SAMPEL PERCUMA

Trial STPM 2023 Mathematics T Semester 1 Terengganu

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Sem 1 · Mathematics T

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KEMENTERIAN PENDIDIKAN
JABATAN PENDIDIKAN NEGERI TERENGGANU

STPM 2023

PEPERIKSAAN PERCUBAAN SEMESTER 1

MATHEMATICS (T)

954/1

Nama :.....

Kelas :.....

DIBIAYAI OLEH KERAJAAN NEGERI TERENGGANU

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ANJAKAN MUAFAKAT NEKAD

Section A [45 marks]

Answer **all** questions in this section

1. The function f is defined by $f: x^2 - 4x$, **for x** $\geq$ **2.**

   a) Find f^{-1}, and state its domain. [4]

   b) Find the coordinates of the point of intersection of graphs f and f^{-1}. [3]

   c) Sketch, on the same coordinates axes, the graphs of f and f^{-1}. [2]

2. Given that $U_r = \left(\frac{1}{4}\right)^{2r-3} + \left(\frac{1}{4}\right)^{2r-1}$.

   a) Express $\sum_{r=1}^{n} U_r$ in terms of $A\left(1 - \frac{B}{16^n}\right)$, where A and B are two constants . [6]

   b) Hence, determine the sum to infinity of the series [2]

3. Matrices A and B are given by $A = \begin{pmatrix} -4 & 0 & -3 \\ 2 & -1 & 2 \\ 4 & 0 & 3 \end{pmatrix}$ and $B = \begin{pmatrix} 1 & -3 & 1 \\ 8 & 3 & 10 \\ 2 & 3 & 2 \end{pmatrix}$. Find

   a) the matrix P such that $P = A^2 + B - 3I$, where I is 3 x 3 identity matrix. [3]

   b) $(A + 2I)P$, and hence $(A + 2I)^{15}P$. [6]

4. If z is a complex number such that $|z| = 1$, find the real part of $\frac{1}{1-z}$. [5]

5. The parametric equations of a conic are $x = 2\sin\theta + 2$ and $y = \sqrt{3}\cos\theta + 1$, where $0 \leq \theta \leq 2\pi$.

   a) Find the standard form for the equation of the conic and identify the type of conic. [3]

   b) Sketch the conic. [2]

6. The point P with coordinates (0 , m , n) lies on the line l_1, which has equation

   $$r = 5i + 18j - k + \lambda(i + 3j - 5k)$$

   a) Find the values of m and n. [3]

   b) The point B lies on l_1 such that OB is perpendicular to l_1, where O is the origin. Find the position vector of point B. [6]

Section B [15 marks]

Answer any **one** question in this section .

7. The polynomial $\boldsymbol{Q(x) = x^3 + mx^2 + nx - 8}$, where $\boldsymbol{m}$ and $\boldsymbol{n}$ are constants, is divisible by $\boldsymbol{x^2 - 4}$.

   a) Find the values of $\boldsymbol{m}$ and $\boldsymbol{n}$, and hence, factorise $\boldsymbol{Q(x)}$ completely. [6]

   b) Find the set of values of x which satisfies $\frac{\mathbf{Q(x)}}{(x+2)} \geq \mathbf{0}$. [4]

   c) Hence, express $\frac{-2(x^2+5x+10)}{Q(x)}$ in partial fractions. [5]

8. The diagram below shown the position vectors of the points $\boldsymbol{P}$, $\boldsymbol{Q}$ and R with respect to an origin $\boldsymbol{O}$ are respectively given by, $\boldsymbol{p = 3i}$, $\boldsymbol{q = 2j}$ $\boldsymbol{and}$ $\boldsymbol{r = 9k}$

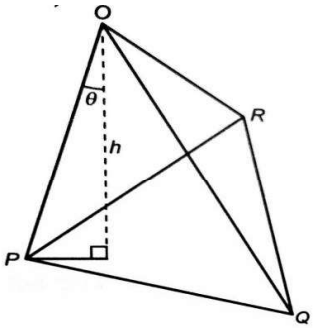


Diagram 1

(a). Find the exact value of the cosine of angle $\boldsymbol{PRQ}$. [3]

(b). Calculate the area of the triangle $\boldsymbol{PRQ}$. [4]

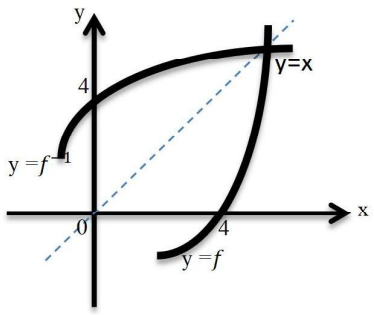
(c). Show that the volume of tetrahedron $\boldsymbol{OPQR}$ is $\frac{1}{6}\left|\overrightarrow{\boldsymbol{OP}} \cdot (\overrightarrow{\boldsymbol{PQ}} \times \overrightarrow{\boldsymbol{PR}})\right|$ and calculate its value. [6]

