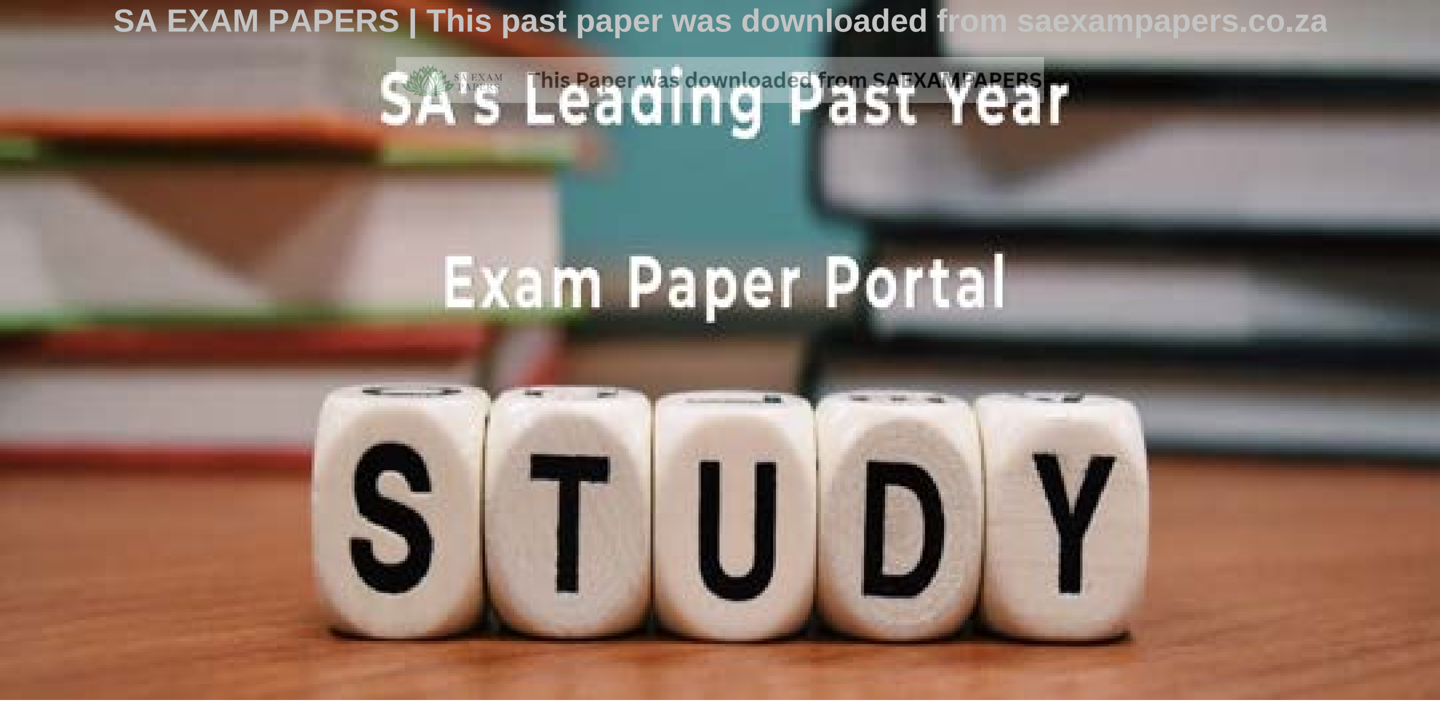
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STUDY

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

JUNE EXAMINATION
GRADE 12

2025

MARKING GUIDELINES

MATHEMATICS

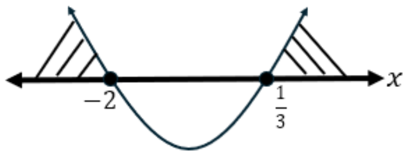
(PAPER 1)

22 pages

GENERAL NOTES

1. Consistent accuracy applies in this marking guideline.
2. If a learner answers the same question twice, but does not cancel one of the answers, **ONLY** consider the first attempt.
3. If a learner cancels the answer but does not make a second attempt, consider the cancelled attempt.
4. If a learner provided an answer not mentioned in this memorandum, first check/prove it before disqualifying their attempt. Please check through all **OPTIONS** provided in this marking guideline.

