NEST Mathematics Sample Paper – 4

Duration: 45 Minutes **Maximum Marks: 60**

Instructions

- This paper contains **20 Multiple Choice Questions (single correct answer)**, modelled on the Mathematics section of **NEST 2026**.
- Each correct answer carries **+3 marks**. There is a deduction of -1 **mark** for each incorrect answer; **no marks** are deducted for an unattempted question.
- Every question has exactly **four options**, of which only **one** is correct. Choose carefully.
- Personal calculators, log tables, mobile phones, and other electronic gadgets are strictly prohibited in the examination hall.
- A simple on-screen (virtual) calculator is provided in the computer-based test interface and may be used; blank sheets for rough work are supplied at the exam centre.

Q1. Let A be a set with 3 elements and B a set with 4 elements. The total number of distinct relations from A to B is

(A) 2^7

(B) 3^4

(C) 2^{12}

(D) 4^3

Q2. The expression $\dfrac{\sin 3\theta}{\sin\theta} - \dfrac{\cos 3\theta}{\cos\theta}$ simplifies to

(A) 2

(B) 1

(C) $\sin 2\theta$

(D) 4

Q3. If $2 + 3i$ is one root of a quadratic equation with real coefficients and leading coefficient 1, then that equation is

(A) $x^2 + 4x + 13 = 0$

(B) $x^2 - 4x + 13 = 0$

(C) $x^2 - 4x - 13 = 0$

(D) $x^2 + 4x - 13 = 0$

Q4. Using the digits $1, 2, 3, 4, 5$ without repetition, the number of three-digit even numbers that can be formed is

(A) 12

(B) 36

(C) 48

(D) 24

Q5. The middle term in the binomial expansion of $\left(2x + \frac{1}{x}\right)^6$ is

(A) 240

(B) 120

(C) 160

(D) 320

Q6. The value of the sum $\sum_{k=1}^{10} k^2 = 1^2 + 2^2 + \cdots + 10^2$ is

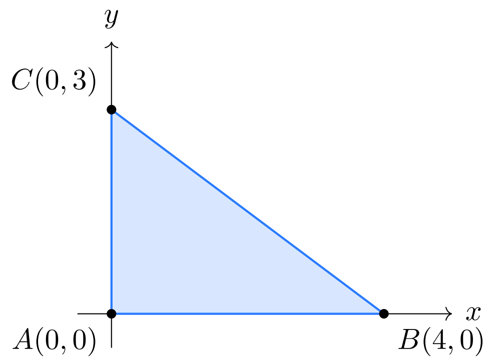
(A) 385

(B) 285

(C) 440

(D) 330

Q7. The area of the triangle whose vertices are $A(0, 0)$, $B(4, 0)$ and $C(0, 3)$ is



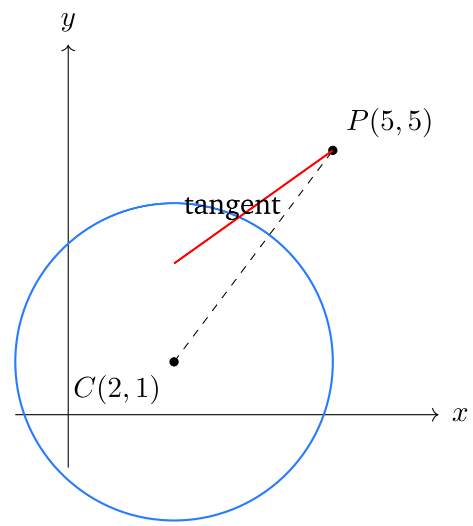
(A) 12 sq. units

(B) 6 sq. units

(C) 7 sq. units

(D) 10 sq. units

Q8. Consider the circle $x^2+y^2-4x-2y-4=0$ and the external point $P(5,5)$. The length of the tangent drawn from P to the circle is



(A) 4

(B) 6

(C) $\sqrt{34}$

(D) $\sqrt{22}$

Q9. The value of $\lim_{x\to\infty} \dfrac{3x^2+5x-1}{6x^2-2x+7}$ is

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

(B) 0

(C) 3

(D) ∞

Q10. One group of 20 students has mean marks 60, and a second group of 30 students has mean marks 70. The combined mean of all 50 students is

