Practice Questions - Marking Scheme
Session 2022-23
Class XII
Mathematics (Code – 041)

	SECTION A - Multiple Choice Questions - 1 Mark each	
Q.No.	**Answer/Solution**	**Marks**
Q.1	C. $\sec^{-1} x$	1
Q.2	B. P and Q must be square matrices of the same order.	1
Q.3	D. all - i), ii) and iii)	1
Q.4	A. -48	1
Q.5	C. $\frac{1}{4}$	1
Q.6	B. $-tan\frac{1}{x} -$ B, where B is a constant.	1
Q.7	D. 4	1
Q.8	C. 9 sq units	1
Q.9	B. $\left(\frac{d^2y}{dx^2}\right)^3 + \frac{dy}{dx} = 0$	1
Q.10	C. $\frac{4}{3}\ e^{3x} + 1$	1
Q.11	A. only ii)	1
Q.12	C. $\frac{9}{2}\hat{i} + \frac{3}{2}\hat{j} + \frac{1}{2}\hat{k}$	1
Q.13	D. 0	1
Q.14	B. 60°	1
Q.15	D. 8	1
Q.16	B. It has a unique solution.	1
Q.17	D. 0.08	1
Q.18	A. Minimise $Z = x + y$	1
Q.19	C. (A) is true but (R) is false.	1
Q.20	C. (A) is true but (R) is false.	1
	SECTION B - VSA questions of 2 marks each	
Q.21	Solves the RHS to obtain $\frac{2\pi}{3}$ as follows: $\cos^{-1}(-1) - \text{cosec}^{-1}\left(\frac{2}{\sqrt{3}}\right)$ $= \pi - \frac{\pi}{3}$ $= \frac{2\pi}{3}$ Equates the LHS to obtain $x = -\frac{1}{\sqrt{3}}$ as follows:	0.5 1

	$\cot^{-1}(x) = \frac{2\pi}{3}$ $x = \cot\left(\frac{2\pi}{3}\right)$ $x = -\left(\frac{1}{\sqrt{3}}\right)$ Finds $tan^{-1}\left(\frac{1}{x}\right)$ as $-\frac{\pi}{3}$ as follows: $\tan^{-1}\left(\frac{1}{x}\right) = \tan^{-1}(-\sqrt{3}) = -\frac{\pi}{3}$ **OR** i) Finds the domain as $\left(-\infty, \frac{2}{5}\right] \cup \left[\frac{4}{5}, \infty\right)$ as follows: $5x - 3 \leq -1$ or $5x - 3 \geq 1$ $\therefore x \leq \frac{2}{5}$ or $x \geq \frac{4}{5}$ ii) Finds the range as $[-2,\ 3\pi - 2]$ as follows: $0 \leq \cos^{-1}\left(\frac{1}{2x-1}\right) \leq \pi$ $3(0) - 2 \leq 3\cos^{-1}\left(\frac{1}{2x-1}\right) - 2 \leq 3(\pi) - 2$ $3(0) - 2 \leq y \leq 3(\pi) - 2$ $-2 \leq y \leq 3\pi - 2$	 0.5 1 1
Q.22	Writes the expression for C as $\frac{1}{2}(A - A')$. Finds A' as: $A' = \begin{bmatrix} 6 & 4 & 9 \\ 8 & 2 & 7 \\ 5 & 3 & 1 \end{bmatrix}$	0.5 0.5

