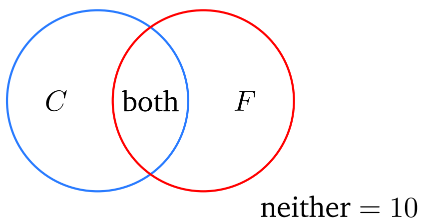
NEST Mathematics Sample Paper – 1

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. In a class of 60 students, 35 play cricket and 30 play football, while 10 play neither game. The number of students who play *both* cricket and football is



(A) 15

(B) 20

(C) 10

(D) 25

Q2. The general solution of the equation $2\cos^2 x = 1$, where $n \in \mathbb{Z}$, is

(A) $x = 2n\pi \pm \frac{\pi}{4}$

(B) $x = n\pi + \frac{\pi}{4}$

(C) $x = n\pi \pm \frac{\pi}{4}$

(D) $x = n\pi \pm \frac{\pi}{3}$

Q3. The modulus and argument of the complex number $z = -1 + i\sqrt{3}$ are, respectively,

(A) 2 and $\frac{\pi}{3}$

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

(C) 4 and $\frac{2\pi}{3}$

(D) 2 and $\frac{5\pi}{6}$

Q4. The number of distinct arrangements of the letters of the word DELHI in which the two vowels (E and I) are never together is

(A) 48

(B) 96

(C) 24

(D) 72

Q5. The term independent of x in the expansion of $\left(x^2 + \frac{1}{x}\right)^9$ is

(A) 84

(B) 126

(C) 36

(D) 72

Q6. For an arithmetic progression with first term $a = 5$ and common difference $d = 3$, the sum of the first 20 terms is

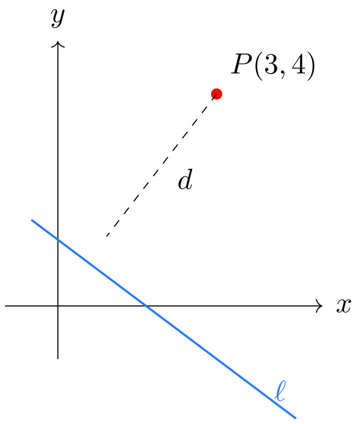
(A) 620

(B) 670

(C) 700

(D) 640

Q7. The perpendicular distance of the point $P(3,4)$ from the line $3x+4y-5=0$ is



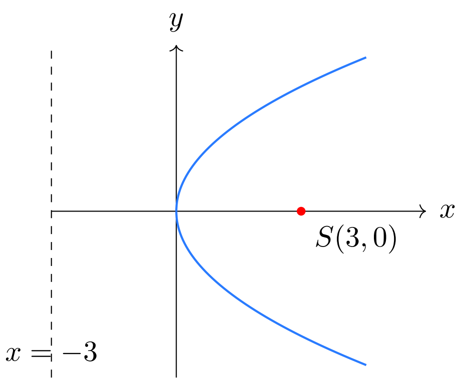
(A) $\dfrac{20}{\sqrt{7}}$

(B) 4

(C) $\dfrac{30}{5}$

(D) 5

Q8. For the parabola $y^2 = 12x$, the focus, equation of the directrix, and length of the latus rectum are, respectively,



(A) $(12,0)$, $x=-12$, 48

(B) $(0,3)$, $y=-3$, 12

(C) $(3,0)$, $x=3$, 6

(D) $(3,0)$, $x=-3$, 12

Q9. The value of $\lim_{x\to 0}\frac{\sin 5x}{\sin 3x}$ is

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

(B) 1

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

(D) $\frac{15}{1}$

Q10. The variance of the data set $\{2,4,6,8,10\}$ is

(A) 10

(B) 8

(C) 6

(D) 4

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

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

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

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

(D) π

Q12. If $A=\begin{pmatrix}1 & 2\\ 3 & 4\end{pmatrix}$ and $B=\begin{pmatrix}2 & 0\\ 1 & 3\end{pmatrix}$, then the element in the second row and first column of the product AB is

