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Your JEE Guide

ISC Class XII · Mathematics

Sample Question Paper 7 · Session 2026-27

Time allowed: 3 hours (plus 15 minutes reading time) **Maximum marks: 80**

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General instructions:

1. You are allowed an additional fifteen minutes for only reading the question paper. You must NOT start writing during the reading time.
2. The paper consists of twenty questions and four sections: Sections A, B, C and D.
3. All questions are compulsory.
4. Section A consists of very short answer questions of 1 mark each. Section B consists of short answer questions of 2 marks each. Section C consists of moderately long answer questions of 3 marks each. Section D consists of long answer questions of 5 marks each.
5. Internal choices have been provided in three questions each in Sections B, C and D.
6. While attempting Multiple Choice Questions in Section A, you are required to write only ONE option as the answer.
7. The intended marks for questions or parts of questions are given in brackets [ ].
8. All workings, including rough work, should be done on the same page as, and adjacent to, the rest of the answer.

Section A (20 marks)

1.	**(i)** On the set {1, 2, 3}, the relation R = {(1, 1), (2, 2), (1, 2), (2, 1)} is: (a) symmetric and transitive but not reflexive (b) reflexive and symmetric but not transitive (c) reflexive only (d) an equivalence relation	1
	(ii) If $f(x) = \frac{3x+2}{5x-3}$, $x \neq \frac{3}{5}$, then (f ∘ f)(x) equals: (a) $\frac{1}{x}$ (b) –x (c) x (d) f(x)	1
	(iii) The value of $\sin^{-1}\left(-\frac{1}{2}\right) + \cos^{-1}\left(-\frac{\sqrt{3}}{2}\right)$ is: (a) π (b) $\frac{\pi}{3}$ (c) $\frac{5\pi}{6}$ (d) $\frac{2\pi}{3}$	1
	(iv) The value of $\sec^2(\tan^{-1} 2) + \csc^2(\cot^{-1} 3)$ is: (a) 5 (b) 15 (c) 13 (d) 10	1

	(v) A 3 × 3 matrix A has entries $a_{ij} = i - j$. Then A is: (a) symmetric (b) an identity matrix (c) skew-symmetric (d) a diagonal matrix	1
	(vi) The value of $\begin{vmatrix} \cos 15^\circ & \sin 15^\circ \\ \sin 75^\circ & \cos 75^\circ \end{vmatrix}$ is: (a) $\frac{1}{2}$ (b) 1 (c) –1 (d) 0	1
	(vii) Statement I: $f(x) = x^{1/3}$ is differentiable at x = 0. **Statement II:** $f(x) = x^{1/3}$ is continuous at x = 0. (a) Statement I is false and Statement II is true. (b) Both the statements are true. (c) Both the statements are false. (d) Statement I is true and Statement II is false.	1
	(viii) If $x = t^2$ and $y = t^3$, then $\frac{d^2y}{dx^2}$ is: (a) $\frac{3}{2}$ (b) $\frac{3}{4t}$ (c) $\frac{3t}{2}$ (d) $\frac{3}{2t}$	1
	(ix) The maximum value of sin x cos x is: (a) 1 (b) $\frac{1}{2}$ (c) $\sqrt{2}$ (d) $\frac{1}{4}$	1
	(x) $\int \frac{dx}{\sqrt{x}(1+\sqrt{x})}$ equals: (a) $2\log(1+\sqrt{x}) + C$ (b) $2\sqrt{x} + C$ (c) $\log(1+\sqrt{x}) + C$ (d) $\frac{1}{2}\log(1+\sqrt{x}) + C$	1
	(xi) $\int_0^{\pi/2} \log(\tan x)\, dx$ equals: (a) 1 (b) $\frac{\pi}{2}$ (c) 0 (d) log 2	1
	(xii) The order of the differential equation whose general solution is $y = e^{2x}(a + bx)$, with a and b arbitrary constants, is: (a) 0 (b) 1 (c) 3 (d) 2	1
	(xiii) If $\lvert\vec{a}\rvert = 3$ and $\lambda\vec{a}$ is a unit vector, then λ is: (a) ±3 (b) $\frac{1}{9}$ (c) ±1 (d) $\pm\frac{1}{3}$	1

