



# basic education

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

## **NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**MATHEMATICS P1**

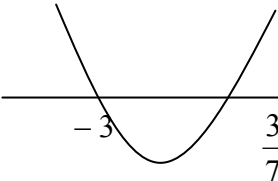
**FEBRUARY/MARCH 2011**

**MEMORANDUM**

**MARKS: 150**

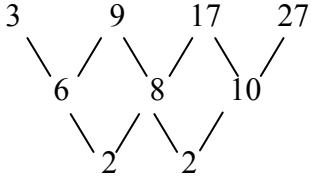
**This memorandum consists of 20 pages.**

**QUESTION 1**

<p>1.1.1</p>	$x^2 - x = 12$ $x^2 - x - 12 = 0$ $(x - 4)(x + 3) = 0$ $x = 4 \text{ or } x = -3$ <p><b>OR</b></p> $x(x - 1) = 12$ $4(3) = 12$ $(-3)(-4) = 12$ <p>By inspection</p> $x = 4 \text{ or } x = -3$	<p>✓ standard form ✓ factors ✓ answers (3)</p> <p>✓ factors</p> <p>✓✓ answers (3)</p>										
<p>1.1.2</p>	$2x^2 + 3x - 7 = 0$ $x = \frac{-3 \pm \sqrt{(3)^2 - 4(2)(-7)}}{2(2)}$ $= \frac{-3 \pm \sqrt{65}}{4}$ $x = 1,27 \text{ or } x = -2,77$	<p>✓ substitution into correct formula</p> <p>✓ 65</p> <p>✓✓ answers (4)</p>										
<p>1.1.3</p>	$7x^2 + 18x - 9 > 0$ $(7x - 3)(x + 3) > 0$ <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;">+</td> <td style="text-align: center;">0</td> <td style="text-align: center;">-</td> <td style="text-align: center;">0</td> <td style="text-align: center;">+</td> </tr> <tr> <td style="text-align: center;">-</td> <td style="text-align: center;">-3</td> <td style="text-align: center;">-</td> <td style="text-align: center;"><math>\frac{3}{7}</math></td> <td style="text-align: center;">+</td> </tr> </table>  $x < -3 \text{ or } x > \frac{3}{7}$ <p><b>OR</b></p> $x \in (-\infty; -3) \cup \left(\frac{3}{7}; \infty\right)$	+	0	-	0	+	-	-3	-	$\frac{3}{7}$	+	<p>✓ factors</p> <p>✓ <math>\frac{3}{7}</math> and <math>-3</math></p> <p>✓ correct intervals (4)</p>
+	0	-	0	+								
-	-3	-	$\frac{3}{7}$	+								
<p>1.2</p>	$2x - y = 7$ $y = 2x - 7$ <p>Substitute <math>y = 2x - 7</math> into <math>x^2 + xy = 21 - y^2</math></p> $x^2 + x(2x - 7) = 21 - (2x - 7)^2$ $x^2 + 2x^2 - 7x = 21 - 4x^2 + 28x - 49$ $7x^2 - 35x + 28 = 0$ $x^2 - 5x + 4 = 0$ $(x - 4)(x - 1) = 0$ $x = 4 \text{ or } x = 1$ $y = 1 \text{ or } y = -5$	<p>✓ <math>y = 2x - 7</math> ✓ substitution</p> <p>✓ multiplication</p> <p>✓ standard form</p> <p>✓ factors ✓ x-answers ✓ y-answers (7)</p>										

