education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MATHEMATICS P1

NOVEMBER 2009(1)

MEMORANDUM

Marks: 150

This memorandum consists of 25 pages.

- Consistent Accuracy will apply as a general rule.
- If a candidate does a question twice and does not delete either, mark the FIRST attempt.
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QUESTION 1

1.1.1

$x(x-1)=30$

$x^2-x=30$

$x^2-x-30=0$

$(x-6)(x+5)=0$

$x=6 \text{ or } x=-5$

If implied as equation : No penalty

If there is no equals sign or the equation is not = 0: No penalty

If x = 6 is answer by inspection : 1 / 3

Both correct answers no calculation : 1 / 3

✓ simplification (multiplying out brackets)

✓ factors

✓ both answers

(3)

OR

$x(x-1)=30$

$x^2-x=30$

$x^2-x-30=0$

$$x=\frac{-(-1)\pm\sqrt{(-1)^2-4(1)(-30)}}{2(1)}$$

$$=\frac{1\pm\sqrt{121}}{2}$$

$$=\frac{1\pm 11}{2}$$

$x=6 \text{ or } x=-5$

✓ simplification (multiplying out brackets)

✓ substitution into formula

✓ both answers *(ca)*

(3)

1.1.2

$3x^2-5x+1=0$

$a=3 \quad b=-5 \quad c=1$

$$x=\frac{-(-5)\pm\sqrt{25-4(3)(1)}}{2(3)}$$

$$=\frac{5\pm\sqrt{13}}{6}$$

$x=1{,}4 \quad \text{or} \quad x=0{,}2$

OR

NOTE:
Penalty 1 for incorrect rounding off in either answer

Using calculator incorrectly: Max: 2 / 4
Answers will be x = 5,6 or 4,4

Incorrect formula: max 1 / 4

If $x=\frac{5\pm\sqrt{37}}{6}$ then CA applies
x = 1,8 and – 0,2 : Max 3 / 4

Correct answer only: 2 / 4

If factorising: 0 / 4

If $x=\frac{5\pm\sqrt{13}}{6}$ only, then 2 / 4

If $x=5\pm\frac{\sqrt{13}}{6}$ only, then 1 / 4

✓ substitution into correct formula

✓ $\sqrt{13}$

✓✓ values of x
(CA with formula)

(4)

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1.1.2 contd

$3x^2 - 5x + 1 = 0$

$x^2 - \frac{5}{3}x = -\frac{1}{3}$

$x^2 - \frac{5}{3}x + \frac{25}{36} = -\frac{1}{3} + \frac{25}{36}$

$\left(x - \frac{5}{6}\right)^2 = \frac{13}{36}$

$x - \frac{5}{6} = \frac{\pm\sqrt{13}}{6}$

$x = \frac{5 \pm \sqrt{13}}{6}$

$x = 1{,}4 \quad \text{or} \quad x = 0{,}2$

✓ correct method of completing the square

✓ $\sqrt{13}$

✓✓ values of x
(CA with formula)

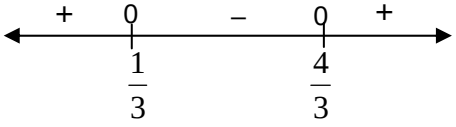
(4)

1.1.3

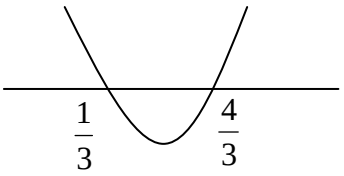
$-9x^2 + 15x - 4 < 0$

$9x^2 - 15x + 4 > 0$

$(3x - 4)(3x - 1) > 0$



OR



$x < \frac{1}{3}$ or $x > \frac{4}{3}$

Answer can be given as: $x \in \left(-\infty ; \frac{1}{3}\right) \cup \left(\frac{4}{3} ; \infty\right)$

✓ factors
✓ correct inequality sign

✓ $\frac{1}{3}$; $\frac{4}{3}$
✓ answer

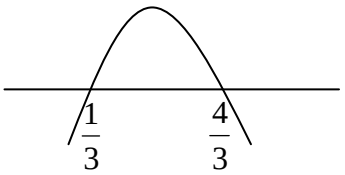
(4)

OR

$-9x^2 + 15x - 4 < 0$

$(-3x + 4)(3x - 1) < 0$

$x < \frac{1}{3}$ or $x > \frac{4}{3}$



✓ factors
✓ correct inequality sign

✓ $\frac{1}{3}$; $\frac{4}{3}$
✓ answer

(4)

NOTE:

If stop at factorisation: 2 / 4

If incorrect factors: CA applies 3 / 4

If answer : $\frac{1}{3} < x < \frac{4}{3}$ then 3 / 4

If $x < \frac{1}{3}$ AND $x > \frac{4}{3}$ then 3 / 4

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1.2	Substitute $x = y + 3$ in $x^2 - xy - 2y^2 - 7 = 0$ $(y+3)^2 - y(y+3) - 2y^2 - 7 = 0$ $y^2 + 6y + 9 - y^2 - 3y - 2y^2 - 7 = 0$ $2y^2 - 3y - 2 = 0$ $(2y+1)(y-2) = 0$ $y = -\frac{1}{2}$ or $y = 2$ $x = 2\frac{1}{2}$ or $x = 5$ **OR** $y = x - 3$ $x^2 - x(x-3) - 2(x-3)^2 - 7 = 0$ $x^2 - x^2 + 3x - 2(x^2 - 6x + 9) - 7 = 0$ $0 = 2x^2 - 15x + 25$ $0 = (2x-5)(x-5)$ $x = 2\frac{1}{2}$ or $x = 5$ $y = -\frac{1}{2}$ or $y = 2$ **NOTE:** If the equation is changed to a linear equation, then max 2 / 5 There are no penalties for not putting = 0.	✓ substitution ✓ standard form ✓ factors ✓ both y-values ✓ both x-values (5) ✓ substitution ✓ standard form ✓ factors ✓ both x-values ✓ both y-values (5)
1.3	$\frac{10^{\frac{2009}{2}}}{10^{\frac{2011}{2}} - 10^{\frac{2007}{2}}}$ $= \frac{10^{\frac{2009}{2}}}{10^{\frac{2007}{2}}(100-1)}$ $= \frac{10}{99}$ **OR**	✓ convert to indices ✓ common factor ✓ answer (3)