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	(xiv) The line through (1, 2, 3) parallel to the z-axis is given by: (a) x = 1, z = 3 (b) y = 2, z = 3 (c) x = 1, y = 2 (d) z = 3	1
	(xv) Three fair coins are tossed. The probability of getting at least one tail is: (a) $\frac{1}{2}$ (b) $\frac{7}{8}$ (c) $\frac{3}{8}$ (d) $\frac{1}{8}$	1
	(xvi) Assertion: Every relation that is symmetric and transitive is reflexive. **Reason:** R = {(1, 1)} on the set {1, 2} is symmetric and transitive but not reflexive. (a) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion. (b) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion. (c) Assertion is true and Reason is false. (d) Assertion is false and Reason is true.	1
	(xvii) Assertion: f(x) = x − sin x is increasing on $\mathbb{R}$. **Reason:** f′(x) = 1 − cos x ≥ 0 for every real x. (a) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion. (b) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion. (c) Assertion is true and Reason is false. (d) Assertion is false and Reason is true.	1
	(xviii) Find x if $\begin{bmatrix} x & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ -2 & 0 \end{bmatrix} = O$.	1
	(xix) Find the interval in which $f(x) = x^2 - 6x + 1$ is strictly decreasing.	1
	(xx) Find the probability that a leap year chosen at random has 53 Sundays.	1

Section B (14 marks)

2.	On $\mathbb{N} \times \mathbb{N}$, the relation R is defined by (a, b) R (c, d) if and only if ad = bc. Show that R is transitive.	2
3.	Prove that $\sin^{-1}\frac{4}{5} + \sin^{-1}\frac{5}{13} = \sin^{-1}\frac{63}{65}$. **OR** Find the value of $\sin^{-1}\left(\sin\frac{13\pi}{7}\right)$.	2
4.	Find $\frac{dy}{dx}$ if $y = x^{\tan x}$, x > 0.	2

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5.	A man 2 m tall walks away from a lamp post 5 m high at 1.2 m/s. How fast is the length of his shadow increasing? **OR** Find the intervals in which $f(x) = x^4 - 2x^2$ is strictly increasing or strictly decreasing.	2
6.	Find $\int \frac{1 - \sin x}{x + \cos x}\, dx$.	2
7.	Find the projection of $\vec{b} + \vec{c}$ on $\vec{a}$, where $\vec{a} = 2\hat{i} - 2\hat{j} + \hat{k}$, $\vec{b} = \hat{i} + 2\hat{j} - 2\hat{k}$ and $\vec{c} = 2\hat{i} - \hat{j} + 4\hat{k}$. **OR** Find $\lvert\vec{a} \times \vec{b}\rvert$ if $\vec{a} = 2\hat{i} + \hat{j} + 3\hat{k}$ and $\vec{b} = 3\hat{i} + 5\hat{j} - 2\hat{k}$.	2
8.	Two cards are drawn at random, without replacement, from a well-shuffled pack of 52 cards. Find the probability that both are kings, and the probability that neither is a king.	2

Section C (21 marks)

9.	Using properties of determinants, prove that $\begin{vmatrix} 1 & 1 & 1 \\ x & y & z \\ yz & zx & xy \end{vmatrix} = (x - y)(y - z)(z - x)$. **OR** For $A = \begin{bmatrix} 2 & 3 \\ 1 & -4 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & -2 \\ -1 & 3 \end{bmatrix}$, verify that $(AB)^{-1} = B^{-1}A^{-1}$.	3
10.	Examine the continuity and differentiability of $f(x) = \begin{cases} x + 1, & x \geq 1 \\ x^2 + 1, & x < 1 \end{cases}$ at x = 1.	3
11.	If $(x - a)^2 + (y - b)^2 = c^2$, c > 0, show that $\frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2}}{\frac{d^2y}{dx^2}}$ is a constant independent of a and b.	3
12.	Find the absolute maximum and minimum values of $f(x) = \sin x + \sqrt{3}\cos x$ on $\left[0, \frac{\pi}{2}\right]$. **OR** Find the equation of the tangent to the curve x = sin 3t, y = cos 2t at $t = \frac{\pi}{4}$.	3
13.	Find $\int \frac{dx}{x \log x\,(2 + \log x)}$.	3

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14.	Evaluate $\int_0^{\pi/2} x^2 \cos x \, dx$. **OR** Evaluate $\int_{-5}^{5} \lvert x+2 \rvert \, dx$.	3
15.	Solve the differential equation $x\frac{dy}{dx} + y = x\log x$, x > 0.	3

