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NATIONAL SENIOR CERTIFICATE EXAMINATION  
SUPPLEMENTARY EXAMINATION – MARCH 2018

**MATHEMATICS: PAPER I**

**MARKING GUIDELINES**

Time: 3 hours

150 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

**SECTION A****QUESTION 1**

(a)  $y = -3x - 1$   
 $\therefore 9x^2 = 9x^2 + 6x + 1$   
 $\therefore -6x = 1$   
 $x = -\frac{1}{6}$   
 $\therefore 3\left(-\frac{1}{6}\right) + y = -1$   
 $\therefore y = -\frac{1}{2}$  (5)

(b)  $2^{2(x-2)} - 2^{4(3x+4)} = 0$   
 $2^{2x-4} = 2^{12x+16}$   
 $2x - 4 = 12x + 16$   
 $-10x = 20$   
 $x = -2$  (3)

|                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>(c) (1) <math>\Delta = b^2 - 4ac</math><br/> <math>= (-5)^2 - 4(2)(-3)</math><br/> <math>= 25 + 24</math><br/> <math>= 49</math><br/> <math>\therefore \Delta</math> is a perfect square<br/> <math>\therefore</math> Roots are Real and rational</p> <p>(2) <math>(2x - 3)(2x + 1) = 0</math><br/> <math>x = \frac{3}{2}</math> or <math>x = -\frac{1}{2}</math></p> | <p><b>Alternative:</b><br/> <math>2x^2 - 5x - 3 = 0</math><br/> <math>(2x + 1)(x - 3) = 0</math><br/> <math>x = -\frac{1}{2}</math> OR <math>x = 3</math><br/> Hence roots are real and rational</p> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**[14]**

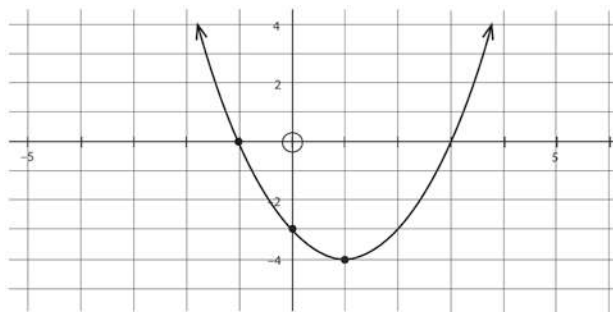
**QUESTION 2**

(a)  $f(x) = x^2 - 2x - 3$

$f(x) = x^2 - 2x + 1 - 1 - 3$

$f(x) = (x - 1)^2 - 4$  (4)

(b)



Shape  
x int.  
y int.  
Tpt.

(4)

(c) Range =  $[-4; \infty)$  OR  $y \geq -4$

(2)

(d) For gradient, use:  $(-1; 0)$  and  $(0; -3)$

$$m = \frac{-3 - 0}{0 - (-1)} \quad \therefore m = -3$$

$c = -3$

$\therefore y = -3x - 3$

(3)  
[13]

**QUESTION 3**

(a)  $p = -3$  and  $q = -2$

$$y = \frac{a}{x+3} - 2 \quad \text{substitute } (-4; -4)$$

$$\therefore -4 = \frac{a}{-4+3} - 2$$

$$\therefore a = 2$$

(4)

(b)  $y = x + 1$  and  $y = -x - 5$

(2)

**[6]****QUESTION 4**

(a)  $A = P(1 + i)^n$

$$7\,024,64 = 5\,600 \left(1 + \frac{r}{100}\right)^2$$

$$r = 12\% \text{ p.a.}$$

$$\left(1 + \frac{k}{400}\right)^4 = 1 + \frac{12}{100} \quad \text{where } k \text{ represents the nominal rate}$$

$$k = 11,49\% \text{ p.a. compounded quarterly.}$$

**Alternative**

$$5\,600 \left(1 + \frac{i^{(4)}}{4}\right)^8 = 7\,024,64$$

$$\therefore \left(1 + \frac{i^{(4)}}{4}\right)^8 = 1,2544$$

$$\therefore 1 + \frac{i^{(4)}}{4} = 1,02873 \dots$$

$$\therefore i^{(4)} = 11,49\%$$

(4)

