CBSE Class 12 Mathematics

Sample Paper – 1

Duration: 180 Minutes | **Maximum Marks: 80**

General Instructions

- This question paper contains **38 questions**. **All questions are compulsory**.
- The paper is divided into **five sections** – A, B, C, D and E.
- **Section A** (Q1–Q20) carries **1 mark** each: Q1–Q18 are multiple choice questions and Q19–Q20 are Assertion–Reason questions.
- **Section B** (Q21–Q25) carries **2 marks** each (Very Short Answer).
- **Section C** (Q26–Q31) carries **3 marks** each (Short Answer).
- **Section D** (Q32–Q35) carries **5 marks** each (Long Answer).
- **Section E** (Q36–Q38) carries **4 marks** each (case study based, with sub-parts).
- There is **no overall choice**, but an **internal choice** has been provided in some questions. Attempt only one of the alternatives in such questions.
- There is **no negative marking**. Use of a **calculator is not permitted**.

Section A (Q1–Q20) – 1 Mark Each

Q1. If A is a matrix of order 2×3 and B is a matrix of order 3×2, then the order of the product AB is:

(A) 2×2

(B) 3×3

(C) 3×2

(D) 2×3

Q2. The value of the determinant $\begin{vmatrix} 3 & -2 \\ 4 & 5 \end{vmatrix}$ is:

(A) 7

(B) 17

(C) 23

(D) -23

Q3. Let $A = \{1, 2, 3\}$ and $R = \{(1,1), (2,2), (3,3), (1,2), (2,3)\}$ be a relation on A. Then R is:

(A) symmetric

(B) reflexive but neither symmetric nor transitive

(C) transitive

(D) an equivalence relation

Q4. The principal value of $\sin^{-1}\left(-\frac{1}{2}\right)$ is:

(A) $\frac{\pi}{6}$

(B) $\frac{5\pi}{6}$

(C) $-\frac{5\pi}{6}$

(D) $-\frac{\pi}{6}$

Q5. If $y = \sin(x^2)$, then $\frac{dy}{dx}$ equals:

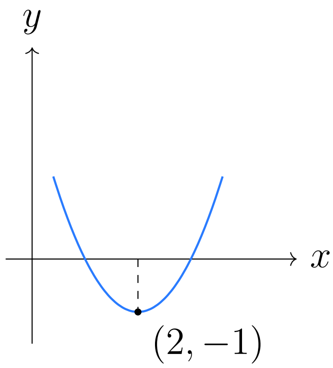
(A) $2x \cos(x^2)$

(B) $\cos(x^2)$

(C) $2x \cos x$

(D) $-2x \cos(x^2)$

Q6. The graph of $f(x) = x^2 - 4x + 3$ is shown below. The function is *increasing* on the interval:



(A) $(-\infty, 2)$

(B) $(-\infty, \infty)$

(C) $(2, \infty)$

(D) $(0, 2)$

Q7. $\int \sec^2 x \, dx$ equals:

(A) $-\cot x + C$

(B) $\tan x + C$

(C) $\sec x \tan x + C$

(D) $\ln|\sec x| + C$

Q8. The order and degree of the differential equation $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^3 + y = 0$ are respectively:

(A) 1 and 2

(B) 2 and 3

(C) 3 and 1

(D) 2 and 1

Q9. The magnitude of the vector $\vec{a} = \hat{i} + 2\hat{j} + 2\hat{k}$ is:

(A) 3

(B) 5

(C) 9

(D) $\sqrt{5}$

Q10. The direction cosines of a line whose direction ratios are $1, -2, 2$ are:

(A) $1, -2, 2$

(B) $\frac{1}{9}, -\frac{2}{9}, \frac{2}{9}$

(C) $\frac{1}{3}, -\frac{2}{3}, \frac{2}{3}$

(D) $\frac{1}{\sqrt{3}}, -\frac{2}{\sqrt{3}}, \frac{2}{\sqrt{3}}$

Q11. $\int_0^{\pi/2} \cos x \, dx$ equals:

(A) 0

(B) 1

(C) -1

(D) $\frac{\pi}{2}$

Q12. If $P(A \cap B) = 0.2$ and $P(B) = 0.5$, then $P(A \mid B)$ equals:

(A) 0.1

(B) 0.7

(C) 0.25

(D) 0.4

Q13. $\int \frac{2x}{1+x^2} \, dx$ equals:

(A) $\ln(1+x^2) + C$

(B) $2\ln(1+x^2) + C$

(C) $\tan^{-1} x + C$

(D) $\frac{1}{1+x^2} + C$

Q14. $\int_{-2}^{2} x^3 \, dx$ equals:

(A) 16

(B) 8

(C) 0

(D) 4

Q15. The local maximum value of $f(x) = x^3 - 3x$ is:

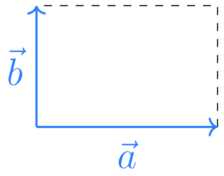
(A) -2

(B) 2

(C) 0

(D) -1

Q16. The area of the parallelogram whose adjacent sides are the vectors $\vec{a} = 3\hat{i}$ and $\vec{b} = 2\hat{j}$ (shown below) is:



(A) 5

(B) 1

(C) 12

(D) 6

Q17. The angle between two lines whose direction ratios are $1, 2, 3$ and $2, -1, 0$ is:

(A) 90°

(B) 0°

(C) 45°

(D) 60°

Q18. If A and B are independent events with $P(A) = \frac{1}{3}$ and $P(B) = \frac{1}{2}$, then $P(A \cup B)$ equals:

(A) $\frac{5}{6}$

(B) $\frac{1}{6}$

(C) $\frac{2}{3}$

(D) $\frac{1}{2}$

Q19. Assertion (A): The function $f(x) = |x|$ is continuous at $x = 0$.
Reason (R): Every differentiable function is continuous.

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is *not* the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

Q20. Assertion (A): $\cos^{-1}\left(\cos\frac{7\pi}{6}\right) = \frac{7\pi}{6}$.
Reason (R): The range (principal value branch) of $\cos^{-1}x$ is $[0, \pi]$.

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is *not* the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

Section B (Q21–Q25) – 2 Marks Each

Q21. Find the principal value of $\tan^{-1}(1) + \cos^{-1}\left(-\frac{1}{2}\right)$. **[2]**

Q22. Differentiate $y = (\sin x)^x$ with respect to x. **[2]**

Q23. Evaluate $\int x\, e^x\, dx$. **[2]**

OR

Evaluate $\int \cos^2 x\, dx$.

