

NDA/NA

National Defence Academy/Naval Academy

SOLVED PAPER 2019 (I)

PAPER I : Mathematics

1. What is the n th term of the sequence
25, -125, 625, -3125, ...?

(a) $(-5)^{2n-1}$ (b) $(-1)^{2n} 5^{n+1}$
(c) $(-1)^{2n-1} 5^{n+1}$ (d) $(-1)^{n-1} 5^{n+1}$

- ⊙ (d) Given, sequence 25, -125, 625, -3125

Here, $\frac{T_2}{T_1} = \frac{T_3}{T_2} = \dots$

So, this sequence in GP whose common ratio is -5.

then $a = 25, r = -5$

$\therefore n$ th term of sequence = ar^{n-1}
= $25(-5)^{n-1}$

= $(-1)^{n-1} 5^2 \times 5^{n-1} = (-1)^{n-1} 5^{n+1}$

2. Suppose $X = \{1, 2, 3, 4\}$ and R is a relation on X . If $R = \{(1, 1), (2, 2), (3, 3), (1, 2), (2, 1), (2, 3), (3, 2)\}$, then which one of the following is correct?

- (a) R is reflexive and symmetric, but not transitive
(b) R is symmetric and transitive, but not reflexive
(c) R is reflexive and transitive, but not symmetric
(d) R is neither reflexive nor transitive, but symmetric

- ⊙ (d) We have, $X = \{1, 2, 3, 4\}$

$R = \{(1, 1), (2, 2), (3, 3), (1, 2), (2, 1), (2, 3), (3, 2)\}$

Since, $(4, 4) \notin R$,

Hence, R is not reflexive.

Since, $(1, 2) \in R, (2, 3) \in R$ but

$(1, 3) \notin R, R$ is not transitive.

$(1, 2), (2, 3) \in R$

and also $(2, 1), (3, 2) \in R$

$\therefore R$ is symmetric.

Hence, R is neither reflexive nor transitive but symmetric.

3. A relation R is defined on the set N of natural numbers as $xRy \Rightarrow x^2 - 4xy + 3y^2 = 0$. Then, which one of the following is correct?

- (a) R is reflexive and symmetric, but not transitive
(b) R is reflexive and transitive, but not symmetric
(c) R is reflexive, symmetric and transitive
(d) R is reflexive, but neither symmetric nor transitive

- ⊙ (d) Given, $xRy \Rightarrow x^2 - 4xy + 3y^2 = 0$

For reflexive

$xRx \Rightarrow x^2 - 4x^2 + 3x^2 = 0$

So, $(x, x) \in R, \forall x \in N$

Hence, R is reflexive.

For symmetric

$xRy \Rightarrow x^2 - 4xy + 3y^2 = 0$

$\therefore yRx \Rightarrow y^2 - 4xy + 3x^2 = 0$

It is not clear, that $y^2 - 4xy + 3x^2$ is equal to zero or not.

i.e. $(x, y) \in R$ but $(y, x) \notin R, \forall x, y \in N$

Hence, R is not symmetric.

For transitive

$xRy \Rightarrow x^2 - 4xy + 3y^2 = 0$

$yRz \Rightarrow y^2 - 4yz + 3z^2 = 0$ (let)

$xRz \Rightarrow x^2 - 4xz + 3z^2$

It is not clear, that $x^2 - 4xz + 3z^2$ is equal to zero or not.

So, $(x, y) \in R, (y, z) \in R$

$\Rightarrow (x, z) \notin R, \forall x, y, z \in N$

Hence, R is not transitive.

4. If $A = \{x \in Z : x^3 - 1 = 0\}$ and $B = \{x \in Z : x^2 + x + 1 = 0\}$, where, Z is set of complex numbers, then what is $A \cap B$ equal to?

(a) Null set

(b) $\left\{ \frac{-1 + \sqrt{3}i}{2}, \frac{-1 - \sqrt{3}i}{2} \right\}$

(c) $\left\{ \frac{-1 + \sqrt{3}i}{4}, \frac{-1 - \sqrt{3}i}{4} \right\}$

(d) $\left\{ \frac{1 + \sqrt{3}i}{2}, \frac{1 - \sqrt{3}i}{2} \right\}$

- ⊙ (b) We have, $A = \{x \in Z : x^3 - 1 = 0\}$

and $B = \{x \in Z : x^2 + x + 1 = 0\}$

$A = \left\{ 1, \frac{-1 + \sqrt{3}i}{2}, \frac{-1 - \sqrt{3}i}{2} \right\}$

$B = \left\{ \frac{-1 + \sqrt{3}i}{2}, \frac{-1 - \sqrt{3}i}{2} \right\}$

$A \cap B = \left\{ \frac{-1 + \sqrt{3}i}{2}, \frac{-1 - \sqrt{3}i}{2} \right\}$

5. Consider the following statements for the two non-empty sets A and B .

1. $(A \cap B) \cup (A \cap \bar{B}) \cup (\bar{A} \cap B)$

= $A \cup B$

2. $(A \cup (\bar{A} \cap \bar{B})) = A \cup \bar{B}$

Which of the above statements is/are correct?

- (a) Only 1 (b) Only 2
(c) Both 1 and 2 (d) Neither 1 nor 2

- ⊙ (a) We have,

1. $(A \cap B) \cup (A \cap \bar{B}) \cup (\bar{A} \cap B) = A \cup B$

LHS $\equiv (A \cap B) \cup (A \cap \bar{B}) \cup (\bar{A} \cap B)$

= $\{A \cap (B \cup \bar{B})\} \cup (\bar{A} \cap B)$

[by distributive property]

$$\begin{aligned}
 &= (A \cap U) \cup (\bar{A} \cap B) \\
 &\quad [\because B \cup \bar{B} = U] \\
 &= A \cup (\bar{A} \cap B) \\
 &= (A \cup \bar{A}) \cap (A \cup B) \\
 &= U \cap (A \cup B) = A \cup B = \text{RHS}
 \end{aligned}$$

Hence, 1 is correct.

$$\begin{aligned}
 2. \quad &A \cup (\bar{A} \cap \bar{B}) = A \cup \bar{B} \\
 \text{LHS} &\equiv A \cup (\bar{A} \cap \bar{B}) \\
 &= (A \cup \bar{A}) \cap (A \cup \bar{B}) \\
 &= U \cap (A \cup \bar{B}) \\
 &= A \cup \bar{B} \neq A \cup B
 \end{aligned}$$

Hence, 2 is false.

\(\therefore\) Only 1 is correct.

6. Let X be a non-empty set and let A, B, C be subsets of X . Consider the following statements.

1. $A \subset C \Rightarrow (A \cap B) \subset (C \cap B)$,
 $(A \cup B) \subset (C \cup B)$
2. $(A \cap B) \subset (C \cap B)$ for all sets $B \Rightarrow A \subset C$
3. $(A \cup B) \subset (C \cup B)$ for all sets $B \Rightarrow A \subset C$

Which of the above statements are correct?

- (a) Only 1 and 2 (b) Only 2 and 3
(c) Only 1 and 3 (d) 1, 2 and 3

\(\Rightarrow\) (d) Let $X = \{1, 2, 3, 4\}$

$$\begin{aligned}
 A &= \{1, 2\}, B = \{2, 3, 4\}, C = \{1, 2, 3\} \\
 A &\subset C \\
 A \cap B &= \{2\}, C \cap B = \{2, 3\}
 \end{aligned}$$

Clearly, $(A \cap B) \subset (C \cap B)$

$$\begin{aligned}
 A \cup B &= \{1, 2, 3, 4\}, (C \cup B) = \{1, 2, 3, 4\} \\
 (A \cup B) &\subset (C \cup B)
 \end{aligned}$$

Hence, Statement 1 is correct.

2. $(A \cap B) \subset (C \cap B)$ for all sets $B \Rightarrow A \subset C$

Hence, Statement 2 is also correct.

3. $(A \cup B) \subset (C \cup B)$ for all sets $B \Rightarrow A \subset C$

Hence, Statement 3 is also correct.

7.

$$\text{If } B = \begin{bmatrix} 3 & 2 & 0 \\ 2 & 4 & 0 \\ 1 & 1 & 0 \end{bmatrix}, \text{ then what is adjoint}$$

of B equal to?

$$\text{(a) } \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ -2 & -1 & 8 \end{bmatrix} \quad \text{(b) } \begin{bmatrix} 0 & 0 & -2 \\ 0 & 0 & -1 \\ 0 & 0 & 8 \end{bmatrix}$$

$$\text{(c) } \begin{bmatrix} 0 & 0 & 2 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} \quad \text{(d) It does not exist}$$

\(\Rightarrow\) (a) We have, $B = \begin{bmatrix} 3 & 2 & 0 \\ 2 & 4 & 0 \\ 1 & 1 & 0 \end{bmatrix}$

Co-factor of B ,

$$\begin{aligned}
 B_{11} &= 0, B_{12} = 0, B_{13} = -2 \\
 B_{21} &= 0, B_{22} = 0, B_{23} = -1
 \end{aligned}$$

$$B_{31} = 0, B_{32} = 0, B_{33} = 8$$

$$\text{adj } B = \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix}'$$

$$= \begin{bmatrix} 0 & 0 & -2 \\ 0 & 0 & -1 \\ 0 & 0 & 8 \end{bmatrix}' = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ -2 & -1 & 8 \end{bmatrix}$$

8. What are the roots of the equation $|x^2 - x - 6| = x + 2$?

- (a) -2, 1, 4 (b) 0, 2, 4
(c) 0, 1, 4 (d) -2, 2, 4

\(\Rightarrow\) (d) We have,

$$\begin{aligned}
 |x^2 - x - 6| &= x + 2 \\
 \Rightarrow |(x-3)(x-2)| &= x + 2
 \end{aligned}$$

Case I $x < 2$

$$\begin{aligned}
 x^2 - x - 6 &= x + 2 \\
 x^2 - 2x - 8 &= 0
 \end{aligned}$$

$$\begin{aligned}
 x^2 - 4x + 2x - 8 &= 0 \\
 x(x-4) + 2(x-4) &= 0
 \end{aligned}$$

$$\begin{aligned}
 (x-4)(x+2) &= 0 \\
 x = -2 \text{ but } x \neq 4 & \quad [\because x < 2]
 \end{aligned}$$

Case II $2 \leq x < 3$

$$\begin{aligned}
 x^2 - x - 6 &= -(x+2) \\
 x^2 - x - 6 + x + 2 &= 0 \\
 x^2 - 4 &= 0
 \end{aligned}$$

$$\begin{aligned}
 x &= \pm 2 \\
 x = 2 \text{ but } x \neq -2 & \quad [\because x \in (2, 3)]
 \end{aligned}$$

Case III $x \geq 3$

$$\begin{aligned}
 x^2 - x - 6 &= x + 2 \\
 x^2 - 2x - 8 &= 0 \\
 (x+2)(x-4) &= 0
 \end{aligned}$$

$$\begin{aligned}
 x = 4 \text{ but } x \neq -2 & \quad [\because x \geq 3] \\
 \therefore x &= -2, 2, 4
 \end{aligned}$$

9.

If $A = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$, then the matrix A is

a/an

- (a) singular matrix
(b) involutory matrix
(c) nilpotent matrix
(d) idempotent matrix

\(\Rightarrow\) (b) We have, $A = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$

$$|A| = -1$$

Since, $|A| \neq 0$

Hence, A is not singular.

$$A^2 = A \cdot A = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$A^2 = I$$

Hence, A is involutory matrix.

10.

$$\text{If } \begin{bmatrix} x & -3i & 1 \\ y & 1 & i \\ 0 & 2i & -i \end{bmatrix} = 6 + 11i, \text{ then what}$$

are the values of x and y respectively?

