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MATHEMATICS P1

SEPTEMBER 2019

PREPARATORY EXAMINATION
MARKING GUIDELINE

**NATIONAL
SENIOR CERTIFICATE**

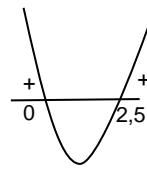
GRADE 12

MARKS: 150

TIME: 3 hours

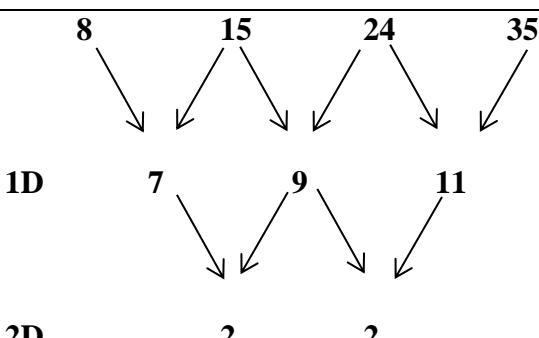
This marking guideline consists of 13 pages.

QUESTION 1

1.1.1	$x = 0 \text{ or } x = 4$	A✓ 0 A✓ 4	(2)
1.1.2	$2x^2 + 5x - 1 = 0$ $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $= \frac{-(5) \pm \sqrt{(5)^2 - 4(2)(-1)}}{2(2)}$ $= 0,19 \quad \text{or} \quad -2,69$	A✓ standard form CA✓ substitution in correct formula CA✓ CA✓ answers (penalize 1 mark if rounding off is incorrect-once here for entire paper)	(4)
1.2.1	$\sqrt{x-2} = 2-x$ $(\sqrt{x-2})^2 = (2-x)^2$ $x-2 = 4-4x+x^2$ $x^2-5x+6=0$ $(x-2)(x-3)=0$ $x=2 \text{ or } x=3$ n/a OR $\sqrt{x-2} = 2-x$ $x-2 \geq 0 \text{ and } 2-x \geq 0$ $x \geq 2 \text{ and } x \leq 2$ $x=2$	A✓ squaring both sides CA✓ standard form CA✓ factors CA✓ answers and rejecting OR A✓ A✓ each inequality A✓ both inequalities CA✓ answer Answer only FULL MARKS	(4)
1.2.2	$p^2 - p = x$ $\therefore p^2 - p = 2$ $p^2 - p - 2 = 0$ $(p+1)(p-2) = 0$ $p = -1 \text{ or } p = 2$	letting $p^2 - p = x$ CA✓ $p^2 - p = 2$ CA✓ standard form CA✓ factors CA✓ answers MAX 3marks if four solutions arrived at	(4)
1.3	$-2x^2 + 5x \leq 0$ $2x\left(x - \frac{5}{2}\right) \geq 0$ $x \leq 0 \quad \text{or} \quad x \geq \frac{5}{2}$ OR 	AA✓✓ factors CA✓ $x \leq 0$ CA✓ $x \geq \frac{5}{2}$ OR If graphical Solution is used: AA 2 marks for graph CAC 2 marks for answer	(4)

1.4	$\begin{aligned} 2^{x+1} + 2^x &= 3^{y+2} - 3^y \\ 2^x(2+1) &= 3^y(9-1) \\ 2^x(3) &= 3^y(8) \\ 2^{x-3} &= 3^{y-1} \\ x-3 = 0 \quad \text{and} \quad y-1 &= 0 \\ x = 3 \quad \text{and} \quad y = 1 & \\ x+y &= 4 \end{aligned}$	A✓ factorising CA✓ simplifying CA✓ exponential form CA✓ each exponent and equal to 0 CA✓ x and y value CA✓ answer If $x-3 = 0$ and $y-1 = 0$ is missing then maximum 5/6 marks	(6)
			[24]

