SMK PERLIS (2005)
MATHEMATICS T – PAPER 1

1. Show that the equation $4x^3 + x + 5 = 0$ has only one real root, and find the value of this real root [5]

2. If $y = \sqrt{\cos x}$, show that $4y^3 \frac{d^2y}{dx^2} + y^4 = 1$ [5]

3 By using the laws of set algebra, show that for any sets A and B,
$B \cap (B - A)' = A \cap B$. [4]

4. If $A = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$, find the matrix A^2. Hence deduce A^{-1} and A^{101}. [5]

5 If $(x + yi)^2 = 3 + 4i$, find all the real values of x and y. [6]

6. The functions f and g are defined by

$$f : x \to 2(x+3)^2 - 5,\ x \le -3, \quad \text{and} \quad g : x \to \sqrt{\frac{x+5}{2}},\ x \ge -5.$$

(a) Show that the function f is one to one, and find an expression for f^{-1}. [3]

(b) Show that the composite function gf is defined.
Find, in the simplest form, an expression for gf. [5]

7. Find the solution set for $|x| \ge \frac{2}{x-1}$. [6]

8. Expand $\left(1 - \frac{x}{n}\right)^n$, with n is a positive integer, in ascending powers of x until the term in x^3. If the coefficient of x^3 is $-\frac{1}{27}$, determine the value of n. [6]

With this value of n, expand $\left(1 - \frac{x}{n}\right)^n \sqrt{1-x}$ in ascending powers of x until the term in x^3. [5]

Hence, by using $x = \frac{1}{10}$, find an approximation for $\sqrt{10}$ correct to three decimal places. [4]

9. The straight line $y = mx - 2$ intersects the curve $y^2 = 4x$ at two points $P(x_1, y_1)$ and $Q(x_2, y_2)$. Show that

(i) $m \ne 0$ and $m > -\frac{1}{2}$, [2]

(ii) $x_1 + x_2 = \frac{4(m+1)}{m^2}$, [3]

(iii) $y_1 + y_2 = \frac{4}{m}$. [3]

If the point O is the origin and T is a point such that $OPTQ$ is a parallelogram, show that, when m changes, the equation of the locus of T is $y^2 + 4y = 4x$. [6]

10. Sketch, on separate diagrams, the graphs for (a) $y = x^2(2-x)$ (b) $y = \frac{1}{x^2(2-x)}$

Show the turning points on each curve.
State the equations of asymptotes of the second curve. [10]

The area bounded by the curve $y = x^2(2-x)$ and the x–axis is rotated completely about the x–axis. Find the volume of revolution generated. [5]

11. Express $\frac{1}{4k^2-1}$ in partial fractions. [3]

Hence, find a simple expression for $S_n = \sum_{k=1}^{n} \frac{1}{4k^2-1}$ and find $\lim_{n \to \infty} S_n$. [5]

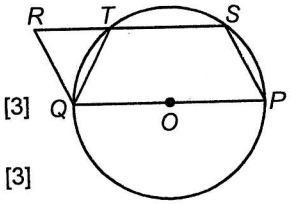
12. (a) Show that $\int_1^e \ln x \, dx = 1$ [4]

(b) By using a suitable substitution, find $\int \frac{3x-1}{\sqrt{x+1}} \, dx$. [4]

MATHEMATICS T – PAPER 2

1. Prove the identity $\frac{\sin 2x + 1}{\sec^2 x + 2\tan x} \equiv \cos^2 x$. [4]

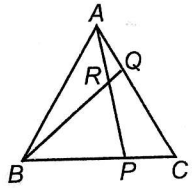
2. In the figure, $PQRS$ is a parallelogram and a circle, centre O, passes through S, PQ cuts the side RS at T.



(i) Show that $\angle QTR = \angle QRT$. [3]

(ii) If N is the foot of the perpendicular from T to PQ, show that ΔPQS and ΔQTN are similar. [3]

3. In the figure, ΔABC is an equilateral triangle and $\angle BAP = \angle CBQ$.



(a) Show that $BP = CQ$. [3]

(b) Find the value of $\angle ARB$. [3]

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4. The variables t and x are connected by $\frac{dx}{dt} = 3t^2(x - e)$, where $x \neq e$.

Find x in terms of t if $x = 2e$ when $t = 2$. [7]

5. Given that $f(x) = 7\cos x - 24\sin x \equiv R\cos(x + \alpha)$, where $R > 0$, and $0 \leq \alpha \leq \frac{\pi}{2}$.

