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# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

## **NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**MATHEMATICS P1**

**NOVEMBER 2012**

**MEMORANDUM**

**MARKS: 150**

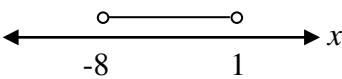
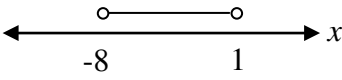
**This memorandum consists of 30 pages.**

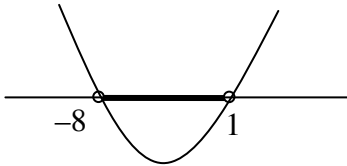
**NOTE:**

- If a candidate answered a question TWICE, mark the FIRST attempt ONLY.
- If a candidate crossed out an attempt of a question and did not redo the question, mark the crossed out question.
- Consistent accuracy applies in ALL aspects of the memorandum.

**QUESTION 1**

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.1.1 | $(2x-1)(x+4)=0$<br>$x = \frac{1}{2} \quad \text{or} \quad -4$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓ answer<br>✓ answer<br>(2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 1.1.2 | <div style="display: flex; justify-content: space-between;"> <div> <math>3x^2 - x = 5</math><br/> <math>3x^2 - x - 5 = 0</math><br/> <math display="block">x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}</math> <math display="block">= \frac{-(-1) \pm \sqrt{(-1)^2 - 4(3)(-5)}}{2(3)}</math> <math display="block">= \frac{1 \pm \sqrt{61}}{6}</math> <math display="block">= 1,47 \quad \text{or} \quad -1,14</math> </div> <div style="border: 1px solid black; padding: 5px; width: 150px;"> <b>Note:</b> if a candidate uses incorrect formula award max 1 mark (for standard form) </div> </div> <p><b>OR</b></p> $3x^2 - x = 5$<br>$x^2 - \frac{1}{3}x = \frac{5}{3}$<br>$\left(x - \frac{1}{6}\right)^2 = \frac{5}{3} + \frac{1}{36}$<br>$\left(x - \frac{1}{6}\right) = \pm \sqrt{\frac{61}{36}}$<br>$x = \frac{1}{6} \pm \sqrt{\frac{61}{36}}$<br>$= 1,47 \quad \text{or} \quad -1,14$ <p><b>OR</b></p> | <div style="display: flex; justify-content: space-between;"> <div> ✓ standard form<br/> ✓ subs into correct formula<br/> <br/> ✓✓ answer<br/> (4) </div> <div style="border: 1px solid black; padding: 5px; width: 150px;"> <b>Note:</b> if a candidate has not rounded off correctly, penalise 1 mark </div> </div><br><div style="display: flex; justify-content: space-between;"> <div> ✓ division by 3<br/> <br/> ✓ <math>\left(x - \frac{1}{6}\right) = \pm \sqrt{\frac{61}{36}}</math><br/> <br/> ✓✓ answer<br/> (4) </div> </div> |

|              | $3x^2 - x = 5$ $3x^2 - x - 5 = 0$ $x^2 - \frac{x}{3} - \frac{5}{3} = 0$ $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $= \frac{-(-\frac{1}{3}) \pm \sqrt{(-\frac{1}{3})^2 - 4(1)(-\frac{5}{3})}}{2(1)}$ $= \frac{\frac{1}{3} \pm \sqrt{\frac{61}{9}}}{2}$ $= 1,47 \quad \text{or} \quad -1,14$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <p>✓ standard form</p> <p>✓ subs into correct formula</p> <p>✓✓ answer</p> <p>(4)</p> |      |     |       |     |     |       |     |     |              |     |     |                                                                                                                                                   |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|------|-----|-------|-----|-----|-------|-----|-----|--------------|-----|-----|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.1.3        | $x^2 + 7x - 8 < 0$ $(x+8)(x-1) < 0$ $\begin{array}{ccccccc} + & 0 & - & 0 & + & & \\ & -8 & & 1 & & & \end{array} \quad \text{OR} \quad \begin{array}{c} \text{Graph of } y = x^2 + 7x - 8 \\ \text{Roots at } x = -8 \text{ and } x = 1 \\ \text{The parabola is below the x-axis between } x = -8 \text{ and } x = 1 \end{array}$ <p><b>OR</b></p> <table border="1"> <thead> <tr> <th><math>x</math></th> <th><math>-8</math></th> <th><math>1</math></th> </tr> </thead> <tbody> <tr> <td><math>x+8</math></td> <td><math>-</math></td> <td><math>+</math></td> </tr> <tr> <td><math>x-1</math></td> <td><math>-</math></td> <td><math>+</math></td> </tr> <tr> <td><math>(x+8)(x-1)</math></td> <td><math>+</math></td> <td><math>+</math></td> </tr> </tbody> </table> <p>Therefore the solution is:<br/> <math>-8 &lt; x &lt; 1</math> <b>OR</b> <math>x \in (-8; 1)</math> <b>OR</b> </p> <p><b>OR</b></p> $x^2 + 7x - 8 < 0$ $(x+8)(x-1) < 0$ <p><math>\therefore x+8 &lt; 0</math> and <math>x-1 &gt; 0</math> or <math>x+8 &gt; 0</math> and <math>x-1 &lt; 0</math><br/> <math>x &lt; -8</math> and <math>x &gt; 1</math> or <math>x &gt; -8</math> and <math>x &lt; 1</math><br/> No solution</p> <p>Therefore the solution is:<br/> <math>-8 &lt; x &lt; 1</math> <b>OR</b> <math>x \in (-8; 1)</math> <b>OR</b> </p> | $x$                                                                                   | $-8$ | $1$ | $x+8$ | $-$ | $+$ | $x-1$ | $-$ | $+$ | $(x+8)(x-1)$ | $+$ | $+$ | <p>✓ factors</p> <p>✓ <math>-8, 1</math></p> <p>✓✓ answer</p> <p>(4)</p> <p>✓ factors</p> <p>✓ <math>-8, 1</math></p> <p>✓✓ answer</p> <p>(4)</p> |
| $x$          | $-8$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | $1$                                                                                   |      |     |       |     |     |       |     |     |              |     |     |                                                                                                                                                   |
| $x+8$        | $-$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $+$                                                                                   |      |     |       |     |     |       |     |     |              |     |     |                                                                                                                                                   |
| $x-1$        | $-$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $+$                                                                                   |      |     |       |     |     |       |     |     |              |     |     |                                                                                                                                                   |
| $(x+8)(x-1)$ | $+$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $+$                                                                                   |      |     |       |     |     |       |     |     |              |     |     |                                                                                                                                                   |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                      |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       | <p><b>NOTE:</b><br/>In this alternative, award max 3/4 marks since there is no conclusion</p> $x^2 + 7x - 8 < 0$ $(x + 8)(x - 1) < 0$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p>✓ factors</p> <p>✓ - 8, 1</p> <p>✓ graph with bolded line</p>                                                                                                                                                                                                                                                                                     |
| 1.2.1 | <p><math>4y - x = 4</math> and <math>xy = 8</math></p> $x = 4y - 4$ $(4y - 4)y = 8$ $(y - 1)y = 2$ $y^2 - y - 2 = 0$ $(y + 1)(y - 2) = 0$ $y = -1 \text{ or } y = 2$ $x = -8 \text{ or } x = 4$ $(x ; y) = (-8 ; -1) \text{ or } (4 ; 2)$ <p><b>OR</b></p> <p><math>4y - x = 4</math> and <math>xy = 8</math></p> $x = 4y - 4$ $(4y - 4)y = 8$ $(y - 1)y = 2$ <p>By inspection <math>y = -1</math> or <math>y = 2</math></p> $x = -8 \text{ or } x = 4$ $(x ; y) = (-8 ; -1) \text{ or } (4 ; 2)$ <p><b>OR</b></p> <p><math>4y - x = 4</math> and <math>xy = 8</math></p> $x = 4y - 4$ $(4y - 4)y = 8$ $(y - 1)y = 2$ $y^2 - y - 2 = 0$ $y = \frac{-(-1) \pm \sqrt{(-1)^2 - 4(1)(-2)}}{2(1)}$ $y = -1 \text{ or } y = 2$ $x = -8 \text{ or } x = 4$ $(x ; y) = (-8 ; -1) \text{ or } (4 ; 2)$ | <p>✓ <math>x = 4y - 4</math></p> <p>✓ substitution</p> <p>✓ factors</p> <p>✓ y-values</p> <p>✓✓ x-values (6)</p> <p>✓ <math>x = 4y - 4</math></p> <p>✓ substitution</p> <p>✓✓ y-values</p> <p>✓✓ x-values (6)</p> <p>✓ <math>x = 4y - 4</math></p> <p>✓ substitution</p> <p>✓ subs into correct formula</p> <p>✓ y-values</p> <p>✓✓ x-values (6)</p> |