Section D (25 marks)

16.	A bakery makes two kinds of cake. Cake A needs 200 g of flour and 25 g of fat; cake B needs 100 g of flour and 50 g of fat. There are 5 kg of flour and 1 kg of fat. The profit is ₹50 on cake A and ₹40 on cake B. Formulate a linear programming problem to maximise the profit and solve it graphically.	5
17.	(a) Show that $\frac{x+\sin x}{1+\cos x} = \frac{x}{2}\sec^2\frac{x}{2} + \tan\frac{x}{2}$. *[2]* (b) Hence evaluate $\int_0^{\pi/2} \frac{x+\sin x}{1+\cos x}\, dx$. *[3]* **OR** Using integration, find the area of the region in the first quadrant enclosed by the x-axis, the line $x = \sqrt{3}\,y$ and the circle $x^2 + y^2 = 4$.	5
18.	Solve the differential equation $(\tan^{-1} y - x)\, dy = (1+y^2)\, dx$. **OR** The population N of a town grows at a rate proportional to N. It was 5000 in 2020 and 6000 in 2024. (a) Form and solve the differential equation for N in terms of the time t in years after 2020. *[3]* (b) In which year will the population reach 7200? *[2]*	5
19.	For the point P(3, 1, 2) and the plane x + y + z = 0, find (a) the foot of the perpendicular from P to the plane, *[2]* (b) the image of P in the plane, *[2]* (c) the distance of P from the plane. *[1]*	5
20.	A pair of dice is thrown three times. Let X be the number of doublets. (a) Find the probability distribution of X. *[3]* (b) Find the mean of X. *[2]* **OR** A courier company sends 50% of its parcels by road, 30% by rail and 20% by air. The probabilities of delay are 0.1, 0.06 and 0.02 respectively. (a) Find the probability that a parcel is delayed. *[2]* (b) A parcel is delayed. Find the probability that it went by road. *[2]* (c) A parcel is not delayed. Find the probability that it went by air. *[1]*	5

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Answers and Marking Scheme

Marks for each step are shown in brackets. Any correct alternative method gets full credit.

Section A (20 marks)

Question 1

(i) **(a)** symmetric and transitive but not reflexive. *Working:* (3, 3) $\notin$ R, so R is not reflexive; every pair has its reverse in R, and every chain such as (1, 2), (2, 1) gives a pair, (1, 1), already in R.

(ii) **(c)** x. *Working:* $\frac{3f+2}{5f-3} = \frac{3(3x+2)+2(5x-3)}{5(3x+2)-3(5x-3)} = \frac{19x}{19}$.

(iii) **(d)** $\frac{2\pi}{3}$. *Working:* $-\frac{\pi}{6} + \frac{5\pi}{6} = \frac{2\pi}{3}$.

(iv) **(b)** 15. *Working:* $(1+2^2)+(1+3^2) = 15$.

(v) **(c)** skew-symmetric. *Working:* $a_{ji} = j - i = -a_{ij}$, so $A' = -A$.

(vi) **(d)** 0. *Working:* cos 15° cos 75° − sin 15° sin 75° = cos 90°.

(vii) **(a)** Statement I is false and Statement II is true. *Working:* $\frac{f(h)-f(0)}{h} = h^{-2/3} \to \infty$, so f is not differentiable at 0; but $h^{1/3} \to 0 = f(0)$, so f is continuous there.

(viii) **(b)** $\frac{3}{4t}$. *Working:* $\frac{dy}{dx} = \frac{3t}{2}$, and $\frac{d^2y}{dx^2} = \frac{d}{dt}\left(\frac{3t}{2}\right) \div \frac{dx}{dt} = \frac{3}{2}\cdot\frac{1}{2t}$.

(ix) **(b)** $\frac{1}{2}$. *Working:* $\sin x \cos x = \frac{1}{2}\sin 2x \le \frac{1}{2}$.

(x) **(a)** $2\log(1+\sqrt{x}) + C$. *Working:* Put $t = 1+\sqrt{x}$, $dt = \frac{dx}{2\sqrt{x}}$.

(xi) **(c)** 0. *Working:* Using $x \to \frac{\pi}{2} - x$, $I = \int \log(\cot x)dx = -I$.

(xii) **(d)** 2. *Working:* Two independent arbitrary constants give a second-order equation.

