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INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION  
NOVEMBER 2024

**MATHEMATICS: PAPER I**

**MARKING GUIDELINES**

Time: 3 hours

150 marks

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**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.**

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## SECTION A

## QUESTION 1

(a) (i)  $x - 1 = \pm 2p$

$$x = 1 \pm 2p$$

(ii)  $2 - x = \log_3 p$

$$x = 2 - \log_3 p$$

(b) (i)  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$$2a = 4 \therefore a = 2$$

$$b = 3$$

(ii)  $9 - 8k$  is a perfect square

$$k = 0 \text{ or } k = 1$$

(iii)  $9 - 8k > 0$

$$\therefore k < \frac{9}{8}$$

(c)  $x - 3 = \sqrt{2x - 3}$

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

$$x^2 - 6x + 9 = 2x - 3$$

$$x^2 - 8x + 12 = 0$$

$$(x - 6)(x - 2) = 0$$

$$x = 6 \text{ or } x = 2(N.A)$$

(d)  $= \log \frac{1}{2} - \log(2^4 \cdot 3)$

$$= -\log 2 - (4\log 2 + \log 3)$$

$$= -\log 2 - 4\log 2 - \log 3$$

$$= -5\log 2 - \log 3$$

$$= -5a - b$$

**QUESTION 2**

$$(a) \quad T_n = 4 \left( \frac{1}{2} \right)^{n-1}$$

$$= \left( \frac{1}{2} \right)^{-2} \left( \frac{1}{2} \right)^{n-1}$$

$$= \left( \frac{1}{2} \right)^{n-3}$$

$$(b) \quad (i) \quad rS_n = ar + ar^2 + ar^3 + \dots + ar^n$$

$$(ii) \quad rS_n - S_n = (ar + ar^2 + ar^3 + \dots + ar^n) - (a + ar + ar^2 + \dots + ar^{n-1})$$

$$S_n(r - 1) = ar^n - a = a(r^n - 1)$$

$$\therefore S_n = \frac{a(r^n - 1)}{r - 1}$$

$$(c) \quad (i) \quad T_1 = a \quad T_2 = a + 4d \quad T_3 = a + 14d \quad \text{Geometric sequence}$$