Q24. Find the value of λ for which the vectors $\vec{a} = 2\hat{i}+\lambda\hat{j}+\hat{k}$ and $\vec{b} = \hat{i}-2\hat{j}+3\hat{k}$ are perpendicular. **[2]**

Q25. A fair die is thrown twice. Find the probability of getting a sum of 9. **[2]**

OR

If $P(A) = 0.6$, $P(B) = 0.3$ and $P(A \cap B) = 0.2$, find $P(A \mid B)$.

Section C (Q26–Q31) – 3 Marks Each

Q26. Evaluate $\displaystyle\int \frac{x}{(x+1)(x+2)}\,dx$. **[3]**

Q27. Solve the differential equation $\dfrac{dy}{dx} + y = e^x$. **[3]**

OR

Solve the differential equation $\dfrac{dy}{dx} = \dfrac{1+y^2}{1+x^2}$.

Q28. Find the inverse of the matrix $A = \begin{bmatrix} 2 & 3 \\ 1 & 2 \end{bmatrix}$ using the adjoint method. **[3]**

Q29. Find the intervals in which $f(x) = x^3 - 6x^2 + 9x + 5$ is increasing or decreasing. **[3]**

OR

Find the equation of the tangent to the curve $y = x^2$ at the point $(1, 1)$.

Q30. Find the vector equation of the line passing through the point $(1, 2, 3)$ and parallel to the vector $3\hat{i} + 2\hat{j} - 2\hat{k}$. Hence check whether the point $(4, 4, 1)$ lies on this line. **[3]**

Q31. Show that the function $f : \mathbb{R} \to \mathbb{R}$ defined by $f(x) = 2x + 3$ is one-one and onto. **[3]**

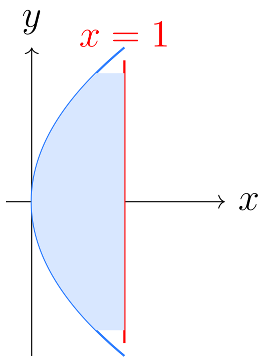
Section D (Q32–Q35) – 5 Marks Each

Q32. Using the matrix method, solve the following system of linear equations:

$$x + y + z = 6, \qquad y + 3z = 11, \qquad x - 2y + z = 0.$$

[5]

Q33. Using integration, find the area of the region bounded by the parabola $y^2 = 4x$ and the line $x = 1$.



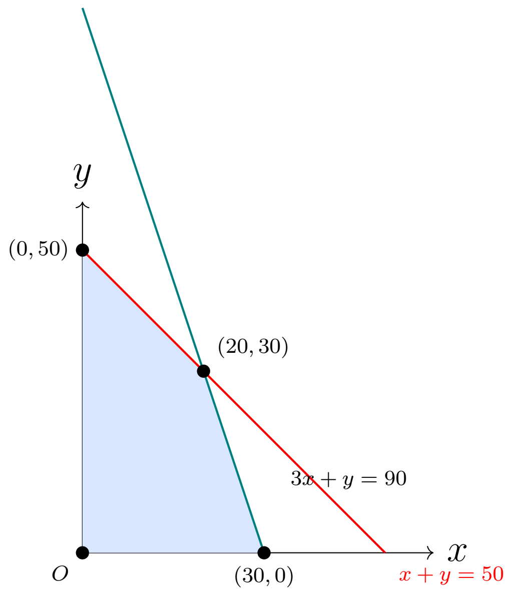
[5]

OR

Using integration, find the area of the region bounded by the curves $y = x^2$ and $y = x$ between $x = 0$ and $x = 1$.

Q34. Solve the following linear programming problem graphically. Maximise $Z = 4x + y$ subject to the constraints

$$x + y \leq 50, \qquad 3x + y \leq 90, \qquad x \geq 0, \ y \geq 0.$$



[5]

Q35. Find the shortest distance between the lines

$$\vec{r} = (\hat{i} + \hat{j}) + \lambda(2\hat{i} - \hat{j} + \hat{k}) \quad \text{and} \quad \vec{r} = (2\hat{i} + \hat{j} - \hat{k}) + \mu(3\hat{i} - 5\hat{j} + 2\hat{k}).$$

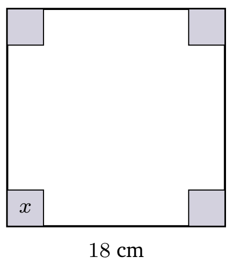
[5]

OR

Find the angle between the line $\vec{r} = (\hat{i} + 2\hat{j} + \hat{k}) + \lambda(\hat{i} + 2\hat{j} + 2\hat{k})$ and the plane $x + y + z = 5$.

Section E (Q36–Q38) – 4 Marks Each (Case Study)

Q36. Case Study – The Open Box.
A square sheet of tin of side 18 cm is to be made into an open-top box by cutting a small square of side x cm from each corner and folding up the flaps, as shown.



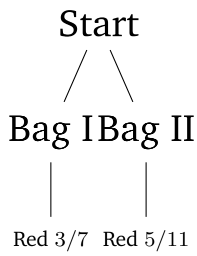
Based on the above, answer the following:

(i) Express the volume V of the box as a function of x. (1)

(ii) Find $\frac{dV}{dx}$. (1)

(iii) Find the value of x for which the volume is maximum, and the maximum volume. (2)

Q37. Case Study – Choosing a Bag.
Bag I contains 3 red and 4 black balls; Bag II contains 5 red and 6 black balls. One bag is selected at random and a ball is drawn from it. The ball drawn is found to be red.



Based on the above, answer the following:

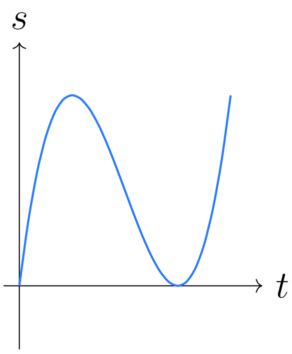
(i) Write $P(\text{Bag I})$ and $P(\text{Bag II})$. (1)

(ii) Write $P(\text{Red} \mid \text{Bag I})$ and $P(\text{Red} \mid \text{Bag II})$. (1)

(iii) Using Bayes' theorem, find the probability that the red ball was drawn from Bag I. (2)

Q38. Case Study – Motion of a Particle.

A particle moves along a straight line so that its position (in metres) at time t seconds is given by $s(t) = t^3 - 6t^2 + 9t$, for $t \geq 0$.