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1.3 contd	$\dfrac{10^{1004}\sqrt{10}}{10^{1005}\sqrt{10}-10^{1003}\sqrt{10}}$	✓ convert to indices
	$=\dfrac{10^{1004}\sqrt{10}}{\sqrt{10}(10^{1005}-10^{1003})}$	✓ common factor
	$=\dfrac{10^{1004}}{10^{1003}(100-1)}$	✓ answer
	$=\dfrac{10}{99}$	(3)
	OR	
	$\dfrac{\sqrt{10^{2009}}}{\sqrt{10^{2009}.10^{2}}-\sqrt{10^{2009}.10^{-2}}}$	✓ convert to indices
	$=\dfrac{\sqrt{10^{2009}}}{\sqrt{10^{2009}}(10-10^{-1})}$	✓ common factor
	$=\dfrac{1}{10-\dfrac{1}{10}}$	✓ answer
	$=\dfrac{1}{\dfrac{99}{10}}$	(3)
	$=\dfrac{10}{99}$	
	OR	
	$\dfrac{\sqrt{10^{2000}}\sqrt{10^{9}}}{\sqrt{10^{2000}.10^{11}}-\sqrt{10^{2000}.10^{7}}}$	✓ convert to indices
	$=\dfrac{\sqrt{10^{2000}}\sqrt{10^{9}}}{\sqrt{10^{2000}}\left(\sqrt{10^{11}}-\sqrt{10^{7}}\right)}$	✓ common factor
	$=\dfrac{\sqrt{10^{9}}}{\sqrt{10^{11}}-\sqrt{10^{7}}}$	✓ answer
	$=\dfrac{10\sqrt{10^{7}}}{100\sqrt{10^{7}}-\sqrt{10^{7}}}$	(3)
	$=\dfrac{10\sqrt{10^{7}}}{\sqrt{10^{7}}(100-1)}$	
	$=\dfrac{10}{99}$	
	OR	

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	$\frac{\sqrt{10^{2007}}.\sqrt{10^2}}{\sqrt{10^{2007}.10^4}-\sqrt{10^{2007}}}$ $=\frac{10\sqrt{10^{2007}}}{\sqrt{10^{2007}}(\sqrt{10^4}-1)}$ $=\frac{10}{100-1}$ $=\frac{10}{99}$ **OR** Let $x = 2009$ $\frac{\sqrt{10^x}}{\sqrt{10^{x+2}}-\sqrt{10^{x-2}}}$ $=\frac{10^{\frac{x}{2}}}{10^{\frac{x}{2}}.10-10^{\frac{x}{2}}.10^{-1}}$ $=\frac{10^{\frac{x}{2}}}{10^{\frac{x}{2}}\left(10-10^{-1}\right)}$ $=\frac{1}{10-\frac{1}{10}}$ $=\frac{1}{\frac{99}{10}}$ $=\frac{10}{99}$	✓ convert to indices ✓ common factor ✓ answer (3) ✓ convert to indices ✓ common factor ✓ answer (3)
1.4	$\left(1+\sqrt{2x^2}\right)^2-\sqrt{8x^2}$ $=1+2\sqrt{2x^2}+2x^2-\sqrt{4}.\sqrt{2x^2}$ $=1+2\sqrt{2x^2}+2x^2-2\sqrt{2x^2}$ $=1+2x^2$ **OR** $\left(1+\sqrt{2x^2}\right)^2-\sqrt{8x^2}$ $=1+\sqrt{8x^2}+2x^2-\sqrt{8x^2}$ $=1+2\sqrt{2x^2}+2x^2-2\sqrt{2x^2}$ $=1+2x^2$	✓ expansion / multiplication $1+2\sqrt{2x^2}+2x^2$ ✓ $\sqrt{8x^2}=2\sqrt{2x^2}$ ✓ answer (3) ✓ expansion / multiplication $1+\sqrt{8x^2}+2x^2$ ✓ $\sqrt{8x^2}=2\sqrt{2x^2}$ ✓ answer (3)

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1.4 contd	**OR** $\left(1+\sqrt{2x^2}\right)^2-\sqrt{8x^2}$ $=1+2\sqrt{2}x+2x^2-2\sqrt{2}x \quad \text{or} \quad =1-2\sqrt{2}x+2x^2+2\sqrt{2}x$ $=1+2x^2$ **Note**: $\sqrt{x^2}=x$ if $x>0$ and $-x$ if $x<0$	✓expansion / multiplication ✓simplification ✓ answer (3)
	OR $\left(1+\sqrt{2x^2}\right)^2-\sqrt{8x^2}$ $=\left(1+(2x^2)^{\frac{1}{2}}\right)^2-8^{\frac{1}{2}}x$ $=1+2.(2x^2)^{\frac{1}{2}}+2x^2-8^{\frac{1}{2}}x$ $=1+2.2^{\frac{1}{2}}x+2x^2-8^{\frac{1}{2}}x$ $=1+8^{\frac{1}{2}}x+2x^2-8^{\frac{1}{2}}x$ $=1+2x^2$ **Note:** $\sqrt{x^2}=x$ if $x>0$ and $-x$ if $x<0$	✓expansion / multiplication $1+2.(2x^2)^{\frac{1}{2}}+2x^2$ ✓simplification ✓ answer (3)
	OR Let $2x^2=y$ $\left(1+\sqrt{2x^2}\right)^2-\sqrt{8x^2}$ $=(1+\sqrt{y})^2-\sqrt{4y}$ $=1+2\sqrt{y}+y-2\sqrt{y}$ $=1+y$ $=1+2x^2$	**[22]**