- (a) -3, 4 (b) 3, 4
(c) 3, -4 (d) -3, -4

\(\Rightarrow\) (a) We have, $\begin{bmatrix} x & -3i & 1 \\ y & 1 & i \\ 0 & 2i & -i \end{bmatrix} = 6 + 11i$

$$\Rightarrow x(-i+2) - y(-3-2i) = 6 + 11i$$

$$\Rightarrow 2x + 3y + (-x + 2y)i = 6 + 11i$$

On equating real and imaginary parts, on both sides,

$$\text{we get } 2x + 3y = 6 \quad \dots(i)$$

$$\text{and } -x + 2y = 11 \quad \dots(ii)$$

On solving Eqs. (i) and (ii), we get

$$x = -3 \text{ and } y = 4$$

11. The common roots of the equations

$$z^3 + 2z^2 + 2z + 1 = 0$$

$$\text{and } z^{2017} + z^{2018} + 1 = 0 \text{ are}$$

- (a) -1, ω (b) 1, ω^2
(c) -1, ω^2 (d) ω, ω^2

\(\Rightarrow\) (d) We have, $z^3 + 2z^2 + 2z + 1 = 0$

$$(z+1)(z^2+z+1) = 0$$

$$\Rightarrow z+1=0 \text{ or } z^2+z+1=0$$

$$z = -1$$

$$\text{or } z = \frac{-1 \pm \sqrt{1-4}}{2}$$

$$= \frac{-1 + i\sqrt{3}}{2}, \frac{-1 - i\sqrt{3}}{2} = \omega, \omega^2$$

$$\text{Now, } z^{2017} + z^{2018} + 1 = 0$$

Put $z = -1$,

$$\text{LHS} = (-1)^{2017} + (-1)^{2018} + 1$$

$$= -1 + 1 + 1$$

$$= 1 \neq 0 \text{ (RHS)}$$

\(\therefore\) $z = -1$ is not a root of equation.

Put $z = \omega$,

$$\text{LHS} = (\omega)^{2017} + (\omega)^{2018} + 1$$

$$= (\omega^3)^{672} \cdot \omega + (\omega^3)^{672} \cdot \omega^2 + 1$$

$$= \omega + \omega^2 + 1 \quad [\because \omega^3 = 1]$$

$$[\because 1 + \omega + \omega^2 = 0]$$

$$= 0 = \text{RHS}$$

\(\therefore\) $z = \omega$ is a root of equation.

put $z = \omega^2$,

$$\text{LHS} = (\omega^2)^{2017} + (\omega^2)^{2018} + 1$$

$$= \omega^{4034} + \omega^{4036} + 1$$

$$= (\omega^3)^{1344} \cdot \omega^2 + (\omega^3)^{1345} \cdot \omega + 1$$

$$= \omega^2 + \omega + 1 = 0 \text{ RHS}$$

\(\therefore\) $z = \omega^2$ is a root of equation.

Hence, ω, ω^2 are the common roots of these equations.

12. If $C(20, n+2) = C(20, n-2)$, then what is n equal to

- (a) 8 (b) 10
(c) 12 (d) 16

⊙ (b) We have, $C(20, n+2) = C(20, n-2)$
 $\Rightarrow {}^{20}C_{n+2} = {}^{20}C_{n-2}$
 $\Rightarrow n+2 + n-2 = 20$
 $[\because {}^nC_x = {}^nC_y \Rightarrow x + y = n]$
 $\therefore n = 10$

13. There are 10 points in a plane. No three of these points are in a straight line. What is the total number of straight lines which can be formed by joining the points?

- (a) 90 (b) 45
(c) 40 (d) 30

⊙ (b) Given, 10 points in a plane where no three of these points are in straight line. Total number of straight line formed from 10 points is
 ${}^{10}C_2 = \frac{10!}{2!8!} = \frac{10 \times 9}{2} = 45$

14. The equation $px^2 + qx + r = 0$ (where p, q, r , all are positive) has distinct real roots a and b . Which one of the following is correct?

- (a) $a > 0, b > 0$
(b) $a < 0, b < 0$
(c) $a > 0, b < 0$
(d) $a < 0, b > 0$

⊙ (b) Given, $px^2 + qx + r = 0$, where $p, q, r > 0$ and a and b are distinct roots.
 $\therefore a + b = \frac{-q}{p}$ and $ab = r$

Now, $r > 0$

$\therefore ab > 0$

$\Rightarrow a > 0, b > 0$... (i)

or $a < 0, b < 0$... (ii)

Now, $\frac{-q}{p} < 0$ $q, p > 0$

$\therefore a + b < 0$

$a < 0, b < 0$... (iii)

From Eqs. (i), (ii) and (iii), we get

$\therefore a < 0$ and $b < 0$

15. If $A = \{\lambda, \{\lambda, \mu\}\}$, then the power set of A is

- (a) $\{\phi, \{\phi\}, \{\lambda\}, \{\lambda, \mu\}\}$
(b) $\{\phi, \{\lambda\}, \{\lambda, \mu\}, \{\lambda, \{\lambda, \mu\}\}\}$
(c) $\{\phi, \{\lambda\}, \{\lambda, \mu\}, \{\lambda, \{\lambda, \mu\}\}\}$
(d) $\{\{\lambda\}, \{\lambda, \mu\}, \{\lambda, \{\lambda, \mu\}\}\}$

⊙ (b) We have, $A = \{\lambda, \{\lambda, \mu\}\}$
 $P(A) = \{\phi, \{\lambda\}, \{\{\lambda, \mu\}\}, \{\lambda, \{\lambda, \mu\}\}\}$

Directions (Q. Nos. 16 and 17) Read the information carefully and answer the given questions.

In a school, all the students play atleast one of three indoor games— chess, carrom and table tennis. 60 play chess, 50 play table tennis, 48 play carrom, 12 play chess and carrom, 15 play carrom and table tennis, 20 play table tennis and chess.

16. What can be the minimum number of students in the school?

- (a) 123 (b) 111 (c) 95 (d) 63

⊙ (b) Let

A = Student play chess

B = Student play table tennis

C = Student play carrom

Given, $n(A) = 60, n(B) = 50, n(C) = 48$

$n(A \cap B) = 20, n(B \cap C) = 15$

$n(A \cap C) = 12$

For minimum number of students in school

$n(A \cap B \cap C)$ must be zero.

$\therefore n(A \cup B \cup C) = n(A) + n(B) + n(C) - n(A \cap B) - n(B \cap C) - n(A \cap C) + n(A \cap B \cap C)$
 $= 60 + 50 + 48 - 20 - 15 - 12 + 0 = 111$

17. What can be the maximum number of students in the school?

- (a) 111 (b) 123
(c) 125 (d) 135

⊙ (b) For maximum number of students in school $n(A \cap B \cap C)$ must be 12.

$\therefore n(A \cup B \cup C) = 60 + 50 + 48 - 20 - 15 - 12 + 12 = 123$

18. If A is an identity matrix of order 3, then its inverse (A^{-1})

- (a) is equal to null matrix
(b) is equal to A
(c) is equal to $3A$ (d) does not exist

⊙ (b) Given, $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$\therefore A^{-1} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = A$

19. A is a square matrix of order 3 such that its determinant is 4. What is the determinant of its transpose?

- (a) 64 (b) 36
(c) 32 (d) 4

⊙ (d) Given, $|A| = 4$

$\therefore |A'| = 4$ [$\because |A| = |A'|$]

20. From 6 programmers and 4 typists, an office wants to recruit 5 people. What is the number of ways this can be done so as to recruit atleast one typist?

- (a) 209 (b) 210
(c) 246 (d) 242

⊙ (c) We have,

6 programmers and 4 typists

Number of ways of 5 recruit people such that atleast one typist

$$= {}^4C_1 {}^6C_4 + {}^4C_2 {}^6C_3 + {}^4C_3 {}^6C_2 + {}^4C_4 {}^6C_1$$

$$= 4 \times 15 + 6 \times 20 + 4 \times 15 + 1 \times 6$$

$$= 60 + 120 + 60 + 6 = 246$$

21. What is the number of terms in the expansion of $[(2x-3y)^2(2x+3y)^2]^2$?

- (a) 4 (b) 5
(c) 8 (d) 16

⊙ (b) Given, $[(2x-3y)^2(2x+3y)^2]^2$
 $= [4x^2 - 9y^2]^4$

\therefore Total number of terms = $4 + 1 = 5$

22. In the expansion of $(1+ax)^n$, the first three terms are respectively $1, 12x$ and $64x^2$. What is n equal to?

- (a) 6 (b) 9
(c) 10 (d) 12

⊙ (b) Given, first three terms of expansion $(1+ax)^n$ is $1, 12x, 64x^2$,

Now,

$$(1+ax)^n = 1 + nax + \frac{n(n-1)}{2} a^2 x^2 + \dots$$

On equating first three terms, we get

$$na = 12 \text{ and } \frac{n(n-1)}{2} a^2 = 64$$

On putting the value of a in

$$\frac{n(n-1)}{2} a^2 = 64, \text{ we get}$$

$$\frac{n(n-1)}{2} \left(\frac{12}{n}\right)^2 = 64$$

$$\Rightarrow \frac{144(n-1)}{2n} = 64$$

$$\therefore n = 9$$

23. The numbers 1, 5 and 25 can be three terms (not necessarily consecutive) of

- (a) only one AP
(b) more than one but finite numbers of APs
(c) infinite number of APs
(d) finite number of GPs

⊙ (d) We have, 1, 5, 25 be three terms.

Clearly, 1, 5, 25 are finite number of GPs.

24. The sum of $(p + q)$ th and $(p - q)$ th terms of an AP is equal to

- (a) $(2p)$ th term (b) $(2q)$ th term
(c) twice the p th term
(d) twice the q th term

⊙ (c) Let a is first term and d is common difference of AP.

$$a_{p+q} = a + (p+q-1)d$$

$$\text{and } a_{p-q} = a + (p-q-1)d$$

Sum of $(p+q)$ th and $(p-q)$ th terms

$$= a_{p+q} + a_{p-q} = 2a + (2p-2)d$$

$$= 2(a + (p-1)d) = 2a_p$$

$$= \text{twice of } p \text{ th term}$$

25. If A is a square matrix of order $n > 1$, then which one of the following is correct?

- (a) $\det(-A) = \det A$
(b) $\det(-A) = (-1)^n \det A$
(c) $\det(-A) = -\det A$
(d) $\det(-A) = n \det A$

⊙ **Sol.** (b) We know that if A is a square matrix of order $n > 1$, then $\det(-A) = (-1)^n \det A$

For example If $A = \begin{bmatrix} 2 & 3 \\ 4 & 5 \end{bmatrix}$,
then $-A = \begin{bmatrix} -2 & -3 \\ -4 & -5 \end{bmatrix}$

$$\therefore \det A = \begin{vmatrix} 2 & 3 \\ 4 & 5 \end{vmatrix} = 10 - 12 = -2 \quad \dots(i)$$

$$\text{and } \det(-A) = \begin{vmatrix} -2 & -3 \\ -4 & -5 \end{vmatrix} = 10 - 12 = -2$$

$$= (-1)^2(-2) \quad [\because \text{here } n = 2]$$

$$= (-1)^2 \det A \quad [\text{from Eq. (i)}]$$

$$\text{if } A = \begin{bmatrix} 1 & 2 & 3 \\ 3 & 1 & 0 \\ 4 & 3 & -2 \end{bmatrix}$$

$$\text{Then, } -A = \begin{bmatrix} -1 & -2 & -3 \\ -3 & -1 & 0 \\ -4 & -3 & 2 \end{bmatrix}$$

$$\therefore \det A = \begin{vmatrix} 1 & 2 & 3 \\ 3 & 1 & 0 \\ 4 & 3 & -2 \end{vmatrix}$$

$$= 1(-2-0) - 2(-6-0) + 3(9-4)$$

$$= -2 + 12 + 15 = 25$$

$$\text{and } \det(-A) = \begin{vmatrix} -1 & -2 & -3 \\ -3 & -1 & 0 \\ -4 & -3 & 2 \end{vmatrix}$$

$$= -1(-2-0) + 2(-6-0) - 3(9-4)$$

$$= 2 - 12 - 15 = -25$$

$$= (-1)^3 25 \quad [\text{here } n = 3]$$

$$= (-1)^3 \det A \quad [\text{from Eq. (i)}]$$

26. What is the least value of $25 \operatorname{cosec}^2 x + 36 \sec^2 x$?

- (a) 1
(b) 11
(c) 120
(d) 121

⊙ (d) Given, $25 \operatorname{cosec}^2 x + 36 \sec^2 x$

$$= 25(1 + \cot^2 x) + 36(1 + \tan^2 x)$$

$$= 25 + 25 \cot^2 x + 36 + 36 \tan^2 x$$

$$= 25 + 36 + 25 \cot^2 x + 36 \tan^2 x$$

$$= 61 + (5 \cot x - 6 \tan x)^2 + 2 \times 5 \times 6$$

$$\geq 61 + 60 = 121 \quad [\because \text{minimum value of } (5 \cot x - 6 \tan x)^2 = 0]$$

\therefore Minimum value of $25 \operatorname{cosec}^2 x + 36 \sec^2 x = 121$

Directions (Q. Nos. 27 and 28) Read the information carefully and answer the given questions.