(A) 65

(B) 64

(C) 66

(D) 68

Q11. The principal value of $\cos^{-1}\left(-\frac{1}{2}\right)$ is

(A) $\frac{\pi}{3}$

(B) $\frac{2\pi}{3}$

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

(D) $-\frac{\pi}{3}$

Q12. If $A = \begin{bmatrix} 2 & 1 \\ 0 & 3 \end{bmatrix}$, then the entry in the first row, second column of A^2 is

(A) 3

(B) 9

(C) 4

(D) 5

Q13. For the system $2x + 3y = 8$ and $4x + 6y = 15$, which of the following is true?

(A) It is inconsistent (no solution).

(B) It has a unique solution.

(C) It has infinitely many solutions.

(D) It has exactly two solutions.

Q14. If $y = x^x$ for $x > 0$, then $\dfrac{dy}{dx}$ equals

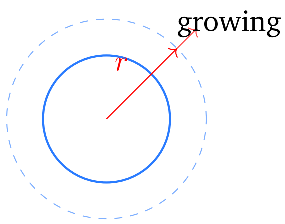
(A) $x\,x^{x-1}$

(B) $x^x\,(1 + \ln x)$

(C) $x^x \ln x$

(D) $x^{x-1}\,(1 + \ln x)$

Q15. The radius of a circular oil patch increases at a constant rate of 2 cm s^{-1}. The rate at which its area is increasing at the instant the radius is 5 cm is



(A) 10π cm^2 s^{-1}

(B) 25π cm^2 s^{-1}

(C) 20π cm^2 s^{-1}

(D) 40π cm^2 s^{-1}

Q16. The value of $\displaystyle\int \frac{dx}{(x-1)(x+2)}$ is (with C an arbitrary constant)

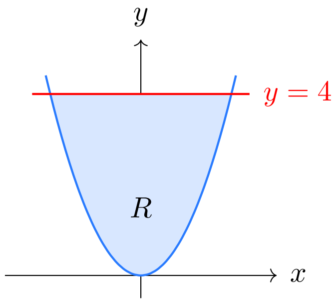
(A) $\dfrac{1}{3}\ln\left|\dfrac{x+2}{x-1}\right| + C$

(B) $\ln|(x-1)(x+2)| + C$

(C) $3\ln\left|\dfrac{x-1}{x+2}\right| + C$

(D) $\dfrac{1}{3}\ln\left|\dfrac{x-1}{x+2}\right| + C$

Q17. The area of the region bounded by the parabola $y = x^2$ and the line $y = 4$ is



(A) $\frac{16}{3}$ sq. units

(B) $\frac{32}{3}$ sq. units

(C) $\frac{8}{3}$ sq. units

(D) 16 sq. units

Q18. The differential equation $\frac{dy}{dx} = \frac{x+y}{x}$ has general solution (with C an arbitrary constant)

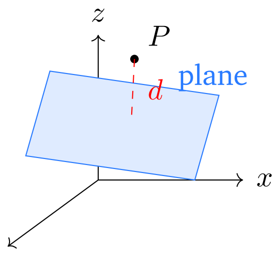
(A) $y = x^2 + C$

(B) $y = Cx^2$

(C) $y = x \ln|x| + Cx$

(D) $y = x\, e^{Cx}$

Q19. The distance of the point $P(1, 2, 3)$ from the plane $2x - y + 2z + 7 = 0$ is



(A) $\frac{13}{2}$

(B) $\frac{5}{3}$

(C) $\frac{9}{2}$

(D) $\frac{13}{3}$

Q20. For two independent events E and F, $P(E) = 0.3$ and $P(F) = 0.4$. The probability $P(E \cup F)$ is

(A) 0.58

(B) 0.70

(C) 0.12

(D) 0.42

Detailed Solutions

Q1.

Solution

Concept — Counting relations: A relation from A to B is any subset of $A \times B$. If $A \times B$ has m ordered pairs, the number of subsets (relations) is 2^m.

Step 1 — Size of $A \times B$: $|A \times B| = |A| \cdot |B| = 3 \times 4 = 12$.

Step 2 — Count subsets: The number of relations is $2^{12} = 4096$.