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QUESTION 2

2.1.1

$T_n = 4n+1$

OR

$T_n = 5+(n-1)(4)$
$= 4n+1$

NOTE:
If $T_n = 5+(n-1)(4)$ then full marks

✓✓✓ Answer only (3)

✓ $d = 4$
✓ substitution
✓ answer (3)

2.1.2

$T_n = 5(25)^{n-1}$

✓ $r = 25$
✓ answer (2)

2.2

The sequence is 1 ; 1 + d ; 1 + 2d ; 1 + 3d; …. (AP)
and 1 ; r ; r^2 ; r^3 ; …. (GP)

$\therefore 1+d = r$ and $d = r-1$
But $1+2d = r^2$

$1+2(r-1) = r^2$
$r^2 - 2r + 1 = 0$
$(r-1)^2 = 0$
$r = 1$

OR

$r^2 = 1+2d$
$(1+d)^2 = 1+2d$
$1+2d+d^2 = 1+2d$
$d^2 = 0$
$d = 0$
$r = 1$

$\therefore d = 0$
$\therefore$ the one and only such sequence is 1 ; 1; 1 ; …..
Nomsa is correct.

✓ $1+d = r$
✓ $1+2d = r^2$
✓ $r = 1$
✓ $d = 0$
✓reason (5)

OR

$T_1 = 1$
Let the sequence be 1 ; a ; b ; ...

Geometric: $r = \frac{a}{1} = \frac{b}{a}$
$a^2 = b$

Arithmetic: $d = a-1 = b-a$
$2a-1 = b$
$2a-1 = a^2$
$0 = a^2 - 2a + 1$
$0 = (a-1)^2$
$a = 1$
$b = 1$

Sequence is 1 ; 1 ; 1 ; ...
Nomsa is correct

If:
Sequence is 1 ; 1 ; 1 ; 1 ; 1 ; 1 ; ...
Then $d = 0$
$r = 1$
Therefore only one sequence exists.
Nomsa is correct
Max 3 / 5

If the candidate only gives
Sequence is 1 ; 1 ; 1 ; 1 ; 1 ; 1 ; ...
then 2 / 5

If $ar^{n-1} = a + (n-1)d$ only
then 1 / 5

✓ Setting up sequence
✓ $a^2 = b$
✓ $b = 2a - 1$
✓ $a = 1$
✓$b = 1$ (5)

[10]

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QUESTION 3

3.1	$-1 + 2 + 5 + ...$ **OR** $-1\ ;\ 2\ ;\ 5$	✓ all three terms (1)
3.2	$S_n = -1 + 2 + 5 + 8 + ...\text{to } 100 \text{ terms}$ $S_n = \frac{n}{2}[2a + (n-1)d]$ $S_{100} = \frac{100}{2}[2(-1) + (100-1)(3)]$ $= 50[-2 + 297]$ $= 14\,750$ **OR** $S_n = -1 + 2 + 5 + 8 + ...\text{to } 100 \text{ terms}$ $T_{100} = 3(100) - 4$ $= 296$ $S_n = \frac{n}{2}[T_1 + T_{100}]$ $S_{100} = \frac{100}{2}[-1 + 296]$ $= 50[295]$ $= 14\,750$ **NOTE**: If $S_n = -1 + 2 + 5 + 8 + ...\text{to } 99 \text{ terms}$ $S_n = \frac{n}{2}[2a + (n-1)d]$ $S_{99} = \frac{99}{2}[2(-1) + (99-1)(3)]$ $= \frac{99}{2}[-2 + 294]$ $= 14454$ **Then 3 / 4** Answer only: 4 / 4 Apply consistent accuracy. This is the answer if series is $2 + 5 + 8 +$ $S_n = 2 + 5 + 8 + ...\text{to } 100 \text{ terms}$ $S_n = \frac{n}{2}[2a + (n-1)d]$ $S_{100} = \frac{100}{2}[2(2) + (100-1)(3)]$ $= 50[4 + 297]$ $= 15050$ **Then 4 / 4**	✓ formula ✓ $n = 100$ ✓ substitution ✓ answer (4) **[5]**

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QUESTION 4

4.1	The first differences are 1; – 1; – 3; – 5; …. These form a linear pattern $T_n = 1 + (n-1)(-2)$ $= 3 - 2n$ **OR** $T_n = -2n + 3$ **ANSWER ONLY:** Full marks	✓ pattern ✓ $d = -2$ ✓ answer (3)
4.2	Between the 35th and 36th terms of the quadratic sequence lies the 35th first difference 35th first difference = 3 – 2(35) = – 67 **OR** From the quadratic sequence: $P_{36} = -1158$ and $P_{35} = -1091$ 35th first difference = – 1158 – (– 1091) = – 67 If substitute and get $T_{35} = -2(35) + 3 = -67$ and $T_{36} = -2(36) + 3 = -69$, leading to the answer – 2 then **1 / 2**	✓ substitution of 35 into $T_n = -2n + 3$ ✓ answer (2) ✓ $P_{36} = -1158$ and $P_{35} = -1091$ ✓ answer (2)
4.3	Second difference of terms is – 2 . $P_n = an^2 + bn + c$ $a = -1$. $3a + b = 1$ $-3 + b = 1$ $b = 4$ $a + b + c = -3$ $-1 + 4 + c = -3$ $c = -6$ $P_n = -n^2 + 4n - 6$ **OR** If the general term has been worked out correctly in 4.2 and not redone in 4.3 but answer just written down then **4 / 4**	✓ $a = -1$ ✓ substitution ✓ $b = 4$ ✓ $c = -6$ (4)