(i) Find the value of R and show that $\alpha = 1.29$, correct to two decimal places. [3]

(ii) Find the minimum value of $f(x)$ and the value of x in the interval $0 \leq x \leq 2\pi$, which gives the minimum value of $f(x)$. [3]

(iii) Find the smallest two possible positive values of x for which

$$0.7\cos x = 2.4\sin x + 1.$$ [4]

6. The position vectors $\underline{a}$ and $\underline{b}$ of two points A and B are given by

$$\underline{a} = 2t\underline{i} + (1 + t)\underline{j} \text{ and } \underline{b} = (t + 1)\underline{i} - (t + 2)\underline{j}.$$

(i) Find the values of t such that OA is perpendicular to OB, where O is the origin. [4]

(ii) Find the vector $\overrightarrow{AB}$ in terms of t. [2]

(iii) Find the value of t for which AB^2 is a minimum. [2]

(iv) Hence, find the shortest distance between A and B. [2]

7. The number of thumb drives, X, sold in a day by a shop has the probability distribution as follow,

$$P(X = x) = \begin{cases} 0.35 - 0.15x & , x = 0,1,2 \\ k & , x = 4,5,6 \\ 0 & , \text{otherwise} \end{cases} \quad \text{where } k \text{ is a constant.}$$

Find

(i) the value of k. [3]

(ii) the probability that 2 or 4 thumb drives have been sold in a day. [2]

8. In a village X, 52% of the adult males smoke cigarettes. Among those who smoke, there is a 0.35 probability that they will have lung cancer. Among those non-smokers, there is also a 0.15 probability that they will have the disease.

(i) Find the probability that an adult male from village X suffer from lung cancer. [4]

(ii) What is the probability that an adult male who is suffering from lung cancer is not a smoker? [3]

9. The pH values of 10 samples of soil taken from a piece of land are shown below.

4.8 6.0 4.3 5.8 6.8 5.6 5.8 6.1 5.7 4.5

Find the percentage of the samples of soil which has pH value between the mean and the third quartile. [7]

10. The mean number of bacteria per mililitre of water taken from a lake is 2.2. Assume that the number of bacteria per mililitre follows a Poisson distribution, find the probability that in 2 mililitre of water, there are

(i) no bacteria, [4]

(ii) at least one bacteria. [3]

Find the most likely number of bacteria per mililitre of water taken from the lake, and calculate its probability. [4]

11. A bag contains 5 blue marbles, 3 white marbles, and 2 yellow marbles. A girl draws 3 marbles at random from the bag. Events X, Y and Z are defined as follows :

X : the girl obtains 2 blue marbles and a white marble.

Y : the girl obtains 2 blue marbles and a marble of another colour.

Z : the girl obtains a special marble which is blue.

(i) Show that $P(X) = 0.25$ [2]

(ii) Find $P(Y)$, $P(Z)$ and $P(Z|Y)$. [6]

(iii) Are events Y and Z mutually exclusive? [2]

(iv) Are events Y and Z independent? [2]

12. The marks of 4200 candidates in Mathematics are found to be approximately normal distributed with a mean of 60 and a standard deviation of 10.

(i) If a mark of 80 and above is required for passing with distinction, estimate the number of candidates who obtained distinction. [4]

(ii) If 28.1% of the candidates fail in the examination, estimate the lowest passing mark. [5]

(iii) Calculate the probability that from three candidates selected at random, only two of the candidates pass in the examination. [3]

(iv) Calculate the probability that a candidate selected at random has a score between 50 and 70. [3]

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1. Let $f(x) = 4x^3 + x + 5$:

$f(-1) = -4 - 1 + 5 = 0$

$\therefore$ -1 is a zero of $f(x)$

$\therefore f(x) = (x+1)(4x^2 - 4x + 5)$

For $f(x) = 0$: $x = -1$ or $\frac{4 \pm \sqrt{16 - 4(4)(5)}}{2(4)}$

$\therefore x = -1$ or $\frac{1}{2} \pm i$

$\therefore f(x) = 0$ has only 1 real root, $x = -1$ *

2. $y = \sqrt{\cos x} \Rightarrow y^2 = \cos x$

$2y\frac{dy}{dx} = -\sin x \Rightarrow 2y\frac{d^2y}{dx^2} + 2\left(\frac{dy}{dx}\right)^2 = -\cos x$