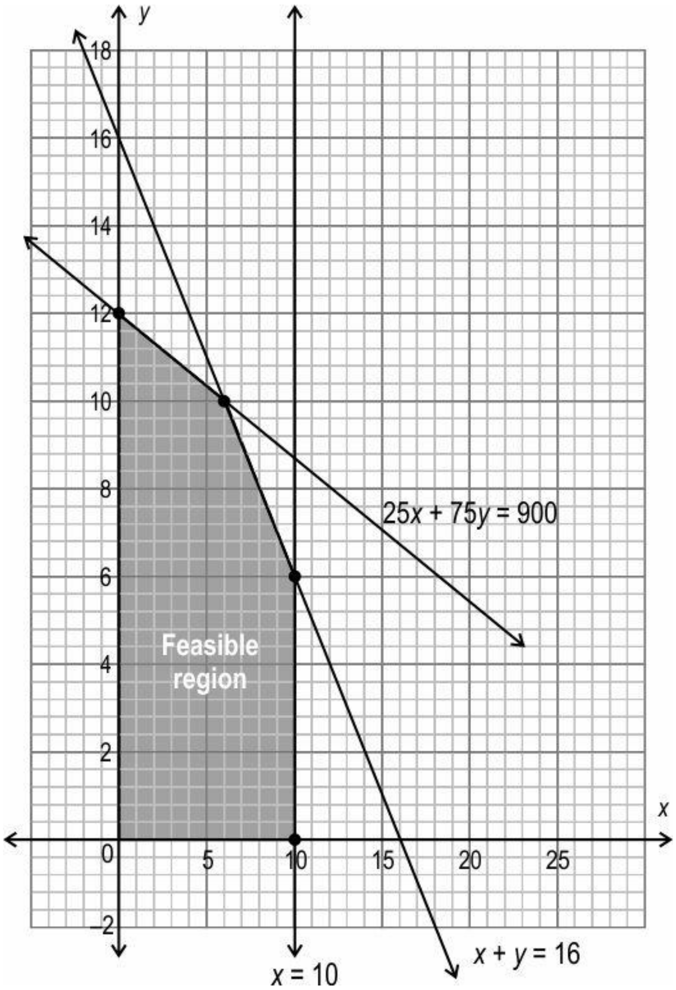
	Finds C as: $C = \frac{1}{2}\left(\begin{bmatrix} 6 & 8 & 5 \\ 4 & 2 & 3 \\ 9 & 7 & 1 \end{bmatrix} - \begin{bmatrix} 6 & 4 & 9 \\ 8 & 2 & 7 \\ 5 & 3 & 1 \end{bmatrix}\right)$ $= \begin{bmatrix} 0 & 2 & -2 \\ -2 & 0 & -2 \\ 2 & 2 & 0 \end{bmatrix}$	1
Q.23	Differentiates y with respect to x using chain rule as: $\frac{dy}{dx} = 4(e^{\sec x} + x)^3 \frac{d}{dx}(e^{\sec x} + x)$ Simplifies the above differential as: $\frac{dy}{dx} = 4(e^{\sec x} + x)^3(e^{\sec x} secxtanx + 1)$	1 1
Q.24	Substitutes $\vec{v} = k(\hat{q} + \hat{r})$ in $\hat{p}.\vec{v} = \hat{q}.\vec{v}$ to get: $\hat{p}.\hat{q} + \hat{p}.\hat{r} = \hat{q}.\hat{q} + \hat{q}.\hat{r}$ $\hat{p}.\hat{q} + \hat{p}.\hat{r} = 1 + \hat{q}.\hat{r}$ Rearranges the terms of the above equation as: $1 - \hat{p}.\hat{q} + \hat{q}.\hat{r} - \hat{p}.\hat{r} = 0$ Simplifies the above equation as: $\Longrightarrow \hat{p}(\hat{p} - \hat{q}) - \hat{r}(\hat{p} - \hat{q}) = 0$ $\Longrightarrow (\hat{p} - \hat{q}) . (\hat{p} - \hat{r}) = 0$ **OR** Uses the cross-product of vectors and writes: Area of QRST = $\lvert\overrightarrow{RQ} \times \overrightarrow{RS}\rvert = \lvert\vec{a} \times \vec{b}\rvert$ Uses the cross-product of vectors and writes: Area of QRTP = $\lvert\overrightarrow{RQ} \times \overrightarrow{RT}\rvert$	0.5 0.5 1 0.5 0.5