Why other options are wrong:

- (A) 2^7 uses $|A| + |B|$ instead of the product.
- (B) 3^4 counts functions from B to A, not relations.
- (D) 4^3 counts functions from A to B, not relations.

Final Answer: 2^{12} relations $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Combining the two fractions: Use a common denominator $\sin\theta\cos\theta$, then apply $\sin(A - B)$ and the double-angle identity.

Step 1 — Common denominator:

$$\frac{\sin 3\theta\cos\theta - \cos 3\theta\sin\theta}{\sin\theta\cos\theta} = \frac{\sin(3\theta - \theta)}{\sin\theta\cos\theta} = \frac{\sin 2\theta}{\sin\theta\cos\theta}.$$

Step 2 — Simplify: Since $\sin 2\theta = 2\sin\theta\cos\theta$,

$$\frac{2\sin\theta\cos\theta}{\sin\theta\cos\theta} = 2.$$

Why other options are wrong:

- (B) 1 forgets the factor 2 in $\sin 2\theta = 2\sin\theta\cos\theta$.
- (C) $\sin 2\theta$ stops before cancelling the denominator.
- (D) 4 doubles the correct factor.

Final Answer: The expression equals $2 \Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — Conjugate root theorem: For a real-coefficient polynomial, complex roots occur in conjugate pairs. So if $2+3i$ is a root, so is $2-3i$.

Step 1 — Sum and product of roots:

$$\text{sum} = (2+3i)+(2-3i) = 4, \qquad \text{product} = (2+3i)(2-3i) = 4+9 = 13.$$

Step 2 — Build the quadratic: With leading coefficient 1,

$$x^2 - (\text{sum})x + (\text{product}) = x^2 - 4x + 13 = 0.$$

Why other options are wrong:

- (A) $x^2+4x+13$ uses the wrong sign for the sum.
- (C) and (D) use -13, which would come from $(2+3i)(2-3i) = 4-9$ (sign error on i^2).

Final Answer: $x^2 - 4x + 13 = 0 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — Counting with a position constraint: Fix the constrained position first. An even number must end in an even digit; here the even digits available are 2 and 4.

Step 1 — Units place: Choose the last (units) digit from $\{2,4\}$: 2 ways.

Step 2 — Remaining two places: From the remaining 4 digits, fill the hundreds and tens places without repetition: $4 \times 3 = 12$ ways.

Step 3 — Total: $2 \times 12 = 24$ even three-digit numbers.

Why other options are wrong:

- (A) 12 fixes only one even ending digit.

- (B) 36 wrongly allows 3 even-ending choices.
- (C) 48 doubles the correct count (e.g. treats 4 remaining slots).

Final Answer: 24 numbers $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Middle term of a binomial: For $(a+b)^n$ with n even, there is a single middle term, the $\left(\frac{n}{2}+1\right)$th term: $T_{n/2+1} = \binom{n}{n/2} a^{n/2} b^{n/2}$.

Step 1 — Identify: Here $n = 6$, so the middle term is the 4th term with $\binom{6}{3} = 20$.

Step 2 — Compute: $a = 2x,\ b = \frac{1}{x}$, both raised to the power 3:

$$T_4 = \binom{6}{3}(2x)^3\left(\tfrac{1}{x}\right)^3 = 20 \cdot 8x^3 \cdot x^{-3} = 20 \cdot 8 = 160.$$

Why other options are wrong:

- (A) 240 uses $\binom{6}{2} = 15$ times 16 (wrong term).
- (B) 120 omits a factor of 2 in $(2x)^3$.
- (D) 320 uses 2^4 instead of 2^3.

Final Answer: Middle term $= 160 \Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q5

Q6.

Solution

Concept — Sum of squares: $\displaystyle\sum_{k=1}^{n} k^2 = \frac{n(n+1)(2n+1)}{6}$.

Step 1 — Substitute $n = 10$:

$$\sum_{k=1}^{10} k^2 = \frac{10 \cdot 11 \cdot 21}{6} = \frac{2310}{6} = 385.$$

Why other options are wrong:

- (B) 285 is $\sum_{k=1}^{9} k^2$ (stops at $n = 9$).

- (C) 440 and (D) 330 come from arithmetic slips in $n(n+1)(2n+1)/6$.