**OR**

$$4y - x = 4 \quad \text{and} \quad xy = 8$$

$$y = \frac{x}{4} + 1$$

$$x\left(\frac{x}{4} + 1\right) = 8$$

$$\frac{x^2}{4} + x - 8 = 0$$

$$x^2 + 4x - 32 = 0$$

$$(x + 8)(x - 4) = 0$$

$$x = -8 \quad \text{or} \quad x = 4$$

$$y = -1 \quad \text{or} \quad y = 2$$

$$(x ; y) = (-8 ; -1) \quad \text{or} \quad (4 ; 2)$$

$$\checkmark \quad y = \frac{x}{4} + 1$$

✓ substitution

✓ factors

✓ x-values

✓✓ y-values

(6)

**OR**

$$4y - x = 4 \quad \text{and} \quad xy = 8$$

$$y = \frac{x}{4} + 1$$

$$x\left(\frac{x}{4} + 1\right) = 8$$

$$\frac{x^2}{4} + x - 8 = 0$$

$$x^2 + 4x - 32 = 0$$

$$x = \frac{-4 \pm \sqrt{4^2 - 4(1)(-32)}}{2(1)}$$

$$x = -8 \quad \text{or} \quad x = 4$$

$$y = -1 \quad \text{or} \quad y = 2$$

$$(x ; y) = (-8 ; -1) \quad \text{or} \quad (4 ; 2)$$

$$\checkmark \quad y = \frac{x}{4} + 1$$

✓ substitution

✓ subs into correct formula

✓ x-values

✓✓ y-values

(6)

**OR**

$$xy = 8 \quad \text{and} \quad 4y - x = 4$$

$$x = \frac{8}{y}$$

$$4y - \frac{8}{y} = 4$$

$$4y^2 - 4y - 8 = 0$$

$$y^2 - y - 2 = 0$$

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

$$y = -1 \quad \text{or} \quad y = 2$$

$$x = -8 \quad \text{or} \quad x = 4$$

$$(x ; y) = (-8 ; -1) \quad \text{or} \quad (4 ; 2)$$

$$\checkmark \quad x = \frac{8}{y}$$

✓ substitution

✓ factors

✓ y-values

✓✓ x-values

(6)

**OR**

$$xy = 8 \quad \text{and} \quad 4y - x = 4$$

$$x = \frac{8}{y}$$

$$4y - \frac{8}{y} = 4$$

$$4y^2 - 4y - 8 = 0$$

$$y^2 - y - 2 = 0$$

$$y = \frac{-(-1) \pm \sqrt{(-1)^2 - 4(1)(-2)}}{2(1)}$$

$$y = -1 \quad \text{or} \quad y = 2$$

$$x = -8 \quad \text{or} \quad x = 4$$

$$(x; y) = (-8; -1) \quad \text{or} \quad (4; 2)$$

$$\checkmark x = \frac{8}{y}$$

✓ substitution

✓ subs into correct formula

✓ y-values

✓✓ x-values

(6)

**OR**

$$xy = 8 \quad \text{and} \quad 4y - x = 4$$

$$y = \frac{8}{x}$$

$$4\left(\frac{8}{x}\right) - x = 4$$

$$0 = x^2 + 4x - 32$$

$$0 = (x+8)(x-4)$$

$$x = -8 \quad \text{or} \quad x = 4$$

$$y = -1 \quad \text{or} \quad y = 2$$

$$(x; y) = (-8; -1) \quad \text{or} \quad (4; 2)$$

$$\checkmark y = \frac{8}{x}$$

✓ substitution

✓ factors

✓ x-values

✓✓ y-values

(6)

**OR**

$$xy = 8 \quad \text{and} \quad 4y - x = 4$$

$$y = \frac{8}{x}$$

$$4\left(\frac{8}{x}\right) - x = 4$$

$$0 = x^2 + 4x - 32$$

$$x = \frac{-4 \pm \sqrt{4^2 - 4(1)(-32)}}{2(1)}$$

$$x = -8 \quad \text{or} \quad x = 4$$

$$y = -1 \quad \text{or} \quad y = 2$$

$$(x; y) = (-8; -1) \quad \text{or} \quad (4; 2)$$

$$\checkmark y = \frac{8}{x}$$

✓ substitution

✓ subs into correct formula

✓ x-values

✓✓ y-values

(6)

|       |                                                                                                                                                                                       |                                                                                                      |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| 1.2.2 | $4x - y = 4$<br><br><b>OR</b><br><br>$y = 4x - 4$<br><br><b>OR</b><br><br>$x = \frac{y+4}{4}$<br><br><b>OR</b><br><br>$4x - y - 4 = 0$<br><br><b>OR</b><br><br>$x = \frac{1}{4}y + 1$ | ✓✓ interchanges $x$ and $y$<br>(2)                                                                   |
| 1.3.1 | $\sqrt{2p+5} = 0$<br>$2p+5 = 0$<br>$2p = -5$<br>$p = -\frac{5}{2}$                                                                                                                    | ✓ $2p+5 = 0$ <b>or</b><br>$\sqrt{2p+5} = 0$ <b>or</b> $\frac{-2 \pm \sqrt{0}}{7}$<br>✓ answer<br>(2) |
| 1.3.2 | $2p+5 < 0$<br>$p < -\frac{5}{2}$                                                                                                                                                      | ✓ answer<br>(1)<br><b>[21]</b>                                                                       |