Based on the above, answer the following:

(i) Find the velocity $v(t)$ of the particle. (1)

(ii) Find the time(s) at which the particle is momentarily at rest. (1)

(iii) Find the acceleration of the particle at $t = 2$ s, and state whether it is speeding up or slowing down at that instant. (2)

Detailed Solutions

Q1.

Solution

Concept — Order of a matrix product: The product AB is defined only when the number of columns of A equals the number of rows of B, and the resulting order is (rows of A)$\times$(columns of B).

Step 1 — Check compatibility: A is 2×3 and B is 3×2.

The inner numbers are 3 and 3; they match, so AB exists.

Step 2 — Read off the order: The outer numbers give the order of AB.

Order of $AB = 2 \times 2$.

Why other options are wrong:

- (B) 3×3 is the order of the other product BA, not of AB.
- (C) 3×2 is the order of B, not of AB.
- (D) 2×3 is the order of A, not of AB.

Final Answer: Order of $AB = 2 \times 2 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Value of a 2×2 determinant: For $\begin{vmatrix} a & b \\ c & d \end{vmatrix}$, the value is $ad - bc$.

Step 1 — Identify entries: Here $a = 3$, $b = -2$, $c = 4$, $d = 5$.

Step 2 — Apply the formula:

$$ad - bc = (3)(5) - (-2)(4).$$

$$= 15 - (-8).$$

$$= 15 + 8.$$

$$= 23.$$

Why other options are wrong: (A) 7 comes from $15 - 8$ (wrong sign on bc); (B) 17 from $9 + 8$; (D) -23 flips the overall sign.

Final Answer: The determinant is $23 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q2

Q3.

Solution

Concept — Properties of a relation: *Reflexive*: $(a, a) \in R$ for all a. *Symmetric*: $(a, b) \in R \Rightarrow (b, a) \in R$. *Transitive*: $(a, b), (b, c) \in R \Rightarrow (a, c) \in R$.

Step 1 — Reflexive? $(1, 1), (2, 2), (3, 3) \in R$, so R is reflexive.

Step 2 — Symmetric? $(1, 2) \in R$ but $(2, 1) \notin R$.

Hence R is not symmetric.

Step 3 — Transitive? $(1, 2) \in R$ and $(2, 3) \in R$, but $(1, 3) \notin R$.

Hence R is not transitive.

Why other options are wrong: (A) fails by Step 2; (C) fails by Step 3; (D) an equivalence relation must be reflexive, symmetric and transitive, but two of these fail.

Final Answer: R is reflexive but neither symmetric nor transitive $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — Principal value of $\sin^{-1}$: The principal value branch of $\sin^{-1} x$ is $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$.

Step 1 — Set up the equation: Let $\sin^{-1}\left(-\frac{1}{2}\right) = \theta$, so $\sin\theta = -\frac{1}{2}$.

Step 2 — Find θ in the branch: We know $\sin\frac{\pi}{6} = \frac{1}{2}$, so $\sin\left(-\frac{\pi}{6}\right) = -\frac{1}{2}$.

Since $-\frac{\pi}{6} \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$, it is the principal value.

Why other options are wrong: (A) $\frac{\pi}{6}$ gives $+\frac{1}{2}$; (B) $\frac{5\pi}{6}$ and (C) $-\frac{5\pi}{6}$ lie outside the principal branch.

Final Answer: $\sin^{-1}\left(-\frac{1}{2}\right) = -\frac{\pi}{6} \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Chain rule: $\frac{d}{dx}\sin(u) = \cos(u)\cdot\frac{du}{dx}$.

Step 1 — Identify the inner function: Let $u = x^2$, so $\frac{du}{dx} = 2x$.

Step 2 — Apply the chain rule:

$$\frac{dy}{dx} = \cos(x^2)\cdot 2x.$$

$$= 2x\cos(x^2).$$

Why other options are wrong: (B) omits the factor $2x$; (C) wrongly differentiates the inside as $\cos x$; (D) has an incorrect negative sign.

Final Answer: $\frac{dy}{dx} = 2x\cos(x^2) \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Increasing function: f is increasing where $f'(x) > 0$.

Step 1 — Differentiate:

$$f(x) = x^2 - 4x + 3.$$

$$f'(x) = 2x - 4.$$

Step 2 — Solve $f'(x) > 0$:

$$2x - 4 > 0.$$

$$2x > 4.$$

$$x > 2.$$

So f is increasing on $(2, \infty)$, which matches the right branch of the parabola.

Why other options are wrong: (A) and (D) describe where $f'(x) < 0$ (decreasing); (B) is false since the parabola first falls then rises.

Final Answer: f increases on $(2, \infty) \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q6

Q7.

Solution

Concept — Standard integral: $\frac{d}{dx}\tan x = \sec^2 x$, hence $\int \sec^2 x\,dx = \tan x + C$.

Step 1 — Recall the antiderivative: The derivative of $\tan x$ is $\sec^2 x$.

Step 2 — Write the integral:

$$\int \sec^2 x\,dx = \tan x + C.$$

Why other options are wrong: (A) is $\int \csc^2 x\,dx$; (C) is $\int \sec x \tan x\,dx$; (D) is $\int \tan x\,dx$.

Final Answer: $\int \sec^2 x\,dx = \tan x + C \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Order and degree: The *order* is the highest derivative present; the *degree* is the power of that highest derivative when the equation is polynomial in derivatives.

Step 1 — Highest derivative: The highest derivative is $\frac{d^2y}{dx^2}$, so the order is 2.

Step 2 — Its power: The term $\frac{d^2y}{dx^2}$ appears to the first power (the cube is on $\frac{dy}{dx}$, a lower derivative).

So the degree is 1.

Why other options are wrong: (A),(B),(C) misread either the highest derivative or its power.

Final Answer: Order 2, degree $1 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Magnitude of a vector: For $\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$, $|\vec{a}| = \sqrt{a_1^2 + a_2^2 + a_3^2}$.

Step 1 — Square the components:

$$1^2 + 2^2 + 2^2 = 1 + 4 + 4.$$

$$= 9.$$

Step 2 — Take the square root:

$$|\vec{a}| = \sqrt{9} = 3.$$

Why other options are wrong: (B) 5 and (C) 9 skip or misuse the square root; (D) $\sqrt{5}$ uses wrong components.

