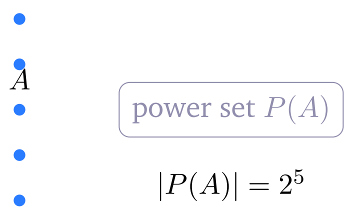
NEST Mathematics Sample Paper – 7

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. A set A has exactly 5 elements. The number of proper subsets of A is



(A) 32

(B) 31

(C) 30

(D) 16

Q2. The general solution of the equation $2\sin^2 x - 3\sin x + 1 = 0$, where $n \in \mathbb{Z}$, includes

(A) $x = n\pi + (-1)^n \frac{\pi}{6}$

(B) $x = 2n\pi + \frac{\pi}{3}$

(C) $x = n\pi \pm \frac{\pi}{6}$

(D) $x = n\pi + \frac{\pi}{2}$

Q3. A square root of the complex number $z = 3 + 4i$ is

(A) $1 + 2i$

(B) $2 + 2i$

(C) $2 + i$

(D) $1 + i$

Q4. The number of ways of distributing 5 distinct books among 3 distinct students (a student may receive any number of books, including none) is

(A) 125

(B) 243

(C) 15

(D) 120

Q5. The term independent of x in the expansion of $\left(x + \frac{1}{x}\right)^8$ is

(A) 56

(B) 28

(C) 112

(D) 70

Q6. Three geometric means are inserted between 2 and 162. The common ratio of the resulting geometric progression is

(A) $\sqrt{3}$

(B) 2

(C) 3

(D) 81

Q7. The equation of the perpendicular bisector of the segment joining $A(1, 2)$ and $B(5, 6)$ is

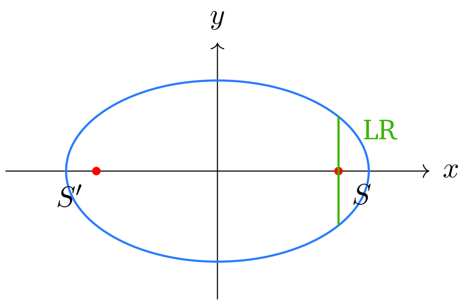
(A) $x + y - 7 = 0$

(B) $x - y + 1 = 0$

(C) $x + y - 1 = 0$

(D) $x + y + 7 = 0$

Q8. For the ellipse $\frac{x^2}{25} + \frac{y^2}{9} = 1$, the length of the latus rectum is



(A) $\frac{9}{5}$

(B) $\frac{25}{3}$

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

(D) $\frac{18}{5}$

Q9. The value of $\lim_{x \to 2} \frac{x^5 - 2^5}{x - 2}$ is

(A) 32

(B) 80

(C) 16

(D) 40

Q10. For a data set of $n = 10$ observations, $\sum x_i = 50$ and $\sum x_i^2 = 310$. The variance of the data is

(A) 31

(B) 25

(C) 6

(D) 11

Q11. The value of $\tan^{-1} 2 + \tan^{-1} 3$ is

(A) $\frac{3\pi}{4}$

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

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

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

Q12. For two matrices A and B such that the product AB is defined, the transpose $(AB)'$ equals

(A) $A'B'$

(B) AB

(C) BA

(D) $B'A'$

Q13. If A is a square matrix of order 3 with $\det(A) = 4$, then $\det(2A)$ equals

(A) 8

(B) 16

(C) 32

(D) 64

Q14. If $y = \sin(3x)$, then $\frac{d^2y}{dx^2}$ equals

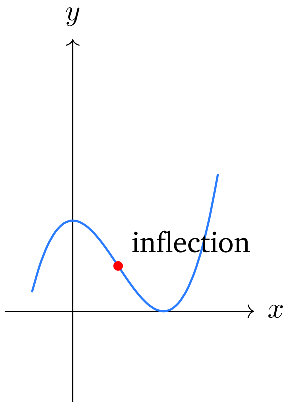
(A) $3\cos(3x)$

(B) $-9\sin(3x)$

(C) $-3\sin(3x)$

(D) $9\sin(3x)$

Q15. The point of inflection of the curve $y = x^3 - 3x^2 + 4$ occurs at



(A) $x = 0$

(B) $x = 2$

(C) $x = 1$

(D) $x = 3$

Q16. The value of the definite integral $\int_{-2}^{2} \left(x^3 + x\cos x + 5\right)\, dx$ is