$$(a + 4d)^2 = a(a + 14d)$$

$$a^2 + 8ad + 16d^2 = a^2 + 14ad$$

$$\frac{16d^2}{2d} = \frac{6ad}{2d}$$

$$\therefore 3a = 8d$$

$$(ii) \quad r = \frac{a + 4d}{a}$$

$$\text{but } d = \frac{3a}{8}$$

$$r = \frac{a + \frac{4 \cdot 3a}{8}}{a}$$

$$r = \frac{5}{2}$$

**QUESTION 3**

(a) (i)  $y = 3x^{\frac{1}{2}} - x^{-\frac{1}{2}}$

$$\frac{dy}{dx} = \frac{3}{2}x^{-\frac{1}{2}} + \frac{1}{2}x^{-\frac{3}{2}}$$

(ii)  $g(x) = \frac{\pi(x-1)(x^2 - 3x + 3\pi)}{x-1}$

$$= \pi x^2 - 3\pi x + 3\pi^2$$

$$g'(x) = 2\pi x - 3\pi$$

(b)  $f'(x) = \lim_{h \rightarrow 0} \frac{\frac{3}{x+h} - \frac{3}{x}}{h}$

$$= \lim_{h \rightarrow 0} \frac{3x - 3(x+h)}{hx(x+h)}$$

$$= \lim_{h \rightarrow 0} \frac{-3h}{x(x+h)h}$$

$$= \lim_{h \rightarrow 0} \frac{-3}{x^2 + xh}$$

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

(c) (i)  $x < -1$

(ii)  $x = 1$

(iii)  $-\frac{1}{3} < x < 1$

**QUESTION 4**

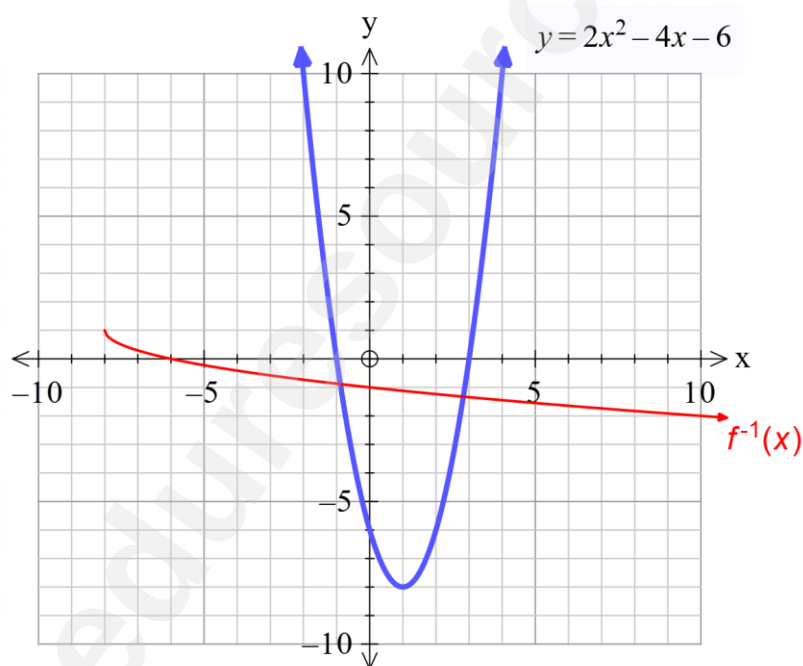
(a)  $k = 1$

(b)  $f(x) = 2(x - 1)^2 - 8$

(c)  $f^{-1}(x) : x = 2(y - 1)^2 - 8$

$$y - 1 = -\sqrt{\frac{x + 8}{2}}$$

$$y = 1 - \sqrt{\frac{x + 8}{2}}; x \geq -8$$

(d)  $(-8;1)$ ,  $(-6;0)$  and  $(0;-1)$  a mark for each point on the correct shape

**QUESTION 5**

(a)  $\left(1 + \frac{i}{4}\right)^4 = 1 + 0,1\,275$

$$\frac{i}{4} = \sqrt[4]{1,1\,275} - 1$$

$$i = 0,1\,218\dots$$

$$\text{Rate} = 12,18\%$$

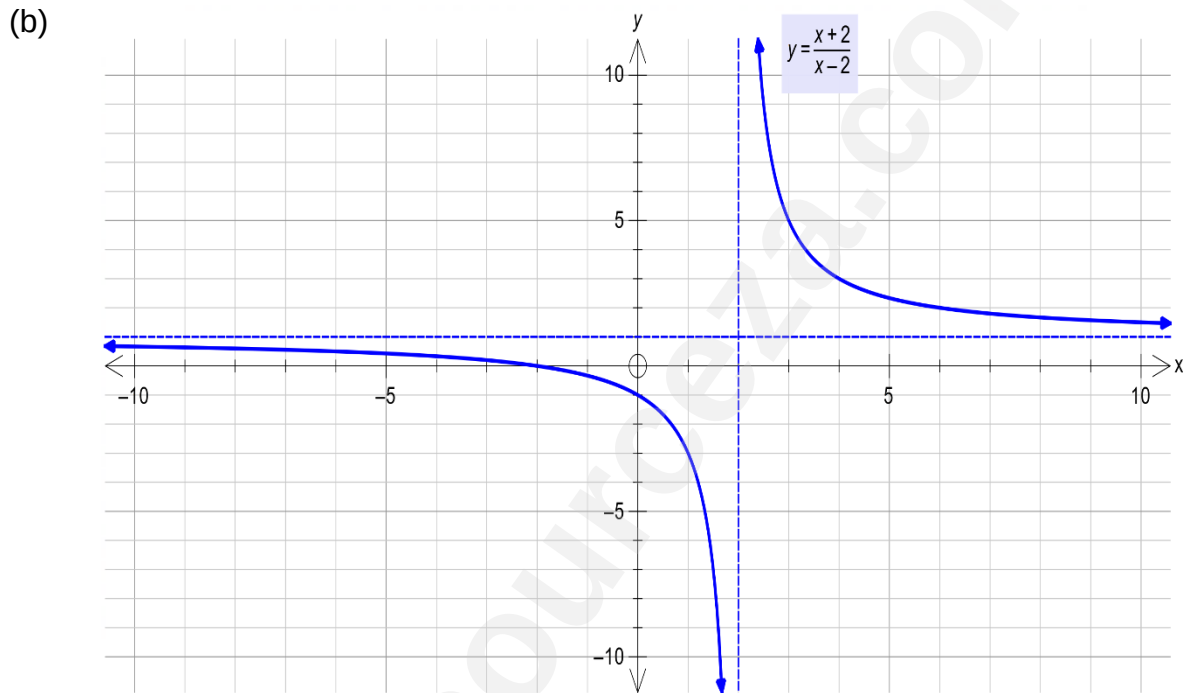
(b) Depreciated price =  $200\,000(1 - 0,087)^2$   
= R166 713,80

$$\text{He needs to save } 166\,713,8 \left(1 + \frac{0,1275}{12}\right)^{-24} = \text{R}129\,363,17$$