Final Answer: $|\vec{a}| = 3 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Direction cosines: Direction cosines are the direction ratios divided by their magnitude $\sqrt{a^2 + b^2 + c^2}$.

Step 1 — Magnitude of ratios $1, -2, 2$:

$$\sqrt{1^2 + (-2)^2 + 2^2} = \sqrt{1 + 4 + 4} = \sqrt{9} = 3.$$

Step 2 — Divide each ratio by 3:

$$\left(\frac{1}{3}, -\frac{2}{3}, \frac{2}{3}\right).$$

Why other options are wrong: (A) are the ratios themselves; (B) divides by 9; (D) divides by $\sqrt{3}$.

Final Answer: Direction cosines $\left(\frac{1}{3}, -\frac{2}{3}, \frac{2}{3}\right) \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Fundamental theorem of calculus: $\int_a^b f(x)\,dx = F(b) - F(a)$, where $F' = f$.

Step 1 — Antiderivative: $\int \cos x\,dx = \sin x$.

Step 2 — Apply limits 0 **to** $\frac{\pi}{2}$**:**

$$\left[\sin x\right]_0^{\pi/2} = \sin\frac{\pi}{2} - \sin 0.$$

$$= 1 - 0.$$

$$= 1.$$

Why other options are wrong: (A) 0 and (C) -1 misuse the limits; (D) confuses the value with the interval length.

Final Answer: The integral equals $1 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q11

Q12.

Solution

Concept — Conditional probability: $P(A \mid B) = \frac{P(A \cap B)}{P(B)}$, provided $P(B) \neq 0$.

Step 1 — Substitute the values:

$$P(A \mid B) = \frac{0.2}{0.5}.$$

Step 2 — Simplify:

$$= \frac{2}{5} = 0.4.$$

Why other options are wrong: (A) 0.1 multiplies instead of dividing; (B) 0.7 adds; (C) 0.25 inverts the ratio.

Final Answer: $P(A \mid B) = 0.4 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Integration by recognising a derivative: If the numerator is the derivative of the denominator, $\int \frac{f'(x)}{f(x)}\,dx = \ln|f(x)| + C$.

Step 1 — Spot the pattern: Here $f(x) = 1 + x^2$, so $f'(x) = 2x$, which is exactly the numerator.

Step 2 — Write the result:

$$\int \frac{2x}{1+x^2}\,dx = \ln(1+x^2) + C.$$

(The absolute value is dropped since $1 + x^2 > 0$.)

Why other options are wrong: (B) has an extra factor 2; (C) is $\int \frac{1}{1+x^2}\,dx$; (D) is a wrong antiderivative.

Final Answer: $\ln(1+x^2) + C \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Integral of an odd function over a symmetric interval: If $g(-x) = -g(x)$, then $\int_{-a}^{a} g(x)\,dx = 0$.

Step 1 — Test the integrand: $g(x) = x^3$ gives $g(-x) = (-x)^3 = -x^3 = -g(x)$. So x^3 is an odd function.

Step 2 — Apply the property: The interval $[-2, 2]$ is symmetric about 0, hence

$$\int_{-2}^{2} x^3\,dx = 0.$$

Why other options are wrong: (A),(B),(D) ignore the symmetry; direct integration also gives $\left[\frac{x^4}{4}\right]_{-2}^{2} = 4 - 4 = 0$.

Final Answer: The integral equals $0 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

Solution

Concept — Local maximum via second derivative: At a critical point where $f'(x) = 0$, a local maximum occurs if $f''(x) < 0$.

Step 1 — Critical points:

$$f(x) = x^3 - 3x.$$
$$f'(x) = 3x^2 - 3 = 0.$$
$$x^2 = 1 \;\Rightarrow\; x = \pm 1.$$

Step 2 — Second-derivative test:

$$f''(x) = 6x.$$

At $x = -1$, $f''(-1) = -6 < 0$, so $x = -1$ gives a local maximum.

Step 3 — Maximum value:

$$f(-1) = (-1)^3 - 3(-1) = -1 + 3 = 2.$$

Why other options are wrong: (A) -2 is the local minimum value at $x = 1$; (C),(D) are not extreme values.

Final Answer: Local maximum value is $2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q15

Q16.

Solution

Concept — Area of a parallelogram: Area $= |\vec{a} \times \vec{b}|$ for adjacent side vectors $\vec{a}, \vec{b}$.

Step 1 — Compute the cross product:

$$\vec{a} \times \vec{b} = (3\hat{\imath}) \times (2\hat{\jmath}) = 6\,(\hat{\imath} \times \hat{\jmath}) = 6\hat{k}.$$

Step 2 — Take the magnitude:

$$|\vec{a} \times \vec{b}| = |6\hat{k}| = 6.$$

(Equivalently, the rectangle has sides 3 and 2, so area $= 3 \times 2 = 6$.)

Why other options are wrong: (A) 5 adds the sides; (B) 1 ignores magnitudes; (C) 12 doubles the area.

Final Answer: Area $= 6 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Angle between two lines: If $\vec{b}_1 \cdot \vec{b}_2 = 0$, the lines are perpendicular $(90°)$.

Step 1 — Dot product of direction ratios:

$$(1)(2) + (2)(-1) + (3)(0).$$

$$= 2 - 2 + 0.$$

$$= 0.$$

Step 2 — Interpret: A zero dot product means the lines are perpendicular, so the angle is $90°$.

Why other options are wrong: (B) $0°$ needs parallel ratios; (C),(D) would need a non-zero dot product giving those cosines.

Final Answer: The angle is $90° \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Union with independent events: $P(A \cup B) = P(A) + P(B) - P(A)P(B)$ when A, B are independent.

Step 1 — Product term:

$$P(A)P(B) = \frac{1}{3} \cdot \frac{1}{2} = \frac{1}{6}.$$

Step 2 — Substitute:

$$P(A \cup B) = \frac{1}{3} + \frac{1}{2} - \frac{1}{6}.$$

$$= \frac{2}{6} + \frac{3}{6} - \frac{1}{6}.$$
$$= \frac{4}{6} = \frac{2}{3}.$$

Why other options are wrong: (A) $\frac{5}{6}$ forgets to subtract the intersection; (B) $\frac{1}{6}$ is only $P(A \cap B)$; (D) $\frac{1}{2}$ uses wrong arithmetic.

Final Answer: $P(A \cup B) = \frac{2}{3} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Assertion–Reason analysis: Judge each statement's truth, then decide whether R correctly explains A.