QUESTION 1			
1.1.1	$x(x+4)=0$ $x=0 \text{ or } x=-4$ ANSWER ONLY $\frac{1}{2}$	✓ factors ✓ both answers values of x	(2)
1.1.2	$2x^2-3x-\frac{1}{2}=0$ $x=\frac{-(-3)\pm\sqrt{(-3)^2-4(2)(-\frac{1}{2})}}{2(2)}$ $x=\frac{3\pm\sqrt{13}}{4}$ $x=1,65$ or $x=-0,15$ OR $4x^2-6x-1=0$ $x=\frac{-(-6)\pm\sqrt{(-6)^2-4(4)(-1)}}{2(4)}$ $x=\frac{6\pm\sqrt{52}}{8}$ $x=1,65$ or $x=-0,15$ ANSWER ONLY $\frac{2}{4}$ Penalize 1 mark for rounding	✓ standard form ✓ substitution ✓ 1,65 ✓ −0,15	(4)

1.1.3	$3x^2 + 5x - 2 \geq 0$ $(3x-1)(x+2) = 0$ Critical Values $x = \frac{1}{3}$ and $x = -2$ $x \leq -2$ *or* $x \geq \frac{1}{3}$ 	✓ standard form ✓ factors ✓ critical values ✓ answers	(4)

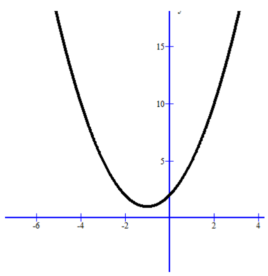
1.1.4	$2^{2x}+2^x-6=0$ Let $k=2^x$ $k^2+k-6=0$ $(k+3)(k-2)=0$ $k\neq-3$ or $k=2$ $2^x=2$ $x=1$ **ANSWER ONLY $\frac{1}{3}$** **OR/OF** $(2^x+3)(2^x-2)=0$ $2^x\neq-3$ or $2^x=2$ $x=1$	✓ factors ✓ rejection ✓ answer **OR/OF** ✓ factors ✓ rejection ✓ answer	(3)
1.1.5	$x^2-2x+3+\frac{2}{x^2-2x}=0$ $k=x^2-2x$ $k+3+\frac{2}{k}=0$ $k(k+3)+2=0$ $k^2+3k+2=0$ $(k+1)(k+2)=0$ $k=-2$ or $k=-1$ $x^2-2x=-1$ $x^2-2x+1=0$ $(x-1)^2=0$ $x=1$ $x^2-2x+2=0$ $\Delta=b^2-4ac$ $=(-2)^2-4(1)(2)$ $\Delta=-4$ (Discriminant <0)	✓ k-method ✓ factors ✓ rejection/discriminant ✓ answer	(4)

1.1.6	$(\sqrt{x+5})^2 = (x-1)^2$ $x + 5 = x^2 - 2x + 1$ $x^2 - 3x - 4 = 0$ $(x-4)(x+1) = 0$ $x \neq -1$ or $x = 4$	✓ squiring both sides ✓standard form ✓ factors ✓ answer/selection	(4)
1.2	$x + 2y = 5$ $\quad And\ 2y^2 - xy - 4x^2 = 8$ From equation 1 $x = 5 - 2y \ldots \ldots (3)$ Substitute (3) into (2) $2y^2 - xy - 4x^2 = 8$ $2y^2 - y(5-2y) - 4(5-2y)^2 - 8 = 0$ $2y^2 - 5y + 2y^2 - 100 + 80y - 16y^2 - 8 = 0$ $-12y^2 + 75y - 108 = 0$ $\frac{-12y^2}{-3} + \frac{75y}{-3}\ \frac{-108}{-3} = 0$ $4y^2 - 25y + 36 = 0$ $(4y-9)(y-4 = 0$ $y = \frac{9}{4}$ or $y = 4$ When $\text{y} = \frac{9}{4}$ $x = 5 - 2y$ $x = 5 - 2(\frac{9}{4})$ $x = \frac{1}{2}$ When $y = 4$ $x = 5 - 2y$ $x = 5 - 2(4)$ $x = -3$	✓ $x = 5 - 2y$ equation 3 ✓ substitution of equation 3 into Equation 2 ✓ standard form ✓ factors ✓ both y-values ✓ Both x-values	(6)