(d). Hence, find the perpendicular distance from $\boldsymbol{O}$ to the plane $\boldsymbol{PQR}$. [2]

----------END OF QUESTIONS----------

SECTION A

1. The function f is defined by $f: x^2 - 4x$, for $x \geq 2$.
   a) Find f^{-1}, and state its domain. [4]
   b) Find the coordinates of the point of intersection of graphs f and f^{-1}. [3]
   c) Sketch, on the same coordinates axes, the graphs of f and f^{-1}. [2]

Q	Answer	Marks	Guidance
1(a)	$f: x^2 - 4x, \quad x \geq 2$		
	$f^{-1}(x) = y$		
	$y^2 - 4y = x$	M1	
	$(y-2)^2 - 4 = x$		
	$y = \sqrt{x+4} + 2$	A1	
	$f^{-1}: x \to \sqrt{x+4} + 2$	A1	In mapping form
	$D_{f^{-1}} = \{y: y \geq -4\}$	B1	
1(b)	$x^2 - 4x = x$		
	$x^2 - 5x = 0$	M1	
	$\therefore \quad x = 0$ or $x = 5$	A1	
	$\because \quad x \geq 2 \quad ; \quad x = 5$		
	intersection point = (5,5)	A1	
		D1	Correct f and f^{-1}
		D1	All correct with $y = x$
	TOTAL MARKS	***9***	

2. Given that $U_r = \left(\frac{1}{4}\right)^{2r-3} + \left(\frac{1}{4}\right)^{2r-1}$.

(a) Express $\sum_{r=1}^{n} U_r$ in terms of $A\left(1 - \frac{B}{16^n}\right)$, where A and B are two constants. [6]

(b) Hence, determine the sum to infinity of the series [2]

Q	Answer	Marks	Guidance
2(a)	$U_r = \left(\frac{1}{4}\right)^{2r-3} + \left(\frac{1}{4}\right)^{2r-1}$		
	$= \left(4^{-1}\right)^{2r-3} + \left(4^{-1}\right)^{2r-1}$		
	$= 4^{-2r+3} + 4^{-2r+1}$		
	$= (4^3)4^{-2r} + (4)4^{-2r}$	M1	
	$= 68(\frac{1}{4})^{2r}$		
	$\sum_{r=1}^{n} U_r = 68\sum_{r=1}^{n}\left(\frac{1}{4}\right)^{2r}$	A1	
	$\sum_{r=1}^{n} U_r = 68\left[\left(\frac{1}{4}\right)^2 + \left(\frac{1}{4}\right)^4 + \left(\frac{1}{4}\right)^6 + \ldots + \left(\frac{1}{4}\right)^{2n}\right]$	M1	
	$= 68\left(\frac{1}{4}\right)^2\left[1 + \left(\frac{1}{4}\right)^2 + \left(\frac{1}{4}\right)^4 + \left(\frac{1}{4}\right)^6 + \ldots + \left(\frac{1}{4}\right)^{2(n-1)}\right]$	M1	GP seen If not ***NEW-1***
	$= \frac{68}{16}\left(\frac{1 - \left(\frac{1}{4}\right)^{2n}}{1 - \left(\frac{1}{4}\right)^2}\right)$	M1	
	$= \frac{68}{15}\left(1 - \frac{1}{16^n}\right)$	A1	
	MARKS	***6***	
2(b)	$\sum_{r=1}^{\infty} U_r = \lim_{n\to\infty} \frac{68}{15}\left(1 - \frac{1}{16^n}\right)$, $\frac{1}{16^n} \to 0$	M1	
	$= \frac{68}{15}$	A1	
	MARKS	***2***	
	TOTAL MARKS	***8***	

3. Matrices **A** and **B** are given by $\mathbf{A} = \begin{pmatrix} -4 & 0 & -3 \\ 2 & -1 & 2 \\ 4 & 0 & 3 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 1 & -3 & 1 \\ 8 & 3 & 10 \\ 2 & 3 & 2 \end{pmatrix}$. Find

(a) the matrix **P** such that $\mathbf{P} = \mathbf{A}^2 + \mathbf{B} - 3\mathbf{I}$, where $\mathbf{I}$ is 3 x 3 identity matrix. [3]