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4.3 contd	Second difference of terms is -2 . $P_n = an^2 + bn + c$ $a = -1$. $P_0 = -6 = c$ $P_n = -n^2 + bn - 6$ $-3 = -(1)^2 + (1)b - 6$ $b = 4$ $P_n = -n^2 + 4n - 6$ **OR** $P_n = \frac{n-1}{2}\left[2(\textit{first first difference}) + (n-2)(\textit{second difference})\right] + P_1$ $P_n = \frac{n-1}{2}[2(1) + (n-2)(-2)] - 3$ $P_n = n - 1 - (n-2)(n-1) - 3$ $P_n = n - 1 - n^2 + 3n - 2 - 3$ $P_n = -n^2 + 4n - 6$ **OR** $P_n = (n-1)P_2 - (n-2)P_1 + 2\textit{nd difference}\frac{(n-1)(n-2)}{2}$ $P_n = (n-1)(-2) - (n-2)(-3) - 2\frac{(n-1)(n-2)}{2}$ $P_n = -2n + 2 + 3n - 6 - n^2 + 3n - 2$ $P_n = -n^2 + 4n - 6$ **OR** $P_n = \frac{(n-2)(n-3)T_1 - 2(n-1)(n-3)T_2 + (n-2)(n-1)T_3}{2}$ $P_n = \frac{(n^2 - 5n + 6)(-3) - 2(n^2 - 4n + 3)(-2) + (n^2 - 3n + 2)(-3)}{2}$ $P_n = \frac{-3n^2 + 15n - 18 + 4n^2 - 16n + 12 - 3n^2 + 9n - 6}{2}$ $P_n = -n^2 + 4n - 6$ **OR**	

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4.3 contd	$P_2 - P_1 = T_1$ $P_3 - P_2 = T_2$ $P_4 - P_3 = T_3$ $P_n - P_{n-1} = T_{n-1}$ $P_n - P_1 = T_1 + T_2 + ... + T_{n-1}$ $P_n - P_1 = \frac{n-1}{2}\left[2(1) + (n-2)(-2)\right]$ $P_n - (-3) = (n-1)(3-n)$ $P_n = -n^2 + 4n - 6$	
4.4	Maximum value of T_n is $\frac{4(-1)(-6) - 4^2}{4(-1)} = -2$ The maximum value is negative and hence the sequence can not have any positive terms as the function is maximum valued **OR** $-n^2 + 4n - 6$ $= -(n-2)^2 + 4 - 6$ $= -(n-2)^2 - 2$ The function has a maximum-value of -2 and therefore the pattern will never have positive values. **OR** $T_n = -n^2 + 4n - 6$ $\frac{d}{dn}(T_n) = -2n + 4$ $0 = -2n + 4$ $n = 2$ $T_2 = -(2)^2 + 4(2) - 6$ $= -2$ The function has a maximum-value of -2 and therefore the pattern will never have positive values. **OR** As the sequence decreases from the second term onwards and the second term is negative, the sequence will never have a positive term. **OR** $T_n = -n^2 + 4n - 6$ $\frac{d}{dn}(T_n) = -2n + 4$ $\frac{d}{dn}(T_n) < 0$ for $n > 2$ and $T_2 < 0$ so the sequence decreases and stays negative	✓ max value – 2 ✓ explanation (2) ✓ max value – 2 ✓ explanation (2) ✓ max value – 2 ✓ explanation (2) ✓✓ answer (2) ✓✓ answer (2) **[11]**

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QUESTION 5

5.1

First year: 150

Second year: 150 + 18 = 168

Third year: $168 + \frac{8}{9}(18) = 184$

Growth = $18\left(\frac{8}{9}\right)^{n-2}$ after n years

17^{th} year growth is $18\left(\frac{8}{9}\right)^{17-2} = 3{,}08$ cm

	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9
Ht	150	168	184	198,2	210,84	222,07	232,06	240,94	248,83
Inc		18	16	14,2	12,64	11,23	9,99	8,88	7,89
	Yr 10	**Yr 11**	**Yr 12**	**Yr 13**	**Yr 14**	**Yr 15**	**Yr 16**	**Yr 17**	
Ht	255,84	262,08	267,62	272,55	276,93	280,82	284,28	287,36	
Inc	7,01	6,24	5,54	4,93	4,38	3,89	3,46	3,08	

✓ general terms

✓ answer (2)

5.2

Height after 10 years

$$= 150 + \frac{18\left(1-\left(\frac{8}{9}\right)^{9}\right)}{1-\frac{8}{9}}$$

= 150 + 105,8768146 …

= 255,88 cm

OR

$$= 150 + \frac{18\left(\left(\frac{8}{9}\right)^{9}-1\right)}{\frac{8}{9}-1}$$

= 150 + 105,8768146 ...

= 255,88 cm

NOTE:
By writing out 9 terms and adding to 150 and answer correct, full marks

Answer only: 2 / 3

✓ $n = 9$
✓ substitution into sum formula
✓ answer (3)

5.3

Max height = 150 + sum to infinity

$$= 150 + \frac{18}{1-\frac{8}{9}}$$

= 150 cm + 162 cm

= 312 cm

The tree will never reach a height of more than 312 cm.

✓ statement
✓ substitution into the sum to infinity formula
✓ max height (3) **[8]**

NOTE:

If a candidate answers in 5.1 that the growth is $18\left(\frac{8}{9}\right)^{n-1} = 18\left(\frac{8}{9}\right)^{16}$ = 2,73 cm then 1 / 2

The answer for 5.2 as continued accuracy uses $n = 10$,
Height after 10 years

$$= 150 + \frac{18\left(1-\left(\frac{8}{9}\right)^{10}\right)}{1-\frac{8}{9}} = 150 + 112{,}11 \ldots = 262{,}11 \text{ cm}$$