1.3	$6x^2 - 4kx + 6 = 0$ $\Delta = b^2 - 4ac$ $\Delta = (-4k)^2 - (4)(6)(6)$ $= 16k^2 - 144$ $16k^2 - 144 = 0$ $\frac{16k^2}{16} = \frac{144}{16}$ $k^2 = 9$ $k = \pm\sqrt{9}$ $k = \pm 3$ Therefore, the values of k for which the roots are real and equal are as follows: $k = 3$ or $k = -3$	✓ correct use a formula of Δ ✓ simplification ✓ answers (only $k = 3$ this mark is not awarded)	(3)
			[30]

QUESTION 2

2.1.1	16 ; 23	✓ 16 ✓ 23	(2)
2.1.2	$S_n = \frac{n}{2}[2a + (n-1)d]$ $S_n = \frac{n}{2}[2(-5) + (n-1)7]$ $S_n = \frac{n}{2}(-10 + 7n - 7)$ $S_n = \frac{n}{2}(7n - 17)$	✓ substitution for a ✓ substitution for d ✓ simplification	(3)
2.2.1	$x \qquad 3x-5 \qquad 4x-3 \qquad 5x+1$ $2x-5 \qquad x+2 \qquad x+4$ $-x+7 \qquad 2$ $-x + 7 = 2$ $\therefore x = 5$	✓ first difference ✓ second difference ✓ 5	(3)
2.2.2	$2a = 2$ $\quad$ $3(1) + b = 5$ $\therefore a = 1$ $\quad$ $\therefore b = 5 - 3 = 2$ $1 + 2 + c = 5$ $\therefore c = 5 - 3 = 2$ $T_n = n^2 + 2n + 2$ $= n^2 + 2n + 1 + 1$ $= (n+1)^2 + 1$ Conclusion: $(n+1)^2$ is always positive for all $n \geq 1$ and adding 1 will make the result remain positive.	✓ $a = 1$ ✓ $b = 2$ ✓ $c = 2$ ✓ $(n+1)^2 + 1$ ✓ explanation	(5)

	OR $2a = 2$ $\quad\quad$ $3(1) + b = 5$ $\therefore a = 1$ $\quad\quad$ $\therefore \text{b} = 5 - 3 = 2$ $1 + 2 + c = 5$ $\therefore c = 5 - 3 = 2$ $\text{T}_n = n^2 + 2n + 2$ $n \in N$ therefor T_n will be positive for all n values	✓ $a = 1$ ✓ $\text{b} = 2$ ✓ $\text{c} = 2$ ✓ $n \in N$ ✓ explanation	
	OR $2a = 2$ $\quad\quad$ $3(1) + b = 5$ $\therefore a = 1$ $\quad\quad$ $\therefore \text{b} = 5 - 3 = 2$ $1 + 2 + c = 5$ $\therefore c = 5 - 3 = 2$ $\text{T}_n = n^2 + 2n + 2$  All term will be positive for all values of n	✓ $a = 1$ ✓ $\text{b} = 2$ ✓ $\text{c} = 2$ ✓ ✓ Graphical explanation	

2.3.1	$r=\dfrac{\frac{3}{4}(p-3)^2}{\frac{1}{2}(p-3)}=\dfrac{3(p-3)}{2}$ For convergence: $-1<r<1\,;r\neq 0$ $-1<\dfrac{3(p-3)}{2}<1$ $-2<3(p-3)<2$ $-2<3p-9<2$ $7<3p<11$ $\dfrac{7}{3}<p<\dfrac{11}{3};\;\; p\neq 3$	✓ r, in terms of p ✓ substitution into convergence formula ✓ simplification ✓ $\frac{7}{3}<p<\frac{11}{3}$	(4)
2.3.2	$S_\infty=\dfrac{a}{1-r}$ $1=\dfrac{\frac{1}{2}(p-3)}{1-\left(\frac{3(p-3)}{2}\right)}$ $\left(1-\dfrac{3p-9}{2}\right)=\dfrac{1}{2}(p-3)$ $\dfrac{11-3p}{2}=\dfrac{p-3}{2}$ $4p=14$ $p=\dfrac{14}{4}=\dfrac{7}{2}$	✓ substitution into the correct formula ✓ simplification ✓ $\dfrac{7}{2}$	(3)
			[20]