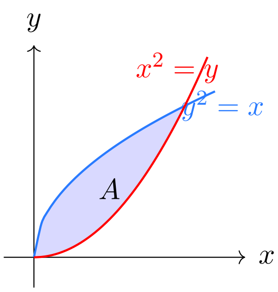
(A) 20

(B) 0

(C) 10

(D) 40

Q17. The area bounded by the two parabolas $y^2 = x$ and $x^2 = y$ is



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

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

(C) 1

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

Q18. The solution of $\frac{dy}{dx} = 6x^2 + 2$ satisfying $y(0) = 4$ is

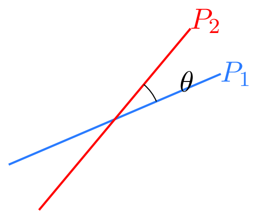
(A) $y = 2x^3 + 2x$

(B) $y = 6x^3 + 2x + 4$

(C) $y = 2x^3 + 4$

(D) $y = 2x^3 + 2x + 4$

Q19. The angle between the planes $x + y + z = 1$ and $x - y + z = 5$ is



(A) $\cos^{-1}\left(\frac{1}{3}\right)$

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

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

(D) $\cos^{-1}\left(\frac{2}{3}\right)$

Q20. A fair coin is tossed 4 times. The probability of getting at least one head is

(A) $\frac{1}{16}$

(B) $\frac{15}{16}$

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

(D) $\frac{7}{8}$

Detailed Solutions

Q1.

Solution

Concept — Power set and proper subsets: A set with n elements has 2^n subsets in all; a *proper* subset is any subset except the set itself, so there are $2^n - 1$ of them.

Step 1 — Count all subsets: With $n = 5$, the total number of subsets is $2^5 = 32$.

Step 2 — Exclude the set itself: Proper subsets $= 32 - 1 = 31$.

Why other options are wrong:

- (A) 32 counts *all* subsets, not just proper ones.
- (C) 30 wrongly removes both A itself and the empty set.
- (D) 16 uses 2^4 (wrong exponent).

Final Answer: $2^5 - 1 = 31 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Quadratic in $\sin x$**:** Treat $\sin x$ as a variable, factor, then write the general solution of each $\sin x = c$ as $x = n\pi + (-1)^n\alpha$.

Step 1 — Factor: $2\sin^2 x - 3\sin x + 1 = (2\sin x - 1)(\sin x - 1) = 0$, so $\sin x = \frac{1}{2}$ or $\sin x = 1$.

Step 2 — Solve each: $\sin x = \frac{1}{2} \Rightarrow x = n\pi + (-1)^n\dfrac{\pi}{6}$; $\sin x = 1 \Rightarrow x = 2n\pi + \dfrac{\pi}{2}$.

Step 3 — Match the option: The family $x = n\pi + (-1)^n\dfrac{\pi}{6}$ is listed and is correct.

Why other options are wrong:

- (B) $2n\pi + \frac{\pi}{3}$ comes from $\sin x = \frac{\sqrt{3}}{2}$, not a root here.
- (C) $n\pi \pm \frac{\pi}{6}$ is the cos-type form, wrong for a sine equation.
- (D) $n\pi + \frac{\pi}{2}$ uses $\sin x = 1$ but with the wrong period ($n\pi$, not $2n\pi$).

Final Answer: $x = n\pi + (-1)^n\dfrac{\pi}{6} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — Square root of $a+bi$**:** Set $(x+iy)^2 = a+bi$. Then $x^2-y^2=a$ and $2xy=b$; solve together with $x^2+y^2=\sqrt{a^2+b^2}$.

Step 1 — Equations: For $z=3+4i$: $x^2-y^2=3$, $2xy=4$, and $x^2+y^2=\sqrt{9+16}=5$.

Step 2 — Solve: Adding $x^2-y^2=3$ and $x^2+y^2=5$ gives $2x^2=8 \Rightarrow x^2=4$, $x=2$; then $y^2=1$, $y=1$ (same sign as b). So a square root is $2+i$.

Step 3 — Check: $(2+i)^2 = 4+4i+i^2 = 3+4i$. Correct.

Why other options are wrong:

- (A) $(1+2i)^2 = 1+4i-4 = -3+4i$, not $3+4i$.
- (B) $(2+2i)^2 = 4+8i-4 = 8i$.
- (D) $(1+i)^2 = 2i$.

Final Answer: $\sqrt{3+4i} = 2+i \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Distributing distinct objects into distinct boxes: Each distinct object independently chooses one of the boxes, so k boxes give k^n ways for n objects.

Step 1 — Count choices: Each of the 5 distinct books can go to any of the 3 students.

Step 2 — Multiply: Total $= 3^5 = 243$.