(b) $(\mathbf{A} + 2\mathbf{I})\mathbf{P}$, and hence $(\mathbf{A} + 2\mathbf{I})^{15}\mathbf{P}$. [6]

Q	Answer	Marks	Guidance
3(a)	$A^2 = \begin{pmatrix} -4 & 0 & -3 \\ 2 & -1 & 2 \\ 4 & 0 & 3 \end{pmatrix}\begin{pmatrix} -4 & 0 & -3 \\ 2 & -1 & 2 \\ 4 & 0 & 3 \end{pmatrix} = \begin{pmatrix} 4 & 0 & 3 \\ -2 & 1 & -2 \\ -4 & 0 & -3 \end{pmatrix}$	M1	
	$P = \begin{pmatrix} 4 & 0 & 3 \\ -2 & 1 & -2 \\ -4 & 0 & -3 \end{pmatrix} + \begin{pmatrix} 1 & -3 & 1 \\ 8 & 3 & 10 \\ 2 & 3 & 2 \end{pmatrix} - 3\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$	M1	
	$P = \begin{pmatrix} 2 & -3 & 4 \\ 6 & 1 & 8 \\ -2 & 3 & -4 \end{pmatrix}$	A1	(All correct)
3(b)	$(A+2I) = \begin{pmatrix} -2 & 0 & -3 \\ 2 & 1 & 2 \\ 4 & 0 & 5 \end{pmatrix}$ $(A+2I)P = \begin{pmatrix} -2 & 0 & -3 \\ 2 & 1 & 2 \\ 4 & 0 & 5 \end{pmatrix}\begin{pmatrix} 2 & -3 & 4 \\ 6 & 1 & 8 \\ -2 & 3 & -4 \end{pmatrix}$	M1	
	$(A+2I)P = \begin{pmatrix} 2 & -3 & 4 \\ 6 & 1 & 8 \\ -2 & 3 & -4 \end{pmatrix}$	A1	
	$(A+2I)P = P$ $Let\ , R = (A+2I)$ $RP = P$	B1	SEEN
	$R^2P = R(RP) = RP = P$ $R^3P = R(R^2P) = RP = P$	M1	SHOWN R^3
	$(A+2I)^{15}P = R^{15}P = (R^3)^5P = (R^3)^4(R^3P)$ $= (R^3)^4P = (R^3)^3P = (R^3)^2P = (R^3)^1P = P$ $(A+2I)^{15}P = \begin{pmatrix} 2 & -3 & 4 \\ 6 & 1 & 8 \\ -2 & 0 & -4 \end{pmatrix}$	M1 A1	TRY TO ATTEMPT $(A+2I)^{15}P = P$ **CAO**
	TOTAL MARKS	***9***	

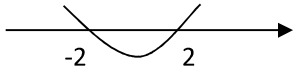
SECTION B

7. The polynomial $Q(x) = x^3 + mx^2 + nx - 8$, where m and n are constants, is divisible by $x^2 - 4$.

a) Find the values of m and n, and hence, factorise Q(x) completely. [6]

b) Find the set of values of x which satisfies $\frac{Q(x)}{(x+2)} \geq 0$. [4]

c) Hence, Express $\frac{-2(x^2+5x+10)}{Q(x)}$ in partial fractions. [5]

Q	Answer	Marks	Guidance
7(a)	$Q(x) = x^3 + mx^2 + nx - 8$		
	$Q(-2) = (-2)^3 + m(-2)^2 + n(-2) - 8 = 0$	M1	Use factor theorem.
	$Q(2) = (2)^3 + m(2)^2 + n(2) - 8 = 0$		
	$2m - n = 8 \ldots (1)$	M1	Either one correct
	$2m + n = 0 \ldots (2)$		
	$(1) + (2) \quad m = 2$	M1	Attempt to solve
	$n = -4$	A1	Both correct
	$Q(x) = x^3 + 2x^2 - 4x - 8$		
	$= (x + 2)(x^2 - 4)$	M1	Get 'his' $(ax^2 + bx + c)$
	$= (x + 2)(x + 2)(x - 2)$	A1	CAO
	$= (x + 2)^2(x - 2)$		
	MARKS	***6***	
7(b)	$\frac{Q(x)}{(x+2)} \geq 0$		
	$\frac{(x+2)(x+2)(x-2)}{(x+2)} \geq 0$	B1	
	$(x + 2)(x - 2) \geq 0 \quad , \quad x \neq -2$	M1	
		M1	
	$\{x: x < -2, x \geq 2\}$	A1	
	MARKS	***4***	
7(c)	$\frac{-2(x^2 + 5x + 10)}{Q(x)} = \frac{-2(x^2 + 5x + 10)}{(x + 2)^2(x - 2)}$		
	$\equiv \frac{A}{(x+2)} + \frac{B}{(x+2)^2} + \frac{C}{(x-2)}$	B1	
	$= \frac{A(x+2)(x-2)+B(x-2)+C(x+2)^2}{(x+2)^2(x-2)}$		
	When $x = 2, \ -48 = 16C \ ; C = -3$	M1	Attempt to solve
	When $x = -2, \ -8 = -4B \ ; B = 2$	A1	Either 2 correct
	When $x = 0, \ -20 = -4A - 2B + 4C \ ; A = 1$	A1	All correct
	$\frac{-2(x^2+5x+10)}{Q(x)} = \frac{1}{(x+2)} + \frac{2}{(x+2)^2} - \frac{3}{(x-2)}$	A1	
	MARKS	***5***	
	TOTAL MARKS	***15***	