## QUESTION 2

|       |                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.1   | $T_2 - T_1 = T_3 - T_2$ $2x - (3x + 1) = (3x - 7) - 2x$ $2x - 3x - 1 = 3x - 7 - 2x$ $-x - 1 = x - 7$ $-2x = -6$ $x = 3$ <p><b>OR</b></p> $T_2 = \frac{T_1 + T_3}{2}$ $2x = \frac{(3x + 1) + (3x - 7)}{2}$ $4x = 6x - 6$ $6 = 2x$ $x = 3$ <p><b>OR</b></p> $T_3 - T_1 = 2(T_2 - T_1)$ $(3x - 7) - (3x + 1) = 2(2x - (3x + 1))$ $-8 = -2x - 2$ $2x = 6$ $x = 3$ | $\checkmark T_2 - T_1 = T_3 - T_2$ <p>or</p> $2x - (3x + 1) = (3x - 7) - 2x$ <p><math>\checkmark</math> answer (2)</p> $\checkmark T_2 = \frac{T_1 + T_3}{2}$ <p>or <math>2x = \frac{(3x + 1) + (3x - 7)}{2}</math></p> <p><math>\checkmark</math> answer (2)</p> <p><math>\checkmark T_3 - T_1 = 2(T_2 - T_1)</math> or<br/> <math>(3x - 7) - (3x + 1) = 2(2x - (3x + 1))</math></p> <p><math>\checkmark</math> answer (2)</p> |
| 2.2.1 | $T_n = a + (n - 1)d$ $T_{11} = 10 + (11 - 1)(-4)$ $= -30$ <p><b>OR</b></p> <p>10; 6; 2; -2; -6; -10; -14; -18; -22; -26; -30 ...</p> <p><math>\therefore T_{11} = -30</math></p>                                                                                                                                                                              | $\checkmark d = -4$ <p><math>\checkmark</math> answer (2)</p> <p><math>\checkmark</math> expands sequence</p> <p><math>\checkmark</math> answer (2)</p>                                                                                                                                                                                                                                                                         |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.2.2 | $S_n = \frac{n}{2}[2a + (n-1)d]$ $-560 = \frac{n}{2}[2(10) + (n-1)(-4)]$ $-1120 = -4n^2 + 24n$ $4n^2 - 24n - 1120 = 0$ $n^2 - 6n - 280 = 0$ $(n-20)(n+14) = 0$ $n = 20 \quad \text{or} \quad -14$ $\therefore n = 20 \quad \text{only}$ <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <b>Note:</b> if candidate substitutes into incorrect formula, award 0/6         </div> <p><b>OR</b></p> $S_n = \frac{n}{2}[2a + (n-1)d]$ $-560 = \frac{n}{2}[2(10) + (n-1)(-4)]$ $-1120 = -4n^2 + 24n$ $4n^2 - 24n - 1120 = 0$ $n^2 - 6n - 280 = 0$ $n = \frac{-(-6) \pm \sqrt{(-6)^2 - 4(1)(-280)}}{2(1)}$ $n = 20 \quad \text{or} \quad -14$ $\therefore n = 20 \quad \text{only}$ <p><b>OR</b></p> $S_n = \frac{n}{2}[2a + (n-1)d]$ $-560 = \frac{n}{2}[2(10) + (n-1)(-4)]$ $-560 = \frac{20n}{2} - \frac{4n^2}{2} + \frac{4n}{2}$ $2n^2 - 12n - 560 = 0$ $n^2 - 6n - 280 = 0$ $(n-20)(n+14) = 0$ $n = 20 \quad \text{or} \quad -14$ $\therefore n = 20 \quad \text{only}$ | ✓ correct formula<br>✓ substitution of $a$ and $d$<br>✓ subs $S_n = -560$<br>✓ $-4n^2 + 24n + 1120 = 0$ or<br>$4n^2 - 24n - 1120 = 0$ or<br>$n^2 - 6n - 280 = 0$<br>✓ factors<br>✓ selects $n = 20$ only<br>(6)                   |
|       | <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <b>Note:</b> if candidate writes answer only, award 1/6 marks         </div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ✓ correct formula<br>✓ substitution of $a$ and $d$<br>✓ subs $S_n = -560$<br>✓ $4n^2 - 24n - 1120 = 0$ or<br>$-4n^2 + 24n + 1120 = 0$ or<br>$n^2 - 6n - 280 = 0$<br>✓ subs into correct formula<br>✓ selects $n = 20$ only<br>(6) |
|       | <p><b>OR</b></p> $S_n = \frac{n}{2}[2a + (n-1)d]$ $-560 = \frac{n}{2}[2(10) + (n-1)(-4)]$ $-560 = \frac{20n}{2} - \frac{4n^2}{2} + \frac{4n}{2}$ $2n^2 - 12n - 560 = 0$ $n^2 - 6n - 280 = 0$ $(n-20)(n+14) = 0$ $n = 20 \quad \text{or} \quad -14$ $\therefore n = 20 \quad \text{only}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ✓ correct formula<br>✓ substitution of $a$ and $d$<br>✓ subs $S_n = -560$<br>✓ $2n^2 - 12n - 560 = 0$ or<br>$-2n^2 + 12n + 560 = 0$ or<br>$n^2 - 6n - 280 = 0$<br>✓ factors<br>✓ selects $n = 20$ only<br>(6)                     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |      |      |      |      |      |      |     |    |    |    |    |    |    |    |    |    |       |     |     |     |     |     |     |     |     |     |       |      |      |      |      |      |      |      |      |      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|-----|----|----|----|----|----|----|----|----|----|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|------|------|------|------|------|------|------|------|------|
| <b>OR</b><br><br>$S_{11} = -110$<br><table border="1"> <tr> <td><math>n</math></td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td></tr> <tr> <td><math>T_n</math></td><td>-34</td><td>-38</td><td>-42</td><td>-46</td><td>-50</td><td>-54</td><td>-58</td><td>-62</td><td>-66</td></tr> <tr> <td><math>S_n</math></td><td>-144</td><td>-182</td><td>-224</td><td>-270</td><td>-320</td><td>-374</td><td>-432</td><td>-494</td><td>-560</td></tr> </table><br>$\therefore n = 20$ |      |      |      |      |      |      |      |      |      | $n$ | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | $T_n$ | -34 | -38 | -42 | -46 | -50 | -54 | -58 | -62 | -66 | $S_n$ | -144 | -182 | -224 | -270 | -320 | -374 | -432 | -494 | -560 |
| $n$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 12   | 13   | 14   | 15   | 16   | 17   | 18   | 19   | 20   |     |    |    |    |    |    |    |    |    |    |       |     |     |     |     |     |     |     |     |     |       |      |      |      |      |      |      |      |      |      |
| $T_n$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | -34  | -38  | -42  | -46  | -50  | -54  | -58  | -62  | -66  |     |    |    |    |    |    |    |    |    |    |       |     |     |     |     |     |     |     |     |     |       |      |      |      |      |      |      |      |      |      |
| $S_n$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | -144 | -182 | -224 | -270 | -320 | -374 | -432 | -494 | -560 |     |    |    |    |    |    |    |    |    |    |       |     |     |     |     |     |     |     |     |     |       |      |      |      |      |      |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |      |      |      |      |      |      |     |    |    |    |    |    |    |    |    |    |       |     |     |     |     |     |     |     |     |     |       |      |      |      |      |      |      |      |      |      |

✓  $S_{11} = -110$

✓ sequence expanded

✓✓ series calculated

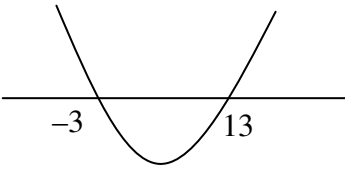
✓✓ answer

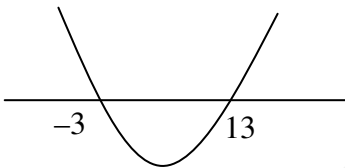
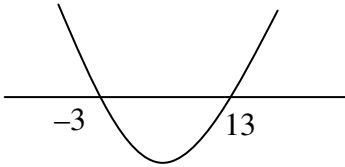
(6)

**[10]****QUESTION 3**

|       |                                                                                                                                                                    |                                                                                                    |                                                                              |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| 3.1.1 | $T_n = ar^{n-1}$<br>$= 27\left(\frac{1}{3}\right)^{n-1}$                                                                                                           | <b>Note:</b> The final answer can also be written as $3^{4-n}$ or $\left(\frac{1}{3}\right)^{n-4}$ | ✓ $a = 27$ and $r = \frac{1}{3}$<br>✓ substitute into correct formula<br>(2) |
| 3.1.2 | $-1 < r < 1$ or $ r  < 1$<br><br><b>OR</b><br>The common ratio ( $r$ ) is $\frac{1}{3}$ which is between $-1$ and $1$ .<br><br><b>OR</b><br>$-1 < \frac{1}{3} < 1$ | <b>Note:</b> If candidate concludes series is not convergent, award 0 marks.                       | ✓ answer (1)<br><br>✓ answer (1)<br><br>✓ answer (1)                         |
| 3.1.3 | $S_\infty = \frac{a}{1-r}$<br>$= \frac{27}{1-\frac{1}{3}}$<br>$= \frac{81}{2}$ or 40,5 or 41                                                                       | <b>Note:</b> If $r > 1$ or $r < -1$ is substituted then 0/2 marks.                                 | ✓ substitution<br>✓ answer (2)                                               |