Why other options are wrong:

- (A) $125 = 5^3$ swaps the roles of books and students.
- (C) $15 = 5 \times 3$ adds instead of using the power.
- (D) $120 = 5!$ treats this as an arrangement problem.

Final Answer: $3^5 = 243 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q4

Q5.

Solution

Concept — General term: For $\left(x+\frac{1}{x}\right)^8$, $T_{r+1}=\binom{8}{r}x^{8-r}\left(\frac{1}{x}\right)^r=\binom{8}{r}x^{8-2r}$.

Step 1 — Power of x: Set $8-2r=0\Rightarrow r=4$.

Step 2 — Coefficient: The constant term is $\binom{8}{4}=\dfrac{8\cdot7\cdot6\cdot5}{4\cdot3\cdot2\cdot1}=70$.

Why other options are wrong:

- (A) $56=\binom{8}{3}$, from $r=3$.
- (B) $28=\binom{8}{2}$, from $r=2$.
- (C) 112 is not a value of $\binom{8}{r}$.

Final Answer: $\binom{8}{4}=70\Rightarrow\boxed{\text{D}}$

Answer: (D) Go Back to Q5

Q6.

Solution

Concept — Inserting geometric means: Inserting m GMs between a and b creates a GP of $m+2$ terms, so $b=a\,r^{m+1}$.

Step 1 — Set up: With $a=2$, $b=162$, $m=3$: the GP has 5 terms, so $162=2\,r^4$.

Step 2 — Solve: $r^4=81\Rightarrow r=3$ (taking the positive ratio).

Step 3 — Check: $2,6,18,54,162$ with ratio 3. Correct.

Why other options are wrong:

- (A) $\sqrt{3}$ solves $r^8=81$ (wrong number of terms).
- (B) 2 does not satisfy $r^4=81$.
- (D) 81 is r^4, not r.

Final Answer: $r=3\Rightarrow\boxed{\text{C}}$

Answer: (C) Go Back to Q6

Q7.

Solution

Concept — Perpendicular bisector: It passes through the midpoint of AB and has slope equal to the negative reciprocal of the slope of AB.

Step 1 — Midpoint and slope of AB: Midpoint $M = \left(\frac{1+5}{2}, \frac{2+6}{2}\right) = (3, 4)$; slope of $AB = \frac{6-2}{5-1} = 1$.

Step 2 — Bisector slope: Perpendicular slope $= -1$.

Step 3 — Equation: $y - 4 = -1(x - 3) \Rightarrow x + y - 7 = 0$.

Why other options are wrong:

- (B) $x - y + 1 = 0$ is the line AB itself (slope $+1$).
- (C) $x + y - 1 = 0$ uses a wrong midpoint.
- (D) $x + y + 7 = 0$ has the wrong intercept sign.

Final Answer: $x + y - 7 = 0 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q7

Q8.

Solution

Concept — Latus rectum of an ellipse: For $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ with $a > b$, the length of the latus rectum is $\frac{2b^2}{a}$.

Step 1 — Read a, b: $a^2 = 25 \Rightarrow a = 5$; $b^2 = 9 \Rightarrow b = 3$.

Step 2 — Apply: Length $= \frac{2b^2}{a} = \frac{2 \cdot 9}{5} = \frac{18}{5}$.

Why other options are wrong:

- (A) $\frac{9}{5}$ forgets the factor 2.
- (B) $\frac{25}{3}$ uses $\frac{2a^2}{?}$ with the axes swapped.
- (C) $\frac{6}{5}$ uses b instead of b^2.

Final Answer: $\frac{18}{5} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Standard limit: $\lim_{x \to a} \frac{x^n - a^n}{x - a} = n\,a^{n-1}$.

Step 1 — Identify: Here $n = 5$ and $a = 2$.

Step 2 — Apply: The limit $= 5 \cdot 2^4 = 5 \cdot 16 = 80$.

Why other options are wrong:

- (A) $32 = 2^5$ forgets the factor $n = 5$ and the exponent drop.
- (C) $16 = 2^4$ omits the factor 5.
- (D) $40 = 5 \cdot 8$ uses 2^3 instead of 2^4.

Final Answer: $5 \cdot 2^4 = 80 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — Variance from sums: $\sigma^2 = \frac{\sum x_i^2}{n} - \left(\frac{\sum x_i}{n}\right)^2$.

Step 1 — Mean: $\bar{x} = \frac{50}{10} = 5$, so $\bar{x}^2 = 25$.

Step 2 — Mean of squares: $\frac{\sum x_i^2}{n} = \frac{310}{10} = 31$.