(A) 4

(B) 6

(C) 12

(D) 10

Q13. The value of the determinant $\begin{vmatrix} 2 & 0 & 1 \\ 3 & 1 & 2 \\ 1 & 0 & 3 \end{vmatrix}$ is

(A) 7

(B) 3

(C) 5

(D) 10

Q14. The function $f(x) = \begin{cases} kx + 1, & x \leq 3 \\ 3x - 5, & x > 3 \end{cases}$ is continuous at $x = 3$ for the value of k equal to

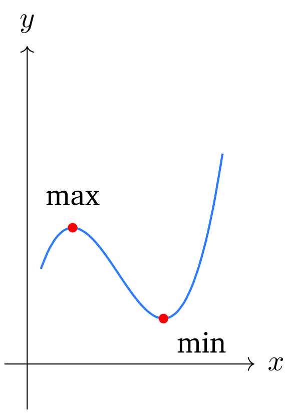
(A) 1

(B) 2

(C) 3

(D) $\frac{4}{3}$

Q15. The function $f(x) = x^3 - 6x^2 + 9x + 2$ attains a local minimum value equal to



(A) 6

(B) 0

(C) 4

(D) 2

Q16. The value of the indefinite integral $\int 2x\, e^{x^2}\, dx$ is (with C an arbitrary constant)

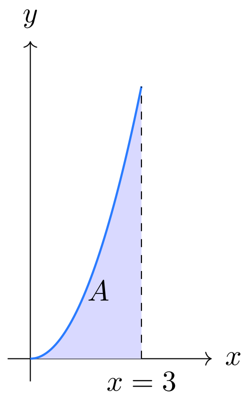
(A) $x^2 e^{x^2} + C$

(B) $2e^{x^2} + C$

(C) $\dfrac{e^{x^2}}{2} + C$

(D) $e^{x^2} + C$

Q17. The area bounded by the curve $y = x^2$, the x-axis and the ordinates $x = 0$ and $x = 3$ is



(A) 27

(B) 9

(C) 3

(D) $\dfrac{27}{2}$

Q18. The order and degree of the differential equation $\left(\dfrac{d^2y}{dx^2}\right)^3 + \left(\dfrac{dy}{dx}\right)^4 + y = 0$ are, respectively,

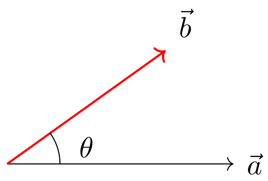
(A) 2 and 3

(B) 3 and 2

(C) 2 and 4

(D) 3 and 4

Q19. The angle between the vectors $\vec{a} = \hat{i} + \hat{j}$ and $\vec{b} = \hat{i} + \hat{j} + \sqrt{2}\,\hat{k}$ is



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

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

(C) $\frac{\pi}{4}$

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

Q20. A fair die is rolled once. Given that the outcome is an even number, the probability that it is greater than 3 is

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

(B) $\frac{1}{3}$

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

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

Detailed Solutions

Q1.

Solution

Concept — Inclusion–exclusion: For two sets, $n(C\cup F) = n(C)+n(F)-n(C\cap F)$, where $n(C \cup F)$ is the number playing at least one game.

Step 1 — At least one game: Of 60 students, 10 play neither, so $n(C \cup F) = 60 - 10 = 50$.

Step 2 — Apply formula: $50 = 35+30-n(C\cap F)$, hence $n(C\cap F) = 65-50 = 15$.

Why other options are wrong:

- (B) 20 ignores the 10 who play neither (uses $n(C\cup F) = 60$, then mis-solves).
- (C) 10 confuses the "neither" count with the "both" count.
- (D) 25 adds instead of subtracting somewhere in the count.

Final Answer: $n(C \cap F) = 15 \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — General solution of $\cos^2 x = \cos^2 \alpha$: If $\cos^2 x = \cos^2 \alpha$, then $x = n\pi \pm \alpha$, $n \in \mathbb{Z}$.