Step 1 — Assertion: $f(x) = |x|$ is continuous everywhere, including at $x = 0$ (left and right limits both equal $0 = f(0)$). So A is **true**.

Step 2 — Reason: "Every differentiable function is continuous" is a standard true theorem. So R is **true**.

Step 3 — Does R explain A? $|x|$ is *not* differentiable at $x = 0$, so its continuity there cannot be justified by differentiability. Hence R is a true statement but *not* the correct explanation of A.

Why other options are wrong: (A) needs R to explain A (it does not); (C),(D) misjudge a truth value.

Final Answer: Both true, R not the correct explanation $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q19

Q20.

Solution

Concept — Inverse cosine of a cosine: $\cos^{-1}(\cos\theta) = \theta$ only when $\theta \in [0, \pi]$; otherwise reduce to the principal branch.

Step 1 — Test the Assertion: $\frac{7\pi}{6} \notin [0, \pi]$, so we cannot simply write the answer as $\frac{7\pi}{6}$.

Now $\cos\frac{7\pi}{6} = -\frac{\sqrt{3}}{2}$, and $\cos^{-1}\left(-\frac{\sqrt{3}}{2}\right) = \frac{5\pi}{6}$.

Hence the correct value is $\frac{5\pi}{6}$, not $\frac{7\pi}{6}$. So A is **false**.

Step 2 — Test the Reason: The principal value branch of $\cos^{-1}$ is indeed $[0, \pi]$. So R is **true**.

Why other options are wrong: (A),(B) require A true; (C) requires R false.

Final Answer: A false, R true $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Principal values: $\tan^{-1} 1$ lies in $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ and $\cos^{-1}$ lies in $[0, \pi]$.

Step 1 — Evaluate $\tan^{-1} 1$:

$$\tan\frac{\pi}{4} = 1 \;\Rightarrow\; \tan^{-1} 1 = \frac{\pi}{4}.$$

Step 2 — Evaluate $\cos^{-1}\left(-\frac{1}{2}\right)$:

$$\cos\frac{2\pi}{3} = -\frac{1}{2} \;\Rightarrow\; \cos^{-1}\left(-\frac{1}{2}\right) = \frac{2\pi}{3}.$$

Step 3 — Add:

$$\frac{\pi}{4} + \frac{2\pi}{3} = \frac{3\pi}{12} + \frac{8\pi}{12} = \frac{11\pi}{12}.$$

Final Answer: $\tan^{-1} 1 + \cos^{-1}\left(-\frac{1}{2}\right) = \frac{11\pi}{12}$. Go Back to Q21

Q22.

Solution

Concept — Logarithmic differentiation: Used when the variable appears in both base and exponent.

Step 1 — Take natural log of both sides:

$$y = (\sin x)^x.$$

$$\ln y = x\ln(\sin x).$$

Step 2 — Differentiate both sides w.r.t. x: (product rule on the right)

$$\frac{1}{y}\frac{dy}{dx} = 1\cdot\ln(\sin x) + x\cdot\frac{\cos x}{\sin x}.$$

$$\frac{1}{y}\frac{dy}{dx} = \ln(\sin x) + x\cot x.$$

Step 3 — Solve for $\frac{dy}{dx}$:

$$\frac{dy}{dx} = y\big[\ln(\sin x) + x\cot x\big].$$

$$= (\sin x)^x\big[\ln(\sin x) + x\cot x\big].$$

Final Answer: $\frac{dy}{dx} = (\sin x)^x\big[\ln(\sin x) + x\cot x\big]$. **Go Back to Q22**

Q23.

Solution

Concept — Integration by parts: $\int u\,dv = uv - \int v\,du$, choosing u by the ILATE rule.

Step 1 — Choose parts: Let $u = x$ and $dv = e^x dx$.

Then $du = dx$ and $v = e^x$.

Step 2 — Apply the formula:

$$\int x\,e^x\,dx = x\,e^x - \int e^x\,dx.$$

$$= x\,e^x - e^x + C.$$

$$= e^x(x-1) + C.$$

Final Answer: $\int x\,e^x\,dx = e^x(x-1) + C$.

OR — $\int \cos^2 x\,dx$**:**

Step 1 — Use the identity $\cos^2 x = \dfrac{1+\cos 2x}{2}$:

$$\int \cos^2 x\, dx = \int \frac{1+\cos 2x}{2}\, dx.$$

Step 2 — Integrate term by term:

$$= \frac{1}{2}\int 1\, dx + \frac{1}{2}\int \cos 2x\, dx.$$

$$= \frac{x}{2} + \frac{1}{2}\cdot\frac{\sin 2x}{2} + C.$$

$$= \frac{x}{2} + \frac{\sin 2x}{4} + C.$$

Final Answer (OR): $\int \cos^2 x\, dx = \dfrac{x}{2} + \dfrac{\sin 2x}{4} + C$. **Go Back to Q23**

Q24.

Solution

Concept — Perpendicular vectors: $\vec{a} \perp \vec{b} \iff \vec{a}\cdot\vec{b} = 0$.

Step 1 — Compute the dot product:

$$\vec{a}\cdot\vec{b} = (2)(1) + (\lambda)(-2) + (1)(3).$$

$$= 2 - 2\lambda + 3.$$

$$= 5 - 2\lambda.$$

Step 2 — Set equal to zero and solve:

$$5 - 2\lambda = 0.$$

$$2\lambda = 5.$$

$$\lambda = \frac{5}{2}.$$

Final Answer: $\lambda = \dfrac{5}{2}$. **Go Back to Q24**

Q25.

Solution

Concept — Equally likely outcomes: Probability $= \dfrac{\text{favourable outcomes}}{\text{total outcomes}}$.

Step 1 — Total outcomes: Two throws of a die give $6 \times 6 = 36$ equally likely outcomes.

Step 2 — Favourable outcomes (sum $= 9$):

$$(3,6),\ (6,3),\ (4,5),\ (5,4).$$

There are 4 such outcomes.

Step 3 — Probability:

$$P(\text{sum} = 9) = \frac{4}{36} = \frac{1}{9}.$$

Final Answer: $P(\text{sum} = 9) = \dfrac{1}{9}$.

OR — $P(A \mid B)$**:**

Step 1 — Formula: $P(A \mid B) = \dfrac{P(A \cap B)}{P(B)}$.

Step 2 — Substitute:

$$P(A \mid B) = \frac{0.2}{0.3} = \frac{2}{3}.$$

Final Answer (OR): $P(A \mid B) = \dfrac{2}{3}$. **Go Back to Q25**

Q26.

