td><math>x</math></td><td>1</td><td>3</td><td>5</td><td>7</td></tr> <tr> <td><math>\frac{y}{x}</math></td><td>3</td><td>4</td><td>5</td><td>6</td></tr> </table>  | $x$                    | 1 | 3   | 5 | 7 | $\frac{y}{x}$ | 3 | 4 | 5 | 6 | B1<br><br>B1 | B1 for at least 3 out of 4 correctly plotted points.<br><br>B1 for correctly plotted line that connects at least 2 points. | AO1 |
| $x$           | 1                                                                                                                                                                                                                                                                                                       | 3                      | 5 | 7   |   |   |               |   |   |   |   |              |                                                                                                                            |     |
| $\frac{y}{x}$ | 3                                                                                                                                                                                                                                                                                                       | 4                      | 5 | 6   |   |   |               |   |   |   |   |              |                                                                                                                            |     |
| 14(b)         | $\frac{y}{x} = Ax + B$<br>Gradient = $A$<br>$A = \frac{6-3}{7-1}$ $= 0.5 \pm 0.02$<br>$\frac{y}{x}$ - intercept = $B$<br>$B = 2.5 \pm 0.025$                                                                                                                                                            | M1<br><br>A1<br><br>B1 |   | AO1 |   |   |               |   |   |   |   |              |                                                                                                                            |     |
| 14(c)         | $y = 0.5x^2 + 2.5x$                                                                                                                                                                                                                                                                                     | B1                     |   | AO2 |   |   |               |   |   |   |   |              |                                                                                                                            |     |
| 14(d)(i)      | When the rectangle is a square, the length=breadth. Hence, the line to draw on the graph is $\frac{y}{x} = x$ .                                                                                                                                                                                         | B1                     |   | AO3 |   |   |               |   |   |   |   |              |                                                                                                                            |     |

|           |                                                                                                                                                                                                                                                                                                                                                |                        |                                     |     |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------------------------------|-----|
| 14(d)(ii) |  <p>Hence, <math>x = 5</math>.</p>                                                                                                                                                                                                                            | M1<br><br>A1           | 1M for the line $\frac{y}{x} = x$ . | AO1 |
| 9 MARKS   |                                                                                                                                                                                                                                                                                                                                                |                        |                                     |     |
| 15(a)     | <p>General Term of <math>\left(x - \frac{1}{x^2}\right)^6</math></p> $= \binom{6}{r} x^{6-r} \left(-\frac{1}{x^2}\right)^r$ $= \binom{6}{r} (-1)^r x^{6-3r}$ $= \binom{6}{r} (-1)^r x^{6-3r}$ <p>For term independent of <math>x</math>, <math>r = 2</math></p> <p>Term independent of <math>x = \binom{6}{2} (-1)^2 x^{6-6}</math></p> $= 15$ | M1<br><br>M1<br><br>A1 |                                     | AO2 |
| 15(b)(i)  | $(2-3x)^5$ $= \binom{5}{0}(2)^5 + \binom{5}{1}(2)^4(-3x)^1 + \binom{5}{2}(2)^3(-3x)^2 + \dots$ $= 32 - 240x + 720x^2 + \dots$                                                                                                                                                                                                                  | M1<br><br>A1           |                                     | AO1 |
| 15(b)(ii) | $(a+bx)(2-3x)^5$ $= (a+bx)(32 - 240x + 720x^2 + \dots)$ $= 32a - 240ax + 32bx + 720ax^2 - 240bx^2 + \dots$ <p>Since <math>(a+bx)(2-3x)^5 = 32 + cx + 660x^2 + \dots</math>,<br/>then</p>                                                                                                                                                       | M1                     |                                     | AO2 |