This is awarded 3/3 as consistent accuracy

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QUESTION 6

6.1	$\frac{1}{2}x^2 = -\frac{1}{x+1}+1$ $x^2(x+1) = -2+2(x+1)$ $x^3+x^2 = -2+2x+2$ $x^3+x^2-2x = 0$ $x(x^2+x-2) = 0$ $x(x+2)(x-1) = 0$ $x = 0 \quad or \quad x = -2 \quad or \quad x = 1$ $y = 0$ or $y = \frac{1}{2}(-2)^2$ or $y = \frac{1}{2}(1)^2$ $y = 2$ or $y = \frac{1}{2}$ P(– 2 ; 2) $Q\left(1;\frac{1}{2}\right)$ **OR** $\frac{1}{2}(-2)^2 = 2$ ∴ (– 2 ; 2) lies on $f(x) = \frac{1}{2}x^2$ $-\frac{1}{(-2)+1}+1 = 2$ ∴ (– 2 ; 2) lies on $g(x) = -\frac{1}{x+1}+1$ ∴ (– 2 ; 2) is one of the points P, O or Q. From the graph it is P $\frac{1}{2}(1)^2 = \frac{1}{2}$ ∴ (– 2 ; 2) lies on $f(x) = \frac{1}{2}x^2$ ∴ $\left(1;\frac{1}{2}\right)$ is one of the points P, O or Q. From the graph it is Q $-\frac{1}{(1)+1}+1 = \frac{1}{2}$ ∴ Q lies on $g(x) = -\frac{1}{x+1}+1$ ∴ $\left(1;\frac{1}{2}\right)$ is one of the points P, O or Q. From the graph it is Q	✓ equating ✓ multiplication by LCD ✓ standard form ✓ common factor ✓ factorisation of quadratic ✓ *y*-answer answer P(– 2 ; 2) answer $Q\left(1;\frac{1}{2}\right)$ (6) ✓ substitution ✓ substitution ✓ P lies on *f* and *g* ✓ substitution ✓ substitution ✓ Q lies on *f* and *g* (6)
6.2	For $m > 0$, $m = 1$ the equation of the axis of symmetry is $y = x + c$. $1 = (-1) + c$ $c = 2$ Therefore the equation is $y = h(x) = x + 2$.	✓ gradient $m = 1$ ✓ $c = 2$ (2)

- Consistent Accuracy will apply as a general rule.
- If a candidate does a question twice and does not delete either, mark the FIRST attempt.
- If a candidate does a question, crosses it out and does not re-do it, mark the deleted attempt.

6.3	The equation of the inverse of h is $x = y + 2$ $\therefore y = x - 2$ Answer only: Full marks	✓interchange x and y ✓ answer (2)
6.4	$g(x) = -\frac{1}{x+1} + 1 = \frac{-1+x+1}{x+1} = \frac{x}{x+1}$ $LHS = \frac{x}{x+1} + \frac{\frac{1}{x}}{\frac{1}{x}+1}$ $= \frac{x}{x+1} + \frac{1}{x+1}$ $= \frac{x+1}{x+1}$ $= 1$ LHS = RHS $RHS = \left(\frac{-x}{1-x}\right)\left(\frac{x-1}{(x-1)+1}\right)$ $= \frac{(1-x)x}{(1-x)x}$ $= 1$ **NOTE**: If substitute a value of x and prove it, then 0 / 3 **OR** $\text{LHS} = g(x) + g\left(\frac{1}{x}\right)$ $= -\frac{1}{x+1} + 1 - \frac{1}{\frac{1}{x}+1} + 1$ $= -\frac{1}{x+1} + 2 - \frac{x}{1+x}$ $= -\frac{1+x}{1+x} + 2$ $= -1 + 2$ $= 1$ LHS = RHS $\text{RHS} = g(-x).g(x-1)$ $= \left(-\frac{1}{-x+1} + 1\right)\left(-\frac{1}{x-1+1} + 1\right)$ $= \left(\frac{-1+1-x}{1-x}\right)\left(\frac{-1+x}{x}\right)$ $= \left(\frac{-x}{1-x}\right)\left(\frac{x-1}{x}\right)$ $= \left(\frac{x}{x-1}\right)\left(\frac{x-1}{x}\right)$ $= 1$	✓ simplification of $g(x)$ ✓simplification of LHS ✓simplification of RHS (3) ✓ 2 substitutions correct. **NOTE**: not just rewriting $g(x)$ again ✓ simplification of LHS ✓simplification of RHS (3) **[13]**

- Consistent Accuracy will apply as a general rule.
- If a candidate does a question twice and does not delete either, mark the FIRST attempt.
- If a candidate does a question, crosses it out and does not re-do it, mark the deleted attempt.

QUESTION 7

7.1	$y \in [-3\,;3]$ **OR** $-3 \le y \le 3$ **OR** y can be any value from – 3 to 3 **NOTE**: Notation incorrect : 0 / 1	✓ answer (1)
7.2	x–value is 7,37° to the left of 90° B(82,63° ; 0,38) **NOTE**: Answer only : 3 / 3 x-value correct and y-value incorrect : 2 / 3 x-value incorrect and y-value correct : 1 / 3 If decimal part incorrect of x and y-value correct: 2 / 3	✓ method ✓ x-value ✓ y-value (3)
7.3	Period $= \dfrac{360°}{3}$ $= 120°$ **NOTE**: Answer only : 2 / 2	✓ $\dfrac{360°}{3}$ ✓ answer (2)
7.4	$x = -180°$	✓ ✓answer (2) **[8]**

QUESTION 8

8.1	$x > 0$ **OR** $x \in (0;\infty)$	✓ answer (1)
8.2	$y = 2^{-x}$ **OR** $y = \left(\dfrac{1}{2}\right)^x$	✓ answer (1)
8.3	$y = 0$	✓ answer (1)
8.4.1	Reflect the graph of f over the x-axis OR For each point the y-coordinate changes sign. **NOTE**: Reflect only : 0 / 1	✓ answer (1)
8.4.2	Reflect the graph of f over the line $y = x$. Then shift the graph down 5 units	✓✓ answer ✓ answer (3)

- Consistent Accuracy will apply as a general rule.
- If a candidate does a question twice and does not delete either, mark the FIRST attempt.
- If a candidate does a question, crosses it out and does not re-do it, mark the deleted attempt.