Step 1 — Rearrange: $2\cos^2 x = 1 \Rightarrow \cos^2 x = \frac{1}{2} = \cos^2 \frac{\pi}{4}$.

Step 2 — Write solution: Hence $x = n\pi \pm \frac{\pi}{4}$, $n \in \mathbb{Z}$.

Why other options are wrong:

- (A) $2n\pi \pm \frac{\pi}{4}$ is the form for $\cos x = \cos\alpha$, not $\cos^2 x$, so it loses half the roots.
- (B) $n\pi + \frac{\pi}{4}$ drops the $\pm$ sign and misses solutions.
- (D) $n\pi \pm \frac{\pi}{3}$ uses $\cos^2 x = \frac{1}{4}$ ($\alpha = \frac{\pi}{3}$), the wrong value.

Final Answer: $x = n\pi \pm \frac{\pi}{4} \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q2

Q3.

Solution

Concept — Modulus and argument: For $z = x + iy$, $|z| = \sqrt{x^2 + y^2}$, and the argument is the angle in the correct quadrant.

Step 1 — Modulus: $|z| = \sqrt{(-1)^2 + (\sqrt{3})^2} = \sqrt{1+3} = 2$.

Step 2 — Argument: $z = -1 + i\sqrt{3}$ lies in the second quadrant $(x < 0,\ y > 0)$. The reference angle satisfies $\tan\alpha = \frac{\sqrt{3}}{1}$, so $\alpha = \frac{\pi}{3}$, and $\arg z = \pi - \frac{\pi}{3} = \frac{2\pi}{3}$.

Why other options are wrong:

- (A) $\frac{\pi}{3}$ is the first-quadrant (reference) angle, ignoring the sign of x.
- (C) modulus 4 forgets the square root.
- (D) $\frac{5\pi}{6}$ uses $\tan\alpha = \frac{1}{\sqrt{3}}$ (swaps x and y).

Final Answer: $|z| = 2,\ \arg z = \frac{2\pi}{3} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — Arrangements with a restriction: (Never together) $=$ (total) $-$ (always together), treating the two vowels as one block for the latter.

Step 1 — Total arrangements: DELHI has 5 distinct letters, so total $= 5! = 120$.

Step 2 — Vowels together: Glue E, I into one block: 4 units arrange in $4! = 24$ ways, and the block internally in $2! = 2$ ways, giving $24 \times 2 = 48$.

Step 3 — Never together: $120 - 48 = 72$.

Why other options are wrong:

- (A) 48 is the "vowels together" count, the opposite of what is asked.
- (B) 96 doubles 48 erroneously.
- (C) 24 is just $4!$ (forgets the internal $2!$ and the subtraction).

Final Answer: $72 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — General term of a binomial expansion: For $\left(x^2+\frac{1}{x}\right)^9$, the general term is $T_{r+1}=\binom{9}{r}(x^2)^{9-r}\left(\frac{1}{x}\right)^r$.

Step 1 — Power of x: The exponent of x is $2(9-r)-r=18-3r$. Set $18-3r=0 \Rightarrow r=6$.

Step 2 — Coefficient: The required term is $\binom{9}{6}=\binom{9}{3}=\dfrac{9\cdot 8\cdot 7}{3\cdot 2\cdot 1}=84$.

Why other options are wrong:

- (B) $126=\binom{9}{4}$, from solving the exponent equation incorrectly.
- (C) $36=\binom{9}{2}$, using $r=2$.
- (D) 72 is not a binomial coefficient $\binom{9}{r}$ for any r.

Final Answer: $84 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Sum of an AP: $S_n=\dfrac{n}{2}\big[2a+(n-1)d\big]$.

Step 1 — Substitute: $a=5$, $d=3$, $n=20$:

$$S_{20}=\frac{20}{2}\big[2(5)+(20-1)(3)\big]=10\,[10+57]=10\times 67=670.$$

Why other options are wrong:

- (A) 620 uses $(n)d=60$ instead of $(n-1)d=57$.
- (C) 700 rounds 67 to 70 inside the bracket.
- (D) 640 uses $2a=10$ with $(n-1)d=54$ (a d slip).