Let A and B be 3×3 matrices with $\det A = 4$ and $\det B = 3$.

27. What is $\det(2AB)$ equal to?

- (a) 96
(b) 72
(c) 48
(d) 36

⊙ (a) A and B be (3×3) matrices with $\det A = 4$ and $\det B = 3$

We know that,
 $\det(KAB) = K^n \det(A) \times \det(B)$

where, n is the order of A and B , K is a real number.

$$\therefore \det(2AB) = (2)^3 \det A \times \det B$$

$$[\because n = 3 \text{ and } k = 2]$$

$$= 8 \times 4 \times 3$$

$$= 96$$

28. What is $\det(3AB^{-1})$ equal to?

- (a) 12 (b) 18
(c) 36 (d) 48

⊙ (c) A and B be (3×3) matrices with $\det A = 4$ and $\det B = 3$

We know that,

$$\det(KAB^{-1}) = K^n \det(A) \times \frac{1}{\det(B)}$$

where n is the order of A and B , K is a real number]

$$\therefore \det(3AB^{-1}) = (3)^3 \det(A) \times \frac{1}{\det B}$$

$$= 27 \times 4 \times \frac{1}{3}$$

$$= 36$$

Directions (Q. Nos. 29 and 30) Read the information carefully and answer the given questions.

A complex number is given by

$$z = \frac{1+2i}{1-(1-i)^2}$$

29. What is the modulus of z ?

- (a) 4 (b) 2 (c) 1 (d) $\frac{1}{2}$

⊙ (c) We have, $z = \frac{1+2i}{1-(1-i)^2}$

$$z = \frac{1+2i}{1-(1-1-2i)}$$

$$= \frac{1+2i}{1+2i} = 1$$

$$\therefore |z| = 1$$

30. What is the principal argument of z ?

- (a) 0 (b) $\frac{\pi}{4}$ (c) $\frac{\pi}{2}$ (d) π

⊙ (a) $\arg(z) = \tan^{-1} \left(\frac{\operatorname{Im}(z)}{\operatorname{Re}(z)} \right)$

$$= \tan^{-1} \left(\frac{0}{1} \right) = \tan^{-1} 0 = 0$$

31. What is the value of

$$\frac{\sin 34^\circ \cos 236^\circ - \sin 56^\circ \sin 124^\circ}{\cos 28^\circ \cos 88^\circ + \cos 178^\circ \sin 208^\circ} ?$$

- (a) -2 (b) -1 (c) 2 (d) 1

⊙ (a) We have,

$$\frac{\sin 34^\circ \cos 236^\circ - \sin 56^\circ \sin 124^\circ}{\cos 28^\circ \cos 88^\circ + \cos 178^\circ \sin 208^\circ}$$

$$= \frac{\sin 34^\circ \cos (180^\circ + 56^\circ) - \sin 56^\circ \sin (90^\circ + 34^\circ)}{\cos 28^\circ \cos 88^\circ + \cos (90^\circ + 88^\circ)}$$

$$= \frac{-\sin 34^\circ \cos 56^\circ - \sin 56^\circ \cos 34^\circ}{\cos 28^\circ \cos 88^\circ + \sin (180^\circ + 28^\circ)}$$

$$= \frac{-\sin 34^\circ \cos 56^\circ - \sin 56^\circ \cos 34^\circ}{\cos 28^\circ \cos 88^\circ + \sin 88^\circ \sin 28^\circ}$$

$$= \frac{-\sin (56^\circ + 34^\circ)}{\cos (88^\circ - 28^\circ)} = \frac{-\sin 90^\circ}{\cos 60^\circ}$$

$$= \frac{-1}{\frac{1}{2}} = -2$$

32. $\tan 54^\circ$ can be expressed as

- (a) $\frac{\sin 9^\circ + \cos 9^\circ}{\sin 9^\circ - \cos 9^\circ}$ (b) $\frac{\sin 9^\circ - \cos 9^\circ}{\sin 9^\circ + \cos 9^\circ}$
(c) $\frac{\cos 9^\circ + \sin 9^\circ}{\cos 9^\circ - \sin 9^\circ}$ (d) $\frac{\sin 36^\circ}{\cos 36^\circ}$

⊙ (c) We have, $\tan 54^\circ = \tan (45^\circ + 9^\circ)$

$$= \frac{\tan 45^\circ + \tan 9^\circ}{1 - \tan 45^\circ \tan 9^\circ} = \frac{1 + \tan 9^\circ}{1 - \tan 9^\circ}$$

$$= \frac{\cos 9^\circ + \sin 9^\circ}{\cos 9^\circ - \sin 9^\circ}$$

Directions (Q. Nos. 33-35) Read the given information carefully and answer the given questions.

If $p = X \cos \theta - Y \sin \theta$,
 $q = X \sin \theta + Y \cos \theta$ and
 $p^2 + 4pq + q^2 = AX^2 + BY^2$,
 $0 \leq \theta \leq \frac{\pi}{2}$.

33. What is the value of θ ?

- (a) $\frac{\pi}{2}$ (b) $\frac{\pi}{3}$
 (c) $\frac{\pi}{4}$ (d) $\frac{\pi}{6}$

⊙ (c) We have,

$$p = X \cos \theta - Y \sin \theta \quad \dots(i)$$

$$q = X \sin \theta + Y \cos \theta \quad \dots(ii)$$

$$\text{and } p^2 + 4pq + q^2 = AX^2 + BY^2 \quad \dots(iii)$$

From Eqs. (i) and (ii), we get

$$p^2 + q^2 = (X \cos \theta - Y \sin \theta)^2 + (X \sin \theta + Y \cos \theta)^2$$

$$\Rightarrow p^2 + q^2 = X^2 + Y^2$$

$$\text{and } pq = (X \cos \theta - Y \sin \theta)$$

$$(X \sin \theta + Y \cos \theta)$$

$$\Rightarrow pq = (X^2 - Y^2) \sin \theta \cos \theta$$

$$+ XY \cos 2\theta$$

$$\therefore p^2 + 4pq + q^2 = X^2 + Y^2 + 2$$

$$(X^2 - Y^2)$$

$$\sin 2\theta + 4XY \cos 2\theta$$

$$\text{Given, } p^2 + 4pq + q^2 = AX^2 + BY^2$$

$$\therefore X^2 + Y^2 + 2(X^2 - Y^2)$$

$$\sin 2\theta + 4XY \cos 2\theta = AX^2 + 2BY^2$$

$$\text{Coefficient of } XY = 0$$

$$\therefore \cos 2\theta = 0$$

$$\Rightarrow 2\theta = \frac{\pi}{2}$$

$$\therefore \theta = \frac{\pi}{4}$$

34. What is the value of A ?

- (a) 4
 (b) 3
 (c) 2
 (d) 1

⊙ (b) $X^2 + Y^2 + 2(X^2 - Y^2) \sin \frac{\pi}{2}$

$$= AX^2 + BY^2$$

$$\Rightarrow X^2 + Y^2 + 2X^2 - 2Y^2 = AX^2 + BY^2$$

$$\Rightarrow 3X^2 - Y^2 = AX^2 + BY^2$$

$$\therefore A = 3, B = -1$$

35. What is the value of B ?

- (a) -1 (b) 0
 (c) 1 (d) 2

⊙ (a) $B = -1$

Directions (Q. Nos. 36 and 37) Read the given information carefully and answer the given questions.

It is given that $\cos(\theta - \alpha) = a$,
 $\cos(\theta - \beta) = b$.

36. What is $\cos(\alpha - \beta)$ equal to?

(a) $ab + \sqrt{1-a^2}\sqrt{1-b^2}$

(b) $ab - \sqrt{1-a^2}\sqrt{1-b^2}$

(c) $a\sqrt{1-a^2} - b\sqrt{1-a^2}$

(d) $a\sqrt{1-b^2} + b\sqrt{1-a^2}$

⊙ (a) Given $\cos(\theta - \alpha) = a$

$$\cos(\theta - \beta) = b$$

$$\cos(\alpha - \beta) = \cos\{(\theta - \beta) - (\theta - \alpha)\}$$

$$= \cos(\theta - \beta) \cos(\theta - \alpha) + \sin(\theta - \beta)$$

$$\sin(\theta - \alpha)$$

$$= ab + \sqrt{1-a^2}\sqrt{1-b^2}$$

37. What is $\sin^2(\alpha - \beta) + 2ab\cos(\alpha - \beta)$ equal to?

(a) $a^2 + b^2$ (b) $a^2 - b^2$

(c) $b^2 - a^2$ (d) $-(a^2 + b^2)$

⊙ (a) $\sin^2(\alpha - \beta) + 2ab\cos(\alpha - \beta)$

$$= 1 - \cos^2(\alpha - \beta) + 2ab\cos(\alpha - \beta)$$

$$= 1 - (ab + \sqrt{1-a^2}\sqrt{1-b^2})^2 + 2ab$$

$$(ab + \sqrt{1-a^2}\sqrt{1-b^2})$$

$$= 1 - [a^2b^2 + (1-a^2)(1-b^2) + 2ab$$

$$\sqrt{1-a^2}\sqrt{1-b^2}] + 2a^2b^2 + 2ab$$

$$(\sqrt{1-a^2})(\sqrt{1-b^2})$$

$$= 1 - a^2b^2 - 1 + a^2 + b^2 - a^2b^2$$

$$- 2ab\sqrt{1-a^2}\sqrt{1-b^2} + 2a^2b^2 + 2ab$$

$$\sqrt{1-a^2}\sqrt{1-b^2}$$

$$= a^2 + b^2$$

38. If $\sin \alpha + \cos \alpha = p$, then what is $\cos^2(2\alpha)$ equal to?

(a) p^2 (b) $p^2 - 1$

(c) $p^2(2 - p^2)$ (d) $p^2 + 1$

⊙ (c) We have, $\sin \alpha + \cos \alpha = p$

$$\sin^2 \alpha + \cos^2 \alpha + 2 \sin \alpha \cos \alpha = p^2$$

$$\Rightarrow 1 + \sin 2\alpha = p^2$$

$$\Rightarrow \sin 2\alpha = p^2 - 1$$

$$\Rightarrow \sin^2 2\alpha = (p^2 - 1)^2$$

$$\Rightarrow 1 - \cos^2 2\alpha = p^4 - 2p^2 + 1$$

$$\Rightarrow \cos^2 2\alpha = 2p^2 - p^4$$

$$\therefore \cos^2 2\alpha = p^2(2 - p^2)$$

39. What is the value of $\sin^{-1} \frac{4}{5} + \sec^{-1} \frac{5}{4} - \frac{\pi}{2}$?

- (a) $\frac{\pi}{4}$ (b) $\frac{\pi}{2}$
 (c) π (d) 0

⊙ (d) We have,

$$\sin^{-1} \frac{4}{5} + \sec^{-1} \frac{5}{4} - \frac{\pi}{2}$$

$$= \sin^{-1} \frac{4}{5} + \cos^{-1} \frac{4}{5} - \frac{\pi}{2}$$

$$\left[\because \sec^{-1} x = \cos^{-1} \left(\frac{1}{x} \right) \right]$$

$$= \frac{\pi}{2} - \frac{\pi}{2} = 0 \left[\because \sin^{-1} x + \cos^{-1} x = \frac{\pi}{2} \right]$$

40.