$\therefore 4y^3\frac{d^2y}{dx^2} + \left[2y\frac{dy}{dx}\right]^2 = -2y^2(y^2)$

$\therefore 4y^3\frac{d^2y}{dx^2} + \sin^2 x + 2y^4 = 0$

$\therefore 4y^3\frac{d^2y}{dx^2} + [1 - (y^2)^2] + 2y^4 = 0$

$\therefore 4y^3\frac{d^2y}{dx^2} + y^4 + 1 = 0$ *

3. $B \cap (B - A)' = B \cap (B \cap A')'$

$= B \cap (B' \cup A) = (B \cap B') \cup (B \cap A)$

$= \emptyset \cup (A \cap B) = A \cap B$ *

4. $A^2 = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}\begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ *

$\therefore A^2 = I$: $A^{-1} = A = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$ *

$A^{101} = A(A^2)^{50} = A(I)^{50} = AI$

$= A = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$ *

5. $(x+iy)^2 = -3 + 4i = x^2 - y^2 + 2xyi$

$\therefore x^2 - y^2 = -3$ and $xy = 2$

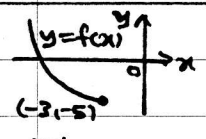
$\therefore x^2 - \left(\frac{4}{x^2}\right) = 3 \Rightarrow x^4 - 3x^2 - 4 = 0$

$\therefore (x^2 - 4)(x^2 + 1) = 0$

$\therefore x = \pm 2$ $[\because x \in \mathbb{R}]$

$x = 2, y = 1$ or $x = -2, y = -1$ *

6. (a)



$y = k$ cuts $y = f(x)$ at only 1 point

$\therefore f$ is 1-1 *

Let $f^{-1}(x) = u$: $x = f(u)$ $(u \le -3)$

$\therefore x = 2(u+3)^2 - 5 \Rightarrow u = -3 - \sqrt{\frac{x+5}{2}}$

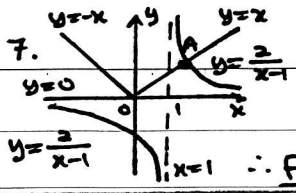
$\therefore f^{-1}: x \to -3 - \sqrt{\frac{x+5}{2}}$, $x \ge -5$ *

(b) $R_f: x \ge -5$, $D_g: x \ge -5$ } $R_f = D_g$ $\therefore gf$ is defined *

$gf(x) = g[2(x+3)^2 - 5] = \sqrt{\frac{1}{2}[2(x+3)^2 - 5 + 5}$

$\therefore gf: x \to -(x+3)$, $x \le -3$ *

7.



For A: $x = \frac{2}{x-1}$

$\therefore x^2 - x - 2 = 0$

$\therefore (x+1)(x-2) = 0$

$\therefore x_A = 2$ $(\because x_A > 1)$

$\therefore$ For $|x| \ge \frac{2}{x-1}$: $\{x : x < 1 \text{ or } 2 \le x\}$ *

8. $\left(1 - \frac{x}{n}\right)^n = 1 + n\left(-\frac{x}{n}\right) + \frac{n(n-1)}{2!}\left(-\frac{x}{n}\right)^2$

$+ \frac{n(n-1)(n-2)}{3!}\left(-\frac{x}{n}\right)^3 + \dots$

$= 1 - x + \frac{1}{2}\left(1 - \frac{1}{n}\right)x^2 - \frac{1}{6}\left(1 - \frac{1}{n}\right)\left(1 - \frac{2}{n}\right)x^3 + \dots$

coef. of $x^3 = -\frac{1}{27}$: $-\frac{1}{6}\left(\frac{n^2 - 3n + 2}{n^2}\right) = -\frac{1}{27}$

$\therefore (7n - 6)(n - 3) = 0 \Rightarrow n = 3$ * $[\because n \in \mathbb{N}]$

$\left(1 - \frac{x}{3}\right)^3(1 - x)^{\frac{1}{2}} = \left(1 - x + \frac{1}{3}x^2 - \frac{1}{27}x^3\right)\left[1 - \frac{1}{2}x\right.$

$\left. + \frac{\left(\frac{1}{2}\right)\left(-\frac{1}{2}\right)}{2!}(-x)^2 + \frac{\left(\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{3}{2}\right)}{3!}(-x)^3 + \dots\right]$