## SECTION B

## QUESTION 6

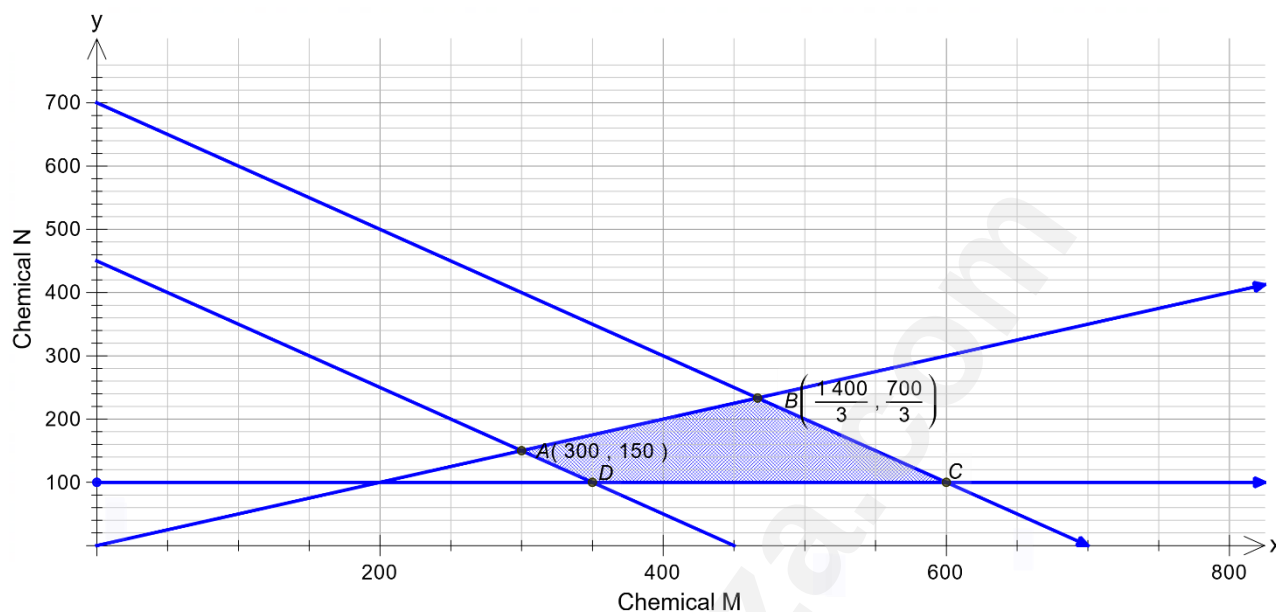
$$\begin{aligned}
 \text{(a)} \quad f(x) &= \frac{a+q(x+p)}{x+p} \\
 &= \frac{qx+a+qp}{x+p}
 \end{aligned}$$



$$\begin{aligned}
 y &= \frac{x+2}{x-2} \\
 &= \frac{(x-2)+4}{x-2} \\
 &= \frac{4}{x-2} + 1
 \end{aligned}$$

$$\begin{aligned}
 \text{(c)} \quad y &= -(x-2)+1 \\
 y &= -x+3
 \end{aligned}$$

## QUESTION 7



(a)  $y \geq -x + 450$

$y \leq -x + 700$

$y \leq \frac{1}{2}x$

(b) On the graph

(c)  $C = 16x + 10y$

search line  $y = 1,6x + \frac{C}{10}$

Most economical 300 kg of M and 150 kg of N

(d)  $C = x + y$

$y = -x + C$

$\therefore$  the minimum cost will be any point on  $y = -x + 450$  between coordinates (350; 100) and (300; 150)