	<p><b>OR</b></p> $2x - y = 7$ $x = \frac{7+y}{2}$ <p>Substitute <math>x = \frac{7+y}{2}</math> into <math>x^2 + xy = 21 - y^2</math></p> $\left(\frac{7+y}{2}\right)^2 + \left(\frac{7+y}{2}\right)y = 21 - y^2$ $\frac{49 + 14y + y^2}{4} + \frac{7y + y^2}{2} = 21 - y^2$ $49 + 14y + y^2 + 2(7y + y^2) = 84 - 4y^2$ $49 + 14y + y^2 + 14y + 2y^2 = 84 - 4y^2$ $7y^2 + 28y - 35 = 0$ $y^2 + 4y - 5 = 0$ $(y+5)(y-1) = 0$ $y = -5 \quad \text{or} \quad y = 1$ $x = 1 \quad \quad \quad x = 4$	<p>✓ <math>x = \frac{7+y}{2}</math></p> <p>✓ substitution</p> <p>✓ multiplication</p> <p>✓ standard form</p> <p>✓ factors</p> <p>✓ x-answers</p> <p>✓ y-answers</p> <p style="text-align: right;">(7)</p>
1.3	$\left(\sqrt[5]{\sqrt{35} + \sqrt{3}}\right)\left(\sqrt[5]{\sqrt{35} - \sqrt{3}}\right)$ $= \sqrt[5]{(\sqrt{35} + \sqrt{3})(\sqrt{35} - \sqrt{3})}$ $= \sqrt[5]{35 - 3}$ $= \sqrt[5]{32}$ $= 2$	<p>✓</p> $\sqrt[5]{(\sqrt{35} + \sqrt{3})(\sqrt{35} - \sqrt{3})}$ <p>✓ <math>\sqrt[5]{35 - 3}</math></p> <p>✓ answer</p> <p style="text-align: right;">(3)</p> <p style="text-align: right;"><b>[21]</b></p>

**QUESTION 2**

2.1	39	✓ answer (1)
2.2	 <p>Let <math>T_n = an^2 + bn + c</math>  Then  <math>2a = 2</math>  <math>a = 1</math>  <math>3a + b = 6</math>  <math>3(1) + b = 6</math>  <math>b = 3</math>  <math>a + b + c = 3</math>  <math>1 + 3 + c = 3</math>  <math>c = -1</math>  <math>T_n = n^2 + 3n - 1</math></p> <p><b>OR</b></p> $2a = 2$ $a = 1$ $c = 3 - 4 = -1$ $T_n = n^2 + bn - 1$ $3 = (1)^2 + b(1) - 1$ (using $T_1 = 3$ ) $b = 3$ $T_n = n^2 + 3n - 1$	<p>✓ formula  ✓ <math>a = 1</math>  ✓ <math>b = 3</math>  ✓ <math>c = -1</math> (4)</p> <p>✓ <math>a = 1</math>  ✓ <math>c = -1</math>  ✓ formula  ✓ <math>b = 3</math> (4)</p>
2.3	$n^2 + 3n - 1 > 269$ $n^2 + 3n - 270 > 0$ $(n + 18)(n - 15) > 0$ The first value of $n$ is 16 The term is $16^2 + 3(16) - 1 = 303$	<p>✓ <math>n^2 + 3n - 1 &gt; 269</math>  ✓ factors  ✓ <math>n = 16</math>  ✓ answer (4)</p> <p><b>[9]</b></p>

## QUESTION 3

3.1	$S_{\infty} = 8 + \frac{8}{\sqrt{2}} + \dots$ $r = \frac{1}{\sqrt{2}} \quad \text{and}$ $s_{\infty} = \frac{a}{1-r}$ $= \frac{8}{1 - \frac{1}{\sqrt{2}}}$ $= \frac{8\sqrt{2}}{\sqrt{2}-1}$ $= \frac{8\sqrt{2}(\sqrt{2}+1)}{(\sqrt{2}-1)(\sqrt{2}+1)}$ $= 8\sqrt{2}\sqrt{2} + 8\sqrt{2}$ $= 16 + 8\sqrt{2}$ <p><b>OR</b></p> $S_{\infty} = 8 + \frac{8}{\sqrt{2}} + \dots$ $r = \frac{1}{\sqrt{2}} \quad \text{and}$ $s_{\infty} = \frac{a}{1-r}$ $= \frac{8}{1 - \frac{1}{\sqrt{2}}}$ $= \frac{8\left(1 + \frac{1}{\sqrt{2}}\right)}{\left(1 - \frac{1}{\sqrt{2}}\right)\left(1 + \frac{1}{\sqrt{2}}\right)}$ $= \frac{8\left(1 + \frac{1}{\sqrt{2}}\right)}{\frac{1}{2}}$ $= 16\left(1 + \frac{1}{\sqrt{2}}\right)$ $= 16 + \frac{16\sqrt{2}}{2}$ $= 16 + 8\sqrt{2}$	$\checkmark r = \frac{1}{\sqrt{2}}$  $\checkmark \text{ substitution}$   $\checkmark \text{ rationalisation}$  $\checkmark \text{ simplification} \quad (4)$          $\checkmark r = \frac{1}{\sqrt{2}}$  $\checkmark \text{ substitution}$   $\checkmark \text{ rationalisation}$ $\checkmark \text{ simplification} \quad (4)$
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<p>3.2.1</p>	$5 + 15 + 45 + \dots + T_{20}$ $= \sum_{n=1}^{20} 5(3)^{n-1}$ <p><b>OR</b></p> $5 + 15 + 45 + \dots + T_{20}$ $= 5 \sum_{n=0}^{19} (3)^n$ <p><b>OR</b></p> $5 + 15 + 45 + \dots + T_{20}$ $= 5 \sum_{i=l}^{l+19} (3)^{i-l} \quad \text{for any } l \in \mathbb{Z}$	<p>✓ ✓ answer (2)</p> <p>✓ ✓ answer (2)</p> <p>✓ ✓ answer (2)</p>
<p>3.2.2</p>	$5 + 15 + 45 + \dots + T_{20}$ $= \frac{5(3^{20} - 1)}{3 - 1}$ $= 8\,716\,961\,000$	<p>✓ formula ✓ substitution</p> <p>✓ answer (3) <b>[9]</b></p>