8.4.2 contd	**OR** Sketch the graph of the inverse of *f*. Shift the graph of the inverse of *f* down by 5 units. **OR** Shift the graph 5 units LEFT. Reflect the graph over the line $y = x$.	
8.5	$\log_2 x < 3$ $-\log_2 x > -3$ For $-\log_2 x = -3$ $2^3 = x$ $x = 8$ $f(x) > -3$ $0 < x < 8$ or $x \in (0\,;8)$ **NOTE:** Notation incorrect: Answer $x < 8$: 2 / 3 Answer only correct: 3 / 3	✓ multiplication by – 1 ✓ Notation ✓ critical values (3) **[10]**

QUESTION 9

Penalise ONCE in question 9 for early rounding off.

9.1	$A = P(1-i)^n$ $15000 = 24000(1-0{,}18)^n$ $0{,}625 = (0{,}82)^n$ $n = \dfrac{\log 0{,}625}{\log 0{,}82}$ $= 2{,}37$ years **NOTE:** If subs A and P incorrectly: Answer would be $n = -2{,}37$ years $\therefore n = 2{,}37$ years: 2 / 4 If subs A and P incorrectly: Answer would be $n = -2{,}37$ years : 1 / 4 Answer $n = 2{,}4$ years 4 / 4 Answer rounded to 3 years and all calculations shown and $n = 2{,}37$ shown: 4/4 Answer rounded to 3 years and $n = 2{,}37$ not shown: 3 / 4	✓ substitution ✓ simplification ✓application of logs ✓ answer (4) Incorrect formula: 0/4
9.2.1	$130\,000\left(1+\dfrac{0{,}18}{12}\right)^2$ $= 130000\,(1{,}015)^2$ = R 133 929,25 **NOTE:** – 1 per error for incorrect substitution to a max of 2 marks	✓✓ substitution ✓ answer (3) Incorrect formula: 0/3

- Consistent Accuracy will apply as a general rule.
- If a candidate does a question twice and does not delete either, mark the FIRST attempt.
- If a candidate does a question, crosses it out and does not re-do it, mark the deleted attempt.

9.2.2(a)	$133\,929{,}25 = \dfrac{x[1-(1{,}015)^{-54}]}{0{,}015}$ $2008{,}93875 = x[1-(1{,}015)^{-54}]$ $x = \text{R } 3636{,}36$ **OR** $133\,929{,}25\left(1+\dfrac{0{,}18}{12}\right)^{54} = \dfrac{x\left[\left(1+\dfrac{0{,}18}{12}\right)^{54}-1\right]}{\dfrac{0{,}18}{12}}$ $299255{,}2087 = 82{,}29517136...x$ $x = \text{R } 3636{,}36$ **OR** $130000\left(1+\dfrac{0{,}18}{12}\right)^{56} = \dfrac{x\left[\left(1+\dfrac{0{,}18}{12}\right)^{54}-1\right]}{\dfrac{0{,}18}{12}}$ $299255{,}2087 = 82{,}29517136...x$ $x = \text{R } 3636{,}36$	✓ $n = 54$ ✓ substitution of 133 929,25 ✓ answer (3) ✓ $n = 54$ ✓ substitution of 133 929,25 ✓ answer (3) ✓ $n = 54$ ✓ $130000\left(1+\dfrac{0{,}18}{12}\right)^{56}$ ✓ answer (3)
9.2.2(b)	$\text{Total} = 3636{,}36 \times 54$ $= \text{R}196\,363{,}66$ **NOTE:** Accept answer = R 196	✓answer (1)
9.2.3	$130\,000 = \dfrac{x[1-(1{,}015)^{-54}]}{0{,}015}$ $1950 = x[1-(1{,}015)^{-54}]$ $x = \text{R } 3529{,}68$ Total payments = R 3529,68 × 54 = R 190 602,72 **OR**	✓ 130 000 ✓ $i = 0{,}015$ ✓ answer 3529,68 ✓ answer R 190 602,72 (4)

- Consistent Accuracy will apply as a general rule.
- If a candidate does a question twice and does not delete either, mark the FIRST attempt.
- If a candidate does a question, crosses it out and does not re-do it, mark the deleted attempt.

9.2.3 contd	$130\,000\left(1+\frac{0,18}{12}\right)^{54} = \frac{x\left[\left(1+\frac{0,18}{12}\right)^{54}-1\right]}{\frac{0,18}{12}}$ $290475,5842 = 82,29517136...x$ $x = \text{R } 3529,68$ Total payments = R 3529,68 × 54 = R 190 602,72 **OR** $130\,000\left(1+\frac{0,18}{12}\right)^{55} = \frac{x\left(1+\frac{0,18}{12}\right)\left[\left(1+\frac{0,18}{12}\right)^{54}-1\right]}{\frac{0,18}{12}}$ $290475,5842 = 82,29517136...x$ $x = \text{R } 3529,68$ Total payments = R 3529,68 × 54 = R 190 602,72 **NOTE:** Disregard the cents values if they are incorrect.	✓ $130\,000\left(1+\frac{0,18}{12}\right)^{54}$ ✓ $i = 0,015$ ✓ answer 3529,68 ✓ answer R 190 602,72 (4) ✓ $130\,000\left(1+\frac{0,18}{12}\right)^{55}$ ✓ $i = 0,015$ ✓ answer 3529,68 ✓ answer R 190 602,72 (4)
9.2.4	R196 363,66 – R190 602,72 =R5 760,96	✓ answer (1) **[16]**

- Consistent Accuracy will apply as a general rule.
- If a candidate does a question twice and does not delete either, mark the FIRST attempt.
- If a candidate does a question, crosses it out and does not re-do it, mark the deleted attempt.