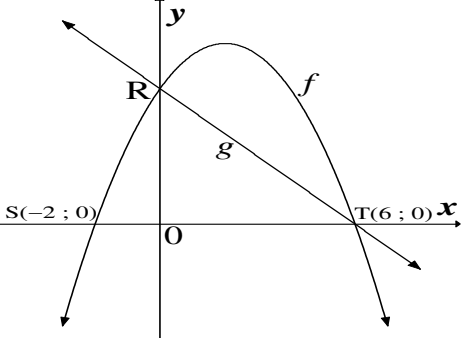
|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.2 | <p>Let <math>V</math> be the volume of the first tank.</p> $\frac{V}{2}; \frac{V}{4}; \frac{V}{8}; \dots$ $S_{19} = \frac{\frac{V}{2} \left[ 1 - \left( \frac{1}{2} \right)^{19} \right]}{1 - \frac{1}{2}}$ $= \frac{524287}{524288} V$ $= 0,9999980927 V$ $< V$ <p>Yes, the water will fill the first tank without spilling over.</p> <p><b>OR</b></p> <p>Let <math>V</math> be the volume of the first tank.</p> $\frac{V}{2}; \frac{V}{4}; \frac{V}{8}; \dots$ $S_{19} = \frac{\frac{V}{2} \left[ 1 - \left( \frac{1}{2} \right)^{19} \right]}{1 - \frac{1}{2}}$ $= V \left[ 1 - \left( \frac{1}{2} \right)^{19} \right]$ $< V \cdot 1$ $= V$ <p>Yes, the water will fill the first tank without spilling over.</p> <p><b>OR</b></p> <p>Let <math>V</math> be the volume of the first tank.</p> $\frac{V}{2}; \frac{V}{4}; \frac{V}{8}; \dots$ $S_{\infty} = \frac{\frac{V}{2}}{1 - \frac{1}{2}}$ $= V$ <p>Since the first tank will hold the water from infinitely many tanks without spilling over, certainly:</p> <p>Yes, the first tank will hold the water from the other 19 tanks without spilling over.</p> | <p>✓ <math>\frac{V}{2}</math></p> <p>✓ substitute into correct formula</p> <p>✓ answer</p> <p>✓ conclusion (4)</p> <p>✓ <math>\frac{V}{2}</math></p> <p>✓ substitute into correct formula</p> <p>✓ observes that <math>\left[ 1 - \left( \frac{1}{2} \right)^{19} \right] &lt; 1</math></p> <p>✓ conclusion (4)</p> <p>✓ <math>\frac{V}{2}</math></p> <p>✓ substitute into correct formula</p> <p>✓✓ correct argument (4)</p> |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|       |                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       | <p><b>OR</b></p> <p>If the tanks are emptied one by one, starting from the second, each tank <b>will fill only half the remaining space</b>, so the first tank can hold all the water from the other 19 tanks.</p>                                                                                                                                                       | <p>✓ Yes (explicit or understood from the argument.)<br/>✓✓✓ argument<br/>(4)</p>                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 3.3.1 | $T_n = -2(n-5)^2 + 18$<br>Term 1 = -14<br>Term 2 = 0<br>Term 3 = 10                                                                                                                                                                                                                                                                                                      | <p>✓ -14<br/>✓ 0<br/>✓ 10<br/>(3)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 3.3.2 | Term 5 <b>OR</b> $n = 5$ <b>OR</b> $T_5$                                                                                                                                                                                                                                                                                                                                 | <p>✓ answer<br/>(1)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 3.3.3 | <p>Second difference = <math>2a</math><br/>           Second difference = <math>2(-2)</math><br/>           Second difference = -4</p> <p><b>OR</b></p> <pre>       -14      0      10        \      /      /         14    -4    10          \      /           -4           </pre> <p>Second difference = -4</p>                                                       | <p>✓ subs - 2 into <math>2a</math><br/>           ✓ answer<br/>(2)</p> <p>✓ first differences<br/>           ✓ second difference<br/>(2)</p>                                                                                                                                                                                                                                                                                                                                                      |
| 3.3.4 | $-2(n-5)^2 + 18 < -110$<br>$-2(n-5)^2 + 128 < 0$<br>$-2n^2 + 20n - 50 + 128 < 0$<br>$-2n^2 + 20n + 78 < 0$<br>$n^2 - 10n - 39 > 0$<br>$(n-13)(n+3) > 0$<br>$\begin{array}{ccccccc} + & 0 & - & 0 & + \\ & -3 & & 13 & \\ \hline n & < -3 & \text{or} & n > 13 & \end{array}$<br>$n \geq 14 ; n \in \mathbb{N}$ <b>OR</b> $n > 13 ; n \in \mathbb{N}$<br><p><b>OR</b></p> | <div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p><b>Note:</b> Answer only award<br/>2/6 marks</p> </div>  <p>✓ <math>T_n &lt; -110</math><br/>           ✓ standard form<br/>           ✓ factors<br/>           ✓ critical values<br/>           ✓ inequalities<br/>           ✓ <math>n &gt; 13</math><br/>           (accept: <math>n \geq 14</math>)<br/>           (6)</p> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |    |   |    |   |   |  |    |  |    |  |   |   |   |   |   |  |    |  |    |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---|----|---|---|--|----|--|----|--|---|---|---|---|---|--|----|--|----|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p> <math>-2(n-5)^2 + 18 &lt; -110</math><br/> <math>-2(n-5)^2 + 128 &lt; 0</math><br/> <math>(n-5)^2 - 64 &gt; 0</math><br/> <math>[(n-5)-8][(n-5)+8] &gt; 0</math><br/> <math>(n-13)(n+3) &gt; 0</math> </p> <div style="display: flex; align-items: center; justify-content: center;"> <table style="margin-right: 20px;"> <tr><td>+</td><td>0</td><td>-</td><td>0</td><td>+</td></tr> <tr><td></td><td>-3</td><td></td><td>13</td><td></td></tr> </table>  </div> <p> <math>n &lt; -3</math> or <math>n &gt; 13</math><br/> <math>n \geq 14 ; n \in \mathbb{N}</math> <b>OR</b> <math>n &gt; 13 ; n \in \mathbb{N}</math> </p> <p><b>OR</b></p> <p> <math>-2(n-5)^2 + 18 &lt; -110</math><br/> <math>-2(n-5)^2 &lt; -128</math><br/> <math>(n-5)^2 &gt; 64</math><br/> <math>n-5 &lt; -8</math> or <math>n-5 &gt; 8</math><br/> <math>n &lt; -3</math> or <math>n &gt; 13</math> </p> <p> <math>n \geq 14 ; n \in \mathbb{N}</math> <b>OR</b> <math>n &gt; 13 ; n \in \mathbb{N}</math> </p> <p><b>OR</b></p> <p> <math>T_n = -2(n-5)^2 + 18</math><br/> <math>T_n = -2n^2 + 20n - 32</math><br/> <math>-2n^2 + 20n - 32 &lt; -110</math><br/> <math>-2n^2 + 20n - 78 &lt; 0</math><br/> <math>n^2 - 10n - 39 &gt; 0</math><br/> <math>(n-13)(n+3) &gt; 0</math> </p> <div style="display: flex; align-items: center; justify-content: center;"> <table style="margin-right: 20px;"> <tr><td>+</td><td>0</td><td>-</td><td>0</td><td>+</td></tr> <tr><td></td><td>-3</td><td></td><td>13</td><td></td></tr> </table>  </div> <p> <math>n &lt; -3</math> or <math>n &gt; 13</math><br/> <math>n \geq 14 ; n \in \mathbb{N}</math> <b>OR</b> <math>n &gt; 13 ; n \in \mathbb{N}</math> </p> <p><b>OR</b></p> <p> <math>-14 ; 0 ; 10 ; 16 ; 18 ; 16 ; 10 ; 0 ; -14 ; -32 ; -54 ; -80 ; -110</math><br/> <math>n \geq 14 ; n \in \mathbb{N}</math> </p> | +  | 0 | -  | 0 | + |  | -3 |  | 13 |  | + | 0 | - | 0 | + |  | -3 |  | 13 |  | <p> <math>\checkmark T_n &lt; -110</math><br/> <math>\checkmark (n-5)^2 - 64 &gt; 0</math><br/> <math>\checkmark</math> factors<br/> <math>\checkmark</math> critical values<br/> <math>\checkmark</math> inequalities<br/> <math>\checkmark n &gt; 13</math><br/>             (accept: <math>n \geq 14</math>)<br/> <b>(6)</b> </p> <p> <math>\checkmark T_n &lt; -110</math><br/> <math>\checkmark 2(n-5)^2 &gt; 128</math><br/> <math>\checkmark 8</math> and <math>-8</math><br/> <math>\checkmark n-5 &gt; 8</math><br/> <math>\checkmark n-5 &lt; -8</math><br/> <math>\checkmark n &gt; 13</math><br/>             (accept: <math>n \geq 14</math>)<br/> <b>(6)</b> </p> <p> <math>\checkmark T_n &lt; -110</math> </p> <p> <math>\checkmark</math> standard form<br/> <math>\checkmark</math> factors<br/> <math>\checkmark</math> critical values         </p> <p> <math>\checkmark</math> inequalities<br/> <math>\checkmark n &gt; 13</math><br/>             (accept: <math>n \geq 14</math>)<br/> <b>(6)</b> </p> <p> <math>\checkmark\checkmark\checkmark\checkmark</math> expansion<br/> <math>\checkmark\checkmark</math> conclusion of<br/> <math>n \geq 14</math><br/>             (accept <math>n &gt; 13</math>)<br/> <b>(6)</b><br/> <b>[21]</b> </p> |
| +                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0  | - | 0  | + |   |  |    |  |    |  |   |   |   |   |   |  |    |  |    |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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| +                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0  | - | 0  | + |   |  |    |  |    |  |   |   |   |   |   |  |    |  |    |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | -3 |   | 13 |   |   |  |    |  |    |  |   |   |   |   |   |  |    |  |    |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

## QUESTION 4

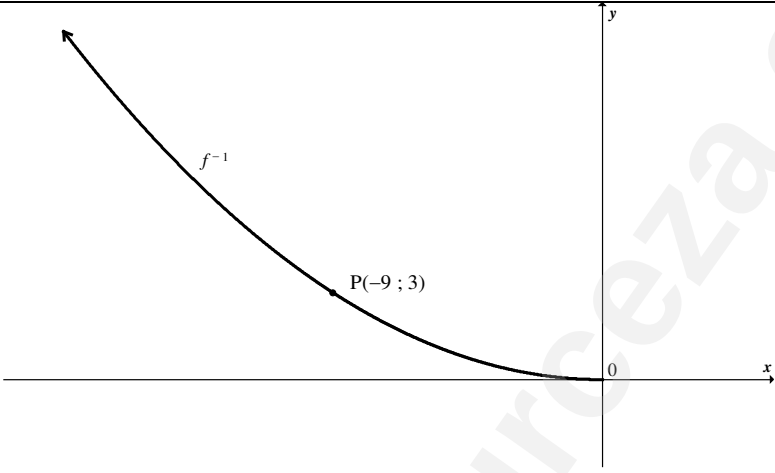
|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                               |
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| 4.1.1 | $y = 3 \cdot 2^0 - 6$<br>$y = 3 - 6$<br>$y = -3 \quad (0; -3)$                                                                                                                                                                                                                                                                                                                                                                                           | ✓ answer<br>(1)                               |
| 4.1.2 | $0 = 3 \cdot 2^x - 6$<br>$3 \cdot 2^x = 6$<br>$2^x = 2^1$<br>$x = 1 \quad (1; 0)$ <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> <b>Note:</b> If a candidate interchanges question 4.1.1 and 4.1.2: 0/3 marks </div> <div style="border: 1px solid black; padding: 5px;"> <b>Note:</b> If a candidate says that <math>3 \cdot 2^x = 6^x</math> (i.e. wrong mathematics) s/he will arrive at correct answer BUT award max 1/2 </div> | ✓ $y = 0$<br>✓ $x$ -value<br>(2)              |
| 4.1.3 |                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ✓ intercepts<br>✓ asymptote<br>✓ shape<br>(3) |
| 4.1.4 | $y > -6$ OR $(-6; \infty)$                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓ answer<br>(1)                               |