Solution

Concept — Partial fractions: Split a proper rational function into simpler fractions, then integrate each.

Step 1 — Set up the decomposition:

$$\frac{x}{(x+1)(x+2)} = \frac{A}{x+1} + \frac{B}{x+2}.$$

$$x = A(x+2) + B(x+1).$$

Step 2 — Find A and B:

Put $x = -1$: $-1 = A(1) + B(0) \Rightarrow A = -1$.

Put $x = -2$: $-2 = A(0) + B(-1) \Rightarrow B = 2$.

Step 3 — Integrate:

$$\int \frac{x}{(x+1)(x+2)}\,dx = \int \left(\frac{-1}{x+1} + \frac{2}{x+2}\right) dx.$$

$$= -\ln|x+1| + 2\ln|x+2| + C.$$

Final Answer: $-\ln|x+1| + 2\ln|x+2| + C$. **Go Back to Q26**

Q27.

Solution

Concept — Linear differential equation: For $\frac{dy}{dx} + Py = Q$, the integrating factor is I.F. $= e^{\int P\,dx}$ and the solution is $y \cdot \text{I.F.} = \int Q \cdot \text{I.F.}\,dx$.

Step 1 — Identify P, Q: Here $P = 1$, $Q = e^x$.

Step 2 — Integrating factor:

$$\text{I.F.} = e^{\int 1\,dx} = e^x.$$

Step 3 — Solve:

$$y\,e^x = \int e^x \cdot e^x\,dx = \int e^{2x}\,dx.$$

$$y\,e^x = \frac{e^{2x}}{2} + C.$$

$$y = \frac{e^x}{2} + C\,e^{-x}.$$

Final Answer: $y = \frac{e^x}{2} + C\,e^{-x}$.

OR — Variables separable $\frac{dy}{dx} = \frac{1+y^2}{1+x^2}$:

Step 1 — Separate variables:

$$\frac{dy}{1+y^2} = \frac{dx}{1+x^2}.$$

Step 2 — Integrate both sides:

$$\tan^{-1} y = \tan^{-1} x + C.$$

Final Answer (OR): $\tan^{-1} y = \tan^{-1} x + C$. **Go Back to Q27**

Q28.

Solution

Concept — Inverse by adjoint: $A^{-1} = \frac{1}{|A|}\text{adj}(A)$, valid when $|A| \neq 0$.

Step 1 — Determinant:

$$|A| = \begin{vmatrix} 2 & 3 \\ 1 & 2 \end{vmatrix} = (2)(2) - (3)(1) = 4 - 3 = 1.$$

Step 2 — Adjoint of a 2×2 matrix: Swap the leading diagonal entries and negate the off-diagonal entries:

$$\text{adj}(A) = \begin{bmatrix} 2 & -3 \\ -1 & 2 \end{bmatrix}.$$

Step 3 — Inverse:

$$A^{-1} = \frac{1}{1}\begin{bmatrix} 2 & -3 \\ -1 & 2 \end{bmatrix} = \begin{bmatrix} 2 & -3 \\ -1 & 2 \end{bmatrix}.$$

Final Answer: $A^{-1} = \begin{bmatrix} 2 & -3 \\ -1 & 2 \end{bmatrix}$. **Go Back to Q28**

Q29.

Solution

Concept — Monotonicity: f increases where $f'(x) > 0$ and decreases where $f'(x) < 0$.

Step 1 — Differentiate:

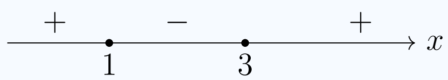
$$f(x) = x^3 - 6x^2 + 9x + 5.$$

$$f'(x) = 3x^2 - 12x + 9.$$

$$= 3(x^2 - 4x + 3) = 3(x-1)(x-3).$$

Step 2 — Critical points: $f'(x) = 0$ at $x = 1$ and $x = 3$.

Step 3 — Sign analysis:



For $x < 1$: $f' > 0$; for $1 < x < 3$: $f' < 0$; for $x > 3$: $f' > 0$.

Conclusion: Increasing on $(-\infty, 1) \cup (3, \infty)$; decreasing on $(1, 3)$.

Final Answer: Increasing on $(-\infty, 1) \cup (3, \infty)$, decreasing on $(1, 3)$.

OR — Tangent to $y = x^2$ at $(1, 1)$:

Step 1 — Slope: $\frac{dy}{dx} = 2x$, so at $x = 1$ slope $= 2$.

Step 2 — Equation: $y - 1 = 2(x - 1) \Rightarrow y = 2x - 1$.

Final Answer (OR): $y = 2x - 1$. **Go Back to Q29**

Q30.

Solution

Concept — Vector equation of a line: A line through point $\vec{a}$ parallel to $\vec{b}$ is $\vec{r} = \vec{a} + \lambda\vec{b}$.

Step 1 — Write the equation: With $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$ and $\vec{b} = 3\hat{i} + 2\hat{j} - 2\hat{k}$,

$$\vec{r} = (\hat{i} + 2\hat{j} + 3\hat{k}) + \lambda(3\hat{i} + 2\hat{j} - 2\hat{k}).$$

Step 2 — Test the point $(4, 4, 1)$: The point lies on the line if some λ satisfies all three component equations.

$$1 + 3\lambda = 4 \;\Rightarrow\; \lambda = 1.$$

$$2 + 2\lambda = 4 \;\Rightarrow\; \lambda = 1.$$

$$3 - 2\lambda = 1 \;\Rightarrow\; \lambda = 1.$$

Step 3 — Conclusion: All three give the same value $\lambda = 1$, so the point $(4, 4, 1)$ lies on the line.

Final Answer: $\vec{r} = (\hat{i} + 2\hat{j} + 3\hat{k}) + \lambda(3\hat{i} + 2\hat{j} - 2\hat{k})$; the point $(4, 4, 1)$ lies on it (at $\lambda = 1$). **Go Back to Q30**

Q31.

Solution

Concept — One-one (injective) and onto (surjective): *One-one*: $f(x_1) = f(x_2) \Rightarrow x_1 = x_2$. *Onto*: every y in the codomain has a pre-image.

Step 1 — One-one: Suppose $f(x_1) = f(x_2)$.

$$2x_1 + 3 = 2x_2 + 3.$$

$$2x_1 = 2x_2.$$

$$x_1 = x_2.$$

Hence f is one-one.