QUESTION 2

2.1	48 ; 63	A✓ answers	(1)
2.2	 $\begin{array}{cccc} 8 & 15 & 24 & 35 \\ \searrow & \searrow & \searrow & \searrow \\ 1D & 7 & 9 & 11 \\ \searrow & \searrow & \searrow & \searrow \\ 2D & 2 & 2 & \end{array}$ $\begin{aligned} 2a &= 2 & a &= 1 \\ 3a + b &= 7 & b &= 4 \\ a + b + c &= 8 & c &= 3 \\ T_n &= n^2 + 4n + 3 \end{aligned}$ <p>OR</p> $\begin{aligned} 2a &= 2 & a &= 1 \\ T_1 + d_2 - d_1 &= c \\ 8 + 2 - 7 &= c \\ 3 &= c \\ T_n &= n^2 + bn + 3 \\ 8 &= 1 + b + 3 \\ b &= 4 \\ T_n &= n^2 + 4n + 3 \end{aligned}$	A✓ a value CA✓ b value CA✓ c value CA✓ answer	(4)

	OR $\begin{aligned} T_n &= T_1 + (n-1)d_1 + \frac{(n-1)(n-2)}{2}d_2 \\ &= 8 + (n-1)(7) + \frac{(n-1)(n-2)}{2}(2) \\ &= 8 + 7n - 7 + n^2 - 3n + 2 \\ &= n^2 + 4n + 3 \end{aligned}$	OR A✓ formula A✓ substitution into correct formula CA✓ simplifying CA✓ answer (4)	
	OR $\begin{aligned} T_n &= \frac{n-1}{2}[2a + (n-2)d] + T_1 \\ &= \frac{n-1}{2}[2(7) + (n-2)(2)] + 8 \\ &= \frac{n-1}{2}[14 + 2n - 4] + 8 \\ &= \frac{n-1}{2}[2n + 10] + 8 \\ &= (n-1)(n+5) + 8 \\ &= n^2 + 4n - 5 + 8 \\ &= n^2 + 4n + 3 \end{aligned}$	OR A✓ formula A✓ substitution into correct formula CA✓ simplifying CA✓ answer (4)	
			[5]

QUESTION 3

3.1	$T_2 - T_1 = T_3 - T_2$ $p + 5 - 2p + 3 = 2p + 7 - p - 5$ $-p + 8 = p + 2$ $p = 3$	A✓ equating differences CA✓ simplifying CA✓ answer (3)	
3.2	Pattern is 3 ; 8 ; 13 ; ... $\begin{aligned} S_n &= \frac{n}{2}[2a + (n-1)d] \\ S_{120} &= \frac{120}{2}[2(3) + 119(5)] \\ &= 36060 \end{aligned}$	CA✓ $a = 3$ and $d = 5$ CA✓ substitution into formula CA✓ answer (3)	
3.3.1	$x = k + 1$ and $y = k + 2$	A✓ x – value A✓ y – value	(2)

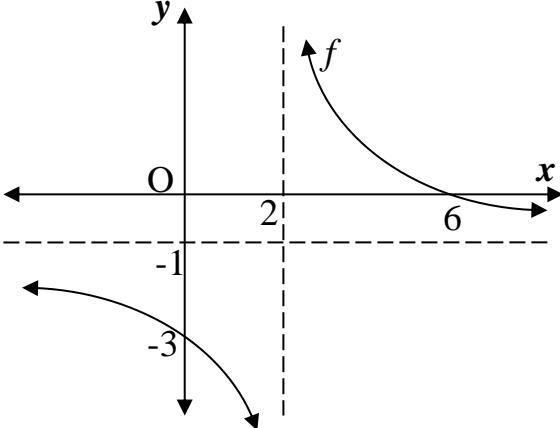
3.3.2	$\begin{aligned} T_x &= a + (x - 1)d = 3 + 5k \\ T_y &= a + (k + 1)d \\ &= 3 + (k + 1)(5) \\ &= 8 + 5k \\ T_x + T_y &= 11 + 10k \end{aligned}$	CA✓ substitution into n^{th} term CA✓ $3 + 5k$ CA✓ $8 + 5k$ CA✓ answer	(4)
			[12]