|       |                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                               |
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| 4.2   |                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                               |
| 4.2.1 | $y = -2x + d$<br>$0 = (-2)(6) + d$<br>$d = 12$<br><br><b>OR</b><br>$y - y_1 = m(x - x_1)$<br>$y - 0 = -2(x - 6)$<br>$y = -2x + 12$<br>$\therefore d = 12$<br><br><b>OR</b><br>Since $m = -2$ and $m = \frac{-d}{6}$<br>$-2 = \frac{-d}{6}$<br>$d = 12$                                                                                                       | ✓ substitution<br>✓ answer<br>(2)<br><br>✓ substitution<br>✓ answer<br>(2)<br><br>✓ substitution<br>✓ answer<br>(2)                                                                                                                                                                                                                                           |
| 4.2.2 | $y = a(x - 6)(x + 2)$<br>$12 = a(0 - 6)(0 + 2)$<br>$a = -1$<br>$y = -(x^2 - 4x - 12)$<br>$= -x^2 + 4x + 12$<br><br><b>OR</b><br>$y = ax^2 + bx + 12$<br>$0 = a(-2)^2 + b(-2) + 12$ i.e. $0 = 4a - 2b + 12$<br>$0 = a(6)^2 + b(6) + 12$ i.e. $0 = 36a + 6b + 12$<br>$0 = 24b - 96$<br>$b = 4$<br><br>$0 = 4a - 2(4) + 12$<br>$a = -1$<br>$y = -x^2 + 4x + 12$ | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <b>Note:</b> No marks for answer only.         </div> ✓ $y = a(x - 6)(x + 2)$<br>✓ subs R(0 ; 12)<br>✓ a-value<br><br>✓ $y = -x^2 + 4x + 12$<br>(4)<br><br>✓ $y = ax^2 + bx + 12$<br>✓ subs S(- 2;0) and T(6;0)<br>✓ b-value<br><br>✓ $y = -x^2 + 4x + 12$<br>(4) |

|       |                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                   |
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|       | <p><b>OR</b></p> $y = a(x-2)^2 + q$ $0 = a(-2-2)^2 + q \text{ or } 0 = a(6-2)^2 + q \quad \text{i.e.} \quad 0 = 16a + q$ $12 = a(0-2)^2 + q \quad \text{i.e.} \quad \frac{12 = 4a + q}{12 = -12a}$ $a = -1$ $q = 16$<br>$y = -(x-2)^2 + 16$ $= -(x^2 - 4x + 4) + 16$ $= -x^2 + 4x + 12$<br><p><b>OR</b></p> $y = a(x-6)(x+2)$ $= a(x^2 - 4x - 12)$ $= -(x^2 - 4x - 12)$ $= -x^2 + 4x + 12$ | <p>✓ <math>y = a(x-2)^2 + q</math><br/> ✓ subs R(0 ; 12)<br/> and S(-2 ; 0)<br/> (or T(6 ; 0) )</p> <p>✓ a-value</p><br><p>✓ <math>y = -x^2 + 4x + 12</math><br/> (4)</p><br><p>✓ <math>y = a(x-6)(x+2)</math><br/> ✓ expand<br/> ✓ a-value</p> <p>✓ <math>y = -x^2 + 4x + 12</math><br/> (4)</p> |
| 4.2.3 | $\frac{dy}{dx} = 0$ $-2x + 4 = 0$ $x = 2$ $y = -(2)^2 + 4(2) + 12$ $= 16$ <p>TP of <math>f</math> is (2 ; 16)</p><br><p><b>OR</b></p> $x = -\frac{b}{2a}$ $= -\frac{4}{2(-1)}$ $= 2$ $y = -(2)^2 + 4(2) + 12$ $= 16$ <p>TP of <math>f</math> is (2 ; 16)</p><br><p><b>OR</b></p> $f(x) = -(x-2)^2 + 16$ <p>TP of <math>f</math> is (2 ; 16)</p>                                            | <p>✓ x-value</p><br><p>✓ y-value<br/> (2)</p><br><p>✓ x-value</p> <p>✓ y-value<br/> (2)</p><br><p>✓ x-value<br/> ✓ y-value<br/> (2)</p>                                                                                                                                                           |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                     |
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|       | <b>OR</b><br>$x = \frac{-2+6}{2}$ $= 2$ $y = -(2)^2 + 4(2) + 12$ $= 16$<br>TP of $f$ is (2 ; 16)                                                                                                                                                                                                                                                                                                                             | ✓ $x$ -value<br>✓ $y$ -value<br>(2)                                                                                                                                 |
| 4.2.4 | $k < 16$ <b>OR</b> $(-\infty; 16)$                                                                                                                                                                                                                                                                                                                                                                                           | ✓✓ answer<br>(2)                                                                                                                                                    |
| 4.2.5 | Maximum value of $h(x) = 3^{f(x)-12}$ occurs at max value of $f(x)$<br>Maximum value = $3^{16-12}$<br>$= 81$<br><br><b>OR</b><br>Maximum value of $h(x) = 3^{f(x)-12}$ occurs at max value of $f(x)$<br>$h(2) = 3^{f(2)-12}$<br>$= 3^{16-12}$<br>$= 3^4$ or 81<br><br><b>OR</b><br>$f(x) - 12 = -x^2 + 4x$<br>$= x(4 - x)$<br>which has a maximum value of $f(2) = 4$<br>$\therefore$ Maximum value of $h(x)$ is $3^4$ or 81 | ✓✓ subs 16 for $f(x)$<br>✓ $3^4$ or 81<br>(3)<br><br>✓✓ subs 16 for $f(x)$<br>✓ $3^4$ or 81<br>(3)<br><br>✓✓ subs $f(2) = 4$<br>✓ $3^4$ or 81<br>(3)<br><b>[20]</b> |

## QUESTION 5

|     |                                                                                                                |                                                                   |                                                                                                        |
|-----|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| 5.1 | $0 \leq x \leq 3$ OR $[0;3]$                                                                                   | <b>Note:</b> if the candidate gives $0 < x < 3$ , award 1/2 marks | ✓ $0 \leq x$<br>✓ $x \leq 3$<br>(2)                                                                    |
| 5.2 | $f^{-1} : \quad x = -\sqrt{27y}$<br>$x^2 = 27y$<br>$y = \frac{x^2}{27} \quad x \leq 0 \text{ OR } (-\infty;0]$ |                                                                   | ✓ interchange $x$ - and $y$ - values<br>✓ $y = \frac{x^2}{27}$<br>✓ $x \leq 0$ or $(-\infty;0)$<br>(3) |
| 5.3 |                              |                                                                   | ✓ shape<br>✓ end at origin<br>✓ any other point on the graph<br>(3)                                    |
| 5.4 | Reflection about the $x$ -axis<br><b>OR</b><br>$(x; y) \rightarrow (x; -y); x \geq 0$                          |                                                                   | ✓ answer<br>(1)<br><br>✓ answer<br>(1)<br><b>[9]</b>                                                   |