QUESTION 10

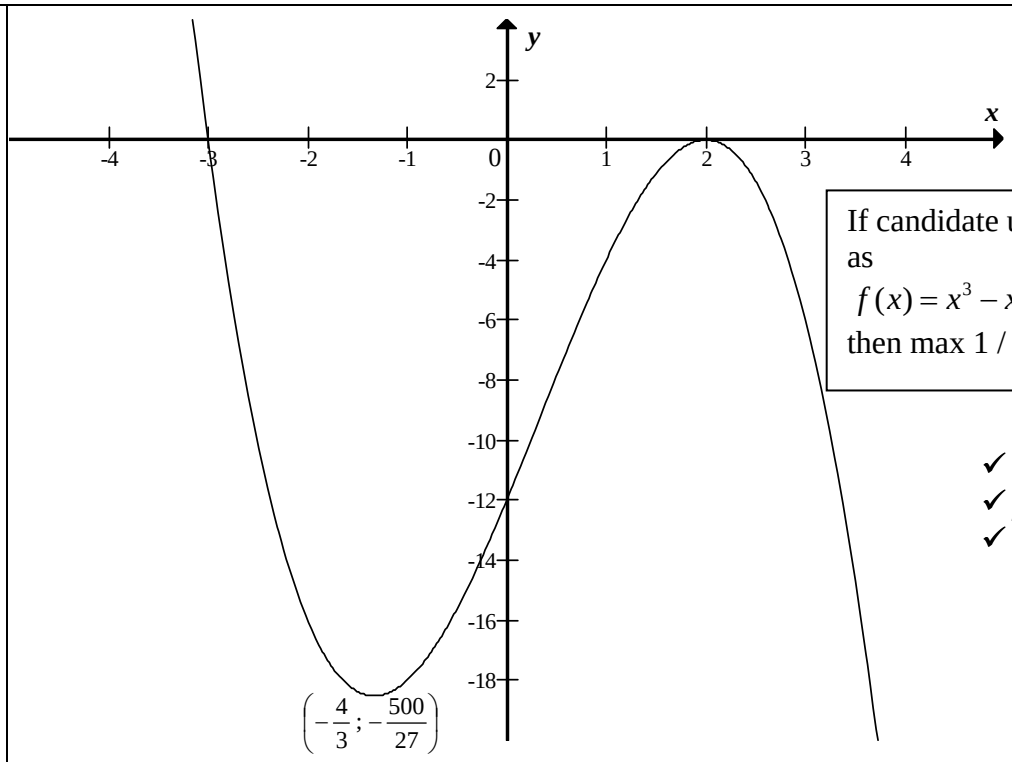
10.1	$f'(x)=\lim\limits_{h\to 0}\dfrac{f(x+h)-f(x)}{h}$ $=\lim\limits_{h\to 0}\dfrac{-2(x+h)^2+3-(-2x^2+3)}{h}$ $=\lim\limits_{h\to 0}\dfrac{-2x^2-4xh-2h^2+3+2x^2-3}{h}$ $=\lim\limits_{h\to 0}\dfrac{h(-4x-2h)}{h}$ $=\lim\limits_{h\to 0}(-4x-2h)$ $=-4x$ **NOTE:** Penalty 1 mark only for incorrect notation (lim missing or = in incorrect place) Answer only : 0 / 5 Cannot give mark for answer if the answer is incorrect according to the working out, even if the answer is given as – 4*x*.	✓ $\lim\limits_{h\to 0}\dfrac{f(x+h)-f(x)}{h}$ ✓ $-2(x+h)^2+3$ ✓ simplification ✓ simplification ✓ answer (5)
10.2	$y=x^2-\dfrac{1}{2x^3}$ $y=x^2-\dfrac{1}{2}x^{-3}$ $\dfrac{dy}{dx}=2x+\dfrac{3}{2}x^{-4}$ **OR** $\dfrac{dy}{dx}=2x+\dfrac{3}{2x^4}$ **OR** $\dfrac{dy}{dx}=2x-(-3)\dfrac{1}{2}x^{-4}$	✓ $2x$ ✓ $+\dfrac{3}{2}x^{-4}$ (2) **[7]**

- Consistent Accuracy will apply as a general rule.
- If a candidate does a question twice and does not delete either, mark the FIRST attempt.
- If a candidate does a question, crosses it out and does not re-do it, mark the deleted attempt.

QUESTION 11

11.1	$0 = -x^3 + x^2 + 8x - 12$ $x^3 - x^2 - 8x + 12 = 0$ $(x-2)(x^2 + x - 6) = 0$ $(x-2)(x-2)(x+3) = 0$ $x = 2$ or $x = -3$ x-intercepts are (2 ; 0) and (– 3 ; 0) **OR** $0 = -x^3 + x^2 + 8x - 12$ $x^3 - x^2 - 8x + 12 = 0$ $(x+3)(x^2 - 4x + 4) = 0$ $(x+3)(x-2)(x-2) = 0$ $x = 2$ or $x = -3$ x-intercepts are (2 ; 0) and (– 3 ; 0)	✓ any one of factors ✓ quadratic factor ✓ linear factors ✓✓ x-answers (5)
11.2	$f'(x) = -3x^2 + 2x + 8$ $0 = 3x^2 - 2x - 8$ $0 = (x-2)(3x+4)$ $x = 2$ or $x = -\frac{4}{3}$ turning points are (2 ; 0) and $\left(-\frac{4}{3} ; -\frac{500}{27}\right)$ OR (2 ; 0) and (– 1,33 ; – 18,52) **NOTE:** If = 0 is omitted in 11.2: penalty 1 mark If not in coordinate form but coordinates implied: OK	✓ $f'(x) = 0$ ✓ $-3x^2 + 2x + 8 = 0$ or $3x^2 - 2x - 8 = 0$ ✓ factors ✓ x-values ✓ y-values (5)

- Consistent Accuracy will apply as a general rule.
- If a candidate does a question twice and does not delete either, mark the FIRST attempt.
- If a candidate does a question, crosses it out and does not re-do it, mark the deleted attempt.