Step 2 — Onto: Let $y \in \mathbb{R}$ be arbitrary. Solve $y = 2x + 3$ for x:

$$x = \frac{y-3}{2} \in \mathbb{R}.$$

Then $f(x) = 2\left(\frac{y-3}{2}\right) + 3 = y$.

So every y has a pre-image; f is onto.

Step 3 — Conclusion: f is both one-one and onto, hence bijective.

Final Answer: $f(x) = 2x + 3$ is one-one and onto (a bijection). **Go Back to Q31**

Q32.

Solution

Concept — Matrix method: Write $AX = B$; then $X = A^{-1}B$ when $|A| \neq 0$.

Step 1 — Form the matrices:

$$A = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 3 \\ 1 & -2 & 1 \end{bmatrix}, \quad X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}, \quad B = \begin{bmatrix} 6 \\ 11 \\ 0 \end{bmatrix}.$$

Step 2 — Determinant of A:

$$|A| = 1(1 \cdot 1 - 3 \cdot (-2)) - 1(0 \cdot 1 - 3 \cdot 1) + 1(0 \cdot (-2) - 1 \cdot 1).$$

$$= 1(1+6) - 1(0-3) + 1(0-1).$$

$$= 7 + 3 - 1 = 9 \ (\neq 0).$$

Step 3 — Cofactors and adjoint: Computing the cofactor matrix and transposing gives

$$\text{adj}(A) = \begin{bmatrix} 7 & -3 & 2 \\ 3 & 0 & -3 \\ -1 & 3 & 1 \end{bmatrix}.$$

Step 4 — Solve $X = \frac{1}{|A|}$ adj$(A)\,B$:

$$X = \frac{1}{9}\begin{bmatrix} 7 & -3 & 2 \\ 3 & 0 & -3 \\ -1 & 3 & 1 \end{bmatrix}\begin{bmatrix} 6 \\ 11 \\ 0 \end{bmatrix}.$$

$$= \frac{1}{9}\begin{bmatrix} 7\cdot 6 - 3\cdot 11 + 2\cdot 0 \\ 3\cdot 6 + 0\cdot 11 - 3\cdot 0 \\ -1\cdot 6 + 3\cdot 11 + 1\cdot 0 \end{bmatrix}.$$

$$= \frac{1}{9}\begin{bmatrix} 42-33 \\ 18 \\ -6+33 \end{bmatrix} = \frac{1}{9}\begin{bmatrix} 9 \\ 18 \\ 27 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}.$$

Step 5 — Verify: $x + y + z = 1 + 2 + 3 = 6$ ✓; $y + 3z = 2 + 9 = 11$ ✓; $x - 2y + z = 1 - 4 + 3 = 0$ ✓.

Final Answer: $x = 1,\ y = 2,\ z = 3$. **Go Back to Q32**

Q33.

Solution

Concept — Area by integration: For a curve symmetric about the x-axis, total area $= 2\times$ area above the axis.

Step 1 — Express y: From $y^2 = 4x$, the upper branch is $y = 2\sqrt{x}$.

Step 2 — Set up the integral (from $x = 0$ to $x = 1$, doubled for symmetry):

$$\text{Area} = 2\int_0^1 2\sqrt{x}\,dx.$$

$$= 4\int_0^1 x^{1/2}\,dx.$$

Step 3 — Integrate:

$$= 4\left[\frac{x^{3/2}}{3/2}\right]_0^1.$$

$$= 4\cdot\frac{2}{3}\left[x^{3/2}\right]_0^1.$$

$$= \frac{8}{3}(1-0) = \frac{8}{3}.$$

Final Answer: Area $= \frac{8}{3}$ square units.

OR — Region between $y = x$ and $y = x^2$, $0 \le x \le 1$:

Step 1 — Top minus bottom: On $[0, 1]$, $x \ge x^2$, so

$$\text{Area} = \int_0^1 (x - x^2)\, dx.$$

Step 2 — Integrate:

$$= \left[\frac{x^2}{2} - \frac{x^3}{3}\right]_0^1 = \frac{1}{2} - \frac{1}{3} = \frac{1}{6}.$$

Final Answer (OR): Area $= \frac{1}{6}$ square units. **Go Back to Q33**

Q34.

Solution

Concept — Corner-point method: The optimum of a linear objective over a bounded feasible region occurs at a corner (vertex).

Step 1 — Find the corner points: The constraints $x + y \le 50$, $3x + y \le 90$, $x \ge 0$, $y \ge 0$ bound the region with vertices:

$$O(0, 0), \quad (30, 0), \quad (0, 50).$$

The lines $x + y = 50$ and $3x + y = 90$ intersect where

$$(3x + y) - (x + y) = 90 - 50 \Rightarrow 2x = 40 \Rightarrow x = 20, \ y = 30.$$

So the fourth vertex is $(20, 30)$.

Step 2 — Evaluate $Z = 4x + y$ at each corner:

$$Z(0, 0) = 0.$$

$$Z(30, 0) = 4(30) + 0 = 120.$$

$$Z(20, 30) = 4(20) + 30 = 110.$$

$$Z(0, 50) = 4(0) + 50 = 50.$$

Step 3 — Pick the maximum: The largest value is 120 at $(30, 0)$.

Final Answer: Z is maximum $= 120$ at $(x, y) = (30, 0)$. **Go Back to Q34**

Q35.

Solution

Concept — Shortest distance between skew lines: For $\vec{r} = \vec{a}_1 + \lambda\vec{b}_1$ and $\vec{r} = \vec{a}_2 + \mu\vec{b}_2$,

$$d = \frac{\left|(\vec{a}_2 - \vec{a}_1)\cdot(\vec{b}_1 \times \vec{b}_2)\right|}{|\vec{b}_1 \times \vec{b}_2|}.$$

Step 1 — Identify vectors: $\vec{a}_1 = \hat{i}+\hat{j}$, $\vec{b}_1 = 2\hat{i}-\hat{j}+\hat{k}$; $\vec{a}_2 = 2\hat{i}+\hat{j}-\hat{k}$, $\vec{b}_2 = 3\hat{i}-5\hat{j}+2\hat{k}$.