$= \left[1 - x + \frac{1}{3}x^2 - \frac{1}{27}x^3\right]\left[1 - \frac{1}{2}x - \frac{1}{8}x^2 - \frac{1}{16}x^3 + \dots\right]$

$= 1 - \frac{3}{2}x + \frac{17}{24}x^2 - \frac{61}{432}x^3 + \dots = f(x)$ *

$f(0.1) = (1 - \frac{1}{30})^3\sqrt{\frac{9}{10}} = \left(\frac{29}{30}\right)^3 \cdot \frac{3}{10}\sqrt{10}$

$\therefore \sqrt{10} = \left(\frac{30}{29}\right)^3\left(\frac{10}{3}\right)\left[1 - \frac{3}{2}(0.1) + \frac{17}{24}(0.1)^2 - \frac{61}{432}(0.1)^3 + \dots\right]$

$= 3.162$ (3 dp) *

9. (i) For P, Q: $(mx - 2)^2 = 4x$

$\therefore m^2x^2 - (4m + 4)x + 4 = 0$ — ①

For $P \ne Q$: $m^2 \ne 0$ and $B^2 - 4AC > 0$

$\therefore m \ne 0$ and $16(m+1)^2 - 4(4)m^2 > 0$

$\therefore 2m + 1 > 0 \Rightarrow m > -\frac{1}{2}$ *

(ii) x_1, x_2 are roots of ①: $x_1 + x_2 = \frac{4(m+1)}{m^2}$ *

(iii) $y^2 = 4\left(\frac{y+2}{m}\right) \Rightarrow y^2 - \frac{4}{m}y - \frac{8}{m} = 0$

y_1, y_2 are roots: $y_1 + y_2 = \frac{4}{m}$ *

Let $T(x, y)$: $M_{OT} = M_{PQ}$

$\therefore \left(\frac{x}{2}, \frac{y}{2}\right) = \left(\frac{2(m+1)}{m^2}, \frac{2}{m}\right)$

$\therefore m = \frac{4}{y}$ and $\frac{x}{4} = \frac{1}{m} + \frac{1}{m^2}$

$\therefore \frac{x}{4} = \frac{y}{4} + \frac{y^2}{16} \Rightarrow y^2 + 4y = 4x$ [locus of T] *

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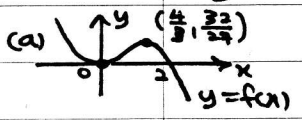
10. $y = x^2(2-x) = 2x^2 - x^3 = f(x)$

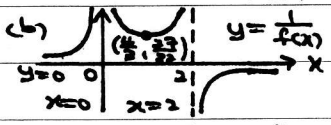
$\frac{dy}{dx} = 4x - 3x^2 = x(4-3x)$

$\therefore$ Turning Points: $(0,0)$, $(\frac{4}{3}, \frac{32}{27})$

(a)



(b)



$\text{Area} = \pi \int_0^2 x^4(2-x)^2\,dx = \pi \int_0^2 [4x^4 - 4x^5 + x^6]\,dx$

$= \pi \left[\frac{4}{5}x^5 - \frac{2}{3}x^6 + \frac{1}{7}x^7\right]_0^2$

$= \pi \left[\frac{4}{5}(32) - \frac{2}{3}(64) + \frac{1}{7}(128) - 0\right] = \frac{105}{128}\pi$ ✱

11. $f(k) = \frac{1}{4k^2-1} \equiv \frac{A}{2k-1} + \frac{B}{2k+1} \equiv \frac{A(2k+1)+B(2k-1)}{4k^2-1}$

$\therefore 1 \equiv A(2k+1) + B(2k-1)$

$k = \frac{1}{2}$: $1 = A(2) \Rightarrow A = \frac{1}{2}$

$[k]$: $0 = 2A + 2B \Rightarrow B = -\frac{1}{2}$

$\therefore f(k) = \frac{1}{2}\left(\frac{1}{2k-1} - \frac{1}{2k+1}\right)$ ✱

$S_n = \sum_{k=1}^{n} f(k) = \frac{1}{2}\left[\left(1 + \frac{1}{3} + \dots + \frac{1}{2n-1}\right) - \left(\frac{1}{3} + \frac{1}{5} + \dots + \frac{1}{2n-1} + \frac{1}{2n+1}\right)\right] = \frac{1}{2}\left[1 - \frac{1}{2n+1}\right] = \frac{n}{2n+1}$ ✱