**QUESTION 4**

<p>4.1.1</p>	$S_{23} = \frac{23}{2}(5(23) + 9)$ $= 1426$	<p>✓ substitution</p> <p>✓ answer (2)</p>
<p>4.1.2</p>	$T_{23} = S_{23} - S_{22}$ $= 1426 - \frac{22}{2}(5(22) + 9)$ $= 1426 - 1309$ $= 117$	<p>✓ statement</p> <p>✓ <math>S_{22} = 1309</math></p> <p>✓ answer (3)</p>
<p>4.2</p>	<p>Arithmetic Sequence: <math>12 ; 12 + d ; 12 + 2d</math>                  Geometric Sequence: <math>12 ; 12r ; 12r^2</math>  <math>12 + d = 12r</math>  <math>d = 12r - 12</math>  <math>12 + 12r + 12r^2 = 12 + 12 + d + 12 + 2d + 3</math>  <math>12r^2 = 12 + 2(12r - 12) + 3</math>  <math>12r^2 = 12 + 24r - 24 + 3</math>  <math>12r^2 - 24r + 9 = 0</math>  <math>4r^2 - 8r + 3 = 0</math>  <math>(2r - 3)(2r - 1) = 0</math>  <math>r = \frac{3}{2} \quad \text{or} \quad r = \frac{1}{2}</math></p>	<p>✓ equation</p> <p>✓ equation</p> <p>✓ standard form</p> <p>✓ factors</p> <p>✓ answers (6)</p>

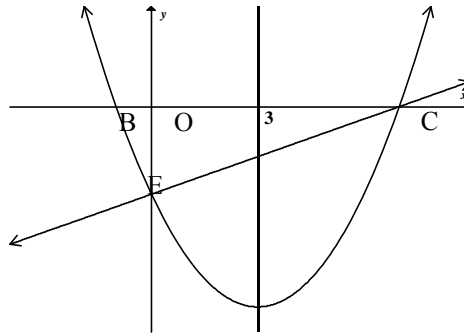
	<p><b>OR</b>                  The 3<sup>rd</sup> term of GP = 3 + 3<sup>rd</sup> term of AP  <math>12r^2 = 3 + 12 + 2d</math>  <math>12r^2 = 15 + 24r - 24</math>  <math>12r^2 - 24r + 9 = 0</math>  <math>4r^2 - 8r + 3 = 0</math>  <math>(2r - 3)(2r - 1) = 0</math>  <math>r = \frac{3}{2}</math> or <math>r = \frac{1}{2}</math></p>	<p>✓ equation                  ✓ equation                    ✓ standard form                    ✓ factors                    ✓ answers</p> <p style="text-align: right;"><b>[11]</b></p>
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**QUESTION 5**

5.1	$x = 1$ $y = -2$	<p>✓✓ answers (2)</p>
5.2	<p>y-intercept:  <math>y = \frac{3}{0-1} - 2 = -5</math>                  x-intercept: <math>\left(\frac{5}{2}; 0\right)</math>  <math>0 = \frac{3}{x-1} - 2</math>  <math>2 = \frac{3}{x-1}</math>  <math>2x - 2 = 3</math>  <math>2x = 5</math>  <math>x = \frac{5}{2}</math></p>	<p>✓ <math>y = -5</math>                    ✓ substitute <math>y = 0</math>                    ✓ answer (3)</p>
5.3		<p>✓ asymptotes                  ✓ y-intercept                  ✓ shape (3)</p>