QUESTION 3

3.1	$\sum_{k=2}^{n} 2(3^{k-1}) = 59\,046$. $6 + 18 + 54 + \cdots + 2(3^{n-1}) = 59\,046$ $r = \frac{18}{6} = 3$ Number of terms $(n-2)+1 = n-1$ $S_n = \frac{a(r^n-1)}{r-1}; r \neq 1$ $S_{n-1} = \frac{6(3^{n-1}-1)}{3-1}$ $\frac{6(3^{n-1}-1)}{3-1} = 59\,046$ $3(3^{n-1}-1) = 59\,046$ $3^{n-1} - 1 = 19\,682$ $3^{n-1} = 19\,683$ $3^{n-1} = 3^9$ $n - 1 = 9$ $\therefore n = 10$ **OR** $\sum_{k=2}^{n} 2(3^{k-1}) = 59\,046$. $6 + 18 + 54 + \cdots + 2(3^{n-1}) = 59\,046$ $r = \frac{18}{6} = 3$ Number of terms $(n-2)+1 = n-1$ Let the number of terms be k $S_n = \frac{a(r^n-1)}{r-1}; r \neq 1$ $S_k = \frac{6(3^k-1)}{3-1}$ $\frac{6(3^k-1)}{3-1} = 59\,046$ $3(3^k-1) = 59\,046$ $3^k - 1 = 19\,682$ $3^k = 19\,683$ $3^k = 3^9$ $k = 9$ $\therefore n - 1 = 9$ $\Rightarrow n = 10$	✓ $r = 3$ ✓ $n - 1$ ✓ substitution ✓ simplification to $3^{n-1} = 19\,683$ ✓ 10 **OR** ✓ $r = 3$ ✓ $n - 1$ ✓ substitution ✓ simplification to $3^k = 19\,683$ ✓ 10 If $k = 9$ max $\frac{4}{5}$	(5)

3.2.1	6p	✓ 6p	(1)
3.2.2	Pythagoras' Theorem $h^2 = (12p)^2 - (6p)^2$ $h^2 = 144p^2 - 36p^2$ $h^2 = 108p^2$ $\therefore h = 6\sqrt{3}p$ units **OR** $\sin 60° = \frac{h}{12p}$ $h = 12p.\frac{\sqrt{3}}{2}$ $\therefore h = 6\sqrt{3}p$ units	✓ Pythagoras' Theorem ✓ $6\sqrt{3}p$ ✓ trig ratio ✓ $6\sqrt{3}p$	(2) **OR** (2)
3.2.3	Area of the first triangle $= \frac{1}{2}(12p)(6\sqrt{3}p) = 36\sqrt{3}p^2$ Area of the second triangle $= \frac{1}{2}(6p)(3\sqrt{3}p) = 9\sqrt{3}p^2$ Area of the third triangle $= \frac{1}{2}(3p).\frac{1}{2}(3\sqrt{3}p) = \frac{9\sqrt{3}p^2}{4}$ $36\sqrt{3}p^2 + 9\sqrt{3}p^2 + \frac{9\sqrt{3}p^2}{4}...$ Geometric pattern $r = \frac{9\sqrt{3}p^2}{36\sqrt{3}p^2} = \frac{1}{4}$ $S_\infty = \frac{a}{1-r}; r \neq 1$ $S_\infty = \frac{36\sqrt{3}p^2}{1-\frac{1}{4}} = 48\sqrt{3}p^2$	✓ $36\sqrt{3}p^2$ ✓ $9\sqrt{3}p^2$ ✓ $\frac{9\sqrt{3}p^2}{4}$ ✓ $\frac{1}{4}$ ✓ substitution into correct formula	