	Simplifies RHS of the above equation as: $= \|\overrightarrow{RQ} \times (\overrightarrow{RQ} + \overrightarrow{QT})\|$ $= \|\vec{a} \times (\vec{a} + \vec{b})\|$ $= \|(\vec{a} \times \vec{a}) + (\vec{a} \times \vec{b})\|$ $= \|0 + \vec{a} \times \vec{b}\| = \|\vec{a} \times \vec{b}\|$ Concludes that the area of parallelogram QRST is equal to the area of parallelogram QRTP.	1
Q.25	i) Expands the vector form to get the following: $x\hat{i} + y\hat{j} + z\hat{k} = (x_1 + \lambda x_1)\hat{i} + (y_1 + 2\lambda y_1)\hat{j} + (z_1 + 3\lambda z_1)\hat{k}$	0.5
	Eliminates λ by equating the like coefficients of the position vectors of the *x*, *y* and *z* axes to get the cartesian equation as follows: $\frac{x - x_1}{x_1} = \frac{y - y_1}{2y_1} = \frac{z - z_1}{3z_1}$	0.5
	ii) Assumes the coordinates of B as (x_2, y_2, z_2) and compares the cartesian form of the equation from step 2 with the regular form of the cartesian equation to find: $x_2 = 2x_1$, $y_2 = 3y_1$ and $z_2 = 4z_1$	0.5
	Substitutes values x_1 = (-2), y_1 = 5 and z_1 = (-3) in the equations from step 3 to get coordinates of B as (-4, 15, -12).	0.5

	SECTION C - Short Answer Questions of 3 Marks each	
Q.26	Finds $\frac{du}{d\theta}$ as: $\frac{du}{d\theta} = e^{\sin^{-1}\theta} \times \frac{1}{\sqrt{1-\theta^2}}$ Finds $\frac{dv}{d\theta}$ as: $\frac{dv}{d\theta} = e^{-\cos^{-1}\theta} \times \frac{1}{\sqrt{1-\theta^2}}$ Uses parametric differentiation and finds $\frac{du}{dv}$ as: $\frac{du}{dv} = \frac{e^{\sin^{-1}\theta}}{e^{-\cos^{-1}\theta}} = e^{\sin^{-1}\theta + \cos^{-1}\theta} = e^{\frac{\pi}{2}}$ Concludes that the given statement is true as $e^{\frac{\pi}{2}}$ is a constant. **OR** Rewrites the given equation by taking logarithm on both sides as: $m(\log x) - n(\log y) = (m - n)(\log x + \log y)$ Differentiates the above equation as: $\frac{m}{x}\, dx - \frac{n}{y}\, dy = (m-n)\left(\frac{1}{x}\, dx + \frac{1}{y}\, dy\right)$ Rearranges the above equation to get: $\frac{n}{x}\, dx = \frac{m}{y}\, dy$ Finds $\frac{dy}{dx}$ to be $\frac{ny}{mx}$.	1 1 0.5 0.5 1 1 0.5 0.5
Q.27	Interprets the question statement and writes it as: $(3x-1)\,f(x) = \frac{d}{dx}(3x^4 - \frac{13}{3}x^3 + \frac{3}{2}x^2 + C)$ Finds the derivative in the above step as: $(3x - 1)f(x) = 12x^3 - 13x^2 + 3x$	0.5 1

	Factorises the above cubic polynomial as: $(3x - 1)f(x) = (3x - 1)(4x^2 - 3x)$ and determines the value of $f(x)$ as $(4x^2 - 3x)$. Substitutes $x = 6$ in $f(x)$ and evaluates $f(6)$ as 126.	1 0.5
Q.28	Rewrites the integral using the identity $\text{cosec}^2 x = 1 + \cot^2 x$ as: $\int \cot^2 x\,(1 + \cot^2 x)^2 \text{cosec}^2 x\, dx$ Substitutes $\cot x = u$ and hence $\text{cosec}^2 x\, dx = - du$ in the above step and rewrites the integral as: $-\int u^2 (1 + u^2)^2\, du$ Integrates the above expression as: $-\left[\frac{u^3}{3} + \frac{u^7}{7} + \frac{2u^5}{5}\right]$ Substitutes $\cot x$ in place of u in the above expression to get: $-\left[\frac{\cot^3 x}{3} + \frac{\cot^7 x}{7} + \frac{2\cot^5 x}{5}\right]$ Substitutes the limits in the above expression to get $\frac{92}{105}$.	0.5 0.5 0.5 0.5 1
Q.29	Rearranges the given differential equation as: $\frac{dy}{dx} + \frac{y}{\sqrt{1-x^2}} = \frac{e^{-\sin^{-1}x}}{\sqrt{1-x^2}}$ Finds the integrating factor as follows as the equation obtained in the above step is of the form $\frac{dy}{dx} + y\,P(x) = Q(x)$. Integrating factor $= e^{\int P(x)\,dx}$ $= e^{\int \frac{1}{\sqrt{1-x^2}} dx} = e^{\sin^{-1}x}$	0.5 0.5