If $\sin^{-1} \frac{2p}{1+p^2} - \cos^{-1} \frac{1-q^2}{1+q^2}$

$= \tan^{-1} \frac{2x}{1-x^2}$, then what is x equal

to?

(a) $\frac{p+q}{1+pq}$ (b) $\frac{p-q}{1+pq}$

(c) $\frac{pq}{1+pq}$ (d) $\frac{p+q}{1-pq}$

⊙ (b) Given,

$$\sin^{-1} \frac{2p}{1+p^2} - \cos^{-1} \left(\frac{1-q^2}{1+q^2} \right) = \tan^{-1} \frac{2x}{1-x^2}$$

$$\Rightarrow 2 \tan^{-1} p - 2 \tan^{-1} q = 2 \tan^{-1} x$$

$$\Rightarrow \tan^{-1} \left(\frac{p-q}{1+pq} \right) = \tan^{-1} x$$

$$\therefore x = \frac{p-q}{1+pq}$$

41. If $\tan \theta = \frac{1}{2}$ and $\tan \phi = \frac{1}{3}$, then what is the value of $(\theta + \phi)$?

- (a) 0 (b) $\frac{\pi}{6}$
 (c) $\frac{\pi}{4}$ (d) $\frac{\pi}{2}$

⊙ (c) Given, $\tan \theta = \frac{1}{2}$, $\tan \phi = \frac{1}{3}$

$$\tan(\theta + \phi) = \frac{\tan \theta + \tan \phi}{1 - \tan \theta \tan \phi}$$

$$\Rightarrow \tan(\theta + \phi) = \frac{\frac{1}{2} + \frac{1}{3}}{1 - \frac{1}{2} \times \frac{1}{3}}$$

$$\Rightarrow \tan(\theta + \phi) = \frac{3+2}{6-1} = \frac{5}{5} = 1$$

$$\Rightarrow \tan(\theta + \phi) = 1$$

$$\Rightarrow \theta + \phi = \tan^{-1} 1 = \frac{\pi}{4}$$

42. If $\cos A = \frac{3}{4}$, then what is the value of $\sin\left(\frac{A}{2}\right)\sin\left(\frac{3A}{2}\right)$?

- (a) $\frac{5}{8}$ (b) $\frac{5}{16}$ (c) $\frac{5}{24}$ (d) $\frac{7}{32}$

⊙ (b) Given, $\cos A = \frac{3}{4}$

$$\begin{aligned} \text{Now, } \sin \frac{A}{2} \sin \frac{3A}{2} &= \frac{1}{2} \left(2 \sin \frac{A}{2} \sin \frac{3A}{2} \right) \\ &= \frac{1}{2} \left[\cos \left(\frac{A}{2} - \frac{3A}{2} \right) - \cos \left(\frac{A}{2} + \frac{3A}{2} \right) \right] \\ &= \frac{1}{2} [\cos A - \cos 2A] \\ &= \frac{1}{2} (\cos A - 2 \cos^2 A + 1) \\ &= \frac{1}{2} \left[\frac{3}{4} - 2 \times \frac{9}{16} + 1 \right] \\ &= \frac{1}{2} \left[\frac{3}{4} - \frac{9}{8} + 1 \right] = \frac{1}{2} \left[\frac{6 - 9 + 8}{8} \right] = \frac{5}{16} \end{aligned}$$

43. What is the value of $\tan 75^\circ + \cot 75^\circ$?

- (a) 2 (b) 4
(c) $2\sqrt{3}$ (d) $4\sqrt{3}$

⊙ (b) We have, $\tan 75^\circ + \cot 75^\circ$
 $= \tan(90^\circ - 15^\circ) + \cot(90^\circ - 15^\circ)$
 $= \cot 15^\circ + \tan 15^\circ$
 $= \frac{\cos 15^\circ}{\sin 15^\circ} + \frac{\sin 15^\circ}{\cos 15^\circ}$
 $= \frac{\cos^2 15^\circ + \sin^2 15^\circ}{\sin 15^\circ \cos 15^\circ}$
 $= \frac{1}{\sin 15^\circ \cos 15^\circ}$
 $= \frac{2}{2 \sin 15^\circ \cos 15^\circ}$
 $= \frac{2}{\sin 30^\circ} = \frac{2}{\frac{1}{2}} = 4$

44. What is the value of $\cos 46^\circ \cos 47^\circ \cos 48^\circ \cos 49^\circ \cos 50^\circ \dots \cos 135^\circ$?

- (a) -1 (b) 0
(c) 1 (d) Greater than 1

⊙ (b) We have,
 $\cos 46^\circ \cos 47^\circ \cos 48^\circ \cos 49^\circ \cos 50^\circ \dots \cos 90^\circ \dots \cos 135^\circ$
 $= 0$ [$\because \cos 90^\circ = 0$]

45. If $\sin 2\theta = \cos 3\theta$, where $0 < \theta < \frac{\pi}{2}$, then what is $\sin \theta$ equal to?

- (a) $\frac{\sqrt{5}+1}{4}$ (b) $\frac{\sqrt{5}-1}{4}$
(c) $\frac{\sqrt{5}+1}{16}$ (d) $\frac{\sqrt{5}-1}{16}$

⊙ (b) Given, $\sin 2\theta = \cos 3\theta$
 $\Rightarrow 2 \sin \theta \cos \theta = 4 \cos^3 \theta - 3 \cos \theta$
 $\Rightarrow 2 \sin \theta = 4 \cos^2 \theta - 3$ [$\because \cos \theta \neq 0$]
 $\Rightarrow 2 \sin \theta = 4(1 - \sin^2 \theta) - 3$
 $\Rightarrow 4 \sin^2 \theta + 2 \sin \theta - 1 = 0$
 $\Rightarrow \sin \theta = \frac{-2 \pm \sqrt{4+16}}{2 \times 4}$
 $\Rightarrow \sin \theta = \frac{-2 \pm 2\sqrt{5}}{2 \times 4} = \frac{-1 \pm \sqrt{5}}{4}$
 $\therefore \sin \theta = \frac{\sqrt{5}-1}{4}$ [$\because \theta \in \left[0, \frac{\pi}{2}\right]$]

46. If the roots of the equation $x^2 + px + q = 0$ are $\tan 19^\circ$ and $\tan 26^\circ$, then which one of the following is correct?

- (a) $q - p = 1$ (b) $p - q = 1$
(c) $p + q = 2$ (d) $p + q = 3$

⊙ (a) Given, $\tan 19^\circ$ and $\tan 26^\circ$ are roots of $x^2 + px + q = 0$.
 $\therefore \tan 19^\circ + \tan 26^\circ = -p$
 $\tan 19^\circ \cdot \tan 26^\circ = q$
 $\tan(19^\circ + 26^\circ) = \frac{\tan 19^\circ + \tan 26^\circ}{1 - \tan 19^\circ \tan 26^\circ}$
 $\Rightarrow \tan 45^\circ = \frac{-p}{1-q} \Rightarrow 1 = \frac{-p}{1-q}$
 $\Rightarrow 1 - q = -p$
 $\therefore q - p = 1$

47. What is the fourth term of an AP of n terms whose sum is $n(n+1)$?

- (a) 6 (b) 8
(c) 12 (d) 20

⊙ (b) Given,
Sum of n terms of an AP
i.e. $S_n = n(n+1)$
 $a_4 = S_4 - S_3$ [$\because a_n = S_n - S_{n-1}$]
 $a_4 = 4(4+1) - 3(3+1)$
 $a_4 = 20 - 12 = 8$
 \therefore Fourth term of an AP = 8

48. What is $-\sec^2 \alpha \sec^2 \beta$ equal to?

- (a) 0 (b) 1
(c) 2 (d) 4

⊙ (a) We have,
 $(1 + \tan \alpha \tan \beta)^2 + (\tan \alpha - \tan \beta)^2 - \sec^2 \alpha \sec^2 \beta$
 $= 1 + \tan^2 \alpha \tan^2 \beta + 2 \tan \alpha \tan \beta + \tan^2 \alpha + \tan^2 \beta - 2 \tan \alpha \tan \beta - \sec^2 \alpha \sec^2 \beta$
 $= 1 + \tan^2 \alpha \tan^2 \beta + \tan^2 \alpha + \tan^2 \beta - \sec^2 \alpha \sec^2 \beta$
 $= (1 + \tan^2 \alpha)(1 + \tan^2 \beta) - \sec^2 \alpha \sec^2 \beta$
 $= \sec^2 \alpha \sec^2 \beta - \sec^2 \alpha \sec^2 \beta = 0$

49. If $p = \operatorname{cosec} \theta - \cot \theta$ and $q = (\operatorname{cosec} \theta + \cot \theta)^{-1}$, then which one of the following is correct?

- (a) $pq = 1$ (b) $p = q$
(c) $p + q = 1$ (d) $p + q = 0$

⊙ (b) Given, $p = \operatorname{cosec} \theta - \cot \theta$
 $q = (\operatorname{cosec} \theta + \cot \theta)^{-1}$

$$\begin{aligned} \Rightarrow q &= \left(\frac{1}{\operatorname{cosec} \theta + \cot \theta} \right) (\operatorname{cosec} \theta - \cot \theta) \\ \Rightarrow q &= \operatorname{cosec} \theta - \cot \theta \\ \therefore q &= p \end{aligned}$$

50. If the angles of a triangle ABC are in the ratio $1 : 2 : 3$, then the corresponding sides are in the ratio

- (a) $1 : 2 : 3$ (b) $3 : 2 : 1$
(c) $1 : \sqrt{3} : 2$ (d) $1 : \sqrt{3} : \sqrt{2}$

⊙ (c) We have, angle of triangle ABC are in the ratio $1 : 2 : 3$

$$\begin{aligned} \therefore x + 2x + 3x &= 180^\circ \\ \Rightarrow x &= 30^\circ \end{aligned}$$

\therefore Angles of triangle are $30^\circ, 60^\circ, 90^\circ$.

We know that, sine rule

$$\begin{aligned} \frac{a}{\sin A} &= \frac{b}{\sin B} = \frac{c}{\sin C} \\ \frac{a}{\sin 30^\circ} &= \frac{b}{\sin 60^\circ} = \frac{c}{\sin 90^\circ} \\ \Rightarrow \frac{a}{\frac{1}{2}} &= \frac{b}{\frac{\sqrt{3}}{2}} = \frac{c}{1} \end{aligned}$$

$$\therefore a : b : c = 1 : \sqrt{3} : 2$$

51. Consider the following statements

1. For an equation of a line,

$x \cos \theta + y \sin \theta = p$, in normal form, the length of the perpendicular from the point (α, β) to the line is $|\alpha \cos \theta + \beta \sin \theta + p|$.