$\lim_{n\to\infty} S_n = \frac{1}{2}[1-0] = \frac{1}{2}$ ✱

12.(a) $\int_1^e \ln x\,dx = [x\ln x]_1^e - \int_1^e x\left(\frac{1}{x}\right)dx$

$= e(1) - 0 - [x]_1^e = e - (e-1) = 1$ ✱

(b) Let $u = \sqrt{x+1}$: $u^2 = x+1 \Rightarrow 2u\frac{du}{dx} = 1$

$\int \frac{3x-1}{\sqrt{x+1}}\,dx = \int \frac{3(u^2-1)-1}{u}(2u\,du)$

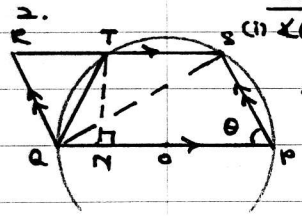
$= \int [6u^2 - 8]\,du = 2u^3 - 8u + c$

$= 2u(u^2-4) + c = 2\sqrt{x+1}(x-3) + c$ ✱

1. $\frac{\sin 2x + 1}{\sec^2 x + 2\tan x} = \frac{2sc+1}{\frac{1}{c^2} + \frac{2s}{c}}$

$= (2sc+1)\left(\frac{c^2}{1+2sc}\right) = \cos^2 x$ ✱

2.



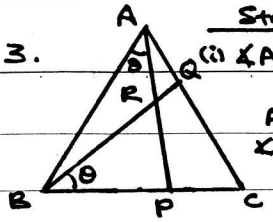
Statements	Reasons
(i) $\angle QTR = \theta$	Exterior angle of cyclic PQTS
$\angle QRT = \theta$	Opposite angle of parallelogram

$\therefore \angle QTR = \angle QRT$ ✱

Statements	Reasons
$\angle TQN = \angle QTR$	Alternate angles
$\therefore \angle TQN = QPS$	
$\angle QSP = 90° = \angle TNQ$	Angle in semicircle
$\angle QTN = 90° - \theta$	sum of angles in Δ
$= \angle PQS$	

$\therefore \Delta PQS \sim \Delta QTN$ ✱

3.



Statements	Reasons
(i) $\angle ABC = 60°$	ΔABC is equilateral
$= \angle BCQ$	
$AB = BC$	"
$\angle BAP = \angle CBQ$	Given
$\Delta BAP \equiv \Delta CBQ$ (By ASA)	
$\therefore BP = CQ$ ✱	

(ii) $\angle ARB = 180° - \angle BAP - \angle ABR$

$= 180° - \theta - (60° - \theta) = 120°$ ✱

4. $\frac{dx}{dt} = 3t^2(x-e) \Rightarrow \int_{2e}^{x} \frac{dx}{x-e} = \int_2^t 3t^2\,dt$

$\therefore [\ln(x-e)]_{2e}^{x} = [t^3]_2^t$

$\therefore \ln(x-e) - 1 = t^3 - 8 \Rightarrow x = e + e^{t^3-7}$ ✱

5. $f(x) = 7\cos x - 24\sin x = R\cos(x+\alpha)$

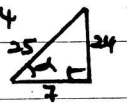
$= R\cos x\cos\alpha - R\sin x\sin\alpha$

(i) $R\cos\alpha = 7$, $R\sin\alpha = 24$

$\therefore \tan\alpha = \frac{24}{7} \Rightarrow \alpha = 1.29$ ✱

$R\left(\frac{24}{38}\right) = 24$

$\therefore R = 25$ ✱



(ii) $f(x)_{min}$ when $\cos(x+\alpha) = -1$:

$f(x)_{min} = 25(-1)$ when $x + \alpha = \pi$

$= -25$ ✱ $\therefore x = 1.85$ ✱

(iii) $0.7\cos x = 2.4\sin x + 1$

$\therefore 25\cos(x + 1.29) = 10$

$\therefore x + 1.29 = 2\pi \pm 1.16 \Rightarrow x = 3.83$ or 6.15 ✱

6. (i) $OA \perp OB$: $\begin{pmatrix} 2t \\ 1+t \end{pmatrix} \cdot \begin{pmatrix} t+1 \\ -t-2 \end{pmatrix} = 0$