Final Answer: $\sum_{k=1}^{10} k^2 = 385 \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept — Area of a triangle from vertices: Area $= \frac{1}{2}|x_1(y_2-y_3)+x_2(y_3-y_1)+x_3(y_1-y_2)|$. For a right triangle on the axes, base $\times$ height $\div 2$ also works.

Step 1 — Identify base and height: AB lies on the x-axis with length 4; AC lies on the y-axis with length 3. These are perpendicular.

Step 2 — Compute: Area $= \frac{1}{2}\cdot 4\cdot 3 = 6$ sq. units.

Why other options are wrong:

- (A) 12 forgets the factor $\frac{1}{2}$.
- (C) 7 adds base and height instead of multiplying.
- (D) 10 is unrelated to the data.

Final Answer: Area $= 6$ sq. units $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Length of tangent: From an external point $P(x_1, y_1)$ to the circle $S \equiv x^2+y^2+2gx+2fy+c=0$, the tangent length is $\sqrt{S_1} = \sqrt{x_1^2+y_1^2+2gx_1+2fy_1+c}$.

Step 1 — Evaluate S_1: Here $S \equiv x^2+y^2-4x-2y-4$. At $P(5,5)$:

$$S_1 = 25+25-4(5)-2(5)-4 = 50-20-10-4 = 16.$$

Step 2 — Tangent length: $\sqrt{S_1} = \sqrt{16} = 4$. (Centre $(2,1)$, radius 3; $CP = \sqrt{9+16} = 5$, and $\sqrt{5^2-3^2} = 4$. ✓)

Why other options are wrong:

- (B) 6 ignores the radius (uses a wrong subtraction).

- (C) $\sqrt{34}$ takes the distance to the centre wrongly.
- (D) $\sqrt{22}$ comes from a sign slip in S_1.

Final Answer: Tangent length $= 4 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q8

Q9.

Solution

Concept — Limit of a rational function at infinity: When numerator and denominator have the same degree, the limit equals the ratio of the leading coefficients.

Step 1 — Divide by x^2:

$$\lim_{x\to\infty} \frac{3+\frac{5}{x}-\frac{1}{x^2}}{6-\frac{2}{x}+\frac{7}{x^2}} = \frac{3+0-0}{6-0+0} = \frac{3}{6}.$$

Step 2 — Simplify: $\frac{3}{6} = \frac{1}{2}$.

Why other options are wrong:

- (B) 0 would apply only if the numerator degree were lower.
- (C) 3 keeps only the numerator's leading coefficient.
- (D) ∞ would apply only if the numerator degree were higher.

Final Answer: The limit is $\frac{1}{2} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Combined (weighted) mean: For groups of sizes n_1, n_2 with means $\bar{x}_1, \bar{x}_2$, the combined mean is $\dfrac{n_1\bar{x}_1 + n_2\bar{x}_2}{n_1+n_2}$.

Step 1 — Total marks: $20 \times 60 + 30 \times 70 = 1200 + 2100 = 3300$.

Step 2 — Divide by total students: $\dfrac{3300}{50} = 66$.

Why other options are wrong:

- (A) 65 is the simple average of 60 and 70 (ignores group sizes).

- (B) 64 and (D) 68 come from swapping or mis-weighting the sizes.

Final Answer: Combined mean $= 66 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Principal value of $\cos^{-1}$: The range of $\cos^{-1}$ is $[0, \pi]$. We need the angle in this range whose cosine is $-\frac{1}{2}$.

Step 1 — Reference angle: $\cos\frac{\pi}{3} = \frac{1}{2}$, and cosine is negative in the second quadrant.

Step 2 — Principal value: $\cos^{-1}(-\frac{1}{2}) = \pi - \frac{\pi}{3} = \dfrac{2\pi}{3}$, which lies in $[0, \pi]$.

Why other options are wrong:

- (A) $\frac{\pi}{3}$ is $\cos^{-1}(+\frac{1}{2})$.
- (C) $\frac{5\pi}{6}$ has cosine $-\frac{\sqrt{3}}{2}$, not $-\frac{1}{2}$.
- (D) $-\frac{\pi}{3}$ lies outside the range $[0, \pi]$.