5.4	$-f(x) = \frac{-3}{x-1} + 2$ $y \in \mathbb{R} - \{2\} \quad \text{OR} \quad y \in (-\infty; 2) \cup (2; \infty) \quad \text{OR} \quad y \in \mathbb{R}; y \neq 2$	✓ answer  (1)
5.5	$g(x) = \frac{-3}{x+1} - 2$ $= \frac{3}{-x-1} - 2$ Reflection of $f$ about the $y$ -axis.  OR (i) horizontal shift 2 units to the left followed by (ii) reflection in $x$ -axis, followed by (iii) vertical downward shift of 4 units	✓ manipulation  ✓ answer  (2) <b>[11]</b>

**QUESTION 6**



6.1	$\frac{x}{2} - \frac{7}{2} = 0$ $x = 7$ $C(7; 0)$ <p>OR</p> $y = \frac{7}{2} - \frac{7}{2}$ $y = 0$ $C(7; 0)$	$\frac{x}{2} - \frac{7}{2} = 0$  (1)  ✓ substitution ✓ answer  (2)
6.2	$x\text{-coordinate of B is}$ $3 - 4 = -1$	✓ answer  (1)

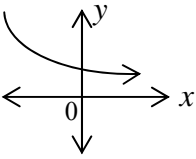


<p>6.3</p>	<p>OPTION 1</p> $f(x) = a(x - 3)^2 + q$ <p>At B and C: <math>0 = 16a + q</math></p> <p>At E: <math>-\frac{7}{2} = 9a + q</math></p> <p>Solving simultaneously gives</p> $a = \frac{1}{2} \text{ and } q = -8$ <p>OPTION 2</p> $f(x) = a(x + 1)(x - 7)$ $y = a(x + 1)(x - 7)$ $-3,5 = a(0 + 1)(0 - 7)$ $-3,5 = -7a$ $a = \frac{1}{2}$ $f(x) = \frac{1}{2}(x + 1)(x - 7)$ $= \frac{1}{2}(x^2 - 6x - 7)$ $= \frac{1}{2}[(x - 3)^2 - 16]$ $= \frac{1}{2}(x - 3)^2 - 8$ <p>OPTION 3</p> $a = \frac{1}{2}$ <p>Axis of symmetry: <math>x = 3</math> or <math>x = \frac{-1 + 7}{2} = 3</math></p> $f(x) = \frac{1}{2}(x - 3)^2 + q$ $0 = \frac{1}{2}(7 - 3)^2 + q$ $q = -8$ $y = \frac{1}{2}(x - 3)^2 - 8$	<p>✓ substitution ✓ substitution</p> <p>✓ substitution</p> <p>✓✓ <math>a = \frac{1}{2}</math> ✓ <math>q = -8</math></p> <p>(6)</p> <p>✓ substitution</p> <p>✓ substitution</p> <p>✓ <math>a = \frac{1}{2}</math> ✓ substitution</p> <p>✓ simplification</p> <p>✓ answer</p> <p>(6)</p> <p>✓✓✓ <math>a = \frac{1}{2}</math></p> <p>✓ substitution</p> <p>✓ substitution</p> <p>✓ answer</p> <p>(6)</p>
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	<p>OPTION 4</p> $a = \frac{1}{2}$ <p>Axis of symmetry: <math>x = 3</math></p> $f(x) = \frac{1}{2}(x-3)^2 + q$ $q = f(3)$ $q = \frac{1}{2}(3+1)(3-7)$ $q = -8$ $y = \frac{1}{2}(x-3)^2 - 8$	<p>✓✓✓ <math>a = \frac{1}{2}</math></p> <p>✓ substitution</p> <p>✓ substitution</p> <p>✓ answer</p> <p>(6)</p>
<p>6.4</p>	$h(x) = -f(x) = -\frac{1}{2}(x-3)^2 + 8$	<p>✓ answer</p> <p>(1)</p>
<p>6.5</p>	$1 - f(x) = -\frac{1}{2}(x-3)^2 + 9$ <p>∴ Maximum value is 9.</p> <p><b>OR</b></p> <p>Maximum value = <math>1 - (-8)</math> = 9</p> <p><b>OR</b></p> $t(x) = -\frac{1}{2}x^2 + 3x + \frac{9}{2}$ $t'(x) = -x + 3 = 0$ $\text{Max } V_{at\ x=3} = -\frac{1}{2}(3)^2 + 3(3) + \frac{9}{2} = 9$	<p>✓ method</p> <p>✓ answer</p> <p>(2)</p>
<p>6.6</p>	$f(x^2 - 2) = 0$ $f(x) = 0 \text{ if } x = -1 \text{ or } x = 7$ $\therefore f(x^2 - 2) = 0 \text{ if } x^2 - 2 = -1 \text{ or } x^2 - 2 = 7$ $\therefore x^2 = 1 \quad \text{or} \quad x^2 = 9$ $\therefore x = 1 \text{ or } x = -1 \quad \text{or} \quad x = 3 \text{ or } x = -3$	<p>✓ substitution</p> <p>✓ simplification</p> <p>✓ answer</p> <p>✓ answer</p> <p>(4)</p>