The length of the perpendicular from the point (α, β) to the line

$$\frac{x}{a} + \frac{y}{b} = 1 \text{ is } \left| \frac{a\alpha + b\beta - ab}{\sqrt{a^2 + b^2}} \right|$$

Which of the above statements is/are correct?

- (a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

⊙ (d) 1. Equation of line $x \cos \theta + y \sin \theta = p$

Perpendicular distance from (α, β) to the given line is

$$\begin{aligned} \left| \frac{\alpha \cos \theta + \beta \sin \theta - p}{\sqrt{\cos^2 \theta + \sin^2 \theta}} \right| \\ = (\alpha \cos \theta + \beta \sin \theta - p) \end{aligned}$$

Hence, statement 1 is incorrect.

2. Length of the perpendicular from the point (α, β) to the line $\frac{x}{a} + \frac{y}{b} = 1$ is

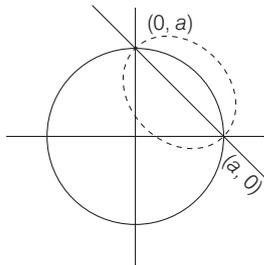
$$\left| \frac{\frac{\alpha}{a} + \frac{\beta}{b} - 1}{\sqrt{\frac{1}{a^2} + \frac{1}{b^2}}} \right| = \left| \frac{\alpha b + a\beta - ab}{\sqrt{a^2 + b^2}} \right|$$

Hence, statement 2 is incorrect.
 \therefore Neither 1 nor 2.

52. A circle is drawn on the chord of a circle $x^2 + y^2 = a^2$ as diameter. The chord lies on the line $x + y = a$. What is the equation of the circle?

- (a) $x^2 + y^2 - ax - ay + a^2 = 0$
- (b) $x^2 + y^2 - ax - ay = 0$
- (c) $x^2 + y^2 + ax + ay = 0$
- (d) $x^2 + y^2 + ax + ay - 2a^2 = 0$

(b) Given, equation of circle is $x^2 + y^2 = a^2$.
 $x + y = a$ is chord of a circle.



\therefore End points of diameter of required circle is $(a, 0)$ and $(0, a)$.

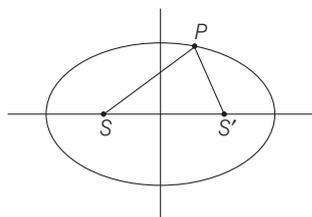
\therefore Equation of circle is $x(x - a) + y(y - a) = 0$
 $\Rightarrow x^2 + y^2 - ax - ay = 0$

53. The sum of the focal distances of a point on an ellipse is constant and equal to

- (a) length of minor axis
- (b) length of major axis
- (c) length of latusrectum
- (d) sum of the lengths of semi major and semi minor axes

(b) The sum of the focal distance of a point on an ellipse is constant and equal to the length of major axis.

We know that, $PS + PS' = 2a$



54. The equation $2x^2 - 3y^2 - 6 = 0$ represents

- (a) a circle
- (b) a parabola
- (c) an ellipse
- (d) a hyperbola

(d) Given, $2x^2 - 3y^2 - 6 = 0$

$$\Rightarrow 2x^2 - 3y^2 = 6$$

$$\Rightarrow \frac{x^2}{3} - \frac{y^2}{2} = 1$$

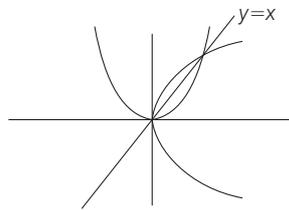
Which represents the equation of a hyperbola.

55. The two parabolas $y^2 = 4ax$ and $x^2 = 4ay$ intersect

- (a) at two points on the line $y = x$
- (b) only at the origin
- (c) at three points one of which lies on $y + x = 0$
- (d) only at $(4a, 4a)$

(a) Given, $y^2 = 4ax$
 and $x^2 = 4ay$

The graph of given curve is clearly from graph the given curve is intersect at two points on the line $y = x$



56. The points $(1, 3)$ and $(5, 1)$ are two opposite vertices of a rectangle. The other two vertices lie on the line $y = 2x + c$. What is the value of c ?

- (a) 2
- (b) -2
- (c) 4
- (d) -4

(d) The points $(1, 3)$ and $(5, 1)$ are two opposite vertex of rectangle. The other two vertices lie on the line $y = 2x + c$.

\therefore The mid point of vertices lie on the line i.e. $\left(\frac{1+5}{2}, \frac{3+1}{2}\right) \equiv (3, 2)$ lie on the line

$$y = 2x + c$$

$$\therefore 2 = 2(3) + c$$

$$\Rightarrow c = -4$$

57. If the lines $3y + 4x = 1$, $y = x + 5$ and $5y + bx = 3$ are concurrent, then what is the value of b ?

- (a) 1
- (b) 3
- (c) 6
- (d) $\frac{1}{2}$

(c) The lines $3y + 4x = 1$, $y = x + 5$ and $5y + bx = 3$ are concurrent.

$$\therefore \begin{vmatrix} 3 & 4 & -1 \\ 1 & -1 & -5 \\ 5 & b & -3 \end{vmatrix} = 0$$

$$\Rightarrow 3(3 + 5b) - 4(-3 + 25) - 1(b + 5) = 0$$

$$\Rightarrow 9 + 15b + 12 - 100 - b - 5 = 0$$

$$\Rightarrow 14b = 84$$

$$\therefore b = 6$$

58. What is the equation of the straight line which is perpendicular to $y = x$ and passes through $(3, 2)$?

- (a) $x - y = 5$
- (b) $x + y = 5$
- (c) $x + y = 1$
- (d) $x - y = 1$

(b) Equation of line perpendicular to $y = x$ is $x + y = \lambda$.

Since, this line is passes through $(3, 2)$

$$\therefore 3 + 2 = \lambda \Rightarrow \lambda = 5$$

Hence, equation of required line is $x + y = 5$.

59. The straight lines $x + y - 4 = 0$, $3x + y - 4 = 0$ and $x + 3y - 4 = 0$ form a triangle, which is

- (a) isosceles
- (b) right angled
- (c) equilateral
- (d) scalene

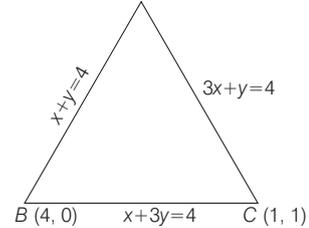
(a) Given, equation of line

$$x + y = 4 \quad \dots(i)$$

$$3x + y = 4 \quad \dots(ii)$$

$$x + 3y = 4 \quad \dots(iii)$$

$$A(0, 4)$$



On solving Eqs. (i) and (ii), we get

$$x = 0, y = 4, A = (0, 4)$$

On solving Eqs. (i) and (iii), we get

$$x = 4, y = 0, B = (4, 0)$$

On solving Eqs. (ii) and (iii), we get

$$x = 1, y = 1, C = (1, 1)$$

Clearly, $AC = BC$

\therefore Triangle is an isosceles.

60. The circle $x^2 + y^2 + 4x - 7y + 12 = 0$, cuts an intercept on Y-axis equal to

- (a) 1
- (b) 3
- (c) 4
- (d) 7

⊙ (a) Given, $x^2 + y^2 + 4x - 7y + 12 = 0$
 For intercept on Y-axis put $x = 0$, we get
 $y^2 - 7y + 12 = 0$
 $(y - 4)(y - 3) = 0$
 $y = 3, y = 4$
 Length of intercept on Y-axis
 $= |y_2 - y_1| = |3 - 4| = 1$

61. The centroid of the triangle with vertices $A(2, -3, 3)$, $B(5, -3, -4)$ and $C(2, -3, -2)$ is the point

- (a) $(-3, 3, -1)$
 (b) $(3, -3, -1)$
 (c) $(3, 1, -3)$
 (d) $(-3, -1, -3)$

⊙ (b) Given vertices of triangle ABC are $A(2, -3, 3)$, $B(5, -3, -4)$ and $C(2, -3, -2)$
 \therefore Centroid of $\triangle ABC$
 $= \left(\frac{2+5+2}{3}, \frac{-3-3-3}{3}, \frac{3-4-2}{3} \right)$
 $= \left(\frac{9}{3}, \frac{-9}{3}, \frac{-3}{3} \right) = (3, -3, -1)$

62. What is the radius of the sphere $x^2 + y^2 + z^2 - 6x + 8y - 10z + 1 = 0$?

- (a) 5 (b) 2
 (c) 7 (d) 3

⊙ (c) Given, equation of sphere
 $x^2 + y^2 + z^2 - 6x + 8y - 10z + 1 = 0$
 On comparing with
 $x^2 + y^2 + z^2 + 2ux + 2vy + 2wz + d = 0$, we get
 $2u = -6, 2v = 8, 2w = -10, d = 1$
 $\Rightarrow u = -3, v = 4, w = -5, d = 1$
 \therefore Radius of sphere $= \sqrt{u^2 + v^2 + w^2 - d}$
 $= \sqrt{(-3)^2 + (4)^2 + (-5)^2 - 1}$
 $= \sqrt{9 + 16 + 25 - 1} = \sqrt{49} = 7$

63. The equation of the plane passing through the intersection of the planes $2x + y + 2z = 9$, $4x - 5y - 4z = 1$ and the point $(3, 2, 1)$ is

- (a) $10x - 2y + 2z = 28$
 (b) $10x + 2y + 2z = 28$
 (c) $10x + 2y - 2z = 28$
 (d) $10x - 2y - 2z = 24$

⊙ (a) Equation of the plane passing through the intersection of plane
 $2x + y + 2z = 9$, $4x - 5y - 4z = 1$ is
 $(2x + y + 2z - 9) + \lambda(4x - 5y - 4z - 1) = 0 \dots(i)$
 Since, plane (i) passes through the point $(3, 2, 1)$
 $\therefore (2 \times 3 + 2 + 2 \times 1 - 9) + \lambda(4 \times 3 - 5 \times 2 - 4 \times 1 - 1) = 0$

$\Rightarrow 1 + \lambda(-3) = 0$
 $\Rightarrow \lambda = \frac{1}{3}$
 On putting $\lambda = \frac{1}{3}$ in Eq. (i), we get
 $(2x + y + 2z - 9) + \frac{1}{3}(4x - 5y - 4z - 1) = 0$
 $\Rightarrow 6x + 3y + 6z - 27 + 4x - 5y - 4z - 1 = 0$
 $\Rightarrow 10x - 2y + 2z - 28 = 0$
 $\therefore 10x - 2y + 2z = 28$

64. The distance between the parallel planes $4x - 2y + 4z + 9 = 0$ and $8x - 4y + 8z + 21 = 0$

- (a) $\frac{1}{4}$ (b) $\frac{1}{2}$
 (c) $\frac{3}{2}$ (d) $\frac{7}{4}$

⊙ (a) Given equation of planes
 $4x - 2y + 4z + 9 = 0 \dots(i)$
 and $8x - 4y + 8z + 21 = 0$
 $\Rightarrow 4x - 2y + 4z + \frac{21}{2} = 0 \dots(ii)$

Distance between parallel planes (i) and (ii)

$= \frac{\left| \frac{21}{2} - 9 \right|}{\sqrt{(4)^2 + (-2)^2 + (4)^2}}$
 $= \frac{\frac{3}{2}}{\sqrt{16 + 4 + 16}} = \frac{\frac{3}{2}}{6} = \frac{1}{4}$

65. What are the direction cosines of Z-axis?

- (a) $\langle 1, 1, 1 \rangle$ (b) $\langle 1, 0, 0 \rangle$
 (c) $\langle 0, 1, 0 \rangle$ (d) $\langle 0, 0, 1 \rangle$

⊙ (d) Direction cosines of Z-axis are $\langle \cos 90^\circ, \cos 90^\circ, \cos 0^\circ \rangle = \langle 0, 0, 1 \rangle$

66. If $\mathbf{a} = \hat{i} - 2\hat{j} + 5\hat{k}$ and $\mathbf{b} = 2\hat{i} + \hat{j} - 3\hat{k}$, then what is $(\mathbf{b} - \mathbf{a}) \cdot (3\mathbf{a} + \mathbf{b})$ equal to?