Final Answer: $S_{20}=670 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Distance from a point to a line: The distance of $P(x_1, y_1)$ from $ax + by + c = 0$ is $d = \dfrac{|ax_1 + by_1 + c|}{\sqrt{a^2 + b^2}}$.

Step 1 — Substitute: $a = 3,\ b = 4,\ c = -5,\ P(3, 4)$:

$$d = \frac{|3(3) + 4(4) - 5|}{\sqrt{3^2 + 4^2}} = \frac{|9 + 16 - 5|}{\sqrt{25}} = \frac{20}{5} = 4.$$

Why other options are wrong:

- (A) $\frac{20}{\sqrt{7}}$ uses $\sqrt{a^2 + b^2} = \sqrt{7}$ (adds $a + b$ before squaring).
- (C) $\frac{30}{5} = 6$ comes from $|9 + 16 + 5|$ (wrong sign on c).
- (D) 5 is the value of $\sqrt{a^2 + b^2}$, not the distance.

Final Answer: $d = 4 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Standard parabola $y^2 = 4ax$: Focus $(a, 0)$, directrix $x = -a$, latus rectum $= 4a$.

Step 1 — Find a: $y^2 = 12x \Rightarrow 4a = 12 \Rightarrow a = 3$.

Step 2 — Read off: Focus $(3, 0)$; directrix $x = -3$; latus rectum $= 4a = 12$.

Why other options are wrong:

- (A) reads $a = 12$ instead of $4a = 12$.
- (B) puts the focus on the y-axis, which suits $x^2 = 4ay$, not $y^2 = 12x$.
- (C) takes directrix $x = +3$ (wrong sign) and latus rectum $= 6 = 2a$.

Final Answer: $(3, 0),\ x = -3,\ 12 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Standard limit: $\lim_{\theta \to 0} \dfrac{\sin\theta}{\theta} = 1$. Rewrite each sine over its own argument.

Step 1 — Multiply and divide:

$$\frac{\sin 5x}{\sin 3x} = \frac{\frac{\sin 5x}{5x} \cdot 5x}{\frac{\sin 3x}{3x} \cdot 3x}.$$

Step 2 — Take the limit: As $x \to 0$ both sine factors $\to 1$, leaving $\dfrac{5x}{3x} = \dfrac{5}{3}$.

Why other options are wrong:

- (A) $\frac{3}{5}$ inverts the ratio of the arguments.
- (B) 1 ignores the differing arguments $5x$ and $3x$.
- (D) 15 multiplies the arguments instead of dividing.

Final Answer: $\dfrac{5}{3} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q9

Q10.

Solution

Concept — Variance: $\sigma^2 = \dfrac{1}{n}\sum(x_i - \bar{x})^2$, where $\bar{x}$ is the mean.

Step 1 — Mean: $\bar{x} = \dfrac{2+4+6+8+10}{5} = \dfrac{30}{5} = 6$.

Step 2 — Squared deviations: $(-4)^2, (-2)^2, 0^2, 2^2, 4^2 = 16, 4, 0, 4, 16$; sum $= 40$.

Step 3 — Variance: $\sigma^2 = \dfrac{40}{5} = 8$.

Why other options are wrong:

- (A) 10 divides 40 by 4 $(n-1)$, the sample formula not used here.
- (C) 6 is the mean, not the variance.
- (D) 4 reports the standard deviation $\sqrt{8} \approx 2.83$ rounded, or mis-divides.

Final Answer: $\sigma^2 = 8 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Principal values: $\sin^{-1} \in [-\frac{\pi}{2}, \frac{\pi}{2}]$ and $\cos^{-1} \in [0, \pi]$.

Step 1 — Each term: $\sin^{-1}(-\frac{1}{2}) = -\dfrac{\pi}{6}$; $\cos^{-1}(-\frac{1}{2}) = \pi - \dfrac{\pi}{3} = \dfrac{2\pi}{3}$.