	Finds the solution as: $ye^{\int P(x)\,dx} = \int Q(x) \times e^{\int P(x)\,dx} dx + C$ $\Rightarrow ye^{\sin^{-1}x} = \int \frac{e^{-\sin^{-1}x}}{\sqrt{1-x^2}} \times e^{-\sin^{-1}x} dx + C$ $\Rightarrow ye^{\sin^{-1}x} = \sin^{-1}x + C$ Where C is the constant of integration.	1.5
	Substitutes $x = y = 0$ in the above equation and finds the value of C as 0. Writes the particular solution as: $ye^{\sin^{-1}x} = \sin^{-1}x$	0.5
	OR	
	Rearranges the given equation in terms of $\frac{y}{x}$ as: $\frac{dy}{dx} = \frac{y}{x} + \frac{y}{x^2}\sqrt{y^2-x^2}$ $\Rightarrow \frac{dy}{dx} = \frac{y}{x} + \frac{y}{x}\sqrt{\frac{y^2}{x^2}-1}$	0.5
	Considers $y = vx$ and finds $\frac{dy}{dx}$ in terms of v as: $\frac{dy}{dx} = v + x\frac{dy}{dx}$	0.5
	Equates the RHS obtained in steps 1 and 2 to get: $x\frac{dv}{dx} = v\sqrt{v^2-1}$	0.5
	Rearranges the terms using the variable separable method as: $\frac{dv}{v\sqrt{v^2-1}} = \frac{dx}{x}$	0.5
	Integrates on both sides to find the general solution as: $\sec^{-1}v = \log\|x\| + C$ or $\sec^{-1}\frac{y}{x} = \log\|x\| + C$, where C is the constant of integration.	1

Q.30	Takes the number of hens and cows to be x and y respectively and formulates the linear programming problem as follows: Maximise $Z = 12x + 40y$ subject to constraints, $25x + 75y \leq 900$ $x + y \leq 16$ $x \leq 10$ $x \geq 0$ $y \geq 0$ Graphs the constraints and marks the feasible region as:  	1.5 1.5

Q.31	Takes E, F and G to be the events of taking out green marbles in the first, second and third draws respectively, and writes: $P(E) = P(green\ marble\ in\ first\ draw) = \frac{8}{14}$	0.5
	Finds the probability that the second marble taken out is green provided first is also green as: $P(F\|E) = P(green\ marble\ in\ the\ second\ draw) = \frac{7}{13}$	0.5
	Finds the probability that the third marble taken out is green provided first two are also green as: $P(G\|EF) = P(green\ marble\ in\ third\ draw) = \frac{6}{12}$	0.5
	Finds the probability that all three marbles taken out are green in colour as: $P(E) \times P(F\|E) \times P(G\|EF)$ $= \frac{8}{14} \times \frac{5}{13} \times \frac{6}{12}$ $= \frac{10}{91}$	1.5
	OR	
	Assumes the number of students as a random variable X and writes that it can take values of 0, 1 and 2.	
	Finds P(X = 0) as: P(non-student and non-student) $= \frac{10}{18} \times \frac{9}{17}$ $= \frac{90}{306}$	0.5
	Finds P(X = 1) as: P(student and non-student) or P(non-student and student) $= \frac{8}{18} \times \frac{10}{17} \times \frac{10}{18} \times \frac{8}{17}$	1.5

$= \frac{160}{306}$

Finds P(X = 2) as: 0.5

P(student and student)

$= \frac{8}{18} \times \frac{7}{17}$

$= \frac{56}{306}$

Writes the required probability distribution as: 0.5

X	0	1	2
P(X)	$\frac{90}{306}$	$\frac{160}{306}$	$\frac{56}{306}$

SECTION D - Long answer type questions (LA) of 5 marks each

Q.32 Assumes the number of litres of orange juice, beetroot juice and kiwi juice as x, y and z, respectively to frame equations as follows: 0.5