- (a) 106 (b) -106
 (c) 53 (d) -53

⊙ (b) We have, $\mathbf{a} = \hat{i} - 2\hat{j} + 5\hat{k}$
 $\mathbf{b} = 2\hat{i} + \hat{j} - 3\hat{k}$
 $\therefore \mathbf{b} - \mathbf{a} = (2\hat{i} + \hat{j} - 3\hat{k}) - (\hat{i} - 2\hat{j} + 5\hat{k})$
 $= \hat{i} + 3\hat{j} - 8\hat{k}$
 and $3\mathbf{a} + \mathbf{b} = 3(\hat{i} - 2\hat{j} + 5\hat{k}) + (2\hat{i} + \hat{j} - 3\hat{k})$
 $= 5\hat{i} - 5\hat{j} + 12\hat{k}$
 $\therefore (\mathbf{b} - \mathbf{a}) \cdot (3\mathbf{a} + \mathbf{b}) = (\hat{i} + 3\hat{j} - 8\hat{k}) \cdot (5\hat{i} - 5\hat{j} + 12\hat{k})$
 $= 5 - 15 - 96 = -106$

67. If the position vectors of points A and B are $3\hat{i} - 2\hat{j} + \hat{k}$ and $2\hat{i} + 4\hat{j} - 3\hat{k}$ respectively, then what is the length of \overline{AB} ?

- (a) $\sqrt{14}$ (b) $\sqrt{29}$
 (c) $\sqrt{43}$ (d) $\sqrt{53}$

⊙ (d) We have, $\mathbf{OA} = 3\hat{i} - 2\hat{j} + \hat{k}$

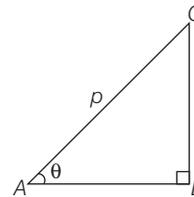
$\mathbf{OB} = 2\hat{i} + 4\hat{j} - 3\hat{k}$

$\therefore |\overline{AB}| = |\mathbf{OB} - \mathbf{OA}|$
 $= |(2\hat{i} + 4\hat{j} - 3\hat{k}) - (3\hat{i} - 2\hat{j} + \hat{k})|$
 $= |(-\hat{i} + 6\hat{j} - 4\hat{k})|$
 $= \sqrt{(-1)^2 + (6)^2 + (-4)^2}$
 $= \sqrt{1 + 36 + 16} = \sqrt{53}$

68. If in a right angled triangle ABC , hypotenuse $AC = p$, then what is $\overline{AB} \cdot \overline{AC} + \overline{BC} \cdot \overline{BA} + \overline{CA} \cdot \overline{CB}$ equal to?

- (a) p^2 (b) $2p^2$
 (c) $\frac{p^2}{2}$ (d) p

⊙ (a) In right angled $\triangle ABC$, we have $\angle ABC = 90^\circ$



Let $\angle BAC = \theta$

Then, $\angle ACB = (90^\circ - \theta)$

$\therefore \overline{AB} \cdot \overline{AC} + \overline{BC} \cdot \overline{BA} + \overline{CA} \cdot \overline{CB}$
 $= |\overline{AB}| |\overline{AC}| \cos \theta + |\overline{BC}| |\overline{BA}| \cos 90^\circ + |\overline{CA}| |\overline{CB}| \cos (90^\circ - \theta)$
 $= |\overline{AB}| |\overline{AB}| + 0 + |\overline{CB}| |\overline{CB}|$
 $= |\overline{AB}|^2 + |\overline{CB}|^2$
 $= |\overline{AC}|^2 = p^2$

69. The sine of the angle between vectors

$\mathbf{a} = 2\hat{i} - 6\hat{j} - 3\hat{k}$ and $\mathbf{b} = 4\hat{i} + 3\hat{j} - \hat{k}$ is

- (a) $\frac{1}{\sqrt{26}}$ (b) $\frac{5}{\sqrt{26}}$
 (c) $\frac{5}{26}$ (d) $\frac{1}{26}$

⊙ (b) Let θ be the angle between vectors \mathbf{a} and \mathbf{b}

$\therefore \cos \theta = \frac{\mathbf{a} \cdot \mathbf{b}}{|\mathbf{a}| |\mathbf{b}|}$

Since,

$\mathbf{a} \cdot \mathbf{b} = (2\hat{i} - 6\hat{j} - 3\hat{k}) \cdot (4\hat{i} + 3\hat{j} - \hat{k})$
 $= 8 - 18 + 3 = -7$
 $|\mathbf{a}| = \sqrt{2^2 + (-6)^2 + (-3)^2}$
 $= \sqrt{49} = 7$

$$|\mathbf{b}| = \sqrt{4^2 + 3^2 + (-1)^2} = \sqrt{26}$$

$$\therefore \cos \theta = \frac{-7}{7 \times \sqrt{26}} = -\frac{1}{\sqrt{26}}$$

$$\therefore \sin \theta = \sqrt{1 - \cos^2 \theta} = \frac{5}{\sqrt{26}}$$

70. What is the value of λ for which the vectors $3\hat{i} + 4\hat{j} - \hat{k}$ and $-2\hat{i} + \lambda\hat{j} + 10\hat{k}$ are perpendicular?

- (a) 1 (b) 2
(c) 3 (d) 4

⊙ (d) Since, given vectors are perpendicular.

$$\therefore (3\hat{i} + 4\hat{j} - \hat{k}) \cdot (-2\hat{i} + \lambda\hat{j} + 10\hat{k}) = 0$$

$$\Rightarrow -6 + 4\lambda - 10 = 0$$

$$\Rightarrow 4\lambda - 16 = 0$$

$$\therefore \lambda = 4$$

71. What is the derivative of $\sec^2(\tan^{-1} x)$ with respect to x ?

- (a) $2x$ (b) $x^2 + 1$
(c) $x + 1$ (d) x^2

⊙ (a) Let $y = \sec^2(\tan^{-1} x)$

On differentiating both sides w.r.t x , we get

$$\frac{dy}{dx} = \frac{d}{dx} \sec^2(\tan^{-1} x)$$

$$= 2 \sec(\tan^{-1} x) \cdot \sec(\tan^{-1} x)$$

$$\tan(\tan^{-1} x) \frac{d}{dx}(\tan^{-1} x)$$

$$= 2 \sec^2(\tan^{-1} x) \cdot x \cdot \frac{1}{1+x^2}$$

$$= 2(1 + \tan^2(\tan^{-1} x)) \cdot \frac{x}{1+x^2}$$

$$= 2(1 + x^2) \cdot \frac{x}{1+x^2} = 2x$$

72. If $f(x) = \log_{10}(1+x)$, then what is $4f(4) + 5f(1) - \log_{10} 2$ equal to?

- (a) 0
(b) 1
(c) 2
(d) 4

⊙ (d) We have, $f(x) = \log_{10}(1+x)$

$$\therefore 4f(4) = 4 \log_{10}(1+4) = 4 \log_{10} 5$$

$$5f(1) = 5 \log_{10}(1+1) = 5 \log_{10} 2$$

$$\therefore 4f(4) + 5f(1) - \log_{10} 2$$

$$= 4 \log_{10} 5 + 5 \log_{10} 2 - \log_{10} 2$$

$$= 4 \log_{10} 5 + 4 \log_{10} 2$$

$$= 4(\log_{10} 5 \times \log_{10} 2)$$

$$= 4 \log_{10}(5 \times 2)$$

$$= 4 \log_{10} 10 = 4 \times 1 = 4$$

73. A function f defined by

$$f(x) = \ln(\sqrt{x^2 + 1} - x)$$

- (a) an even function
(b) an odd function
(c) both even and odd function
(d) neither even nor odd function

⊙ (b) We have, $f(x) = \log(\sqrt{x^2 + 1} - x)$

$$\therefore f(-x) = \log(\sqrt{x^2 + 1} + x)$$

$$= \log \left(\frac{(\sqrt{x^2 + 1} + x)(\sqrt{x^2 + 1} - x)}{\sqrt{x^2 + 1} - x} \right)$$

$$= \log \left(\frac{x^2 + 1 - x^2}{\sqrt{x^2 + 1} - x} \right)$$

$$= \log \left(\frac{1}{\sqrt{x^2 + 1} - x} \right)$$

$$= -\log(\sqrt{x^2 + 1} - x)$$

$$= -f(x)$$

74. The domain of the function f defined by

$$f(x) = \log_x 10$$

- (a) $x > 10$
(b) $x > 0$ excluding $x = 10$
(c) $x \geq 10$
(d) $x > 0$ excluding $x = 1$

⊙ (d) We have, $f(x) = \log_x 10$

$$= \frac{\log 10}{\log x} = \frac{1}{\log x}$$

$\therefore f(x)$ is define when $x > 0$ and $x \neq 1$.

75. $\lim_{x \rightarrow 0} \frac{1 - \cos^3 4x}{x^2}$ is equal to

- (a) 0 (b) 12
(c) 24 (d) 36

⊙ (c) $\lim_{x \rightarrow 0} \frac{1 - \cos^3 4x}{x^2} \left[\frac{0}{0} \text{ form} \right]$

On apply L' Hospital rule we get

$$\lim_{x \rightarrow 0} \frac{-3 \cos^2(4x) (-\sin 4x) (4)}{2x}$$

$$= \lim_{x \rightarrow 0} \frac{12 \cos^2 4x \sin 4x}{2x} \left[\frac{0}{0} \text{ form} \right]$$

Again, apply's L' Hospital rule, we get

$$\frac{12 [2 \cos(4x) (-\sin 4x) (4)]}{2}$$

$$\lim_{x \rightarrow 0} \frac{\sin 4x + \cos^2 4x (\cos 4x) (4)}{2}$$

$$= \lim_{x \rightarrow 0} \frac{12 [-8 \cos 4x \sin^2 4x + 4 \cos^3 4x]}{2}$$

$$= 6(-8 \times 0 + 4)$$

$$= 24$$

76. For $r > 0$, $f(r)$ is the ratio of perimeter to area of a circle of radius r . Then, $f(1) + f(2)$ is equal to

- (a) 1 (b) 2
(c) 3 (d) 4

⊙ (c) We have,

$$f(r) = \frac{\text{Perimeter of a circle with radius } r}{\text{Area of a circle with radius } r}$$

$$\Rightarrow f(r) = \frac{2\pi r}{\pi r^2} = \frac{2}{r}$$

$$\therefore f(1) = \frac{2}{1} = 2 \Rightarrow f(2) = \frac{2}{2} = 1$$

$$\therefore f(1) + f(2) = 2 + 1 = 3$$

77. If $f(x) = 3^{1+x}$, then $f(x) f(y) f(z)$ is equal to

- (a) $f(x+y+z)$ (b) $f(x+y+z+1)$
(c) $f(x+y+z+2)$ (d) $f(x+y+z+3)$

⊙ (c) We have, $f(x) = 3^{1+x}$

$$\text{Similarly, } f(y) = 3^{1+y}$$

$$\text{and } f(z) = 3^{1+z}$$

$$\therefore f(x) f(y) f(z) = 3^{1+x+1+y+1+z}$$

$$= 3^{1+2+x+y+z}$$

$$= f(2+x+y+z)$$

78. The number of real roots for the equation $x^2 + 9|x| + 20 = 0$ is

- (a) zero
(b) one
(c) two
(d) three

⊙ (a) Given, $x^2 + 9|x| + 20 = 0$

$$\Rightarrow x^2 + 9x + 20 = 0$$

$$\text{or } x^2 - 9x + 20 = 0$$

$$\Rightarrow x^2 + 4x + 5x + 20 = 0$$

$$\text{or } x^2 - 4x - 5x + 20 = 0$$

$$\Rightarrow x(x+4) + 5(x+4) = 0$$

$$\text{or } x(x-4) - 5(x-4) = 0$$

$$\Rightarrow (x+4)(x+5) = 0$$

$$\text{or } (x-4)(x-5) = 0$$

$$\Rightarrow x = -4, -5, \text{ or } 4, 5$$

But these values of x does not satisfy the given equation.