Final Answer: $\cos^{-1}(-\frac{1}{2}) = \dfrac{2\pi}{3} \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q11

Q12.

Solution

Concept — Matrix multiplication: The (i, j) entry of $A^2 = A \cdot A$ is the dot product of row i of A with column j of A.

Step 1 — Compute A^2:

$$A^2 = \begin{bmatrix} 2 & 1 \\ 0 & 3 \end{bmatrix} \begin{bmatrix} 2 & 1 \\ 0 & 3 \end{bmatrix} = \begin{bmatrix} 4 & 5 \\ 0 & 9 \end{bmatrix}.$$

Step 2 — Read off entry $(1, 2)$: Row 1 of A is $(2, 1)$, column 2 of A is $(1, 3)^T$, so $(1, 2)$ entry $= 2 \cdot 1 + 1 \cdot 3 = 5$.

Why other options are wrong:

- (A) 3 just copies an original entry.

- (B) 9 is the $(2, 2)$ entry of A^2.
- (C) 4 is the $(1, 1)$ entry of A^2.

Final Answer: The $(1, 2)$ entry is $5 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Consistency via the coefficient determinant: If $\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$ the lines are parallel and the system is inconsistent (no solution).

Step 1 — Compare ratios: For $2x + 3y = 8$ and $4x + 6y = 15$:

$$\frac{2}{4} = \frac{1}{2}, \quad \frac{3}{6} = \frac{1}{2}, \quad \frac{8}{15} \neq \frac{1}{2}.$$

Step 2 — Conclusion: The coefficient determinant $\begin{vmatrix} 2 & 3 \\ 4 & 6 \end{vmatrix} = 12 - 12 = 0$ while the constants are not proportional, so the lines are parallel and distinct: no solution.

Why other options are wrong:

- (B) A unique solution needs a nonzero determinant.
- (C) Infinitely many solutions would need $\frac{8}{15} = \frac{1}{2}$ too.
- (D) A linear system never has exactly two solutions.

Final Answer: The system is inconsistent $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Logarithmic differentiation: For a variable base and variable exponent, take $\ln$ of both sides, then differentiate implicitly.

Step 1 — Take logs: $\ln y = x \ln x$.

Step 2 — Differentiate: $\frac{1}{y}\frac{dy}{dx} = \ln x + x \cdot \frac{1}{x} = \ln x + 1.$

Step 3 — Solve for the derivative: $\frac{dy}{dx} = y(1 + \ln x) = x^x(1 + \ln x).$

Why other options are wrong:

- (A) $x\,x^{x-1}$ treats the exponent as constant (power rule only).
- (C) $x^x \ln x$ drops the 1 from differentiating $x \ln x$.
- (D) misplaces the exponent as $x - 1$.

Final Answer: $\dfrac{dy}{dx} = x^x(1 + \ln x) \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Related rates: Differentiate $A = \pi r^2$ with respect to time: $\dfrac{dA}{dt} = 2\pi r\,\dfrac{dr}{dt}$.

Step 1 — Substitute: $r = 5$ cm and $\dfrac{dr}{dt} = 2$ cm s^{-1}:

$$\frac{dA}{dt} = 2\pi(5)(2) = 20\pi \text{ cm}^2\,\text{s}^{-1}.$$

Why other options are wrong:

- (A) 10π forgets the factor $\frac{dr}{dt} = 2$.
- (B) 25π uses πr^2 (the area, not its rate).
- (D) 40π doubles the correct rate.

Final Answer: $\dfrac{dA}{dt} = 20\pi \text{ cm}^2\,\text{s}^{-1} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Partial fractions: Write $\dfrac{1}{(x-1)(x+2)} = \dfrac{A}{x-1} + \dfrac{B}{x+2}$ and solve for A, B.

Step 1 — Find A, B: $1 = A(x+2) + B(x-1)$. Put $x = 1$: $1 = 3A \Rightarrow A = \frac{1}{3}$. Put $x = -2$: $1 = -3B \Rightarrow B = -\frac{1}{3}$.