$500x + 20y + 800z = 1860$
$2x + 5y + 3z = 22$
$100x + 120y + 200z = 760$

Writes the above system of equations in the matrix form using AX = B as 0.5

$$\begin{bmatrix} 500 & 20 & 800 \\ 2 & 5 & 3 \\ 100 & 120 & 200 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 1860 \\ 22 \\ 760 \end{bmatrix}$$

Finds $|A| = 110000 \neq 0$ and hence writes that A is non-singular and has a unique solution. 0.5

Finds *adj* A as: 1

$$\begin{bmatrix} 640 & 92000 & -3940 \\ -100 & 20000 & 100 \\ -260 & -58000 & 2460 \end{bmatrix}$$

	Finds A^{-1} using $\|A\|$ and *adj* A as: $A^{-1} = \frac{1}{\|A\|} \times adj\,A$ $= \frac{1}{5500}\begin{bmatrix} 32 & 4600 & -197 \\ -5 & 1000 & 5 \\ -13 & -2900 & 123 \end{bmatrix}$	1
	Writes that $X = A^{-1}B$ and finds X as $\begin{bmatrix} 2 \\ 3 \\ 1 \end{bmatrix}$	1
	Concludes that 2 litres of orange juice, 3 litres of beetroot juice and 1 litre of kiwi juice should go into the mixture.	0.5
Q.33	Writes the endpoints of the ellipse as $(-9, 0), (9, 0),\ (0, 6)$ and $(0, -6)$ respectively. Expresses *y* in terms of *x* as: $y = \pm\frac{6}{9}\sqrt{9^2 - x^2}$	1
	Sets up the equation for the area of the shaded region as: $\text{Shaded Area} = \left\| \int_{-9}^{0} \frac{6}{9}\sqrt{9^2 - x^2}\,dx \right\| + \text{Area of 2 triangles} + \int_{0}^{9} \frac{6}{9}\sqrt{9^2 - x^2}\,dx$ $= 2\int_{0}^{9} \frac{6}{9}\sqrt{9^2 - x^2}\,dx + \text{Area of 2 triangles}$	1
	Evaluates the 1st part of the above equation as: $2\int_{0}^{9} \frac{6}{9}\sqrt{9^2 - x^2}\,dx$ $= 2 \times \frac{6}{9}\left[\frac{x}{2}\sqrt{81 - x^2} + \frac{81}{9}\sin^{-1}\frac{x}{9}\right]_0^9$	1

	Applies the upper and the lower limit and finds the value of the integral as: $= 2 \times \frac{6}{9}\left\{\left[\frac{9}{2}\sqrt{81-81} + \frac{81}{2}\sin^{-1}\frac{9}{9}\right] - \left[\frac{0}{2}\sqrt{81-0} + \frac{81}{2}\sin^{-1}\frac{0}{9}\right]\right\}$ $= 2 \times \frac{6}{9} \times \frac{81}{2} \times \frac{\pi}{2} = 27\pi$ Evaluates the 2nd part of the equation from step 2 as: Area of 2 triangles $= 2 \times \frac{1}{2} \times 9 \times 6 = 54$ sq units Adds the area obtained in step 3 and 4 to find the area of the shaded region in terms of π as: $(27\pi + 54)$ sq units or $27(\pi + 2)$ sq units.	1 0.5 0.5
Q.34	Compares $\vec{r_1} = \vec{a_1} + \lambda\vec{b_1}$ and $\vec{r_2} = \vec{a_2} + \mu\vec{b_2}$ with the given equations to get $\vec{a_1} = \hat{i} - 2\hat{j} + 2\hat{k}$, $\vec{a_2} = 2\hat{i} - 2\hat{j} + 3\hat{k}$, $\vec{b_1} = \hat{i} + 2\hat{j} - 3\hat{k}$ and $\vec{b_2} = -\hat{i} + \hat{j} + 2\hat{k}$. Notes that the lines are skewed and writes the formula to find the shortest distance between the lines (d) as follows: $d = \left\| \frac{(\vec{b_1} \times \vec{b_2}) \cdot (\vec{a_2} - \vec{a_1})}{\|\vec{b_1} \times \vec{b_2}\|} \right\|$ Solves $(\vec{b_1} \times \vec{b_2})$ as $\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & -3 \\ -1 & 1 & 2 \end{vmatrix} = 7\hat{i} + \hat{j} + 3\hat{k}$. Finds $\|\vec{b_1} \times \vec{b_2}\| = \sqrt{49 + 1 + 9} = \sqrt{59}$, and $(\vec{a_2} - \vec{a_1}) = \hat{i} + \hat{k}$. Finds $(\vec{b_1} \times \vec{b_2}) \cdot (\vec{a_2} - \vec{a_1})$ as 7 + 3 = 10. Substitutes values from above steps to find distance as $\frac{10}{\sqrt{59}}$ units. **OR** **Writes that** $\frac{x-4}{1} = \frac{y-2}{3} = \frac{z-1}{2} = \lambda$. Assumes P ($x$, y, z) to be the point of intersection of the two lines. Finds $x = \lambda + 4, y = 3\lambda + 2$ and $z = 2\lambda + 1$. Takes Tara's position as T(2, -2, 1) to find the direction ratios of TP as $(\lambda + 2), (3\lambda + 4)$ and (2λ).	1 1 1 1.5 0.5 0.5 0.5 1