## QUESTION 6

|                                                                                                                                                                                                                 |                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $f(x) = \frac{a}{x-5} + 1$ $0 = \frac{a}{(2)-5} + 1$ $-1 = \frac{a}{-3}$ $a = 3$ $f(x) = \frac{3}{x-5} + 1$ <p><b>OR</b></p> $(x-5)(y-1) = k$ $(2-5)(0-1) = k$ $k = 3$ $(x-5)(y-1) = 3$ $y = \frac{3}{x-5} + 1$ | <p><b>NOTE:</b><br/> <math>f(x) = \frac{x-2}{x-5}</math> as an alternative simplified form.</p> | <ul style="list-style-type: none"> <li>✓ <math>x - 5</math></li> <li>✓ <math>+ 1</math></li> <li>✓ substitution of <math>(2 ; 0)</math></li> <li>✓ <math>a = 3</math></li> </ul> <p style="text-align: right;">(4)</p><br><ul style="list-style-type: none"> <li>✓ <math>(x - 5)</math></li> <li>✓ <math>(y - 1)</math></li> <li>✓ substitution of <math>(2 ; 0)</math></li> <li>✓ <math>k = 3</math></li> </ul> <p style="text-align: right;">(4)</p> <p style="text-align: right;"><b>[4]</b></p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## QUESTION 7

|       |                                                                                                                                                                                                                  |                                                                                   |                                                                                                                                                                                                                                                                                                 |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7.1.1 | $A = P(1 - i)^n$ $= 120\,000(1 - 0,09)^5$ $= R74\,883,86$                                                                                                                                                        | <p><b>NOTE:</b><br/>Incorrect formula (in 7.1.1 or 7.1.2) award max 1/3 marks</p> | <ul style="list-style-type: none"> <li>✓ <math>i, n</math> and <math>P</math> identified</li> <li>✓ subs into correct formula</li> <li>✓ answer</li> </ul> <p style="text-align: right;">(3)</p>                                                                                                |
| 7.1.2 | $A = P(1 + i)^n$ $= 120\,000(1 + 0,07)^5$ $= R168\,306,21$                                                                                                                                                       |                                                                                   | <ul style="list-style-type: none"> <li>✓ <math>i, n</math> and <math>P</math> identified</li> <li>✓ subs into correct formula</li> <li>✓ answer</li> </ul> <p style="text-align: right;">(3)</p>                                                                                                |
| 7.1.3 | <p>Sinking fund needed: <math>F_v = R\,90\,000</math></p> $F_v = \frac{x[(1+i)^n - 1]}{i}$ $90\,000 = \frac{x \left[ \left( 1 + \frac{0,085}{12} \right)^{61} - 1 \right]}{\frac{0,085}{12}}$ $x = R\,1\,184,68$ | <p><b>NOTE:</b> Incorrect formula award max 2/5 marks</p>                         | <ul style="list-style-type: none"> <li>✓ <math>F_v = R\,90\,000</math></li> <li>✓ <math>i = \frac{0,085}{12} = \frac{17}{2400}</math> in annuity formula</li> <li>✓ <math>n = 61</math></li> <li>✓ subs into correct formula</li> <li>✓ answer</li> </ul> <p style="text-align: right;">(5)</p> |

**OR**

Consider the scenario as money deposited at the beginning of every month, but in the last month an additional payment was made at the end of the month:

$$F_v = \frac{x(1+i)\left[(1+i)^n - 1\right]}{i} + x$$

$$= x \left( \frac{(1+i)\left[(1+i)^n - 1\right]}{i} + 1 \right)$$

$$90\,000 = x \left( \frac{\left(1 + \frac{0,085}{12}\right) \left[\left(1 + \frac{0,085}{12}\right)^{60} - 1\right]}{\frac{0,085}{12}} + 1 \right)$$

$$x = \frac{90\,000 \left(\frac{0,085}{12}\right)}{\left(1 + \frac{0,085}{12}\right) \left[\left(1 + \frac{0,085}{12}\right)^{60} - 1\right] + \left(\frac{0,085}{12}\right)}$$

$$= R1184,68$$

**OR**

Present value of sinking fund needed:

$$90\,000 = P_v \left(1 + \frac{0,085}{12}\right)^{61}$$

$$P_v = R58513,03$$

Using the present value formula:

$$P_v = \frac{x[1 - (1+i)^{-n}]}{i}$$

$$58513,03 = \frac{x \left[1 - \left(1 + \frac{0,085}{12}\right)^{-61}\right]}{\frac{0,085}{12}}$$

$$x = R1\,184,68$$

$$\checkmark i = \frac{0,085}{12} = \frac{17}{2400}$$

in annuity formula

$$\checkmark n = 60 \text{ in annuity formula}$$

$$\checkmark F_v = R\,90\,000$$

✓ subs into correct formula

✓ answer

(5)

$$\checkmark i = \frac{0,085}{12} = \frac{17}{2400}$$

in annuity formula

$$\checkmark n = 61$$

$$\checkmark P_v = R58513,03$$

✓ subs into correct formula

✓ answer

(5)

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7.2 | <div style="text-align: center;"> <math display="block">P_v = \frac{x[1 - (1+i)^{-n}]}{i}</math> <math display="block">900\,000 = \frac{18\,000 \left[ 1 - \left( 1 + \frac{0,105}{12} \right)^{-n} \right]}{\frac{0,105}{12}}</math> <math display="block">1 - \frac{900\,000 \left( \frac{0,105}{12} \right)}{18\,000} = \left( 1 + \frac{0,105}{12} \right)^{-n}</math> <math display="block">-n = \log_{\left( 1 + \frac{0,105}{12} \right)} \frac{9}{16}</math> <math display="block">n = 66,04 \text{ months}</math> </div> <p>She will be able to maintain her current lifestyle for a little more than 66 months using her pension money.</p> <p><b>OR</b></p> <div style="text-align: center;"> <math display="block">P_v = \frac{x[1 - (1+i)^{-n}]}{i}</math> <math display="block">900\,000 = \frac{18\,000 \left[ 1 - \left( 1 + \frac{0,105}{12} \right)^{-n} \right]}{\frac{0,105}{12}}</math> <math display="block">1 - \frac{900\,000 \left( \frac{0,105}{12} \right)}{18\,000} = \left( 1 + \frac{0,105}{12} \right)^{-n}</math> <math display="block">-n \log \left( 1 + \frac{0,105}{12} \right) = \log \frac{9}{16}</math> <math display="block">n = 66,04 \text{ months}</math> </div> <p>She will be able to maintain her current lifestyle for a little more than 66 months using her pension money.</p> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p><b>Note:</b> If <math>F_v</math> formula used, possibly award one each for <math>x</math>, <math>i</math>, use of logs: max 3/6 marks</p> <p>If any other incorrect formula is used, award 0/6 marks</p> </div> <p>✓ <math>x = 18\,000</math><br/> ✓ <math>i = \frac{0,105}{12}</math> in annuity formula<br/> ✓ subs into correct formula<br/> ✓ simplification<br/> ✓ use of logs<br/> ✓ answer in months (6)</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p><b>Note:</b> If candidate rounds off early in Question 7.2 (and obtain 58 months), penalise 1 mark</p> </div> <p>✓ <math>x = 18\,000</math><br/> ✓ <math>i = \frac{0,105}{12}</math> in annuity formula<br/> ✓ subs into correct formula<br/> ✓ simplification<br/> ✓ use of logs<br/> ✓ answer in months (6)</p> |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                           |
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|  | <p><b>OR</b></p> $A = F_v$ $P(1+i)^n = \frac{x[(1+i)^n - 1]}{i}$ $900\,000\left(1 + \frac{0,105}{12}\right)^n = \frac{18\,000\left[\left(1 + \frac{0,105}{12}\right)^n - 1\right]}{\frac{0,105}{12}}$ $\frac{0,105}{12} \times 900\,000\left(1 + \frac{0,105}{12}\right)^n = 18\,000\left(1 + \frac{0,105}{12}\right)^n - 18\,000$ $18\,000 = 18\,000\left(1 + \frac{0,105}{12}\right)^n - \frac{0,105}{12} \times 900\,000\left(1 + \frac{0,105}{12}\right)^n$ $18\,000 = \left(1 + \frac{0,105}{12}\right)^n \left(18\,000 - \frac{0,105}{12} \times 900\,000\right)$ $18\,000 \div \left(18\,000 - \frac{0,105}{12} \times 900\,000\right) = \left(1 + \frac{0,105}{12}\right)^n$ $\frac{16}{9} = \left(1 + \frac{0,105}{12}\right)^n$ $-n = \log_{\left(1 + \frac{0,105}{12}\right)} \frac{9}{16}$ $n = 66,04 \text{ months}$ <p>She will be able to maintain her current lifestyle for a little more than 66 months using her pension money.</p> | <p>✓ <math>x = 18\,000</math><br/>         ✓ <math>i = \frac{0,105}{12}</math> in annuity formula<br/>         ✓ subs into correct formula</p> <p>✓ simplification</p> <p>✓ use of logs</p> <p>✓ answer in months</p> <p>(6)<br/>[17]</p> |
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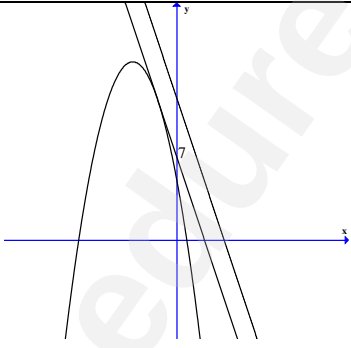
## QUESTION 8

|     |                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                             |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8.1 | $f(x) = 2x^2 - 5$ $f(x+h) = 2(x+h)^2 - 5$ $= 2x^2 + 4xh + 2h^2 - 5$ $f(x+h) - f(x) = 4xh + 2h^2$ $f'(x) = \lim_{h \rightarrow 0} \frac{4xh + 2h^2}{h}$ $= \lim_{h \rightarrow 0} \frac{h(4x + 2h)}{h}$ $= \lim_{h \rightarrow 0} (4x + 2h)$ $= 4x$ <p><b>OR</b></p> | <p><b>Note:</b> If candidate makes a notation error<br/>Penalise 1 mark</p> <p><b>Note:</b> If candidate uses differentiation rules<br/>Award 0/5 marks</p> <p>✓ substitution of <math>x+h</math></p> <p>✓ simplification to <math>4xh + 2h^2</math></p> <p>✓ formula</p> <p>✓ <math>\lim_{h \rightarrow 0} (4x + 2h)</math></p> <p>✓ answer</p> <p>(5)</p> |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