(xiii) **(d)** $\pm\frac{1}{3}$. *Working:* $|\lambda|\cdot 3 = 1$.

(xiv) **(c)** x = 1, y = 2. *Working:* Along the line only z changes.

(xv) **(b)** $\frac{7}{8}$. *Working:* 1 − P(HHH) = 1 − 1/8.

(xvi) **(d)** Assertion is false and Reason is true. *Working:* The Reason is a true counter-example ((2, 2) $\notin$ R), so the Assertion is false.

(xvii) **(a)** Both Assertion and Reason are true, and Reason is the correct explanation of Assertion. *Working:* f′ ≥ 0 everywhere and is zero only at isolated points, so f is increasing; the Reason explains the Assertion.

(xviii) The product is [x − 2 0] (½), so x = 2 (½).

(xix) f′(x) = 2x − 6 < 0 (½) for x < 3: the interval is (−∞, 3) (½).

(xx) A leap year has 52 weeks and 2 extra days; of the 7 equally likely pairs, 2 contain a Sunday (½). Probability $= \frac{2}{7}$ (½).

Section B (14 marks)

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2. Let (a, b) R (c, d) and (c, d) R (e, f): ad = bc and cf = de (1). Multiplying, adcf = bcde; cancelling cd ≠ 0 gives af = be, so (a, b) R (e, f) (1).

3. Let $\sin A = \frac{4}{5}$, $\sin B = \frac{5}{13}$, so $\cos A = \frac{3}{5}$, $\cos B = \frac{12}{13}$ (½). $\sin(A+B) = \frac{4}{5}\cdot\frac{12}{13} + \frac{3}{5}\cdot\frac{5}{13} = \frac{63}{65}$ (1). A + B is acute, so the result follows (½).

OR $\sin\frac{13\pi}{7} = \sin\left(2\pi - \frac{\pi}{7}\right) = \sin\left(-\frac{\pi}{7}\right)$ (1). As $-\frac{\pi}{7}$ lies in $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$, the value is $-\frac{\pi}{7}$ (1).

4. log y = tan x log x (½). $\frac{1}{y}\frac{dy}{dx} = \sec^2 x \log x + \frac{\tan x}{x}$ (1). $\frac{dy}{dx} = x^{\tan x}\left(\sec^2 x \log x + \frac{\tan x}{x}\right)$ (½).

5. With distance x and shadow s, similar triangles give $\frac{s}{2} = \frac{x+s}{5}$, so $s = \frac{2x}{3}$ (1). $\frac{ds}{dt} = \frac{2}{3} \times 1.2 = 0.8$ m/s (1).

OR $f'(x) = 4x(x-1)(x+1)$ (½). Strictly increasing on (–1, 0) and (1, ∞) (1); strictly decreasing on (–∞, –1) and (0, 1) (½).

6. The numerator is the derivative of the denominator (1). Integral $= \log|x + \cos x| + C$ (1).

7. $\vec{b} + \vec{c} = 3\hat{i} + \hat{j} + 2\hat{k}$ and $\vec{a}\cdot(\vec{b}+\vec{c}) = 6 - 2 + 2 = 6$ (1). Projection $= \frac{6}{|\vec{a}|} = \frac{6}{3} = 2$ (1).

OR $\vec{a}\times\vec{b} = -17\hat{i} + 13\hat{j} + 7\hat{k}$ (1). $|\vec{a}\times\vec{b}| = \sqrt{289+169+49} = \sqrt{507} = 13\sqrt{3}$ (1).

8. P(both kings) $= \frac{4}{52}\cdot\frac{3}{51} = \frac{1}{221}$ (1). P(neither) $= \frac{48}{52}\cdot\frac{47}{51} = \frac{188}{221}$ (1).

Section C (21 marks)

9. $C_2 \to C_2 - C_1$, $C_3 \to C_3 - C_1$: $\begin{vmatrix} 1 & 0 & 0 \\ x & y-x & z-x \\ yz & z(x-y) & y(x-z) \end{vmatrix}$ (1). Taking out (y – x)(z – x): $\begin{vmatrix} 1 & 1 \\ -z & -y \end{vmatrix} = z - y$ (1½). Value $= (y-x)(z-x)(z-y) = (x-y)(y-z)(z-x)$ (½).