Hence, number of real roots of the given equation is zero.

79. If $f(x) = \sin(\cos x)$, then $f'(x)$ is equal to

- (a) $\cos(\cos x)$
(b) $\sin(-\sin x)$
(c) $(\sin x)\cos(\cos x)$
(d) $(-\sin x)\cos(\cos x)$

⊙ (d) Given, $f(x) = \sin(\cos x)$

$$\Rightarrow f'(x) = \cos(\cos x) (-\sin x)$$

80. The domain of the function

$f(x) = \sqrt{(2-x)(x-3)}$ is

- (a) $(0, \infty)$ (b) $[0, \infty)$
 (c) $[2, 3]$ (d) $(2, 3)$

⊙ (c) We have, $f(x) = \sqrt{(2-x)(x-3)}$

$f(x)$ will be define if $(2-x)(x-3) \geq 0$

$$\Rightarrow (x-2)(x-3) \leq 0$$

$$\therefore 2 \leq x \leq 3$$

81. The solution of the differential equation

$$\frac{dy}{dx} = \cos(y-x) + 1 \text{ is}$$

- (a) $e^x [\sec(y-x) - \tan(y-x)] = c$
 (b) $e^x [\sec(y-x) + \tan(y-x)] = c$
 (c) $e^x \sec(y-x) \tan(y-x) = c$
 (d) $e^x = c \sec(y-x) \tan(y-x)$

⊙ (a) Given, $\frac{dy}{dx} = \cos(y-x) + 1 \dots(i)$

Let $y-x=t$

$$\Rightarrow \frac{dy}{dx} - 1 = \frac{dt}{dx} \Rightarrow \frac{dy}{dx} = 1 + \frac{dt}{dx}$$

From Eq. (i), $1 + \frac{dt}{dx} = \cos t + 1$

$$\Rightarrow \frac{dt}{dx} = \cos t$$

$$\Rightarrow \sec t \, dt = dx$$

On integrating both sides, we get

$$\int \sec t \, dt = \int dx$$

$$\log(\sec t + \tan t) = x + a$$

$$\Rightarrow \sec t + \tan t = e^{x+a}$$

$$\Rightarrow \sec t + \tan t = e^x \cdot e^a$$

$$\Rightarrow \frac{e^x}{\sec t + \tan t} = e^{-a}$$

$$\Rightarrow \frac{e^x (\sec t - \tan t)}{(\sec t + \tan t)(\sec t - \tan t)} = e^{-a}$$

$$\Rightarrow \frac{e^x (\sec t - \tan t)}{\sec^2 t - \tan^2 t} = e^{-a}$$

$$\Rightarrow e^x (\sec t - \tan t) = e^{-a}$$

$$\Rightarrow e^x [\sec(y-x) - \tan(y-x)] = e^{-a}$$

$$\therefore e^x [\sec(y-x) - \tan(y-x)] = c, \text{ [where, } c = e^{-a}]$$

82. $\int_0^{\frac{\pi}{2}} |\sin x - \cos x| dx$ is equal to

- (a) 0 (b) $2(\sqrt{2}-1)$
 (c) $2\sqrt{2}$ (d) $2(\sqrt{2}+1)$

⊙ (b) $\int_0^{\frac{\pi}{2}} |\sin x - \cos x| dx$

$$= \int_0^{\frac{\pi}{4}} (\cos x - \sin x) dx$$

$$+ \int_{\frac{\pi}{4}}^{\frac{\pi}{2}} (\sin x - \cos x) dx$$

$$= [\sin x + \cos x]_0^{\frac{\pi}{4}} + [-\cos x - \sin x]_0^{\frac{\pi}{4}}$$

$$= \left[\left(\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}} \right) - (0+1) \right]$$

$$+ \left[(-0-1) - \left(-\frac{1}{\sqrt{2}} - \frac{1}{\sqrt{2}} \right) \right]$$

$$= \frac{2}{\sqrt{2}} - 1 - 1 + \frac{2}{\sqrt{2}} = \frac{4}{\sqrt{2}} - 2$$

$$= 2\sqrt{2} - 2 = 2(\sqrt{2} - 1)$$

83. If $y = a \cos 2x + b \sin 2x$, then

- (a) $\frac{d^2y}{dx^2} + y = 0$ (b) $\frac{d^2y}{dx^2} + 2y = 0$
 (c) $\frac{d^2y}{dx^2} - 4y = 0$ (d) $\frac{d^2y}{dx^2} + 4y = 0$

⊙ (d) Given, $y = a \cos 2x + b \sin 2x \dots(i)$

$$\Rightarrow \frac{dy}{dx} = -2a \sin 2x + 2b \cos 2x$$

$$\Rightarrow \frac{d^2y}{dx^2} = -4a \cos 2x - 4b \sin 2x$$

$$\Rightarrow \frac{d^2y}{dx^2} = -4(a \cos 2x + b \sin 2x)$$

$$\Rightarrow \frac{d^2y}{dx^2} = -4y \text{ [using Eq. (i)]}$$

$$\therefore \frac{d^2y}{dx^2} + 4y = 0$$

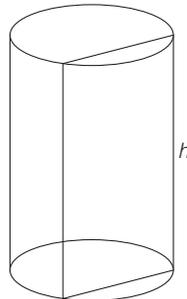
84. A given quantity of metal is to be cast into a half cylinder

(i.e. with a rectangular base and semicircular ends). If the total surface area is to be minimum, then the ratio of the height of the half cylinder to the diameter of the semicircular ends is

- (a) $\pi : (\pi+2)$ (b) $(\pi+2) : \pi$
 (c) 1 : 1 (d) None of these

⊙ (a) Let r be the radius and h be the height of the half cylinder,

Then, surface area, $S = \pi rh + \pi r^2 + 2rh$



$$\therefore \frac{dS}{dr} = \pi h + 2\pi r + 2h$$

On putting $\frac{dS}{dr} = 0$

$$\Rightarrow 2r = -\frac{(\pi h + 2h)}{\pi}$$

$$\Rightarrow 2r = \frac{-h(\pi+2)}{\pi}$$

$$\Rightarrow \frac{2r}{h} = \frac{-(\pi+2)}{\pi} \Rightarrow \frac{h}{2r} = \frac{-\pi}{\pi+2}$$

Neglecting $-$ sign as r and h can not be negative.

$$\therefore \frac{h}{2r} = \frac{\pi}{\pi+2}$$

85. $\int_0^{\frac{\pi}{2}} e^{\sin x} \cos x dx$ is equal to

- (a) $e+1$ (b) $e-1$
 (c) $e+2$ (d) e

⊙ (b) Let $I = \int_0^{\frac{\pi}{2}} e^{\sin x} \cos x dx$

Let $\sin x = t$

$$\Rightarrow \cos x dx = dt$$

When $x = \frac{\pi}{2}, t = 1$

$$x = 0, t = 0$$

$$\therefore I = \int_0^1 e^t dt = [e^t]_0^1$$

$$= e^1 - e^0 = e - 1$$

86. If $f(x) = \frac{x-2}{x+2}, x \neq -2$, then what is

$f^{-1}(x)$ equal to ?

- (a) $\frac{4(x+2)}{x-2}$ (b) $\frac{x+2}{4(x-2)}$
 (c) $\frac{x+2}{x-2}$ (d) $\frac{2(1+x)}{1-x}$

⊙ (d) Given, $f(x) = \frac{x-2}{x+2} \Rightarrow y = \frac{x-2}{x+2}$

$$\Rightarrow x-2 = xy+2y$$

$$\Rightarrow x-xy=2y+2$$

$$\Rightarrow x(1-y)=2y+2$$

$$\Rightarrow x = \frac{2(y+1)}{1-y}$$

$$\Rightarrow f^{-1}(y) = \frac{2(y+1)}{1-y}$$

$$\therefore f^{-1}(x) = \frac{2(x+1)}{1-x}$$

87. What is $\int \ln(x^2) dx$ equal to?

- (a) $2x \ln(x) - 2x + C$
 (b) $\frac{2}{x} + C$
 (c) $2x \ln(x) + C$
 (d) $\frac{2 \ln(x)}{x} - 2x + C$

⊙ (a) Let $I = \int \ln(x^2) dx = \int 2 \ln x dx$

$$= \ln x \int 2 dx$$

$$- \int \left(\frac{d}{dx} (\ln x) \right) \int (2 dx) dx$$

$$= \ln x \cdot 2x - \int \frac{1}{x} \cdot 2x dx$$

$$= 2x \ln x - 2x + C$$

88. The minimum distance from the point (4, 2) to $y^2 = 8x$ is equal to

- (a) $\sqrt{2}$ (b) $2\sqrt{2}$
 (c) 2 (d) $3\sqrt{2}$

⊙ (b) Let (x, y) be any point on the curve $y^2 = 8x$.

Then, the distance between (x, y) and (4, 2) is

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

$$\Rightarrow D^2 = \left(\frac{y^2}{8} - 4\right)^2 + (y - 2)^2 \quad \dots(i)$$

$$\left[\because y^2 = 8x\right]$$

$$\Rightarrow \frac{dD^2}{dy} = 2\left(\frac{y^2}{8} - 4\right)\left(\frac{2y}{8}\right) + 2(y - 2)$$

$$= 2\left(\frac{2y^3}{64} - 4 \times \frac{2y}{8}\right) + 2(y - 2)$$

$$= \frac{y^3}{16} - 2y + 2y - 4 = \frac{y^3}{16} - 4$$

$$\Rightarrow \frac{d^2D^2}{d^2y} = \frac{3y^2}{16}$$

On putting $\frac{dD^2}{dy} = 0 \Rightarrow \frac{y^3}{16} - 4 = 0$

$$\Rightarrow y^3 = 64 \Rightarrow y = 4$$

At $y = 4, \frac{d^2D^2}{d^2y} > 0$

So, it is point of minima.

$$\therefore \text{Minimum } D = \sqrt{(2 - 4)^2 + (4 - 2)^2}$$

$$= \sqrt{4 + 4} = \sqrt{8} = 2\sqrt{2}$$

89. The differential equation of the system of circles touching the Y-axis at the origin is

- (a) $x^2 + y^2 - 2xy \frac{dy}{dx} = 0$
 (b) $x^2 + y^2 + 2xy \frac{dy}{dx} = 0$
 (c) $x^2 - y^2 + 2xy \frac{dy}{dx} = 0$
 (d) $x^2 - y^2 - 2xy \frac{dy}{dx} = 0$

⊙ (c) The system of circles touching the Y-axis at the origin is

$$(x - a)^2 + y^2 = a^2$$

$$\Rightarrow x^2 + a^2 - 2ax + y^2 = a^2$$

$$\Rightarrow x^2 - 2ax + y^2 = 0 \quad \dots(i)$$

On differentiating Eq. (i) w.r.t. x, we get

$$2x - 2a + 2yy' = 0$$

$$\Rightarrow x + yy' = a$$

Put value of a in Eq. (i), we get

$$x^2 - 2(x + yy')x + y^2 = 0$$

$$\Rightarrow x^2 - 2x^2 - 2xyy' + y^2 = 0$$

$$\Rightarrow -x^2 - 2xyy' + y^2 = 0$$

$$\therefore x^2 - y^2 + 2xy \frac{dy}{dx} = 0$$

90. Consider the following in respect of the differential equation :

$$\frac{d^2y}{dx^2} + 2\left(\frac{dy}{dx}\right)^2 + 9x = x$$

- The degree of the differential equation is 1.
- The order of the differential equation is 2.