$(2t^2 + 2t) - (t^2 + 3t + 2) = 0 \Rightarrow (t+1)(t-2) = 0$

$\therefore t = -1$ or 2 ✱

(ii) $\overrightarrow{AB} = \begin{pmatrix} t+1 \\ -t-2 \end{pmatrix} - \begin{pmatrix} 2t \\ 1+t \end{pmatrix} = \begin{pmatrix} 1-t \\ -2t-3 \end{pmatrix}$ ✱

(iii) $|\overrightarrow{AB}|^2 = (1-t)^2 + (-2t-3)^2 = 5(t^2 + 2t + 2)$

$= 5(t+1)^2 + 5$

$\therefore |\overrightarrow{AB}|^2_{min}$ when $t = -1$ ✱

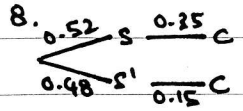
(iv) $|\overrightarrow{AB}|_{min} = \left|\begin{pmatrix} 2 \\ -1 \end{pmatrix}\right| = \sqrt{5}$ ✱

7. (i) $\Sigma P(X=x) = 1$: $3(0.25) - 0.15(0+1+2) + 3k = 1$

$\therefore k = \frac{2}{15}$ ✱

(ii) $P(X = 2 \text{ or } 4) = 0.05 + \frac{2}{15} = \frac{11}{60}$ ✱

8.



(i) Prob. $= 0.52(0.25) + 0.48(0.15)$

$= 0.254$ ✱

(ii) $P(S'|C) = \frac{0.48(0.15)}{0.254} = \frac{36}{127}$ ✱

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No.: Date:

9. $\bar{x} = \frac{\Sigma x}{10} = 5.54$, $Q_3 = 6.0$

4.3, 4.5, 4.8, 5.6, 5.7, 5.8, 5.8, 6.0, 6.1, 6.8

Percentage $= \frac{4}{10} \times 100\% = 40\%$ *

10. X = no. of bacteria per ml. $X \sim Po(2.2)$

(i) $P(X_1 + X_2 = 0) = e^{-2.2} \cdot e^{-2.2} = 0.01228$ *

(ii) $P(X_1 + X_2 \geq 1) = 1 - 0.01228 = 0.98772$ *

For $k < 2.2 - 1$ $(k < 1.2)$: $P_{k+1} > P_k$

$\therefore$ $P_0 < P_1 < P_2 > P_3 > P_4 \ldots$

$\therefore$ most likely no. of bacteria/ml $= 2$ *

11. (i) $P(X) = P(2B, 1W) = \frac{{}^5C_2 \cdot {}^3C_1}{{}^{10}C_3} = \frac{1}{4}$ *

(ii) $P(Y) = \frac{{}^5C_2 \cdot {}^5C_1}{{}^{10}C_3} = \frac{5}{12}$ *

$P(Z) = \frac{{}^1C_1 \cdot {}^9C_2}{{}^{10}C_3} = \frac{3}{10}$ *

$P(Z|Y) = \frac{{}^1C_1 \cdot {}^4C_1 \cdot {}^5C_1}{{}^{10}C_3} \Big/ \frac{5}{12} = \frac{1}{6}\left(\frac{12}{5}\right) = \frac{2}{5}$ *

(iii) $P(Y \cap Z) = \frac{1}{6}$ $(\neq 0)$

$\therefore$ Y and Z are not mutually exclusive *

(iv) $P(Z|Y) = \frac{2}{5}$ $\{\neq P(Z)\}$

$\therefore$ Y and Z are not independent. *

12. X = marks , $X \sim N(60, 10^2)$

(i) $P(X \geq 80) = P\left(Z \geq \frac{80-60}{10}\right) = 0.0228$

$\therefore$ No. of candidates $= 4200(0.0228)$

$= 95.76 \approx 96$ *

(ii) $P(X < k) = 0.281 \Rightarrow \frac{k-60}{10} = -z_{0.281}$

$\therefore$ $k - 60 = 10(-0.58) \Rightarrow k = 54.2$

$\therefore$ Lowest passing mark $= 55$ *

(iii) Prob. $= \frac{3!}{5!}(0.281)(0.719)^2 = 0.4258$ *

(iv) $P(50 < X < 70) = P\left(\frac{-10}{10} < Z < \frac{10}{10}\right)$

$= 1 - (0.1587)(2) = 0.6826$ *

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