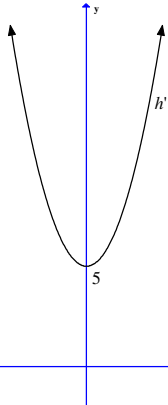
|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                             |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       | $f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$ $= \lim_{h \rightarrow 0} \frac{[2(x+h)^2 - 5] - (2x^2 - 5)}{h}$ $= \lim_{h \rightarrow 0} \frac{[2(x^2 + 2xh + h^2) - 5] - 2x^2 + 5}{h}$ $= \lim_{h \rightarrow 0} \frac{[2x^2 + 4xh + 2h^2 - 5] - 2x^2 + 5}{h}$ $= \lim_{h \rightarrow 0} \frac{4xh + 2h^2}{h}$ $= \lim_{h \rightarrow 0} \frac{h(4x + 2h)}{h}$ $= \lim_{h \rightarrow 0} (4x + 2h)$ $= 4x$                                            | <p>✓ formula</p> <p>✓ substitution of <math>x + h</math></p> <p>✓ simplification to <math>\frac{4xh + 2h^2}{h}</math></p> <p>✓ <math>\lim_{h \rightarrow 0} (4x + 2h)</math></p> <p>✓ answer</p> <p>(5)</p> |
| 8.2   | $\frac{dy}{dx} = -4x^{-5} + 6x^2 - \frac{1}{5}$ $= -\frac{4}{x^5} + 6x^2 - \frac{1}{5}$ <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-top: 10px;"> <b>Note:</b> notation error penalise 1 mark         </div> <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-top: 10px; margin-left: 20px;"> <b>Note:</b> candidates do NOT need to give their answer with positive exponents         </div> | <p>✓ <math>-4x^{-5}</math></p> <p>✓ <math>6x^2</math></p> <p>✓ <math>-\frac{1}{5}</math></p> <p>(3)</p>                                                                                                     |
| 8.3.1 | $g(x) = \frac{x^2 + x - 2}{x - 1}$ $= \frac{(x+2)(x-1)}{x-1}$ $= x + 2 \quad (x \neq 1)$ $g'(x) = 1 \quad (x \neq 1)$                                                                                                                                                                                                                                                                                                                                             | <p>✓ simplification</p> <p>✓ answer</p> <p>(2)</p>                                                                                                                                                          |
| 8.3.2 | <p>The function is undefined at <math>x = 1</math>.</p> <p><b>OR</b></p> <p>Division by zero is undefined.</p> <p><b>OR</b></p> <p>The denominator cannot be zero.</p> <p><b>OR</b></p> <p>In the definition of the derivative, <math>g'(1) = \lim_{h \rightarrow 0} \frac{g(1+h) - g(1)}{h}</math>, but <math>g(1)</math> does not exist.</p>                                                                                                                    | <p>✓ answer</p> <p>(1)</p> <p><b>[11]</b></p>                                                                                                                                                               |

## QUESTION 9

|       |                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9.1.1 | $f(x) = -x^3 - x^2 + 16x + 16$ $f'(x) = -3x^2 - 2x + 16$ $0 = -3x^2 - 2x + 16$ $3x^2 + 2x - 16 = 0$ $(3x + 8)(x - 2) = 0$ $x = -\frac{8}{3} \text{ or } x = 2$ <p><b>OR</b></p> $f(x) = -x^3 - x^2 + 16x + 16$ $f'(x) = -3x^2 - 2x + 16$ $0 = -3x^2 - 2x + 16$ $0 = 3x^2 + 2x - 16$ $x = \frac{-2 \pm \sqrt{2^2 - 4(3)(-16)}}{2(3)}$ $x = -\frac{8}{3} \text{ or } x = 2$ | <p><b>Note:</b> if neither <math>f'(x) = 0</math> nor <math>0 = -3x^2 - 2x + 16</math> explicitly stated, award maximum 3/4 marks</p> <p>✓ <math>f'(x) = -3x^2 - 2x + 16</math><br/> ✓ <math>f'(x) = 0</math> or<br/> <math>0 = -3x^2 - 2x + 16</math><br/> ✓ factors<br/> ✓ <math>x</math> values<br/> (4)</p> <p>✓ <math>f'(x) = -3x^2 - 2x + 16</math><br/> ✓ <math>f'(x) = 0</math> or<br/> <math>0 = -3x^2 - 2x + 16</math><br/> ✓ subs into formula<br/> ✓ <math>x</math> values<br/> (4)</p> |
| 9.1.2 | $f''(x) = 0$ $-6x - 2 = 0$ $x = -\frac{1}{3}$ <p><b>OR</b></p> $x = \frac{-\frac{8}{3} + 2}{2}$ $x = -\frac{1}{3}$ <p><b>OR</b></p> $f'(x) = -3x^2 - 2x + 16$ $x = \frac{-(-2)}{2(-3)}$ $= -\frac{1}{3}$ <p><b>OR</b></p>                                                                                                                                                 | <p>✓ <math>f''(x) = -6x - 2</math><br/> ✓ <math>-6x - 2 = 0</math><br/> ✓ answer<br/> (3)</p> <p>✓ <math>x = \frac{-\frac{8}{3} + 2}{2}</math><br/> ✓✓ answer<br/> (3)</p> <p>✓✓ <math>x = \frac{-(-2)}{2(-3)}</math><br/> ✓ answer<br/> (3)</p>                                                                                                                                                                                                                                                    |

|       |                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                    |
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|       | $f(x) = -x^3 - x^2 + 16x + 16$ $x = \frac{-(-1)}{3(-1)}$ $= -\frac{1}{3}$                                                                                                                                                                                                                                                                           | $\checkmark\checkmark \quad x = \frac{-(-1)}{3(-1)}$ $\checkmark \text{ answer}$ <p style="text-align: right;">(3)</p>                                                                                                                                                                                                                                             |
| 9.2.1 | $g(x) = -2x^2 - 9x + 5$ $g(-1) = -2(-1)^2 - 9(-1) + 5$ $= 12$ $g'(x) = -4x - 9$ $m_{\text{tan}} = -4(-1) - 9$ $= -5$ $y = -5x + c$ $12 = -5(-1) + c$ $c = 7$ $y = -5x + 7$ <p><b>OR</b></p> $g(x) = -2x^2 - 9x + 5$ $g(-1) = -2(-1)^2 - 9(-1) + 5$ $= 12$ $g'(x) = -4x - 9$ $m_{\text{tan}} = -4(-1) - 9$ $= -5$ $y - 12 = -5(x + 1)$ $y = -5x + 7$ | $\checkmark \quad g(-1) = 12$ $\checkmark \quad g'(x) = -4x - 9$<br>$\checkmark \quad m_{\text{tan}} = -5$<br>$\checkmark \text{ answer}$ <p style="text-align: right;">(4)</p><br>$\checkmark \quad g(-1) = 12$ $\checkmark \quad g'(x) = -4x - 9$<br>$\checkmark \quad m_{\text{tan}} = -5$<br>$\checkmark \text{ answer}$ <p style="text-align: right;">(4)</p> |
| 9.2.2 |  <p style="text-align: center;"><math>q &gt; 7</math></p> <p><b>OR</b></p> $y = -5x + q \quad \text{and} \quad y = -2x^2 - 9x + 5$ $-5x + q = -2x^2 - 9x + 5$ $q = -2(x+1)^2 + 7$ $\therefore q > 7$                                                             | $\checkmark \text{ sketch}$<br>$\checkmark 7$ $\checkmark \text{ correct inequality}$ <p style="text-align: right;">(3)</p><br>$\checkmark \text{ method}$<br>$\checkmark 7$ $\checkmark \text{ correct inequality}$ <p style="text-align: right;">(3)</p>                                                                                                         |