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

$$850\,000 = x \left[ \frac{1 - \left(1 + \frac{8,5}{1200}\right)^{-(20 \times 12)}}{\frac{8,5}{1200}} \right]$$

$$x = R7\,376,497484$$

$$x \sim R7\,376,50$$

(4)

$$(2) \quad A = 850\,000 \left( 1 + \frac{8,5}{1\,200} \right)^{144}$$

$$A = 2\,348\,755,326$$

$$F = 7376,497484 \left[ \frac{\left( 1 + \frac{8,5}{1\,200} \right)^{144} - 1}{\frac{8,5}{1\,200}} \right]$$

$$F = 1\,836\,218,39$$

$$A - F = R512\,536,9355$$

$$\therefore \text{Balance} \approx R512\,536,94$$

**Alternative (1)**

$$A = 850\,000 \left( 1 + \frac{8,5}{1\,200} \right)^{144}$$

$$A = 2\,348\,755,326$$

$$\approx 2\,348\,755,33$$

$$F = 7376,50 \left[ \frac{\left( 1 + \frac{8,5}{1\,200} \right)^{144} - 1}{\frac{8,5}{1\,200}} \right]$$

$$F = 1\,836\,218,39$$

$$A - F = R512\,536,94$$

**Alternative (2)**

$$P = 7\,376,497484 \left[ \frac{1 - \left( 1 + \frac{8,5}{1\,200} \right)^{-(8 \times 12)}}{\frac{8,5}{1\,200}} \right]$$

$$P = 512\,536,9358$$

$$\therefore \text{Balance} \approx R512\,536,94$$

(4)

- (3) Total amount paid in 12 years =  $7\,376,497484 \times 144$   
 Total amount paid in 12 years = R1 062 215,638

$$\text{Balance} \approx R512\,536,9355$$

$$\text{Amount that went towards paying original loan} = 850\,000 - 512\,536,9355 = 337\,463,0645$$

$$\begin{aligned} \text{\% of 144 payments gone towards reducing the amount outstanding} &= \\ \frac{337\,463,0645}{1\,062\,215,638} \times 100 &= \\ &= 31,77\% \end{aligned}$$

(3)  
[15]

**QUESTION 5**

(a)  $f(x) = 2x^2 + x + 7$   
 $f'(x) = \lim_{h \rightarrow 0} \frac{2(x+h)^2 + (x+h) + 7 - (2x^2 + x + 7)}{h}$   
 $f'(x) = \lim_{h \rightarrow 0} \frac{2x^2 + 4xh + 2h^2 + x + h + 7 - 2x^2 - x - 7}{h}$   
 $f'(x) = \lim_{h \rightarrow 0} \frac{h(4x + 2h + 1)}{h}$  notations  
 $f'(x) = 4x + 1$  (5)

(b)  $f(x) = \frac{x(x^2 - 2x - 3)}{x - 3}$   
 $f(x) = \frac{x(x-3)(x+1)}{(x-3)}$   
 $f(x) = x^2 + x$   
 $f'(x) = 2x + 1$   
 $f'(2) = 5$  (5)

(c)  $y = 4x^{-1} - 5x^{\frac{1}{2}}$   
 $\frac{dy}{dx} = -4x^{-2} - \frac{5}{2}x^{-\frac{1}{2}}$  (3)

(d)  $g(x) = \frac{1}{2}x + 5 \therefore m_{\tan} = -2$

For the point of contact:  $f'(x) = 2x - 3$

$$2x - 3 = -2$$

$$x = \frac{1}{2} \therefore y = -\frac{29}{4}$$

Substitute  $\left(\frac{1}{2}; -\frac{29}{4}\right)$  in  $y = -2x + c$

$$-\frac{29}{4} = -2\left(\frac{1}{2}\right) + c$$

$$c = -\frac{25}{4}$$

$$y = -2x - \frac{25}{4} \text{ i.e. } 4y = -8x - 25$$
 (5)

**[18]**

**QUESTION 6**

$$\begin{aligned}
 \text{(a)} \quad & [2(3)^2 - 3(3) + 1] + [2(4)^2 - 3(4) + 1] + [2(5)^2 - 3(5) + 1] \\
 & 10 + 21 + 36 \\
 & = 67 \quad (3)
 \end{aligned}$$

$$\begin{aligned}
 \text{(b)} \quad & T_3 = ar^2 = 36 \\
 & T_3 = ar^5 = 7\,776
 \end{aligned}$$

$$\frac{ar^5}{ar^2} = \frac{7\,776}{36} \text{ m}$$

$$r^3 = 216$$

$$r = 6$$

$$\therefore a = 1$$

(6)  
[9]

|                 |
|-----------------|
| <b>75 marks</b> |
|-----------------|

**SECTION B****QUESTION 7**

(a) First and last =  $(5 \times 2) \times 2 = 20$

Middle 18 =  $18 \times 4 \times 2 = 144$

$\therefore$  Perimeter = 164 (4)