	OR Area of the first triangle $= \frac{1}{2}(12p)(6\sqrt{3}p) = 36\sqrt{3}p^2$ Ratio of corresponding sides of consecutive triangles= $1:2$ Ratio of areas of consecutive triangles= $1:4$ $\therefore\ r = \frac{1}{4}$ $S_\infty = \frac{a}{1-r}; r \neq 1$ $S_\infty = \frac{36\sqrt{3}p^2}{1-\frac{1}{4}} = 48\sqrt{3}p^2$ **OR** **Use area rule.** Area of the first triangle $= \frac{1}{2}(12p)(12p)\sin 60°$ $= 36\sqrt{3}p^2$ Area of the second triangle $= \frac{1}{2}(6p)(6p)\sin 60°$ $= 9\sqrt{3}p^2$ Area of the third triangle $= \frac{1}{2}(3p)(3p)\sin 60°$ $= \frac{9\sqrt{3}p^2}{4}$ $36\sqrt{3}p^2 + 9\sqrt{3}p^2 + \frac{9\sqrt{3}p^2}{4} \ldots$ Geometric pattern $r = \frac{9\sqrt{3}p^2}{36\sqrt{3}p^2} = \frac{1}{4}$ $S_\infty = \frac{a}{1-r}; r \neq 1$ $S_\infty = \frac{36\sqrt{3}p^2}{1-\frac{1}{4}} = 48\sqrt{3}p^2$	**OR** ✓ $36\sqrt{3}p^2$ ✓ $1:2$ ✓ $1:4$ ✓ $\frac{1}{4}$ ✓ substitution into correct formula **OR** ✓ $36\sqrt{3}p^2$ ✓ $9\sqrt{3}p^2$ ✓ $\frac{9\sqrt{3}p^2}{4}$ ✓ $\frac{1}{4}$ ✓ substitution into correct formula	**(5)**
			[13]

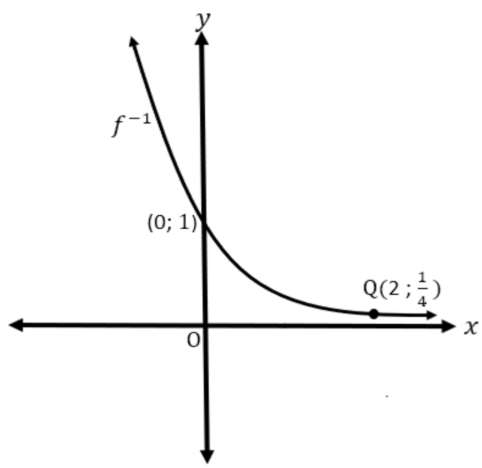
QUESTION 4			
4.1	$(0;\frac{15}{2})$ Penalize if NOT in coordinate form	✓ $(0;\frac{15}{2})$	(1)
4.2	$x^2+2x=0$ $x(x+2)=0$ $x=0$ or $x=-2$ $C(-2;0)$ DO NOT penalize if not in coordinate form	✓ factorization ✓ $C(-2;0)$	(2)
4.3.1	$x=\frac{-b}{2a}$ $x=\frac{-2}{2(1)}=-1$ $\therefore p=-1$ **OR** $P=\frac{0+(-2)}{2}=-1$ **OR** $g(x)=(x+1)^2-1$ $x=-1$ $\therefore p=-1$	✓ $p=-1$	(1)
4.3.2	$g(-1)=(-1)^2+2(-1)=-1$ $y_E=-1$ $\therefore \text{DE}=8-(-1)=9$ units	✓ $y_E=-1$ ✓ 9	(2)

4.4	$f(x) = a(x+p)^2 + q$ $f(x) = a(x+1)^2 + 8$ Use F(0 ; $\frac{15}{2}$) $a(0+1)^2 + 8 = \frac{15}{2}$ $a + 8 = \frac{15}{2}$ $\therefore a = -\frac{1}{2}$ $f(x) = -\frac{1}{2}(x+1)^2 + 8$ $f(x) = -\frac{1}{2}(x^2 + 2x + 1) + 8$ $f(x) = -\frac{1}{2}x^2 - x - \frac{1}{2} + 8$ $f(x) = -\frac{1}{2}x^2 - x + \frac{15}{2}$ $\therefore b = -1$	✓ substitution of p and q using point D(1 ; 8) ✓ substitution of x and y using point F(0 ; $\frac{15}{2}$) ✓ simplification leading to $a = -\frac{1}{2}$ ✓ simplification leading to $b = -1$	(4)