Step 3 — Variance: $\sigma^2 = 31 - 25 = 6$.

Why other options are wrong:

- (A) 31 is $\frac{\sum x_i^2}{n}$, forgetting to subtract $\bar{x}^2$.
- (B) 25 is $\bar{x}^2$ alone.
- (D) 11 subtracts $\bar{x}$ (not $\bar{x}^2$) from 31.

Final Answer: $\sigma^2 = 6 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Sum formula with adjustment: $\tan^{-1} x + \tan^{-1} y = \pi + \tan^{-1} \dfrac{x+y}{1-xy}$ when $x > 0, y > 0$ and $xy > 1$.

Step 1 — Check xy: Here $x = 2$, $y = 3$, so $xy = 6 > 1$; the $+\pi$ adjustment applies.

Step 2 — Compute: $\dfrac{x+y}{1-xy} = \dfrac{5}{1-6} = \dfrac{5}{-5} = -1$, so $\tan^{-1}(-1) = -\dfrac{\pi}{4}$.

Step 3 — Add π: Result $= \pi - \dfrac{\pi}{4} = \dfrac{3\pi}{4}$.

Why other options are wrong:

- (B) $\frac{\pi}{4}$ ignores the $xy > 1$ adjustment.
- (C) $-\frac{\pi}{4}$ is just $\tan^{-1}(-1)$ before adding π.
- (D) $\frac{\pi}{2}$ would need $1 - xy = 0$.

Final Answer: $\dfrac{3\pi}{4} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept — Transpose of a product: The reversal law states $(AB)' = B'A'$; the order of the factors flips when transposing a product.

Step 1 — State the rule: For conformable matrices, $(AB)^T = B^T A^T$.

Step 2 — Reason: The (i, j) entry of $(AB)'$ is the (j, i) entry of AB, which equals row j of A times column i of B = column j of A' times row i of B', i.e. the (i, j) entry of $B'A'$.

Why other options are wrong:

- (A) $A'B'$ keeps the original order; it is generally not even defined.
- (B) AB ignores transposition entirely.
- (C) BA reverses order but forgets to transpose each factor.

Final Answer: $(AB)' = B'A' \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Scalar multiple of a determinant: For an $n \times n$ matrix, $\det(kA) = k^n \det(A)$, because each of the n rows is scaled by k.

Step 1 — Identify n and k: Order $n = 3$, scalar $k = 2$, $\det(A) = 4$.

Step 2 — Apply: $\det(2A) = 2^3 \cdot 4 = 8 \cdot 4 = 32$.

Why other options are wrong:

- (A) $8 = 2^3$ forgets to multiply by $\det A$.
- (B) $16 = 2 \cdot 4 \cdot 2$ uses k^2 (wrong order).
- (D) $64 = 2^4 \cdot 4$ uses k^4 (wrong order).

Final Answer: $\det(2A) = 32 \Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q13**

Q14.

Solution

Concept — Second derivative: Differentiate twice, applying the chain rule each time for the inner function $3x$.

Step 1 — First derivative: $\dfrac{dy}{dx} = 3\cos(3x)$.

Step 2 — Second derivative: $\dfrac{d^2y}{dx^2} = 3 \cdot (-\sin(3x)) \cdot 3 = -9\sin(3x)$.

Why other options are wrong:

- (A) $3\cos(3x)$ is the first derivative only.
- (C) $-3\sin(3x)$ applies the chain factor once instead of twice.
- (D) $9\sin(3x)$ has the wrong sign.

Final Answer: $-9\sin(3x) \Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q14**

Q15.

Solution

Concept — Point of inflection: A point of inflection occurs where the concavity changes, i.e. where $f''(x) = 0$ and f'' changes sign.

Step 1 — Derivatives: $y' = 3x^2 - 6x$, $y'' = 6x - 6$.

Step 2 — Solve $y'' = 0$: $6x - 6 = 0 \Rightarrow x = 1$. For $x < 1$, $y'' < 0$ (concave down); for $x > 1$, $y'' > 0$ (concave up), so concavity changes at $x = 1$.

Why other options are wrong:

- (A) $x = 0$ is where $y' = 0$ (a local maximum), not an inflection.
- (B) $x = 2$ is the other critical point (a local minimum).
- (D) $x = 3$ satisfies neither $y' = 0$ nor $y'' = 0$.

Final Answer: inflection at $x = 1 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Odd/even symmetry on $[-a, a]$: $\int_{-a}^{a} (\text{odd})\, dx = 0$, and $\int_{-a}^{a} (\text{even})\, dx = 2\int_{0}^{a} (\text{even})\, dx$.