8. The diagram below shown the position vectors of the points P , Q and R with respect to an origin O are respectively given by, $\boldsymbol{p = 3i}$, $\boldsymbol{q = 2j}$ $\boldsymbol{and}$ $\boldsymbol{r = 9k}$

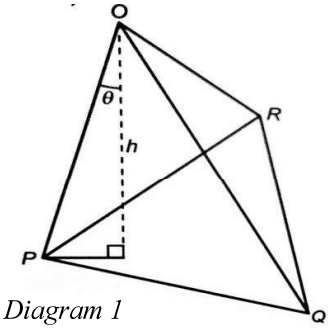


Diagram 1

(a). Find the exact value of the cosine of angle PRQ. [3]
(b). Calculate the area of the triangle PRQ. [4]
(c). Show that the volume of tetrahedron OPQR is $\frac{1}{6}\left|\overrightarrow{OP}\ (\overrightarrow{PQ}\ X\ \overrightarrow{PR})\right|$ and calculate its value. [6]
(d). Hence, find the perpendicular distance from O to the plane PQR. [2]

Q	Answer	Marks	Guidance
8(a)	$\cos\angle PRQ = \frac{\overrightarrow{RP}.\overrightarrow{RQ}}{\lvert\overrightarrow{RP}\rvert\lvert RQ\rvert} = \frac{(3,0,-9).(0,2,-9)}{\lvert(3,0,-9)\rvert\lvert(0,2,-9)\rvert}$	M1	
	$= \frac{81}{\sqrt{9+81}\sqrt{4+81}}$	M1	
	$= \frac{27}{\sqrt{850}} = \frac{27}{5\sqrt{34}}$	A1	
	MARKS	***3***	
8(b)	Area of $\Delta PRQ = \frac{1}{2}\lvert\overrightarrow{RP}\times\overrightarrow{RQ}\rvert$		
	$= \frac{1}{2}\left\lvert\begin{pmatrix}3\\0\\-9\end{pmatrix}\times\begin{pmatrix}0\\2\\-9\end{pmatrix}\right\rvert$		
	$= \frac{1}{2}\lvert i(0+18) - j(-27-0) + k(6-0)\rvert$	M1	Try to cross two vector "-j" seen
	$= \frac{1}{2}\lvert 18i + 27j + 6k\rvert$	A1	Correct vector
	$= \frac{1}{2}\sqrt{18^2 + 27^{2+}6^2}$	M1	
	$= \frac{33}{2} = 16.5\ unit^2$	A1	
	MARKS	***4***	
8(c)	Volume of PQR $= \frac{1}{3}$ $(base\ area)(perpendicular\ height)$	B1	$\overrightarrow{OP}.n = \left(\lvert\overrightarrow{OP}\rvert\lvert n\rvert cos\theta\right)$ $n = \overrightarrow{PQ}X\overrightarrow{PR}$
	$= \frac{1}{3}\left(\frac{1}{2}\lvert\overrightarrow{PQ}X\overrightarrow{PR}\rvert\right)\left(\lvert\overrightarrow{OP}\rvert cos\theta\right)$	M1	
	$= \frac{1}{6}\left(\lvert\overrightarrow{PQ}X\overrightarrow{PR}\rvert\right)\left(\lvert\overrightarrow{OP}\rvert cos\theta\right)$		
	$= \frac{1}{6}(n)\left(\lvert\overrightarrow{OP}\rvert cos\theta\right)$		
	$= \frac{1}{6}\lvert\overrightarrow{OP}.n\rvert$	M1	
	$= \frac{1}{6}\lvert\overrightarrow{OP}.(\overrightarrow{PQ}\ X\overrightarrow{PR})\rvert$	A1	

TAMAT SAMPEL

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