4.5	$-\frac{1}{2}x^2 - x - \frac{15}{2} = x^2 + 2x$ $\frac{3}{2}x^2 + 3x - \frac{15}{2} = 0$ $x^2 + 2x - 5 = 0$ $x = \frac{-2 \pm \sqrt{2^2 - 4(1)(-5)}}{2(1)}$ $x = \frac{-2 \pm \sqrt{24}}{2}$ $x = 1.45 \text{ or } x = -3.45$ $g(1.45) = (1.45)^2 + 2(1.45) = 5.00$ $g(-3.45) = (-3.45)^2 + 2(-3.45) = 5.00$ $\therefore y = 5$ **OR** $f(1.45) = -\frac{1}{2}(1.45)^2 - 1.45 - \frac{15}{2} = 5.00$ $f(-3.45) = -\frac{1}{2}(-3.45)^2 - (-3.45) - \frac{15}{2} =$ 5.00 $\therefore y = 5$	✓ equating f and g ✓ standard equation ✓ x-values ✓ y-values ✓ $y = 5$	(5)
			[15]

QUESTION 5

5.1.1	$y = \log_a x$ $2 = \log_a \frac{1}{4}$ $a^2 = \frac{1}{4}$ $a = \pm\sqrt{\frac{1}{4}}$ $a = \pm\frac{1}{2}$ $\therefore a = \frac{1}{2}$	✓ substitution ✓ $a = \frac{1}{2}$	(2)

5.1.2	$y = \log_{\frac{1}{2}} x$ $x = \log_{\frac{1}{2}} y$ $y = \left(\frac{1}{2}\right)^x$ ANSWER ONLY FULL MARKS	✓ swopping of variables ✓ $y = \left(\frac{1}{2}\right)^x$	(2)
5.2		✓ shape ✓ y-intercept ✓ any other correct point on the graph	(3)
5.3	$\log_{\frac{1}{2}} x > -5$ $x < \left(\frac{1}{2}\right)^{-5}$ $x < 32$; but $x > 0$ $\therefore 0 < x < 32$ ANSWER ONLY FULL MARKS	✓ $x < \left(\frac{1}{2}\right)^{-5}$ ✓ $x < 32$ accept: Critical value $x = 32$ ✓ $0 < x < 32$	(3)
			[10]

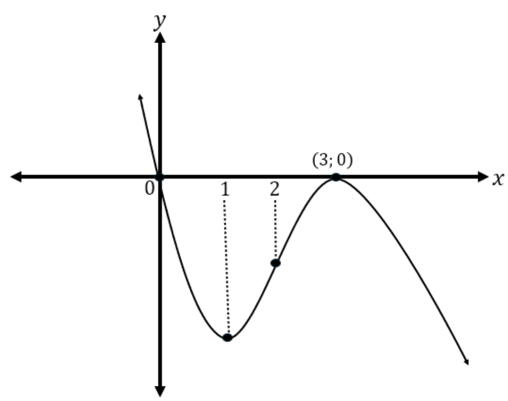
QUESTION 6			
6.1.1	$y = -x + k$ $-1 = -(-4) + k$ $-1 = 4 + k$ $k = -5$	✓ substitution ✓ $k = -5$	(2)
6.1.2	$p = 4$ $q = -1$ $y = \frac{a}{x+4} - 1$ Use A $(-8; 0)$ $0 = \frac{a}{-8+4} - 1$ $0 = \frac{a}{-4} - 1$ $1 = \frac{a}{-4}$ $\therefore a = -4$ $f(x) = -\frac{-4}{x+4} - 1$	✓ $p = 4$ ✓ q= -1 ✓ substitution ✓ $a = -4$	(4)
6.2	$-\frac{-4}{x+4} - 1 \geq -x - 5$ $\frac{-4}{x+4} \geq -x - 4$ $(x+4)^2 \geq 4$ Critical values: $(x+4)^2 = 4$ $x + 4 = \pm 2$ $x = -2$ and $x = -6$ $-6 \leq x < -4$ or $x \geq -2$	✓ inequality/ equate ✓ simplification ✓ critical values ✓ $-6 \leq x < -4$ ✓ $x \geq -2$	(5)

6.3	$\frac{-4}{x+4}-1=x+t$ $-4-1(x+4)=x(x+4)+t(x+4)$ $-4-x-4=x^2+4x+tx+4t$ $x^2+(5+t)x+8+4t=0$ $b^2-4ac=0$ $(5+t)^2-4(1)(8+4t)=0$ $t^2+10t+25-32-16t=0$ $t^2-6t-7=0$ $(t-7)(t+1)=0$ $t=7$ or $t=-1$	✓ Equating ✓ $x^2+(5+t)x+8+4t=0$ ✓ Substitution into discriminant ✓ $t^2-6t-7=0$ ✓ Factors/ Method ✓ Values of t	(6)
			[17]