OR $AB = \begin{bmatrix} -1 & 5 \\ 5 & -14 \end{bmatrix}$, |AB| = –11, $(AB)^{-1} = \frac{1}{11}\begin{bmatrix} 14 & 5 \\ 5 & 1 \end{bmatrix}$ (1). $B^{-1} = \begin{bmatrix} 3 & 2 \\ 1 & 1 \end{bmatrix}$, $A^{-1} = \frac{1}{11}\begin{bmatrix} 4 & 3 \\ 1 & -2 \end{bmatrix}$ (1). $B^{-1}A^{-1} = \frac{1}{11}\begin{bmatrix} 14 & 5 \\ 5 & 1 \end{bmatrix}$ (1).

10. Both one-sided limits and f(1) equal 2, so f is continuous at 1 (1). Left derivative: $\lim \frac{(1+h)^2+1-2}{h} = 2$ as h → 0⁻; right derivative: 1 (1½). They differ, so f is not differentiable at 1 (½).

11. $y' = -\frac{x-a}{y-b}$ (½). $y'' = -\frac{(y-b)-(x-a)y'}{(y-b)^2} = -\frac{c^2}{(y-b)^3}$ (1). $1 + y'^2 = \frac{c^2}{(y-b)^2}$, so the expression equals $\frac{c^3/|y-b|^3}{-c^2/(y-b)^3} = \mp c$, a constant (1½).

12. $f'(x) = \cos x - \sqrt{3}\sin x = 0$ at $x = \frac{\pi}{6}$ (1). $f(0) = \sqrt{3}$, $f\left(\frac{\pi}{6}\right) = 2$, $f\left(\frac{\pi}{2}\right) = 1$ (1). Absolute maximum 2, absolute minimum 1 (1).

OR The point is $\left(\frac{\sqrt{2}}{2}, 0\right)$ (½). $\frac{dy}{dx} = \frac{-2\sin 2t}{3\cos 3t} = \frac{-2}{3(-\sqrt{2}/2)} = \frac{2\sqrt{2}}{3}$ (1½). Tangent: $y = \frac{2\sqrt{2}}{3}\left(x - \frac{\sqrt{2}}{2}\right)$, i.e. $2\sqrt{2}x - 3y - 2 = 0$ (1).

13. Put t = log x, $dt = \frac{dx}{x}$: $\int \frac{dt}{t(t+2)}$ (1) $= \frac{1}{2}\int\left(\frac{1}{t} - \frac{1}{t+2}\right)dt$ (1) $= \frac{1}{2}\log\left|\frac{\log x}{2+\log x}\right| + C$ (1).

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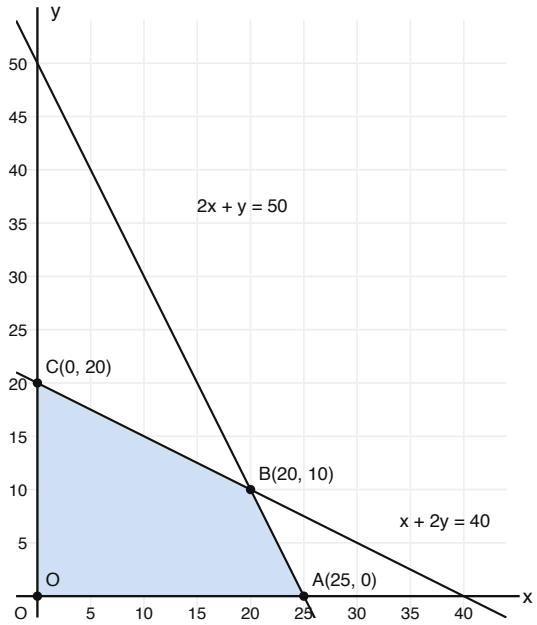
14. By parts twice: $\int x^2 \cos x\, dx = x^2 \sin x + 2x \cos x - 2 \sin x$ (2). Value $= \frac{\pi^2}{4} - 2$ (1).

OR $\int_{-5}^{-2}(-x-2)dx + \int_{-2}^{5}(x+2)dx$ (1) $= \frac{9}{2} + \frac{49}{2}$ (1) $= 29$ (1).

15. The left side is $\frac{d}{dx}(xy)$ (1). $xy = \int x \log x\, dx = \frac{x^2}{2}\log x - \frac{x^2}{4} + C$ (1½). $y = \frac{x}{2}\log x - \frac{x}{4} + \frac{C}{x}$ (½).