QUESTION 4

4.1.1	15 ; 5	AA✓✓ both terms	(2)
4.1.2	$\begin{aligned} S_{\infty} &= \frac{a}{1-r} \\ &= \frac{15}{1-\frac{1}{3}} \\ &= \frac{45}{2} = 22,5 \end{aligned}$	CA✓ substitution of common ratio CA✓ answer	(2)
4.2	$\sin 30^\circ ; \cos 30^\circ ; \frac{3}{2}$ $\frac{1}{2} ; \frac{\sqrt{3}}{2} ; \frac{3}{2}$ $a = \frac{1}{2} ; r = \sqrt{3}$ $ar^{n-1} = 40,5\sqrt{3}$ $\frac{1}{2}(\sqrt{3})^{n-1} = \frac{81}{2}\sqrt{3}$ $3^{\frac{n-1}{2}} = 3^4 \cdot 3^{\frac{1}{2}}$ $\frac{n-1}{2} = 4 \frac{1}{2} = \frac{9}{2}$ $n-1 = 9$ $n = 10$ OR	A✓ listing terms CA✓ $\frac{1}{2}(\sqrt{3})^{n-1} = \frac{81}{2}\sqrt{3}$ CA✓ $3^{\frac{n-1}{2}} = 3^4 \cdot 3^{\frac{1}{2}}$ CA✓ $\frac{n-1}{2} = 4 \frac{1}{2} = \frac{9}{2}$ CA✓ answer OR	(5)

$\sin 30^\circ ; \cos 30^\circ ; \frac{3}{2}$ $\frac{1}{2} ; \frac{\sqrt{3}}{2} ; \frac{3}{2}$ $a = \frac{1}{2} ; r = \sqrt{3}$ $ar^{n-1} = \frac{81}{2}\sqrt{3}$ $\frac{1}{2}(\sqrt{3})^{n-1} = \frac{81}{2}\sqrt{3}$ $\frac{(\sqrt{3})^n}{\sqrt{3}} = 81\sqrt{3}$ $243 = (\sqrt{3})^n$ $3^5 = 3^{\frac{1}{2}n}$ $n = 10$	A✓ listing terms CA✓ $\frac{1}{2}(\sqrt{3})^{n-1} = \frac{81}{2}\sqrt{3}$ CA✓ $243 = (\sqrt{3})^n$ CA✓ $3^5 = 3^{\frac{1}{2}n}$ CA✓ answer	(5)
		[9]

QUESTION 5

5.1	$x = 2$ and $y = -1$	AA✓ $x = 2$ ✓ $y = -1$	(2)
5.2	y -intercept: $(0 ; -3)$ x -intercept: $\frac{-4}{2-x} - 1 = 0$ $\frac{-4}{2-x} = 1$ $-4 = 2 - x$ $x = 6$ $(6 ; 0)$	A✓ y -intercept A✓ $\frac{-4}{2-x} - 1 = 0$ A✓ x -intercept (co-ordinate form not needed)	(3)
5.3		CA✓ x -intercepts CA✓ y -intercept CA✓ both asymptotes A✓ shape	(4) [9]

QUESTION 6

	$x = -\frac{b}{2a} = -\frac{5}{2(-1)} = \frac{5}{2}$ $y = -\left(\frac{5}{2}\right)^2 + 5\left(\frac{5}{2}\right) + 6 = \frac{49}{4} = 12,25$ $\left(\frac{5}{2}; 12,25\right)$ OR $f'(x) = -2x + 5 = 0 \quad \therefore x = \frac{5}{2}$ $y = -\left(\frac{5}{2}\right)^2 + 5\left(\frac{5}{2}\right) + 6 = \frac{49}{4} = 12,25$ $\left(\frac{5}{2}; 12,25\right)$	A✓ formula CA✓ Axis of symmetry value CA✓ substitution CA✓ answer OR A✓ derivative and equal to 0 CA✓ Axis of symmetry value CA✓ substitution CA✓ answer	(4)
6.5.2	$PQ = -x^2 + 4x + 5$ $x = -\frac{b}{2a} = -\frac{4}{2(-1)} = 2$ Max. $PQ = -(2)^2 + 4(2) + 5 = 9$ units OR $PQ = -x^2 + 4x + 5$ $PQ' = -2x + 4 = 0 \quad \therefore x = 2$ Max. $PQ = -(2)^2 + 4(2) + 5 = 9$ units	A✓ PQ in terms of x CA✓ substitution CA✓ x -value CA✓ answer OR A✓ PQ in terms of x CA✓ derivative and equal to 0 CA✓ x -value CA✓ answer	(4)
			[18]