Step 2 — Add: $-\dfrac{\pi}{6} + \dfrac{2\pi}{3} = -\dfrac{\pi}{6} + \dfrac{4\pi}{6} = \dfrac{3\pi}{6} = \dfrac{\pi}{2}$.

Why other options are wrong:

- (A) $\frac{2\pi}{3}$ keeps only the second term.
- (B) $\frac{\pi}{6}$ takes $\cos^{-1}(-\frac{1}{2}) = \frac{\pi}{3}$ (wrong range).
- (D) π uses $\sin^{-1}(-\frac{1}{2}) = +\frac{\pi}{6}$ (sign error).

Final Answer: $\dfrac{\pi}{2} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Matrix multiplication: The (i, j) entry of AB is the dot product of row i of A with column j of B.

Step 1 — Identify row and column: Second row of A is $(3,\ 4)$; first column of B is $\binom{2}{1}$.

Step 2 — Compute the entry: $(AB)_{21} = 3(2) + 4(1) = 6 + 4 = 10$.

Why other options are wrong:

- (A) 4 keeps only the 4×1 product.
- (B) 6 keeps only the 3×2 product.
- (C) 12 uses the second column of B (0 and 3) wrongly, or multiplies 3×4.

Final Answer: $(AB)_{21} = 10 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Determinant by cofactor expansion: Expand along the column with the most zeros (here column 2) to reduce work.

Step 1 — Expand along column 2: Only the entry 1 (row 2, col 2) is nonzero:

$$\Delta = 1 \cdot (-1)^{2+2} \begin{vmatrix} 2 & 1 \\ 1 & 3 \end{vmatrix}.$$

Step 2 — Evaluate the 2×2: $\begin{vmatrix} 2 & 1 \\ 1 & 3 \end{vmatrix} = 2(3) - 1(1) = 6 - 1 = 5$. So $\Delta = 5$.

Why other options are wrong:

- (A) 7 adds instead of subtracting in the 2×2 minor $(6 + 1)$.
- (B) 3 keeps only one product term.
- (D) 10 doubles the result.

Final Answer: $\Delta = 5 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q13

Q14.

Solution

Concept — Continuity at a point: f is continuous at $x = 3$ iff the left-hand limit, right-hand limit and $f(3)$ all agree.

Step 1 — Left value (and $f(3)$): For $x \leq 3$, $f(3) = k(3) + 1 = 3k + 1$.

Step 2 — Right limit: For $x > 3$, $\lim_{x \to 3^+} (3x - 5) = 3(3) - 5 = 4$.

Step 3 — Match: $3k + 1 = 4 \Rightarrow 3k = 3 \Rightarrow k = 1$.

Why other options are wrong:

- (B) 2 solves $3k + 1 = 7$ (wrong right limit).
- (C) 3 ignores the $+1$ in the first piece.
- (D) $\frac{4}{3}$ solves $3k = 4$ (drops the constant term).

Final Answer: $k = 1 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q14

Q15.

Solution

Concept — Local extrema: Find critical points from $f'(x) = 0$; use the second derivative to classify, then evaluate f at the minimum.

Step 1 — Derivative: $f'(x) = 3x^2 - 12x + 9 = 3(x^2 - 4x + 3) = 3(x-1)(x-3)$. Critical points $x = 1, 3$.

Step 2 — Classify: $f''(x) = 6x - 12$. At $x = 3$, $f''(3) = 6 > 0$, so $x = 3$ gives a local minimum.

Step 3 — Minimum value: $f(3) = 27 - 54 + 27 + 2 = 2$.

Why other options are wrong:

- (A) 6 is the local *maximum* value $f(1) = 1 - 6 + 9 + 2$.
- (B) 0 forgets the constant $+2$.
- (C) 4 mis-evaluates $f(3)$.

Final Answer: local minimum $= 2 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q15

Q16.

Solution

Concept — Integration by substitution: Choose $t = g(x)$ so that $g'(x)\,dx$ appears in the integrand.

Step 1 — Substitute: Let $t = x^2$, so $dt = 2x\,dx$. The integral becomes $\int e^t\,dt$.