(b) (1) Converging areas:  $\pi \cdot 16^2$ ;  $\pi \cdot \frac{16^2}{7}$ ;  $\pi \cdot \frac{16^2}{7^2}$

Common ratio =  $\frac{\pi \cdot 16^2}{7} \div \pi \cdot 16^2$

$= \frac{1}{7}$

Since  $-1 < r < 1$ , the series converges (4)

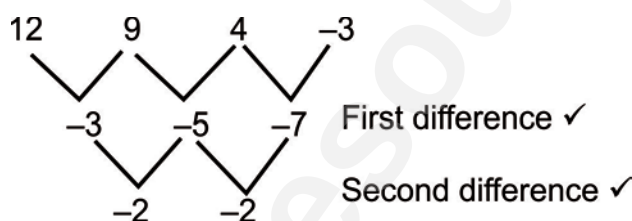
(2)  $S_{\infty} = \frac{a}{1-r}$

$S_{\infty} = \frac{16^2 \cdot \pi}{1 - \frac{1}{7}}$

$S_{\infty} = 938,289$   
 $\approx 938$

(3)

(c)



$T_n = an^2 + bn + c$

$a + b + c = 12$

$4a + 2b + c = 9$

$9a + 3b + c = 4$

$3a + b = -3$  and  $5a + b = -5$

$\therefore b = -3 - 3a$

Substitute  $b = -3 - 3a$  into  $5a + b = -5$

$5a - 3 - 3a = -5$

$a = -1$

$\therefore b = 0$  and  $c = 13$

$\therefore T_n = -n^2 + 13$

(6)  
[17]

**QUESTION 8**

- (a) The sums that are prime are: {2 ; 3 ; 5 ; 7 ; 11}

2: (1 ; 1)

3: (1 ; 2), (2 ; 1)

5: (1 ; 4), (2 ; 3), (3 ; 2), (4 ; 1)

7: (1 ; 6), (2 ; 5), (3 ; 4), (4 ; 3), (5 ; 2), (6 ; 1)

11: (5 ; 6), (6 ; 5)

Total favourable outcomes = 15

$$P(\text{sum is prime}) = \frac{15}{36}$$

$$= \frac{5}{12}$$

(5)

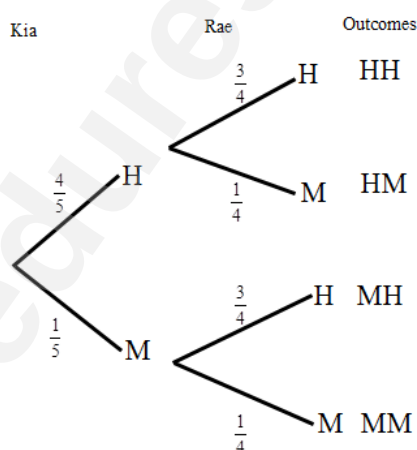
- (b)
- $P(\text{Kia will miss}) = 1 - P(\text{Kia will hit})$

$$= 1 - \frac{4}{5}$$

$$= \frac{1}{5}$$

Similarly,  $P(\text{Rae will miss}) = 1 - \frac{3}{4}$

$$= \frac{1}{4}$$



KEY: H represents HIT M represents MISS

$$P(\text{target will be missed by only one of them}) = P(\text{HM}) + P(\text{MH})$$

$$= \frac{4}{5} \times \frac{1}{4} + \frac{1}{5} \times \frac{3}{4}$$

$$= \frac{7}{20}$$

(6)

(c) (1)  $8!$   
 $= 40\,320$  (2)

(2)  $2^3 \times 4!$   
 $= 192$

$$P(\text{same suit}) = \frac{192}{40\,320}$$

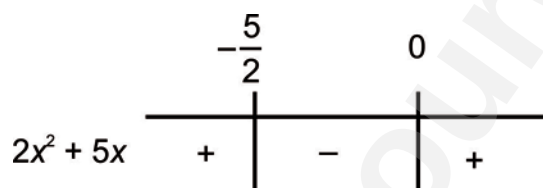
$$= \frac{1}{210}$$
 (4)

[17]