	$\frac{1}{2}(x^2 - 2 - 3)^2 - 8 = 0$ $\frac{1}{2}(x^2 - 5)^2 = 8$ $(x^2 - 5)^2 = 16$ $x^2 - 5 = 4 \quad \text{or} \quad x^2 - 5 = -4$ $x^2 = 9 \quad \text{or} \quad x^2 = 1$ $x = 3 \quad \text{or} \quad x = -3 \quad \text{or} \quad x = 1 \quad \text{or} \quad x = -1$ <p><b>OR</b></p> $f(x^2 - 2) = 0$ $\frac{1}{2}(x^2 - 2 - 3)^2 - 8 = 0$ $\frac{1}{2}(x^2 - 5)^2 = 8$ $(x^2 - 5)^2 - 16 = 0$ $(x^2 - 5 - 4)(x^2 - 5 + 4) = 0$ $(x^2 - 9)(x^2 - 1) = 0$ $(x - 3)(x + 3)(x - 1)(x + 1) = 0$ $x = 3 \quad \text{or} \quad x = -3 \quad \text{or} \quad x = 1 \quad \text{or} \quad x = -1$	<p>✓ substitution</p> <p>✓ simplification</p> <p>✓ factors</p> <p>✓ answer</p> <p>(4)</p> <p>✓ substitution</p> <p>✓ simplification</p> <p>✓ factors</p> <p>✓ answer</p> <p>(4)</p> <p>[15]</p>
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**QUESTION 7**

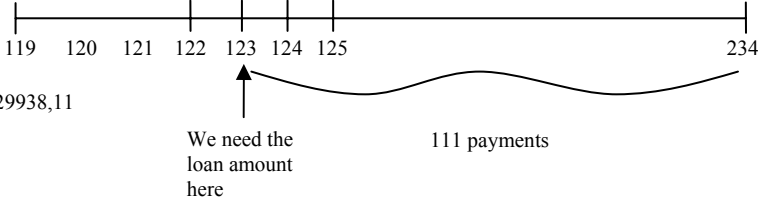
7.1	<p>Decreasing function Since <math>0 &lt; a &lt; 1</math>      OR      As <math>x</math> increases, <math>f(x)</math> decreases</p>	<p>✓ decreasing</p> <p>✓ <math>a &lt; 1</math></p> <p>(2)</p>
7.2	<p><math>f^{-1} : x = \left(\frac{1}{3}\right)^y</math>      OR      </p> <p><math>y = \log_{\frac{1}{3}} x</math></p> <p>OR</p> <p><math>f^{-1} : x = \left(\frac{1}{3}\right)^y</math></p> <p><math>y = -\log_3 x</math></p>	<p>✓ <math>x = \left(\frac{1}{3}\right)^y</math></p> <p>✓ <math>y = \log_{\frac{1}{3}} x</math> or</p> <p><math>y = -\log_3 x</math></p> <p>(2)</p>
7.3	$y = -5$	<p>✓ answer</p> <p>(1)</p>

7.4	<p>Reflection about <math>y = x</math>. Reflection about the <math>x</math>-axis.</p> <p><b>OR</b></p> <p>Reflection about the <math>y</math>-axis. Then reflection about the line <math>y = x</math>.</p> <p><b>OR</b></p> <p>Reflection about the line <math>y = -x</math> followed by reflection about the <math>y</math>-axis.</p> <p><b>OR</b></p> <p>Rotation through <math>90^\circ</math> in a clockwise direction.</p> <p><b>OR</b></p> <p>Rotation through <math>90^\circ</math> in an anti-clockwise direction. Reflection through the origin.</p>	<p>✓ reflection about <math>y = x</math> ✓ reflection about <math>y</math>-axis (2)</p> <p>✓ reflection about <math>y</math>-axis ✓ reflection about <math>y = x</math> (2)</p> <p>✓ rotation through <math>90^\circ</math> ✓ clockwise direction (2)</p> <p>✓ answer ✓ answer (2) <b>[7]</b></p>
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**QUESTION 8**