Section D (25 marks)

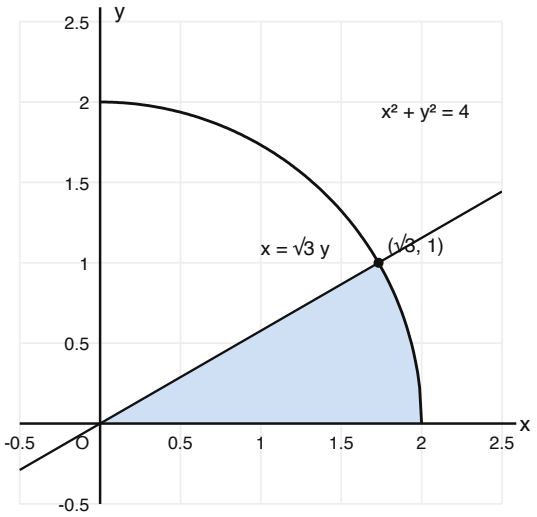
16. Let x cakes of A and y of B be made. Maximise Z = 50x + 40y subject to 2x + y ≤ 50, x + 2y ≤ 40, x, y ≥ 0 (1½). Feasible region OABC (1½):



Z(O) = 0, Z(A) = 1250, Z(B) = 1400, Z(C) = 800 (1). Maximum profit ₹1400 with 20 cakes of A and 10 of B (1).

17. (a) $1 + \cos x = 2\cos^2\frac{x}{2}$ and $\sin x = 2\sin\frac{x}{2}\cos\frac{x}{2}$ (1); dividing gives the result (1). (b) The integrand is $\frac{d}{dx}\left(x \tan\frac{x}{2}\right)$ (2), so the value is $\left[x\tan\frac{x}{2}\right]_0^{\pi/2} = \frac{\pi}{2}$ (1).

OR The line meets the circle at $(\sqrt{3}, 1)$ (1). Sketch (1):



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Area $= \int_0^{\sqrt{3}} \frac{x}{\sqrt{3}}dx + \int_{\sqrt{3}}^{2} \sqrt{4-x^2}\,dx$ (1) $= \frac{\sqrt{3}}{2} + \left(\frac{\pi}{3} - \frac{\sqrt{3}}{2}\right) = \frac{\pi}{3}$ square units (2).

18. $\frac{dx}{dy} + \frac{x}{1+y^2} = \frac{\tan^{-1} y}{1+y^2}$, linear in x (1). IF $= e^{\tan^{-1} y}$ (1). $xe^{\tan^{-1} y} = \int \frac{\tan^{-1} y\, e^{\tan^{-1} y}}{1+y^2}dy = (\tan^{-1} y - 1)e^{\tan^{-1} y} + C$ (2). $x = \tan^{-1} y - 1 + Ce^{-\tan^{-1} y}$ (1).

OR (a) $\frac{dN}{dt} = kN$, so $N = 5000e^{kt}$ (1½). $e^{4k} = 1.2$, $k = \frac{1}{4}\log 1.2$ (1½). (b) $7200 = 5000(1.2)^2 = 5000e^{8k}$ (1), so t = 8: in 2028 (1).

19. (a) The perpendicular is (3 + t, 1 + t, 2 + t); on the plane, 6 + 3t = 0, t = –2 (1). Foot (1, –1, 0) (1). (b) Image = 2(foot) – P = (–1, –3, –2) (2). (c) $\frac{|3+1+2|}{\sqrt{3}} = 2\sqrt{3}$ units (1).

20. (a) P(doublet) = 6/36 = 1/6 on each throw (½). $P(0) = \left(\frac{5}{6}\right)^3 = \frac{125}{216}$, $P(1) = 3 \cdot \frac{1}{6}\left(\frac{5}{6}\right)^2 = \frac{75}{216}$, $P(2) = 3\left(\frac{1}{6}\right)^2\frac{5}{6} = \frac{15}{216}$, $P(3) = \frac{1}{216}$ (2½). (b) Mean $= \frac{75+30+3}{216} = \frac{108}{216} = \frac{1}{2}$ (2).

OR (a) P(D) = 0.05 + 0.018 + 0.004 = 0.072 (2). (b) $\frac{0.05}{0.072} = \frac{25}{36}$ (2). (c) $\frac{0.2\times 0.98}{0.928} = \frac{49}{232}$ (1).

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