**QUESTION 9**

(a)  $(x+1)(2x+3) < 3$   
 $2x^2 + 5x < 0$   
 $x(2x+5) < 0$

Critical Values:  $0; -\frac{5}{2}$



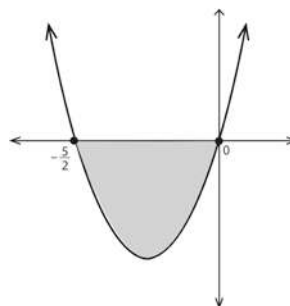
Solution:  $\left\{ x : -\frac{5}{2} < x < 0 \right\}$

**Alternative**

$$2x^2 + 5x < 0$$

Sketch  $y = 2x^2 + 5x$ 

$x$ -int:  $x = 0$  OR  $x = -\frac{5}{2}$



Solution:  $\left\{ x : -\frac{5}{2} < x < 0 \right\}$

(4)

(b)  $\sqrt{\frac{5-x^2}{1+2x^2}} = \frac{1}{3}$

$$\frac{5-x^2}{1+2x^2} = \frac{1}{9}$$

$$9(5-x^2) = (1+2x^2)$$

$$11x^2 - 44 = 0$$

$$x = \pm 2$$

(5)

[9]

**QUESTION 10**

(a)  $y = \log_{\frac{1}{p}} x$       substitute (3; -1)

$$-1 = \log_{\frac{1}{p}} 3$$

$$\left(\frac{1}{p}\right)^{-1} = 3$$

$$p = 3$$

$$\therefore f(x) = -x^3 + mx^2 + nx + 3 \quad \text{substitute } (-1; 0)$$

$$0 = -(-1)^3 + m(-1)^2 + n(-1) + 3$$

$$n = m + 4$$

$$f'(x) = -3x^2 + 2mx + n \quad \text{substitute } x = -1 \text{ when } m = 0$$

$$0 = -3(-1)^2 + 2m(-1) + n$$

$$0 = -3 - 2m + n \quad \text{substitute } n = m + 4$$

$$0 = -3 - 2m + m + 4$$

$$m = 1$$

$$\therefore n = 5$$

(6)

(b)  $f'(x) = -3x^2 + 2x + 5$

$$f''(x) = -6x + 2$$

$g$  is concave up for all  $x > 0$

$\therefore$  Both are concave up if  $f''(x) > 0$

$$\therefore -6x + 2 > 0$$

$$\therefore x < \frac{1}{3}$$

(4)

(c)  $g(x) = \log_{\frac{1}{3}} x$

$$\text{For } g^{-1}(x): \quad x = \log_{\frac{1}{3}} y$$

$$y = \left(\frac{1}{3}\right)^x$$

(3)

(d) Domain of  $g^{-1}(x): x \in \mathbb{R}$

(2)

(e)  $x$  intercept of  $f: x^3 - x^2 - 5x - 3 = 0$

$$(x + 1)(x + 1)(x - 3) = 0$$

$$x = 3 \text{ or } x = -1$$

$x$  intercept of  $g: \log_{\frac{1}{3}} x = 0$

$$\left(\frac{1}{3}\right)^0 = x \therefore x = 1$$

$\therefore$  solution for  $x$  if  $\frac{f(x)}{g(x)} \leq 0$  is:  $1 < x \leq 3$  (7)

(f)  $k > 1$  (2)

[24]

### QUESTION 11

Let the amount increased/decreased by be  $x$

$\therefore$  Length of square  $= 3 + x$

Perpendicular height  $= 9 - x$

$$V = \frac{1}{3}(3 + x)^2(9 - x)$$

$$V = \frac{1}{3}(9 + 6x + x^2)(9 - x)$$

$$V = \frac{1}{3}(81 + 54x + 9x^2 - 9x - 6x^2 - x^3)$$

$$V = \frac{1}{3}(-x^3 + 3x^2 + 45x + 81)$$

$$V = -\frac{1}{3}x^3 + x^2 + 15x + 27$$

$$\frac{dV}{dx} = -x^2 + 2x + 15 \text{ for min / max let } \frac{dV}{dx} = 0$$

$$x^2 - 2x - 15 = 0$$

$$x = 5 \text{ or } x = -3$$

Maximum for  $x = 5$

$\therefore$  New length  $= 3 + 5 = 8$

$\therefore$  New perp. height  $= 9 - 5 = 4$

$\therefore \frac{\text{New length}}{\text{New perp. length}} = \frac{8}{4} = 2$

Volume is a maximum when the perp. height is half that of the length of the square. (8)  
[8]

|          |
|----------|
| 75 marks |
|----------|