QUESTION 7

7.1	$y = 5^x$	AA✓✓ answer	(2)
7.2	$y > 0$ or $y \in (0; \infty)$	A✓ answer	(1)
7.3	$\log_5 x = -4$ $x = 5^{-4} = \frac{1}{625}$ $0 < x \leq \frac{1}{625}$	A✓ Equating log graph to -4 A✓ writing in exponential form CA✓ end points A✓ interval Can be solved by log inequalities.	(4)
			[7]

QUESTION 8

8.1	$A = P(1 - i)^n$ $250000 = P(1 - 13,5\%)^5$ $P = \frac{250000}{(1 - 13,5\%)^5}$ $= R516249$	A✓ substitution into the correct formula CA✓ making P the subject CA✓ answer	(3)
8.2.1	$P = \frac{x[1 - (1 + i)^{-n}]}{i}$ $950000 = \frac{x \left[1 - \left(1 + \frac{14,25\%}{12} \right)^{-240} \right]}{\frac{14,25\%}{12}}$ $x = R11986,33$	A✓ value of n A✓ value of i CA✓ substitution into correct formula CA✓ answer	(4)
8.2.2	$P = \frac{x[1 - (1 + i)^{-n}]}{i}$ $= \frac{11986,33 \left[1 - \left(1 + \frac{14,25\%}{12} \right)^{-140} \right]}{\frac{14,25\%}{12}}$ $= R816048,67$ <p>OR</p> $A = P(1 + i)^n$ $A = 950\ 000 \left(1 + \frac{14,25\%}{12} \right)^{100}$ $= R3093215,766$ $F = \frac{x[(1 + i)^n - 1]}{i}$ $F = \frac{11986,33 \left[\left(1 + \frac{14,25\%}{12} \right)^{100} - 1 \right]}{\frac{14,25\%}{12}}$ $= R2277167,107$ <p>Balance on Loan</p> $= R3093215,766 - R2277167,107$ $= R816048,67$	A✓ Present value formula A✓ value of n CA✓ substitution into correct formula CA✓ answer OR A✓ Substitution into Compound Interest Formula CA✓ substitution into Future Value Formula CA✓ A - F CA✓ answer	(4)

8.2.3	$A = P(1+i)^n$ $= 816\ 048,67 \left(1 + \frac{14,25\%}{12}\right)^4$ $= R855\ 506,92$ $855\ 506,92 = \frac{x[1-(1+i)^{-n}]}{i}$ $= \frac{x \left[1 - \left(1 + \frac{14,25\%}{12}\right)^{-136}\right]}{\frac{14,25\%}{12}}$ $x = R12711,51$	CA✓ substitution CA✓ substitution of P and i A✓ value of n CA✓ answer	(4)
			[15]

QUESTION 9(penalize 1 mark once for incorrect notation in this question)