Step 2 — Integrate and back-substitute: $\int e^t\,dt = e^t + C = e^{x^2} + C$.

Why other options are wrong:

- (A) $x^2e^{x^2}$ wrongly multiplies by x^2 rather than substituting.
- (B) $2e^{x^2}$ keeps an extra factor of 2 (the $2x\,dx$ is fully absorbed by dt).
- (C) $\frac{e^{x^2}}{2}$ divides by 2 as if the 2 were not already matched.

Final Answer: $e^{x^2} + C \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Area under a curve: The area between $y = f(x) \geq 0$, the x-axis, and $x = a$ to $x = b$ is $\int_a^b f(x)\,dx$.

Step 1 — Set up: $A = \int_0^3 x^2\,dx$.

Step 2 — Integrate: $\int_0^3 x^2\,dx = \left[\frac{x^3}{3}\right]_0^3 = \frac{27}{3} - 0 = 9$.

Why other options are wrong:

- (A) 27 forgets to divide by 3 (the antiderivative).
- (C) 3 integrates as if the antiderivative were x.
- (D) $\frac{27}{2}$ uses $\frac{x^2}{2}$ at $x = 3$ (treats $y = x$, not x^2).

Final Answer: $A = 9 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Order and degree: The *order* is the highest derivative present; the *degree* is the power of that highest-order derivative once 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: It appears as $\left(\frac{d^2y}{dx^2}\right)^3$, and the equation is already polynomial in derivatives, so the degree is 3.

Why other options are wrong:

- (B) $3, 2$ swaps order and degree.
- (C) $2, 4$ takes the degree from the $\left(\frac{dy}{dx}\right)^4$ term, not from the highest-order one.
- (D) $3, 4$ misreads both quantities.

Final Answer: order 2, degree $3 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q18

Q19.

Solution

Concept — Angle via dot product: $\cos\theta = \dfrac{\vec{a}\cdot\vec{b}}{|\vec{a}|\,|\vec{b}|}$.

Step 1 — Dot product: $\vec{a}\cdot\vec{b} = (1)(1) + (1)(1) + (0)(\sqrt{2}) = 2$.

Step 2 — Magnitudes: $|\vec{a}| = \sqrt{1+1} = \sqrt{2}$; $|\vec{b}| = \sqrt{1+1+2} = \sqrt{4} = 2$.

Step 3 — Angle: $\cos\theta = \dfrac{2}{\sqrt{2}\cdot 2} = \dfrac{2}{2\sqrt{2}} = \dfrac{1}{\sqrt{2}}$, so $\theta = \dfrac{\pi}{4}$.

Why other options are wrong:

- (A) $\frac{\pi}{6}$ corresponds to $\cos\theta = \frac{\sqrt{3}}{2}$, not $\frac{1}{\sqrt{2}}$.
- (B) $\frac{\pi}{3}$ corresponds to $\cos\theta = \frac{1}{2}$.
- (D) $\frac{\pi}{2}$ would need $\vec{a}\cdot\vec{b} = 0$.

Final Answer: $\theta = \dfrac{\pi}{4} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — Conditional probability: $P(B \mid A) = \dfrac{P(A\cap B)}{P(A)} = \dfrac{n(A\cap B)}{n(A)}$ for equally likely outcomes.

Step 1 — Event A (even): $A = \{2, 4, 6\}$, so $n(A) = 3$.

Step 2 — Event B (greater than 3) within A: Even numbers greater than 3 are $\{4, 6\}$, so $n(A\cap B) = 2$.

Step 3 — Conditional probability: $P(B \mid A) = \dfrac{2}{3}$.

Why other options are wrong:

- (B) $\frac{1}{3}$ counts only one favourable even number.
- (C) $\frac{1}{2}$ uses the whole sample space of 6, ignoring the condition.
- (D) $\frac{1}{6}$ is the unconditional probability of a single outcome.

Final Answer: $P(B \mid A) = \dfrac{2}{3} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q20

Answer Key

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