Step 2 — Cross product $\vec{b}_1 \times \vec{b}_2$:

$$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -1 & 1 \\ 3 & -5 & 2 \end{vmatrix}.$$

$$= \hat{i}\big[(-1)(2) - (1)(-5)\big] - \hat{j}\big[(2)(2) - (1)(3)\big] + \hat{k}\big[(2)(-5) - (-1)(3)\big].$$

$$= \hat{i}(-2+5) - \hat{j}(4-3) + \hat{k}(-10+3).$$

$$= 3\hat{i} - \hat{j} - 7\hat{k}.$$

Step 3 — Its magnitude:

$$|\vec{b}_1 \times \vec{b}_2| = \sqrt{3^2 + (-1)^2 + (-7)^2} = \sqrt{9+1+49} = \sqrt{59}.$$

Step 4 — $(\vec{a}_2 - \vec{a}_1)$ and the dot product:

$$\vec{a}_2 - \vec{a}_1 = (2-1)\hat{i} + (1-1)\hat{j} + (-1-0)\hat{k} = \hat{i} - \hat{k}.$$

$$(\vec{a}_2 - \vec{a}_1)\cdot(\vec{b}_1 \times \vec{b}_2) = (1)(3) + (0)(-1) + (-1)(-7) = 3 + 0 + 7 = 10.$$

Step 5 — Distance:

$$d = \frac{|10|}{\sqrt{59}} = \frac{10}{\sqrt{59}} \text{ units.}$$

Final Answer: Shortest distance $= \dfrac{10}{\sqrt{59}}$ units.

OR — Angle between line and plane:

Step 1 — Direction $\vec{b} = \hat{i} + 2\hat{j} + 2\hat{k}$, normal $\vec{n} = \hat{i} + \hat{j} + \hat{k}$.

Step 2 — Use $\sin\theta = \dfrac{|\vec{b}\cdot\vec{n}|}{|\vec{b}||\vec{n}|}$**:**

$$\vec{b}\cdot\vec{n} = 1+2+2 = 5, \quad |\vec{b}| = 3, \quad |\vec{n}| = \sqrt{3}.$$

$$\sin\theta = \frac{5}{3\sqrt{3}}.$$

Final Answer (OR): $\theta = \sin^{-1}\left(\frac{5}{3\sqrt{3}}\right)$. Go Back to Q35

Q36.

Solution

Concept — Maxima by derivatives: Build the volume function, set $\frac{dV}{dx} = 0$, and select the value giving a genuine maximum.

(i) Volume function: After cutting squares of side x, the base is $(18 - 2x)$ by $(18 - 2x)$ and the height is x:

$$V = x(18-2x)^2, \qquad 0 < x < 9.$$

(ii) Differentiate:

$$\frac{dV}{dx} = (18-2x)^2 + x \cdot 2(18-2x)(-2).$$

$$= (18-2x)\big[(18-2x) - 4x\big].$$

$$= (18-2x)(18-6x).$$

(iii) Critical points and maximum: Set $\frac{dV}{dx} = 0$:

$$18 - 2x = 0 \;\Rightarrow\; x = 9 \quad \text{(rejected; gives } V = 0).$$

$$18 - 6x = 0 \;\Rightarrow\; x = 3.$$

For $x < 3$, $\frac{dV}{dx} > 0$ and for $3 < x < 9$, $\frac{dV}{dx} < 0$, so $x = 3$ gives a maximum.
Maximum volume:

$$V(3) = 3(18-6)^2 = 3(12)^2 = 3 \times 144 = 432.$$

Final Answer: $V = x(18-2x)^2$; $\frac{dV}{dx} = (18-2x)(18-6x)$; maximum at $x = 3$ cm with $V_{\max} = 432$ cm^3. Go Back to Q36

Q37.

Solution

Concept — Bayes' theorem: $P(E_i \mid A) = \dfrac{P(E_i)P(A \mid E_i)}{\sum_j P(E_j)P(A \mid E_j)}$.

(i) Prior probabilities: A bag is chosen at random, so

$$P(\text{Bag I}) = P(\text{Bag II}) = \frac{1}{2}.$$

(ii) Conditional (red) probabilities:

$$P(\text{Red} \mid \text{Bag I}) = \frac{3}{7}, \qquad P(\text{Red} \mid \text{Bag II}) = \frac{5}{11}.$$

(iii) Apply Bayes' theorem:

$$P(\text{Bag I} \mid \text{Red}) = \frac{\frac{1}{2} \cdot \frac{3}{7}}{\frac{1}{2} \cdot \frac{3}{7} + \frac{1}{2} \cdot \frac{5}{11}}.$$

Cancel the common $\frac{1}{2}$:

$$= \frac{\frac{3}{7}}{\frac{3}{7} + \frac{5}{11}}.$$

Take LCM 77 in the denominator:

$$\frac{3}{7} = \frac{33}{77}, \qquad \frac{5}{11} = \frac{35}{77}.$$

$$= \frac{33/77}{(33 + 35)/77} = \frac{33}{68}.$$

Final Answer: $P(\text{Bag I} \mid \text{Red}) = \dfrac{33}{68}$. **Go Back to Q37**

Q38.

Solution

Concept — Velocity and acceleration: Velocity $v = \dfrac{ds}{dt}$, acceleration $a = \dfrac{dv}{dt}$. The body is at rest when $v = 0$.

(i) Velocity:

$$s(t) = t^3 - 6t^2 + 9t.$$

$$v(t) = \frac{ds}{dt} = 3t^2 - 12t + 9.$$

(ii) Times at rest: Set $v(t) = 0$:

$$3t^2 - 12t + 9 = 0.$$

$$t^2 - 4t + 3 = 0.$$

$$(t-1)(t-3) = 0 \Rightarrow t = 1 \text{ s and } t = 3 \text{ s}.$$

(iii) Acceleration at $t = 2$:

$$a(t) = \frac{dv}{dt} = 6t - 12.$$

$$a(2) = 6(2) - 12 = 0.$$

At $t = 2$, $v(2) = 3(4) - 24 + 9 = -3$ m/s $(\neq 0)$ and $a = 0$, so the speed is momentarily neither increasing nor decreasing (the velocity is at its minimum).

Final Answer: $v(t) = 3t^2 - 12t + 9$; at rest at $t = 1$ s and $t = 3$ s; $a(2) = 0$ m/s^2 (instantaneously neither speeding up nor slowing down). **Go Back to Q38**

Answer Key – Section A (Q1–Q20)

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	C	3	B	4	D	5	A
6	C	7	B	8	D	9	A	10	C
11	B	12	D	13	A	14	C	15	B
16	D	17	A	18	C	19	B	20	D

Sections B–E are descriptive; refer to the Detailed Solutions above for full model answers and step marking.