8.1	<p><math>A = P(1 + i)^n</math></p> <p><math>1711,41 = 1430,77 \left(1 + \frac{i}{12}\right)^{18}</math></p> <p><math>\left(1 + \frac{i}{12}\right)^{18} = 1,196146131... \quad \mathbf{OR} \quad \left[\frac{1711,41}{1430,77}\right]^{\frac{1}{18}} = 1,00999...</math></p> <p><math>1 + \frac{i}{12} = 1,009999937... \quad \therefore i = 12(1,01 - 1) = 0,12 = 12\%</math></p> <p><math>i = 0,1199992431... = 12\%</math></p> <p>Rate = 12, 00% p.a. compounded monthly.</p>	<p>✓ substitution</p> <p>✓ <math>\left(1 + \frac{i}{12}\right)^{18} = 1,196146131...</math></p> <p>✓ <math>1 + \frac{i}{12} = 1,009999937...</math></p> <p>✓ answer (4)</p>
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<p>8.2.1</p> $P_v = \frac{x[1 - (1 + i)^{-n}]}{i}$ $800000 = \frac{10000 \left[ 1 - \left( 1 + \frac{0,14}{12} \right)^{-n} \right]}{\frac{0,14}{12}}$ $1 - \left( 1 + \frac{0,14}{12} \right)^{-n} = \frac{14}{15} \quad (= 0,933333)$ $\left( 1 + \frac{0,14}{12} \right)^{-n} = \frac{1}{15} \quad (= 0,06666666)$ $\log \left( 1 + \frac{0,14}{12} \right)^{-n} = \log \frac{1}{15}$ $-n \log \left( 1 + \frac{0,14}{12} \right) = \log \frac{1}{15} \quad \left( \begin{array}{l} -n = \frac{\log \frac{1}{15}}{\log \left( 1 + \frac{0,14}{12} \right)} \\ = -233,47 \end{array} \right)$ <p><math>n = 233,47</math> ∴ the loan will be paid off at the end of the 234<sup>th</sup> month</p> <p><b>OR</b></p> <p>Balance outstanding after 233<sup>rd</sup> month</p> $= 800000 \left( 1 + \frac{0,14}{12} \right)^{233} - \frac{10000 \left[ \left( 1 + \frac{0,14}{12} \right)^{233} - 1 \right]}{\frac{0,14}{12}}$ <p>= R4 660,04 which is less than R10 000 Therefore the loan will be paid off after 234 months.</p> <p><b>OR</b></p> <p>Total value of the loan after 234 payments</p> $= \frac{10000 \left( 1 - \left( 1 + \frac{0,14}{12} \right)^{-234} \right)}{\frac{0,14}{12}}$ <p>= R800 350,21 &gt; R800 000 and the differences is less than R10 000 Therefore the loan will be paid off after 234 months.</p>	<p>✓ substitute into P<sub>v</sub> ✓ <math>i = \frac{0,14}{12}</math></p> <p>✓ using logs</p> <p>✓ answer (4)</p> <p>✓ substitution into P formula ✓ 234 ✓ answer ✓ argument (4)</p> <p>✓ substitution into F formula ✓ 234 ✓ answer ✓ argument (4)</p>
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<p>8.2.2</p> <p>Balance Outstanding after 119 months</p> $= 800000 \left(1 + \frac{0,14}{12}\right)^{119} - \frac{10000 \left[ \left(1 + \frac{0,14}{12}\right)^{119} - 1 \right]}{\frac{0,14}{12}}$ <p>= R629 938,11</p>  <p>R629938,11</p> <p>Total Payable at the end of the 123<sup>rd</sup> month</p> $= 629\,938,11 \left(1 + \frac{0,14}{12}\right)^4$ <p>= R659 853,68</p> <p>New instalment:</p> $659\,853,68 = \frac{x \left[ 1 - \left(1 + \frac{0,14}{12}\right)^{-111} \right]}{\frac{0,14}{12}}$ <p><math>x = R10\,632,39</math></p>	<p>✓ <math>800000 \left(1 + \frac{0,14}{12}\right)^{119}</math></p> <p>✓ <math>\frac{10000 \left[ \left(1 + \frac{0,14}{12}\right)^{119} - 1 \right]}{\frac{0,14}{12}}</math></p> <p>✓ R629 938,11</p> <p>✓ <math>629938,11 \left(1 + \frac{0,14}{12}\right)^4</math></p> <p>✓ R659 853,68</p> <p>✓ substitution into <math>P_v</math></p> <p>✓ answer</p> <p style="text-align: right;">(7) <b>[15]</b></p>
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## QUESTION 9