Step 2 — Integrate:

$$\int\left(\frac{1/3}{x-1}-\frac{1/3}{x+2}\right)dx=\frac{1}{3}\ln|x-1|-\frac{1}{3}\ln|x+2|+C=\frac{1}{3}\ln\left|\frac{x-1}{x+2}\right|+C.$$

Why other options are wrong:

- (A) inverts the ratio inside the log (wrong sign on B).
- (B) ignores partial fractions entirely.
- (C) uses coefficient 3 instead of $\frac{1}{3}$.

Final Answer: $\frac{1}{3}\ln\left|\frac{x-1}{x+2}\right|+C\Rightarrow\boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Area between a curve and a horizontal line: Integrate (top − bottom) over the x-range where they intersect. Here the region is symmetric about the y-axis.

Step 1 — Intersection: $x^2=4\Rightarrow x=\pm2$. The line $y=4$ is above the parabola on $[-2,2]$.

Step 2 — Integrate:

$$A=\int_{-2}^{2}(4-x^2)\,dx=2\int_{0}^{2}(4-x^2)\,dx=2\left[4x-\frac{x^3}{3}\right]_0^2=2\left(8-\frac{8}{3}\right)=2\cdot\frac{16}{3}=\frac{32}{3}.$$

Why other options are wrong:

- (A) $\frac{16}{3}$ integrates over $[0,2]$ only (half the region).
- (C) $\frac{8}{3}$ integrates x^2 alone, ignoring the line.
- (D) 16 uses the bounding rectangle, not the curved region.

Final Answer: Area $=\frac{32}{3}$ sq. units $\Rightarrow\boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Homogeneous first-order ODE: The equation $\frac{dy}{dx} = \frac{x+y}{x} = 1 + \frac{y}{x}$ depends only on $\frac{y}{x}$; substitute $y = vx$.

Step 1 — Substitute $y = vx$: Then $\frac{dy}{dx} = v + x\frac{dv}{dx}$, and the equation becomes $v + x\frac{dv}{dx} = 1 + v$, i.e. $x\frac{dv}{dx} = 1$.

Step 2 — Separate and integrate: $dv = \frac{dx}{x} \Rightarrow v = \ln|x| + C$.

Step 3 — Back-substitute: $v = \frac{y}{x}$, so $\frac{y}{x} = \ln|x| + C$, giving $y = x\ln|x| + Cx$.

Why other options are wrong:

- (A) and (B) ignore the logarithmic term arising from $\int \frac{dx}{x}$.
- (D) wrongly exponentiates a separable form that does not apply here.

Final Answer: $y = x\ln|x| + Cx \Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q18**

Q19.

Solution

Concept — Distance from a point to a plane: For plane $ax + by + cz + d = 0$ and point (x_1, y_1, z_1), the distance is $\frac{|ax_1 + by_1 + cz_1 + d|}{\sqrt{a^2 + b^2 + c^2}}$.

Step 1 — Numerator: With plane $2x - y + 2z + 7 = 0$ and $P(1, 2, 3)$:

$$|2(1) - 1(2) + 2(3) + 7| = |2 - 2 + 6 + 7| = 13.$$

Step 2 — Denominator and distance: $\sqrt{2^2 + (-1)^2 + 2^2} = \sqrt{9} = 3$, so $d = \frac{13}{3}$.

Why other options are wrong:

- (A) $\frac{13}{2}$ uses denominator 2 (forgets to square-root 9 correctly).
- (B) $\frac{5}{3}$ mis-evaluates the numerator.
- (C) $\frac{9}{2}$ uses both a wrong numerator and denominator.

Final Answer: $d = \frac{13}{3} \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q19**

Q20.

Solution

Concept — Addition theorem with independence: $P(E \cup F) = P(E) + P(F) - P(E \cap F)$, and for independent events $P(E \cap F) = P(E)P(F)$.

Step 1 — Intersection: $P(E \cap F) = 0.3 \times 0.4 = 0.12$.

Step 2 — Union: $P(E \cup F) = 0.3 + 0.4 - 0.12 = 0.58$.

Why other options are wrong:

- (B) 0.70 forgets to subtract the intersection (treats them as mutually exclusive).
- (C) 0.12 is the intersection $P(E \cap F)$, not the union.
- (D) 0.42 subtracts a wrong intersection value.

Final Answer: $P(E \cup F) = 0.58 \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q20

Answer Key

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