	Notes that the dot product of the direction ratios of the given line and TP will be 0, since they are perpendicular, and cos 90° = 0. Writes that $1(\lambda + 2) + 3(3\lambda + 4) + 2(2\lambda) = 0$. Solves the above equation to find $\lambda = (-1)$. Substitutes the value of λ to find $x = 3, y = 7$ and $z = 2$. Finds the length of TP as √83 units, using the following formula: $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$	1.5 0.5 1
Q.35	Rewrites the given integral as: $\int x^4 x^3 \sin(2x^4)\, dx$ Substitutes $x^4 = u$ and hence $x^3\, dx = \frac{1}{4} du$ in the above integral to get: $\frac{1}{4} \int u \sin(2u)\, du$ Uses integration by parts to integrate the above expression as: $\frac{1}{4} \left[u \int \sin(2u)\, du - \int (\int \sin(2u) du)\, du\right]$ Integrates the above expression to get: $-\frac{1}{8} u \cos(2u) + \frac{1}{16} \sin(2u) + C$ Substitutes x^4 in place of u in the above expression to get: $-\frac{1}{8} x^4 \cos(2x^4) + \frac{1}{16} \sin(2x^4) + C$ **OR** Expands the denominator using the identity $(a^3 - b^3)$ as: $\int \frac{1}{(2-x)(x^2+2x+4)}\, dx$ Rewrites the integral as a sum of two integrals using partial fractions as: $\frac{1}{12} \int \frac{1}{(2-x)}\, dx + \frac{1}{12} \int \frac{x+4}{x^2+2x+4}\, dx$	0.5 1 1 2 0.5 0.5 1

	Solves the first integral as: $-\frac{1}{12}\log\|2-x\|$ Rewrites the second integral as: $\frac{1}{24}\int\frac{2x+2}{x^2+2x+4}\,dx + \frac{1}{4}\int\frac{1}{(x+1)^2+(\sqrt{3})^2}\,dx$ Solves the above integral as: $\frac{1}{24}\log\|x^2+2x+4\| + \frac{1}{4\sqrt{3}}\tan^{-1}\left(\frac{x+1}{\sqrt{3}}\right)$ Concludes the final answer as: $-\frac{1}{12}\log\|2-x\| + \frac{1}{24}\log\|x^2+2x+4\| + \frac{1}{4\sqrt{3}}\tan^{-1}\left(\frac{x+1}{\sqrt{3}}\right) + C$	0.5 1 1.5 0.5
	SECTION E - Case Studies/Passage based questions of 4 Marks each	
Q.36i)	Lists all the elements of R as: R = {(C, PB), (PB, C), (V, PB), (PB, V), (PB, SwD), (SwD, PB), (PB, ShD), (ShD, PB), (SwD, ShD), (ShD, SwD)}	1
Q.36ii)	Writes that the relation R is symmetric. Gives a reason. For example, for every $(x_1, x_2) \in R$, $(x_2, x_1) \in R$ as every direct ship/direct ferry runs in both the directions.	0.5 0.5
Q.36iii)	Writes that R is not transitive. Gives a reason. For example, (C, PB) ∈ R as there is a direct ship from Chennai to Port Blair. (PB, SwD) ∈ R as there is a direct ferry from Port Blair to Swaraj Dweep. But (C, SwD) ∉ R as there is no direct ship/ferry from Chennai to Swaraj Dweep. **OR**	0.5 1.5