9.1	$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$ $= \lim_{h \rightarrow 0} \frac{1 - 3(x+h)^2 - (1 - 3x^2)}{h}$ $= \lim_{h \rightarrow 0} \frac{1 - 3x^2 - 6xh - 3h^2 - 1 + 3x^2}{h}$ $= \lim_{h \rightarrow 0} \frac{-6xh - 3h^2}{h}$ $= \lim_{h \rightarrow 0} \frac{h(-6x - 3h)}{h}$ $= \lim_{h \rightarrow 0} (-6x - 3h)$ $= -6x$	<p>✓ substitution into formula</p> <p>✓ <math>1 - 3x^2 - 6xh - 3h^2</math></p> <p>✓ <math>h(-6x - 3h)</math></p> <p>✓ answer</p> <p>(4)</p>
9.2	$D_x \left[ 4 - \frac{4}{x^3} - \frac{1}{x^4} \right]$ $= D_x \left[ 4 - 4x^{-3} - x^{-4} \right]$ $= 12x^{-4} + 4x^{-5}$	<p>✓ simplification</p> <p>✓✓ answer</p> <p>(3)</p>
9.3	$y = (1 + \sqrt{x})^2$ $y = 1 + 2\sqrt{x} + x$ $y = 1 + 2x^{\frac{1}{2}} + x$ $\frac{dy}{dx} = x^{-\frac{1}{2}} + 1$	<p>✓ expansion</p> <p>✓ <math>x^{-\frac{1}{2}}</math></p> <p>✓ 1</p> <p>(3)</p> <p><b>[10]</b></p>

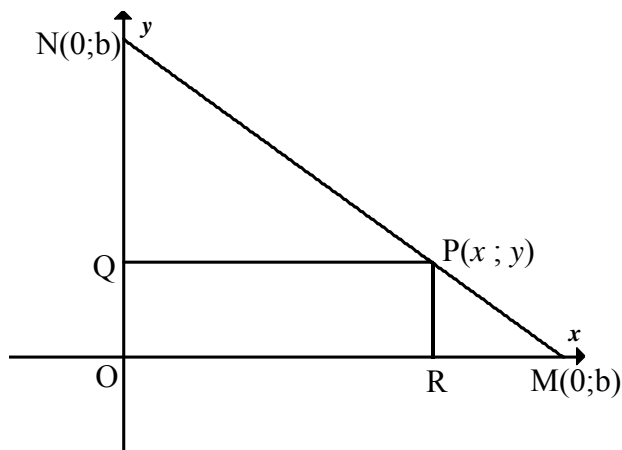
**QUESTION 10**

<p>10.1</p>	<p><math>(-6)(-3)(+2) = 36</math></p> <p>y-intercept is 36</p> <p><b>OR</b></p> <p><math>g(x) = (x-6)(x^2 - x - 6)</math>  <math>g(x) = x^3 - 7x^2 + 36</math>  y-intercept : (0;36)</p>	<p>✓ <math>(-6)(-3)(+2)</math></p> <p>✓ y-intercept is 36 (1)</p> <p>✓ trinomial</p> <p>✓ 36 (1)</p>
<p>10.2</p>	<p><math>g(x) = 0</math>  <math>x = 6</math> or <math>x = 3</math> or <math>x = -2</math>  intercepts are (6 ; 0) and (3 ; 0) and (-2 ; 0)</p>	<p>✓ <math>g(x) = 0</math></p> <p>✓ all x-intercepts (2)</p>
<p>10.3</p>	<p><math>g(x) = (x-6)(x^2 - x - 6)</math>  <math>= x^3 - 7x^2 + 36</math>  <math>g'(x) = 3x^2 - 14x</math>  <math>0 = x(3x - 14)</math>  <math>x = 0</math> or <math>x = \frac{14}{3}</math></p> <p>Turning points are (0 ; 36) and <math>(\frac{14}{3} ; -\frac{400}{27})</math></p>	<p>✓ <math>x^3 - 7x + 36</math></p> <p>✓ <math>g'(x) = 3x^2 - 14x</math></p> <p>✓ <math>g'(x) = 0</math></p> <p>✓ answers</p> <p>✓✓ points (6)</p>
<p>10.4</p>		<p>✓ x-intercepts</p> <p>✓✓ turning points</p> <p>✓ shape (4)</p>