QUESTION 7			
7.1	$f(x) = \frac{3}{x}$ $f^{/}(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$ $= \lim_{h \to 0} \frac{\left(\frac{3}{x+h}\right) - \left(\frac{3}{x}\right)}{h}$ $= \lim_{h \to 0} \frac{\left(\frac{3x - 3(x+h)}{x(x+h)}\right)}{h}$ $= \lim_{h \to 0} \frac{\left(\frac{3x - 3x - 3h}{x(x+h)}\right)}{h}$ $= \lim_{h \to 0} \left[\frac{-3h}{x(x+h)} \times \frac{1}{h}\right]$ $= \lim_{h \to 0} \left[\frac{-3}{x(x+h)}\right]$ $= \frac{-3}{x^2}$	✓ $\left(\frac{3}{x+h}\right)$ ✓ simplification of numerator to $-3h$ ✓ denominator $x(x+h)$ ✓ $\frac{-3h}{x(x+h)} \times \frac{1}{h}$ ✓ $\frac{-3}{x^2}$ ANSWER ONLY $\frac{0}{5}$ Penalize for notation 1 mark Only penalize notation in 7.1	(5)
7.2.1	$D_x\left[\frac{\sqrt[3]{x^2} - x^{-\frac{3}{2}}}{\sqrt{x}}\right]$ $D_x\left[\frac{x^{\frac{2}{3}} - x^{-\frac{3}{2}}}{x^{\frac{1}{2}}}\right]$ $D_x\left[x^{-\frac{1}{2}}\left(x^{\frac{2}{3}} - x^{-\frac{3}{2}}\right)\right]$ $D_x\left[x^{\frac{1}{6}} - x^{-2}\right]$ $\frac{1}{6}x^{-\frac{5}{6}} + 2x^{-3}$	✓ changing both radicals to exponents. ✓ $x^{\frac{1}{6}} - x^{-2}$ ✓ $\frac{1}{6}x^{\frac{-5}{6}}$ ✓ $2x^{-3}$	(4)

7.2.2	$\frac{dy}{dx}$ if $xy - y = x^2 - 1$ $y = \frac{(x^2-1)}{(x-1)}$ $y = \frac{(x-1)(x+1)}{(x-1)}$ $y = x + 1$ $\therefore \frac{dy}{dx} = 1$	✓ $y = \frac{(x^2-1)}{(x-1)}$ ✓ $y = x + 1$ ✓ 1	(3)
7.3.1	$f(x) = ax^3 + bx^2$ The gradient of the tangent at $x = 1$ is 12. $f'(x) = 3ax^2 + 2bx$ $f'(1) = 3a(1)^2 + 2b(1)$ $12 = 3a + 2b$ Use point (1; 5) $5 = a(1)^2 + b(1)$ $5 = a + b$ Solving simultaneously: $b = 6 - \frac{3a}{2}$…………... (1) $b = 5 - a$ …………... (2) $6 - \frac{3a}{2} = 5 - a$ $10 - 2a = 12 - 3a$ $3a - 2a = 2$ $\therefore a = 2$ $\Rightarrow b = 5 - 2 = 3$	✓ $f'(x) = 3ax^2 + 2bx$ ✓ $3a + 2b = 12$ ✓ $a + b = 5$ ✓ Simplifying to $a = 2$ ✓ Simplifying to $b = 3$	(5)

7.3.2	$f(x) = 2x^3 + 3x^2$ $f^/(x) = 6x^2 + 6x$ $6x^2 + 6x = 0$ $x^2 + x = 0$ $x(x + 1) = 0$ $\therefore x = 0$ or $x = -1$ $f(0) = 2(0)^3 + 3(0)^2 = 0$ $f(-1) = 2(-1)^3 + 3(-1)^2 = 1$ The coordinates are $(0,0)$ *and* $(-1,1)$	✓ $f^/(x)$ ✓ equating to 0 ✓ x-values ✓ $(0,0)$ ✓ $(-1,1)$	(5)
			[22]