	Writes that the function *f* is one-one. Gives a reason. For example, no two elements of set Y are mapped to a common element in set X. Writes that the function *f* is not onto. Gives a reason. For example, C ∈ X (co-domain of *f*) but it has no pre-image in Y.	0.5 0.5 0.5 0.5
Q.37i)	Finds the rate at which the amount of drug is changing in the blood stream 5 hours after the drug has been administered as: $C'(\mathrm{t}) = -3t^2 + 9\mathrm{t} + 54$ $\Rightarrow \mathrm{C}'(5) = 24$ mg/hr	1
Q.37ii)	Equates the derivative $C'(\mathrm{t})$ to 0 and factorises $C'(\mathrm{t})$as $3(3 + \mathrm{t})(6 - \mathrm{t})$. Writes that for $\mathrm{t} \in (3, 4)$, $3 > 0$, $(3 + \mathrm{t}) > 0$ and $(6 - \mathrm{t}) > 0$ Therefore, $\mathrm{C}'(\mathrm{t}) > 0$. Concludes that *C*(*t*) is strictly increasing in the interval (3, 4). **OR** Equates the derivative $C'(\mathrm{t}) = -3t^2 + 9\mathrm{t} + 54$ to 0 and finds the critical points as *t* = 6 hours and *t* = (-3) hours. Differentiate $C'(\mathrm{t})$ to get C"(t) as: $\mathrm{C}''(\mathrm{t}) = -6\mathrm{t} + 9$ Finds C"(6) as (-27) and writes that C(t) attains its maximum at $\mathrm{t} = 6$ hours, as $\mathrm{C}''(6) = (-27) < 0$. Concludes that 6 hours after the drug is administered, C_{max} is attained.	0.5 1.5 0.5 0.5 0.5 0.5
Q.37iii)	Finds the value of C(t) at $\mathrm{t} = 6$ hours as: $\mathrm{C}(6) = -(6)^3 + 4.5(6)^2 + 54(6)$ $\Rightarrow \mathrm{C}(6) = 270$	1

	Writes the amount of drug in the bloodstream when the effect of the drug is maximum as 270 mg.	
Q.38i)	Takes P(S), P(C) and P(T) as the probabilities that a person selected randomly from the staff prefers sugar, coffee and tea respectively. Finds $\mathrm{P(T)} = \mathrm{P(C')} = 1 - 0.6 = 0.4.$ Finds $\mathrm{P(S \mid T)} = 1 - 0.2 = 0.8.$ Uses theorem on total probability and finds the probability that a randomly selected staff prefers a beverage with sugar as: $\mathrm{P(S)} = \mathrm{P(C)} \times \mathrm{P(S \mid C)} + \mathrm{P(T)} \times \mathrm{P(S \mid T)}$ $= 0.6 \times 0.9 + 0.4 \times 0.8 = 0.86$ or $\frac{86}{100}$ or $\frac{43}{50}$	1 1
Q.38ii)	Uses the sum of probabilities = 1 and finds the following probabilities: ♦ $\mathrm{P(without\ sugar \mid coffee)} = 1 - 0.9 = 0.1$ ♦ $\mathrm{P(tea)} = 1 - 0.6 = 0.4$ Uses Bayes' theorem to find the probability that a staff selected at random prefers coffee given that it is without sugar, $\mathrm{P(coffee \mid without\ sugar)}$ as: $\frac{\mathrm{P(coffee)} \times \mathrm{P(without\ sugar \mid coffee)}}{\mathrm{P(coffee)} \times \mathrm{P(without\ sugar \mid coffee)} + \mathrm{P(tea)} \times \mathrm{P(without\ sugar \mid tea)}}$ $= \frac{0.6 \times 0.1}{0.6 \times 0.1 + 0.4 \times 0.2}$ (Award 0.5 marks if only the formula for Bayes′ theorem is written correctly.) Simplifies the above expression and finds the required probability as $\frac{6}{14}$ or $\frac{3}{7}$.	0.5 1 0.5