9.1	$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$ $= \lim_{h \rightarrow 0} \frac{(x+h)^2 - \frac{1}{2}(x+h) - \left(x^2 - \frac{1}{2}x\right)}{h}$ $= \lim_{h \rightarrow 0} \frac{x^2 + 2xh + h^2 - \frac{1}{2}x - \frac{1}{2}h - x^2 + \frac{1}{2}x}{h}$ $= \lim_{h \rightarrow 0} \frac{h\left(2x + h - \frac{1}{2}\right)}{h}$ $= 2x - \frac{1}{2}$ <p>OR</p> $f(x+h) = (x+h)^2 - \frac{1}{2}(x+h)$ $f(x+h) = x^2 + 2xh + h^2 - \frac{1}{2}x - \frac{1}{2}h$ $f(x+h) - f(x) = 2xh + h^2 - \frac{1}{2}h$ $\frac{f(x+h) - f(x)}{h} = \frac{2xh + h^2 - \frac{1}{2}h}{h}$ $\frac{f(x+h) - f(x)}{h} = \frac{h(2x + h - \frac{1}{2})}{h}$ $f'(x) = \lim_{h \rightarrow 0} \left(2x + h - \frac{1}{2}\right)$ $f'(x) = 2x - \frac{1}{2}$	A✓ formula A✓ substitution CA✓ simplification of numerator CA✓ factorization CA✓ answer OR A✓ value of $f(x+h)$ CA✓ simplification CA✓ factorization A✓ formula CA✓ answer	(5)
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9.2.1	$\frac{d}{dx} [3x^4 + \sqrt[5]{x} + a^2]$ $\frac{d}{dx} [3x^4 + x^{\frac{1}{5}} + a^2]$ $= 12x^3 + \frac{1}{5}x^{-\frac{4}{5}}$	A✓ rewriting in exponential form A✓ CA✓ derivatives Penalize 1 mark if a is included in answer	(3)
9.2.2	$xy = x + x^2 - 1$ $y = 1 + x - x^{-1}$ $\frac{dy}{dx} = 1 + x^{-2}$	A✓ dividing by x ($x \neq 0$) A✓ $1 + x - x^{-1}$ CACACAC✓✓ each derivative	(4)
			[12]

QUESTION 10

10.1.1	$x^3 + 5x^2 - 8x - 12 = 0$ $(x + 1)$ is a factor $f(-1) = 0$ $(x + 1)(x^2 - 4x - 12) = 0$ $(x + 6)(x + 1)(x - 2) = 0$ $x = -6 \text{ or } x = -1 \text{ or } x = 2$	A ✓ $f(-1) = 0$ A ✓ $(x + 1)(x^2 - 4x - 12) = 0$ A✓ all three factors CACACAC✓✓✓ each value Answer only 3/6 Marks	(6)
10.1.2	$f(x) = x^3 + 5x^2 - 8x - 12$ $f'(x) = 3x^2 + 10x - 8 = 0$ $(3x - 2)(x + 4) = 0$ $x = \frac{2}{3} \text{ or } x = -4$ $f\left(\frac{2}{3}\right) = \left(\frac{2}{3}\right)^3 + 5\left(\frac{2}{3}\right)^2 - 8\left(\frac{2}{3}\right) - 12 = -\frac{400}{27}$ $= -14,81$ $B\left(\frac{2}{3}; -14,81\right)$	A✓ derivative and equal to 0 CA✓ factors CA✓ x -values CA✓ y -value	(4)
10.1.3	$f''(x) = 6x + 10 = 0$ $x = -\frac{5}{3}$ OR $x = \frac{\frac{2}{3} + (-4)}{2} = -\frac{5}{3}$ OR $x = -\frac{b}{3a} = -\frac{5}{3}$	CA✓ second derivative and equal to 0 CA✓ answer OR CA✓ subst. into midpoint formula CA✓ answer OR A✓ formula CA✓ answer	(2)

10.2.1	$f'(0) = -8$ $y = -8x - 12$	CA✓ gradient CA✓ answer	(2)
10.2.2	$f'(x) \cdot g'(x) > 0$ Since $g'(x) < 0$ for all $x \in R$ $(3x^2 + 10x - 8) < 0$ $(3x - 2)(x + 4) < 0$ $-4 < x < \frac{2}{3}$ OR $-4 < x < \frac{2}{3}$	A✓ $g'(x) < 0$ CA✓ factors CA✓ answer OR CAC A ✓✓ end points A✓ interval	(3)
			[14]