Step 1 — Classify terms: x^3 is odd; $x\cos x$ is odd $\times$ even $=$ odd; 5 is even (constant). So the first two integrate to 0.

Step 2 — Evaluate the surviving term: $\int_{-2}^{2} 5\, dx = 5 \cdot (2 - (-2)) = 5 \cdot 4 = 20$.

Why other options are wrong:

- (B) 0 wrongly treats the constant 5 as odd too.
- (C) 10 integrates 5 over $[0, 2]$ only (forgets to double).
- (D) 40 doubles the constant integral once too often.

Final Answer: $20 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q16

Q17.

Solution

Concept — Area between two curves: Between intersection points, area = $\int (\text{upper} - \text{lower})\, dx$.

Step 1 — Intersection: $y^2 = x$ gives $y = \sqrt{x}$ (upper); $x^2 = y$ gives $y = x^2$ (lower). They meet where $\sqrt{x} = x^2 \Rightarrow x = x^4 \Rightarrow x = 0, 1$.

Step 2 — Integrate:

$$A = \int_0^1 (\sqrt{x} - x^2)\, dx = \left[\frac{2}{3}x^{3/2} - \frac{x^3}{3}\right]_0^1 = \frac{2}{3} - \frac{1}{3} = \frac{1}{3}.$$

Why other options are wrong:

- (A) $\frac{1}{6}$ integrates only one of the two areas.
- (B) $\frac{2}{3}$ keeps only the $\sqrt{x}$ part.
- (C) 1 ignores the subtraction of the lower curve.

Final Answer: $A = \frac{1}{3} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q17

Q18.

Solution

Concept — Direct integration with initial condition: Integrate $\frac{dy}{dx} = f(x)$ to get y with a constant C, then use the given point to fix C.

Step 1 — Integrate: $y = \int (6x^2 + 2)\, dx = 2x^3 + 2x + C$.

Step 2 — Apply $y(0) = 4$: $4 = 2(0) + 2(0) + C \Rightarrow C = 4$.

Step 3 — Write solution: $y = 2x^3 + 2x + 4$.

Why other options are wrong:

- (A) $2x^3 + 2x$ drops the constant $C = 4$.
- (B) $6x^3 + 2x + 4$ forgets to divide 6 by 3 on integrating.
- (C) $2x^3 + 4$ omits the $2x$ term.

Final Answer: $y = 2x^3 + 2x + 4 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q18

Q19.

Solution

Concept — Angle between two planes: It equals the angle between their normal vectors: $\cos\theta = \dfrac{\vec{n}_1 \cdot \vec{n}_2}{|\vec{n}_1|\,|\vec{n}_2|}$.

Step 1 — Normals: $\vec{n}_1 = (1,1,1)$ for $x+y+z=1$; $\vec{n}_2 = (1,-1,1)$ for $x-y+z=5$.

Step 2 — Dot product and magnitudes: $\vec{n}_1 \cdot \vec{n}_2 = 1-1+1 = 1$; $|\vec{n}_1| = |\vec{n}_2| = \sqrt{3}$.

Step 3 — Angle: $\cos\theta = \dfrac{1}{\sqrt{3}\cdot\sqrt{3}} = \dfrac{1}{3}$, so $\theta = \cos^{-1}\left(\dfrac{1}{3}\right)$.

Why other options are wrong:

- (B) $\frac{\pi}{3}$ corresponds to $\cos\theta = \frac{1}{2}$, not $\frac{1}{3}$.
- (C) $\frac{\pi}{2}$ would require $\vec{n}_1 \cdot \vec{n}_2 = 0$.
- (D) $\cos^{-1}(\frac{2}{3})$ mis-computes the dot product as 2.

Final Answer: $\theta = \cos^{-1}\left(\dfrac{1}{3}\right) \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept — "At least one" via complement: $P(\text{at least one head}) = 1 - P(\text{no head})$.

Step 1 — No head: All four tosses tails: $P(\text{no head}) = \left(\dfrac{1}{2}\right)^4 = \dfrac{1}{16}$.

Step 2 — Complement: $P(\text{at least one head}) = 1 - \dfrac{1}{16} = \dfrac{15}{16}$.

Why other options are wrong:

- (A) $\frac{1}{16}$ is the probability of *no* head.
- (C) $\frac{1}{2}$ is the probability of a head on a single toss.
- (D) $\frac{7}{8}$ uses only 3 tosses $(1 - \frac{1}{8})$.

Final Answer: $\dfrac{15}{16} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q20

Answer Key

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