QUESTION 8			
8.1.1	The graph has a local maximum when $x = 3$ **OR** The graph is concave down.	✓ ✓ local maximum **OR** ✓✓ concave down	(2) (2)
8.1.2		✓ intercepts ✓ turning points ✓ point of inflection ✓ Shape	(4)

8.1.3	$x < 0$ $1 < x < 3$	✓ $x < 0$ ✓✓ $1 < x < 3$	(3)
8.2	$f(x) = a(x)(x-3)^2$ $-40 = a(5)(5-3)^2$ $-40 = 20a$ $\therefore a = -2$ $f(x) = -2(x)(x-3)^2$ $f(x) = -2x(x^2 - 6x + 9)$ $f(x) = -2x^3 + 12x^2 - 18x$ **OR** $f(x) = px^3 + qx + rx$ $f^/(x) = 3px^2 + 2qx + r$ At turning the point; $f^/(x) = 0$ $3px^2 + 2qx + r = 0$ $x^2 + \frac{2q}{3p}x + \frac{r}{3p} = 0$	✓ substitution of $(5;\ -40)$ ✓ -2 ✓ 12 ✓ -18	

	The graph has turning points at $x = 1$ and $x = 3$ $\therefore a(x-1)(x-3) = 0$ $(x-1)(x-3) = 0$ $x^2 - 4x + 3 = 0$ $\Rightarrow \frac{2q}{3p} = -4$ $q = -6p$ and $\frac{r}{3p} = 3$ $r = 9p$ But $f(5) = -40$ $\therefore 125p + 25q + 5r = -40$ $125p + 25(-6p) + 5(9p) = -40$ $20p = -40$ $p = -2$ $q = -6(-2) = 12$ $r = 9(-2) = -18$ $f(x) = -2x^3 + 12x^2 - 18x$ **OR** $f'(x) = 3px^2 + 2qx + r$ $f'(1) = 3p + 2q + r$ $3p + 2q + r = 0$ ……..Equation 1 $f'(3) = 27p + 6q + r$ $27p + 6q + r = 0$…….Equation 2 $f(5) = -40$ $\therefore 125p + 25q + 5r = -40$ $25p + 5q + r = -8$ ….Equation 3 From the three equations, eliminate r to get $22p + 3q = -8$ and $2p + q = 8$	**OR** $f''(x) = 6px + 2q$ $f''(2) = 12p + 2q$ $12p + 2q = 0$ $q = -6p$	**OR** ✓ Substitution of $(5; -40)$ ✓ -2 ✓ 12 ✓ -18 **OR** ✓ method ✓ -2 ✓ 12 ✓ -18

	$q = 8 - 2p$ $22p + 3(8 - 2p) = -8$ $22p + 24 - 6p = -8$ $16p = -32$ $p = -2$ $q = 8 - 2(-2) = 12$ $3p + 2q + r = 0$ $3(-2) + 2(12) + r = 0$ $18 + r = 0$ $r = -18$		**(4)**
			[13]

QUESTION 9			
9.1.	$V = lbh$ $2\,160\,000 = x^2h$ $\therefore h = \frac{2\,160\,000}{x^2}$	✓ substitution ✓ $\frac{2\,160\,000}{x^2}$	(2)
9.2	$Surface\ area = 3x^2 + x^2 + 4xh$ $= 4x^2 + 4x\left(\frac{2\,160\,000}{x^2}\right)$ $A(x) = 4x^2 + \frac{8\,640\,000}{x}$	✓ $4x^2$ ✓ $4xh$ ✓ substitution of h	(3)
9.3	$A(x) = 4x^2 + 8\,640\,000x^{-1}$ $A^/(x) = 8x - 8\,640\,000x^{-2}$ $= 8x - \frac{8\,640\,000}{x^2}$ $S^/(x) = 0$ $8x - \frac{8\,640\,000}{x^2} = 0$ $8x^3 = 8\,640\,000$ $x^3 = 1\,080\,000$ $x = \sqrt[3]{1\,080\,000} = 102{,}6cm$ $\therefore h = \frac{2\,160\,000}{(102.6)^2} = 205{,}19cm$	✓ $8x - 8\,640\,000x^{-2}$ ✓ equating $A^/(x)$ to 0. ✓ simplification ✓ $102{,}6cm$ ✓ $205{,}19cm$	(5)
			[10]

TOTAL: 150