**QUESTION 8**

(a)  $f'(x) = 3ax^2 + 2bx + c$

$$f''(x) = 6ax + 2b$$

$$6a(3) + 2b = 0$$

$$2b = -18a$$

$$b = -9a$$

(b)  $d = 0$

$$f'(0) = 3$$

$$c = 3$$

$$f(3) = -9$$

$$a(3^3) + b(3^2) + 3(3) = -9$$

$$27a + 9b = -18$$

$$27a + 9(-9a) = -18$$

$$-54a = -18$$

$$a = \frac{1}{3}$$

$$\therefore b = -3$$

$$f(x) = \left(\frac{1}{3}\right)x^3 - 3x^2 + 3x$$

(c) (i)  $-0,8 < k < 18,8$

(ii)  $-1,15 < m < 0$  or  $-7,85 < m < -1,15$

- (d) Drawn on the original graph (concave up parabola). A mark for each root ( $x = 0,55$  and  $x = 5,45$ ) and a mark for the turning point with  $x = 3$ .

**QUESTION 9**

(a)  $T_k = S_k - S_{k-1}$

$$= 2k^2 - k - (2(k-1)^2 - (k-1))$$

$$2k^2 - k - 2k^2 + 4k - 2 + k - 1$$

$$= 4k - 3$$

Or  $T_1 = S_1 = 1$

$$T_2 = S_2 - S_1 = 5$$

$$T_3 = S_3 - S_2 = 9$$

$$\therefore T_k = 4k - 3$$

(b) Horizontal:  $12 - 6 + 3 - 1.5 + \dots$

$$\therefore S_{\infty} = \frac{12}{1 + \frac{1}{2}} = 8$$

Vertical:  $4 - 2 + 1 - 0.5 + \dots$

$$\therefore S_{\infty} = \frac{4}{1 + \frac{1}{2}} = 2\frac{2}{3}$$

$$x = 8 + 8 = 16$$

$$y = -5 + 2\frac{2}{3} = -2\frac{1}{3}$$

$$(16; -2\frac{1}{3})$$

**QUESTION 10**

$$(a) \quad 1\,000\,000 = \frac{x \left( 1 - \left( 1 + \frac{0,072}{12} \right)^{-300} \right)}{\frac{0,072}{12}}$$

$$x = 1\,000\,000 \div \frac{1 - 1,006^{-300}}{0,006}$$

$$= R7\,195,89$$

(b) Outstanding Balance after 5 years:

$$= \frac{7\,195,89(1 - 1,006^{-240})}{0,006} \quad \text{OR} \quad 1\,000\,000(1,006)^{60} - \frac{7\,195,89(1,006^{60} - 1)}{0,006}$$

$$= 913\,938,71$$

$$= 913\,938,09$$

$\therefore$  time taken

$$913\,938,71 = \frac{7\,195,89 \left( 1 - \left( 1 + \frac{0,068}{12} \right)^{-n} \right)}{\frac{0,068}{12}}$$

$$1 - \left( 1 + \frac{0,068}{12} \right)^{-n} = 0,7\,197\,144\,514$$

$$-n = \log_{1 + \frac{0,068}{12}}(0,2\,802\,855\,486)$$

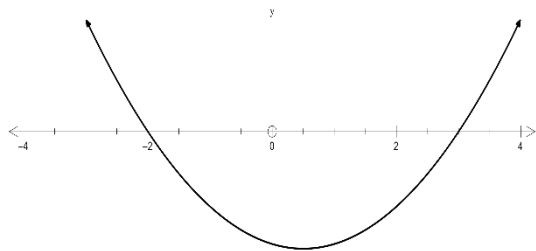
$$-n = -225,0\,964\,999$$

$$n = 225$$

It will change by  $300 - 225 - 60 = 15$  months.

**QUESTION 11**

(a)  $-2^x < 0 \therefore (x-3)(x+2) \geq 0$   
 $\therefore x \leq -2$  or  $\geq 3$



(b) (i)  $\text{time} = \frac{k}{v} \text{ hrs}$

$$\begin{aligned}\therefore C &= (2 + 0,001v^3) \frac{k}{v} \\ &= 2kv^{-1} + 0,001kv^2\end{aligned}$$

(ii)  $\frac{dC}{dv} = -2kv^{-2} + 0,002kv$

at min cost;  $-2kv^{-2} + 0,002kv = 0$

$$0,002v^3 - 2 = 0$$

$$v^3 = 1000$$

$$v = 10 \text{ km/h}$$

Justification:  $C''(v) = 4kv^{-3} + 0,002k$

$$C''(10) = \frac{4k}{1000} + 0,002k > 0$$

$\therefore$  minimum

**Total: 150 marks**