10.5	$g(x).g'(x < 0$  $x < -2$ or $0 < x < 3$ or $\frac{14}{3} < x < 6$	1 mark for each inequality  (3) <b>[16]</b>
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**QUESTION 11**



11.1	$m = -\frac{b}{a}$  $y - b = \frac{-b}{a}(x - 0)$ $y = \frac{-b}{a}x + b$  OR $y = mx + b$ $0 = ma + b$ $m = \frac{-b}{a}$ $y = -\frac{b}{a}x + b$  OR $\frac{x}{a} + \frac{y}{b} = 1$	✓ $m = -\frac{b}{a}$  ✓ answer  (2)
11.2	$A = xy$ $A = x\left(\frac{-bx}{a} + b\right)$ $= -\frac{b}{a}x^2 + bx$ $\frac{dA}{dx} = -\frac{2b}{a}x + b$ $0 = -\frac{2b}{a}x + b$ $-ba = -2bx$ $x = \frac{a}{2}$ $y = -\frac{b}{a}\left(\frac{a}{2}\right) + b$ $= \frac{b}{2}$ $P\left(\frac{a}{2}; \frac{b}{2}\right)$ which is the midpoint of MN  <b>OR</b>	✓ area formula ✓ substitution  ✓ $\frac{dA}{dx} = -\frac{2b}{a}x + b$ ✓ $\frac{dA}{dx} = 0$  ✓ x-value  ✓ y-value  (6)

	$\frac{x}{a} + \frac{y}{b} = 1$ $\frac{y}{b} = 1 - \frac{x}{a}$ <p>To maximise <math>xy</math>, we maximise</p> $\frac{xy}{ab} = \frac{x}{a} \left( \frac{y}{b} \right) = \frac{x}{a} \left( 1 - \frac{x}{a} \right)$ <p>This is a maximum when <math>\frac{x}{a} = \frac{1}{2}</math> i.e. <math>x = \frac{a}{2}</math></p> <p>By the midpoint theorem, P is then the midpoint of MN.</p>	<p>(6) [8]</p>
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**QUESTION 12**

12.1	$x \geq 1$ $y \leq 12$ $x + y \geq 10$ $x + y \leq 15$ $y \geq 2x$ $x, y \in N_0$	<ul style="list-style-type: none"> <li>✓ <math>x \geq 1</math></li> <li>✓ <math>y \leq 12</math></li> <li>✓ <math>x + y \geq 10</math></li> <li>✓ <math>x + y \leq 15</math></li> <li>✓✓ <math>y \geq 2x</math></li> </ul> <p>(6)</p>
12.2		<ul style="list-style-type: none"> <li>✓ <math>x \geq 1</math> ;</li> <li>✓ <math>y \leq 12</math></li> <li>✓ <math>x + y \leq 15</math></li> <li>✓ <math>x + y \geq 10</math></li> <li>✓ <math>y \geq 2x</math></li> <li>✓✓ feasible region</li> </ul> <p>(7)</p>
12.3	<p>No. The point (5 ; 8) lies outside the feasible region</p> <p style="text-align: center;"><b>OR</b></p> <p>8 is not greater than <math>2(5) = 10</math></p>	<ul style="list-style-type: none"> <li>✓ No</li> <li>✓ Reason</li> </ul> <p>(2)</p>

12.4	<p><math>I = 600x + 900y</math></p> $y = -\frac{2}{3}x + \frac{I}{900}$ <p>Maximum Income at(3 ; 12)                  3 single bedrooms and 12 double bedrooms</p> <p style="text-align: center;"><b>OR</b></p> <p>To optimise profit, the group must build as many rooms as possible and then, as many double rooms as possible. So 15 rooms, 12 double rooms, hence 3 single rooms.</p>	<p>✓ objective function</p> <p>✓ search line</p> <p>✓ answer</p> <p style="text-align: right;">(3)  <b>[18]</b></p>
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**TOTAL: 150**