11.3	 If candidate used function as $f(x)=x^3-x^2-8x+12$ then max 1 / 3	✓ shape ✓ *y*-intercept ✓ turning pts (3)
11.4	$f''(x)=0$ or $f''(x)=0$ $6x-2=0$ or $-6x+2=0$ $x=\frac{1}{3}$ $x=\frac{1}{3}$ **OR** $x=\frac{2-\frac{4}{3}}{2}$ $x=\frac{1}{3}$ **Note:** If write down $f''(x)=6x-2$ or $f''(x)=-6x+2$ then 1 / 2	✓ method ✓ answer Answer only: Full marks (2)
11.5	$(2\ ;\ -3)$ and $\left(-\frac{4}{3};-\frac{581}{27}\right)$ **OR** $(2\ ;\ -3)$ and $(-1{,}33;-21{,}52)$	✓✓ each answer (2) **[17]**

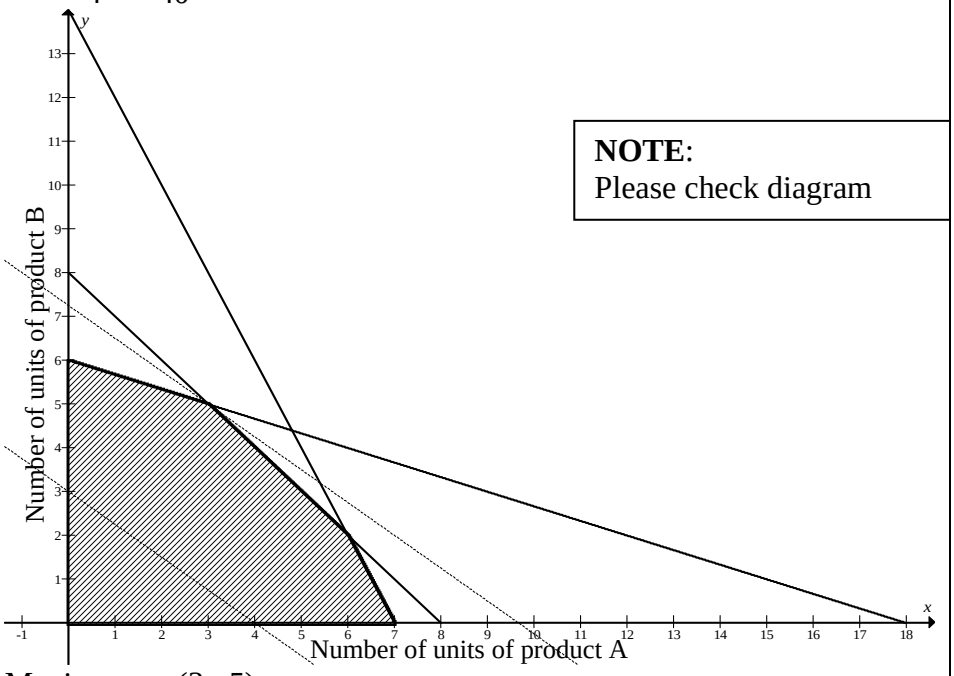
- Consistent Accuracy will apply as a general rule.
- If a candidate does a question twice and does not delete either, mark the FIRST attempt.
- If a candidate does a question, crosses it out and does not re-do it, mark the deleted attempt.

QUESTION 12

12.1	$s(0) = 5(0)^3 - 65(0)^2 + 200(0) + 100$ = 100 metres **NOTE:** If subs $t = 8$, then answer = 100: 0 / 2	✓ $t = 0$ ✓ answer (2) Answer only: full marks
12.2	$s(t) = 5t^3 - 65t^2 + 200t + 100$ $s'(t) = 15t^2 - 130t + 200$ $s'(4) = 15(4)^2 - 130(4) + 200$ = – 80 metres per minute **NOTE:** If used average rate of change between $t = 0$ and $t = 4$: 0 / 3 If subs $t = 4$ into $s(t)$: 0 / 3	✓ $s'(t) = 15t^2 - 130t + 200$ ✓ substitution $t = 4$ ✓ answer (– 80) (3)
12.3	The height of the car above sea level is decreasing at 80 metres per minute and the car is travelling downwards hence it is a negative rate of change. **OR** The **vertical** velocity of the car at $t = 4$ is 80 metres per minute. **NOTE:** Mark this CA even if answer to QUESTION 12.2 is completely inaccurate.	✓ speed 80 metres per minute ✓ downwards (2)
12.4	$s'(t) = 15t^2 - 130t + 200$ $s''(t) = 30t - 130$ $130 = 30t$ $t = 4{,}3\dot{3}$ minutes **OR** $t = \frac{-(-130)}{2(15)}$ $t = 4{,}3\dot{3}$ minutes	✓ $s''(t) = 30t - 130$ ✓ $s''(t) = 0$ ✓ answer (3) **[10]**

- Consistent Accuracy will apply as a general rule.
- If a candidate does a question twice and does not delete either, mark the FIRST attempt.
- If a candidate does a question, crosses it out and does not re-do it, mark the deleted attempt.

QUESTION 13

13.1	$x + 3y \le 18$ $x + y \le 8$ $2x + y \le 14$ $x, y \ge 0$ **OR** $6x + 18y \le 108$ $8x + 8y \le 64$ $14x + 7y \le 98$ $x, y \ge 0$ **OR** $y \le -\frac{1}{3}x + 6$ $y \le -x + 8$ $y \le -2x + 14$ $x, y \ge 0$ **NOTE**: If written as equations (inequality omitted): max 6 / 7 If inequalities sign the wrong way round: max 6 / 7 One should note that x and y should be counting numbers	✓✓ answer ✓✓ answer ✓✓ answer ✓ answer (7)
13.2	P = 30x + 40y **NOTE**: If P = 30A + 40B then 1 / 2	✓✓ answer (2)
13.3	$y = -\frac{3}{4}x + \frac{P}{40}$  Maximum at (3 ; 5) **NOTE**: Please check diagram	✓✓ answer (2) Answer only : Full marks
13.4	$-2 < m < -1$ **NOTE**: accept $1 < m < 2$: 2 / 2. If ≤ signs used then max 1 / 2	✓✓answer (2) **[13]**