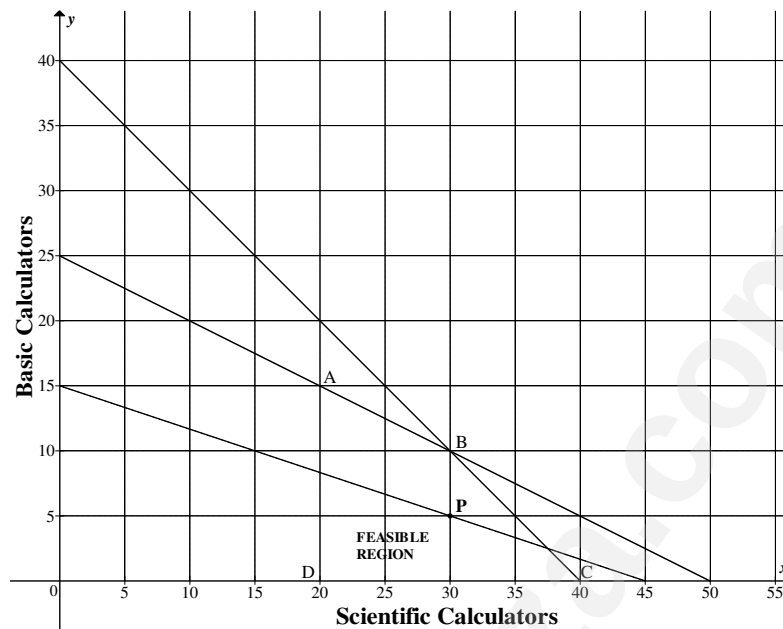
|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                       |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     | <p><b>OR</b></p> $y = -5x + q \text{ and } y = -2x^2 - 9x + 5$ $-5x + q = -2x^2 - 9x + 5$ $2x^2 + 4x + q - 5 = 0$ $x = \frac{-4 \pm \sqrt{16 - 4(2)(q - 5)}}{2(2)}$ $x = \frac{-4 \pm \sqrt{56 - 8q}}{4}$ $56 - 8q < 0$ $q > 7$ <p><b>OR</b></p> <p>Since <math>g(-1) = 12</math> and at <math>x = -1</math>, tangent equation is <math>y = -5x + 7</math>,<br/> <math>y = -5x + q</math> not intersecting <math>g \Rightarrow</math><br/> <math>12 &lt; -5(-1) + q</math><br/> <math>12 - 5 &lt; q</math><br/> <math>7 &lt; q</math></p>                                                                                                                                                                                                                                                                                                          | <p>✓ method</p> <p>✓ 7<br/>         ✓ correct inequality<br/>         (3)</p> <p>✓ method</p> <p>✓ 7<br/>         ✓ correct inequality<br/>         (3)</p>                                                                                                                           |
| 9.3 | <p><math>h'(x) = 12x^2 + 5</math></p> <p>For all values of <math>x</math>: <math>x^2 \geq 0</math></p> $12x^2 \geq 0$ $12x^2 + 5 \geq 5$ $12x^2 + 5 > 0$ <p>For all values of <math>x</math>: <math>h'(x) &gt; 0</math></p> <p>All tangents drawn to <math>h</math> will have a positive gradient.<br/>         It will never be possible to draw a tangent with a negative gradient to the graph of <math>h</math>.</p> <p><b>OR</b></p> <p><math>h'(x) = 12x^2 + 5</math></p> <p>Suppose <math>h'(x) &lt; 0</math> and try to solve for <math>x</math>:</p> $12x^2 + 5 < 0$ $x^2 < -\frac{5}{12}$ <p>but <math>x^2</math> is always positive<br/> <math>\therefore</math> no solution for <math>x</math><br/> <math>\therefore h'(x) \geq 0</math> for all <math>x \in R</math><br/>         i.e. there are no tangents with negative slopes</p> | <p>✓ <math>h'(x) = 12x^2 + 5</math></p> <p>✓ clearly argues that <math>h'(x) &gt; 0</math></p> <p>✓ conclusion<br/>         (3)</p> <p>✓ <math>h'(x) = 12x^2 + 5</math></p> <p>✓ clearly argues that <math>h'(x) &lt; 0</math> is impossible</p> <p>✓ conclusion<br/>         (3)</p> |

|  |                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                          |
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|  | <p><b>OR</b></p> $h'(x) = 12x^2 + 5$  <p>Since clearly <math>h'(x) &gt; 0</math> for all <math>x \in \mathbb{R}</math>,<br/>it will never be possible to draw a tangent with a negative gradient to<br/>the graph of <math>h</math>.</p> | <p>✓ <math>h'(x) = 12x^2 + 5</math></p> <p>✓ argues <math>h'(x) &gt; 0</math> by<br/>drawing a sketch</p> <p>✓ conclusion</p> <p>(3)<br/><b>[17]</b></p> |
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## QUESTION 10

|      |                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                         |                                                                                                                                                                                                   |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.1 | $s(t) = 2t^2 - 18t + 45$<br>$s'(t) = 4t - 18$<br>$s'(0) = 4(0) - 18$<br>$= -18 \text{ m/s}$                                                                                                                                                                                                                                                                              | <div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>Note:</b> answer only<br/>award 0/3 marks         </div> | ✓ $s'(t)$<br>✓ subs $t = 0$ into $s'(t)$ formula<br>✓ answer<br>(3)                                                                                                                               |
| 10.2 | $s''(t) = 4 \text{ m/s}^2$                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                         | ✓ answer<br>(1)                                                                                                                                                                                   |
| 10.3 | $4t - 18 = 0$<br>$4t = 18$<br>$t = \frac{9}{2} \text{ seconds or } 4,5 \text{ seconds}$<br><br><b>OR</b><br><br>$s(t) = 2\left(t - \frac{9}{2}\right)^2 + \frac{9}{2}$<br>$t = \frac{9}{2} \text{ seconds or } 4,5 \text{ seconds}$<br><br><b>OR</b><br>$s(t) = 2t^2 - 18t + 45$<br>$t = -\frac{-18}{2(2)}$<br>$t = \frac{9}{2} \text{ seconds or } 4,5 \text{ seconds}$ |                                                                                                                                         | ✓ $s'(t) = 0$<br><br>✓ answer<br>(2)<br><br>✓ $s(t) = 2\left(t - \frac{9}{2}\right)^2 + \frac{9}{2}$<br><br>✓ answer<br>(2)<br><br>✓ $t = -\frac{-18}{2(2)}$<br><br>✓ answer<br>(2)<br><b>[6]</b> |

## QUESTION 11



|        |                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                         |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 11.1   | No, because (15 ; 5) does not lie within the feasible region.<br><b>OR</b><br>No, because according to the constraints, the $x$ -value (number of scientific calculators) must be at least 20.                                                                                                                                                                             | ✓ answer<br>(with motivation)<br>(1)                                                                                                    |
| 11.2   | $x \geq 20$<br>$x + 2y \leq 50$<br>$x + y \leq 40$<br>$y \geq 0$<br><b>OR</b> $x \geq 20$<br>$y \leq -\frac{1}{2}x + 25$<br>$y \leq -x + 40$<br>$y \geq 0$<br><b>OR</b> $x \geq 20$<br>$\frac{y}{25} + \frac{x}{50} \leq 1$<br>$\frac{y}{40} + \frac{x}{40} \leq 1$<br>$y \geq 0$<br><b>OR</b> $x \geq 20$<br>$40x + 40y \leq 1600$<br>$25x + 50y \leq 1250$<br>$y \geq 0$ | $\checkmark x \geq 20$<br>$\checkmark\checkmark x + 2y \leq 50$<br>$\checkmark\checkmark x + y \leq 40$<br>$\checkmark y \geq 0$<br>(6) |
| 11.3.1 | A                                                                                                                                                                                                                                                                                                                                                                          | ✓ answer<br>(1)                                                                                                                         |
| 11.3.2 | All points on the search line yield the same profit.<br>Hence no such point exists.<br><b>OR</b><br>If such an $(x ; y)$ exists, $Q = x + 3y$ and<br>$y = -\frac{1}{3}x + 15$<br>so $45 = 3y + x = Q$<br>$Q = 4\ 500$<br>Hence, there is no such point.                                                                                                                    | $\checkmark\checkmark$ No point exists<br>(2)<br>$\checkmark\checkmark$ No point exists<br>(2)                                          |

|        |                                                                                                                                                                                     |                                                                                                                                                                   |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11.3.3 | $Q = ax + by$<br>$y = -\frac{a}{b}x + \frac{Q}{b}$<br>$-1 \leq -\frac{a}{b} \leq -\frac{1}{2}$<br>$\frac{1}{2} \leq \frac{a}{b} \leq 1$<br>The maximum value of $\frac{a}{b}$ is 1. | $\checkmark y = -\frac{a}{b}x + \frac{Q}{b}$<br>$\checkmark -1 \leq -\frac{a}{b}$<br>$\checkmark \frac{a}{b} \leq 1$<br>$\checkmark$ answer<br>(4)<br><b>[14]</b> |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**TOTAL: 150**