QUESTION 11

11.1	$\Delta PQB:$ $\frac{PQ}{2y} = \tan 60^\circ$ $\therefore PQ = 2\sqrt{3}y$ $QR = d - 4y$ $A = 2\sqrt{3}y(d - 4y)$ OR ΔAPS is equilateral $AP = PS = AS = d - 4y$ $SC = 4y$ $SR^2 = (4y)^2 - (2y)^2 = 12y^2$ $SR = 2\sqrt{3}y$ $A = 2\sqrt{3}y(d - 4y)$	A✓ $\tan 60^\circ$ A✓ setting up ratio A✓ value of PQ A✓ value of QR OR A✓ value of PS A✓ value of SC A✓ use of theorem of Pythagoras A✓ value of SR	(4)
11.2	$A = 2\sqrt{3}y(d - 4y).$ $= 2\sqrt{3}yd - 8\sqrt{3}y^2$ $A' = 2\sqrt{3}d - 16\sqrt{3}y = 0$ $d - 8y = 0$ $y = \frac{d}{8}$	A✓ expression for Area CA✓ derivative and equal to 0 CA✓ y – value	

	$\begin{aligned} \text{Max } A &= 2\sqrt{3} \cdot \frac{d}{8} \left(d - 4 \left(\frac{d}{8} \right) \right) \\ &= \frac{\sqrt{3}d}{4} \left(d - \frac{d}{2} \right) \\ &= \frac{\sqrt{3}d}{4} \left(\frac{d}{2} \right) = \frac{\sqrt{3}d^2}{8} \end{aligned}$	CA✓ substitution into original equation CA✓ simplifying CA✓ answer	(6)
			[10]

QUESTION 12

12.1	$P(\text{GG}) = \frac{18}{40} \cdot \frac{17}{39}$ $= \frac{51}{260}$ or 0.1962 or 19.62%	A✓ $\frac{18}{40}$ A✓ $\frac{17}{39}$ A✓ answer in any form	(3)
12.2	$P(\text{B and R}) = \frac{12}{40} \cdot \frac{10}{39} + \frac{10}{40} \cdot \frac{12}{39}$ $P(\text{B and R}) = \frac{2}{13}$ or 0,1538 or 15,38 %	A✓ $\frac{12}{40} \cdot \frac{10}{39}$ A✓ $\frac{10}{40} \cdot \frac{12}{39}$ A✓ answer in any form	(3)
			[6]

QUESTION 13

13.1	9 x 9 x 9 = 729	A✓ 9 x 9 x 9 A✓ 729	(2)																								
13.2	$5 \times 8 \times 7 = 280$ OR <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>5</td><td>8 digits</td><td>7 digits</td><td>56 ways</td></tr> <tr> <td>6</td><td>8 digits</td><td>7 digits</td><td>56 ways</td></tr> <tr> <td>7</td><td>8 digits</td><td>7 digits</td><td>56 ways</td></tr> <tr> <td>8</td><td>8 digits</td><td>7 digits</td><td>56 ways</td></tr> <tr> <td>9</td><td>8 digits</td><td>7 digits</td><td>56 ways</td></tr> <tr> <td></td><td></td><td>Total</td><td>280 ways</td></tr> </table>	5	8 digits	7 digits	56 ways	6	8 digits	7 digits	56 ways	7	8 digits	7 digits	56 ways	8	8 digits	7 digits	56 ways	9	8 digits	7 digits	56 ways			Total	280 ways	A✓ 5 x 8 x 7 A✓ 280 OR A✓ table A✓ answer	(2)
5	8 digits	7 digits	56 ways																								
6	8 digits	7 digits	56 ways																								
7	8 digits	7 digits	56 ways																								
8	8 digits	7 digits	56 ways																								
9	8 digits	7 digits	56 ways																								
		Total	280 ways																								
13.3	9 x 1 x 9 = 81	A✓ 9 x 1 x 9 A✓ 81	(2)																								
			[6]																								

Total : 150