Which of the above statements is/are correct ?

- (a) Only 1
 (b) Only 2
 (c) Both 1 and 2
 (d) Neither 1 nor 2
- ⊙ (c) The order of highest order derivative occurring in the differential equation is 2 and its degree is 1.

91. What is the general solution of the differential equation $\frac{dy}{dx} + \frac{x}{y} = 0$?

- (a) $x^2 + y^2 = C$ (b) $x^2 - y^2 = C$
 (c) $x^2 + y^2 = Cxy$ (d) $x + y = C$

⊙ (a) Given differential equation,

$$\frac{dy}{dx} + \frac{x}{y} = 0$$

$$\Rightarrow \frac{dy}{dx} = -\frac{x}{y}$$

$$\Rightarrow ydy = -x dx$$

Integrating both sides, we get

$$\frac{y^2}{2} = -\frac{x^2}{2} + C_1$$

$$\therefore x^2 + y^2 = C \quad [\text{where, } C = 2C_1]$$

92. The value of k which makes $f(x) = \begin{cases} \sin x, & x \neq 0 \\ k, & x = 0 \end{cases}$ continuous at $x = 0$, is

- (a) 2 (b) 1
 (c) -1 (d) 0

⊙ (d) Given, f(x) is continuous at $x = 0$.

$$\therefore \lim_{x \rightarrow 0} f(x) = f(0)$$

$$\Rightarrow \lim_{x \rightarrow 0} \sin x = k$$

$$\therefore k = 0$$

93. What is the minimum value of $a^2x + b^2y$ where $xy = c^2$?

- (a) abc (b) 2abc
 (c) 3abc (d) 4abc

⊙ (b) Let $z = a^2x + b^2y$... (i)

Since, $xy = c^2$

$$\Rightarrow y = \frac{c^2}{x}$$

On putting $y = \frac{c^2}{x}$ in Eq. (i), we get

$$\Rightarrow z = a^2x + b^2\left(\frac{c^2}{x}\right) \quad \dots(ii)$$

On differentiability Eq. (ii) both sides, we get

$$\frac{dz}{dx} = a^2 - \frac{b^2c^2}{x^2} \quad \dots(iii)$$

$$\Rightarrow \frac{d^2z}{dx^2} = \frac{2b^2c^2}{x^3} \quad \dots(iv)$$

For maxima and minima, we put $\frac{dz}{dx} = 0$

$$\therefore a^2 - \frac{b^2c^2}{x^2} = 0$$

$$\Rightarrow \frac{b^2c^2}{x^2} = a^2$$

$$\Rightarrow x = \pm \frac{bc}{a}$$

At $x = \frac{bc}{a}, \frac{d^2z}{dx^2} = \frac{2a^3}{bc} > 0$

\Rightarrow Gives minimum value

At $x = -\frac{bc}{a}, \frac{d^2z}{dx^2} = -\frac{2a^3}{bc} < 0$

Gives maximum value

\therefore Minimum value of z at $x = \frac{bc}{a}$ is $abc + abc = 2abc$.

94. What is $\int e^{x \ln(a)} dx$ equal to?

- (a) $\frac{a^x}{\ln(a)} + C$ (b) $\frac{e^x}{\ln(a)} + C$
 (c) $\frac{e^x}{\ln(ae)} + C$ (d) $\frac{ae^x}{\ln(a)} + C$

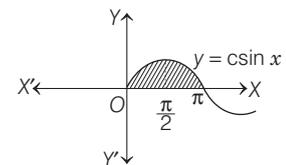
⊙ (a) Let $I = \int e^{x \ln a} dx = \int e^{\ln a^x} dx$

$$= \int a^x dx = \frac{a^x}{\ln a} + C$$

95. What is the area of one of the loops between the curve $y = c \sin x$ and X-axis?

- (a) c (b) 2c
 (c) 3c (d) 4c

⊙ (d) \therefore Required area = $2 \int_0^\pi c \sin x dx$



$$= 2c \int_0^\pi \sin x dx = 2c[-\cos x]_0^\pi$$

$$= 2c[-(\cos \pi - \cos 0)]$$

$$= 2c(2) = 4c \text{ sq units}$$

96. If $\sin \theta + \cos \theta = \sqrt{2} \cos \theta$, then what is $(\cos \theta - \sin \theta)$ equal to?

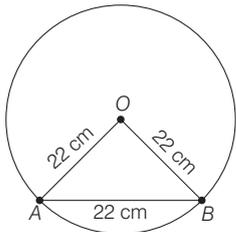
- (a) $-\sqrt{2} \cos \theta$ (b) $-\sqrt{2} \sin \theta$
 (c) $\sqrt{2} \sin \theta$ (d) $2 \sin \theta$

- ⊙ (c) Given, $\sin \theta + \cos \theta = \sqrt{2} \cos \theta$
 $\Rightarrow \sin \theta = (\sqrt{2} - 1) \cos \theta$... (i)
 Now, $\cos \theta - \sin \theta$
 $= \cos \theta - (\sqrt{2} - 1) \cos \theta$ [from Eq. (i)]
 $= \cos \theta [1 - (\sqrt{2} - 1)] = \cos \theta [2 - \sqrt{2}]$
 $= \cos \theta \cdot \sqrt{2} (\sqrt{2} - 1)$
 $= \sqrt{2} \sin \theta$ [using Eq. (i)]

97. In a circle of diameter 44 cm, the length of a chord is 22 cm. What is the length of minor arc of the chord?

- (a) $\frac{484}{21}$ cm (b) $\frac{242}{21}$ cm
 (c) $\frac{121}{21}$ cm (d) $\frac{44}{7}$ cm

- ⊙ (a) Given, diameter of a circle be 44 cm.



$\Rightarrow 2r = 44$
 $\Rightarrow r = 22$
 $\Rightarrow \triangle OAB$ is an equilateral triangle.
 $\Rightarrow \angle AOB = 60^\circ$
 \therefore Length of minor arc
 $= \left(\frac{60^\circ}{360^\circ}\right) \times 2\pi \times 22$
 $= \frac{1}{6} \times 2 \times \frac{22}{7} \times 22$
 $= \frac{484}{21}$ cm

98. If $\sin \theta = -\frac{1}{2}$ and $\tan \theta = \frac{1}{\sqrt{3}}$, then in which quadrant does θ lie?

- (a) First
 (b) Second
 (c) Third
 (d) Fourth

(c) We know that, if θ lies in third quadrant then, $\sin \theta < 0$ and $\tan \theta > 0$.

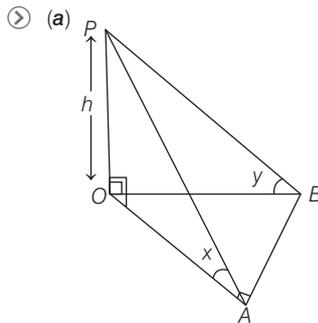
99. How many three digit even numbers can be formed using the digits 1, 2, 3, 4 and 5 when repetition of digits is not allowed?

- (a) 36 (b) 30
 (c) 24 (d) 12

- ⊙ (c) Here, unit digit can be filled by 2 or 4. so number of ways is 2. Since repetition is not allowed therefore hundred place and ten place can be fill in ${}^4C_2 \times 2$ ways
 \therefore Total number of three digits even number = $4 \times 3 \times 2 = 24$

100. The angle of elevation of a tower of height h from a point A due South of it is x and from a point B due East of A is y . If $AB = z$, then which one of the following is correct ?

- (a) $h^2(\cot^2 y - \cot^2 x) = z^2$
 (b) $z^2(\cot^2 y - \cot^2 x) = h^2$
 (c) $h^2(\tan^2 y - \tan^2 x) = z^2$
 (d) $z^2(\tan^2 y - \tan^2 x) = h^2$



Here, OP be the tower,

$OA = h \cot x$

$OB = h \cot y$

In right-angled $\triangle OAB$,

$h^2 \cot^2 y = z^2 + h^2 \cot^2 x$

$\therefore z^2 = h^2(\cot^2 y - \cot^2 x)$

101. From a deck of cards, cards are taken out with replacement. What is the probability that the fourteenth card taken out is an ace?

- (a) $\frac{1}{51}$ (b) $\frac{4}{51}$ (c) $\frac{1}{52}$ (d) $\frac{1}{13}$

- ⊙ (d) Total number of possible outcomes = 52

And number of favourable outcomes = 4

\therefore Required probability = $\frac{4}{52} = \frac{1}{13}$

102. If A and B are two events such that

$P(A) = 0.5$, $P(B) = 0.6$ and
 $P(A \cap B) = 0.4$, then what is
 $P(A \cup B)$ equal to ?

- (a) 0.9 (b) 0.7
 (c) 0.5 (d) 0.3

- ⊙ (d) $P(\overline{A \cup B}) = 1 - P(A \cup B)$

We have,

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$
 $= 0.5 + 0.6 - 0.4$
 $= 1.1 - 0.4$
 $= 0.7$

$\therefore P(\overline{A \cup B}) = 1 - 0.7 = 0.3$

103. A problem is given to three students A, B and C whose probabilities of solving the

problem are $\frac{1}{2}$, $\frac{3}{4}$ and $\frac{1}{4}$ respectively.

What is the probability that the problem will be solved if they all solve the problem independently ?

- (a) $\frac{29}{32}$ (b) $\frac{27}{32}$
 (c) $\frac{25}{32}$ (d) $\frac{23}{32}$

- ⊙ (a) We have, $P(A) = \frac{1}{2}$, $P(\overline{A}) = \frac{1}{2}$

$P(B) = \frac{3}{4}$, $P(\overline{B}) = \frac{1}{4}$

and $P(C) = \frac{1}{4}$, $P(\overline{C}) = \frac{3}{4}$

\therefore Required probability

$= 1 - P(\overline{A})P(\overline{B})P(\overline{C})$

$= 1 - \frac{1}{2} \times \frac{1}{4} \times \frac{3}{4} = \frac{29}{32}$

104. A pair of fair dice is rolled. What is the probability that the second dice lands on a higher value than does the first?

- (a) $\frac{1}{4}$ (b) $\frac{1}{6}$
 (c) $\frac{5}{12}$ (d) $\frac{5}{18}$

- ⊙ (c) Total number of possible outcomes = 36

Favourable outcomes

$= (1, 2), (1, 3), (1, 4), (1, 5), (1, 6),$

$(2, 3), (2, 4), (2, 5), (2, 6), (3, 4),$
 $(3, 5), (3, 6), (4, 5), (4, 6), (5, 6)$

\therefore Total number of favourable outcomes = 15

\therefore Required probability = $\frac{15}{36} = \frac{5}{12}$

105. A fair coin is tossed and an unbiased dice is rolled together. What is the probability of getting a 2 or 4 or 6 along with head?

- (a) $\frac{1}{2}$ (b) $\frac{1}{3}$ (c) $\frac{1}{4}$ (d) $\frac{1}{6}$

- ⊙ (c) Total number of possible outcomes = $2 \times 6 = 12$

And favourable outcomes

$= (H, 2), (H, 4), (H, 6)$

\therefore Total number of possible outcomes = 3

\therefore Required probability = $\frac{3}{12} = \frac{1}{4}$

106. If A, B and C are three events, then what is the probability that atleast two of these events occur together ?

- (a) $P(A \cap B) + P(B \cap C) + P(C \cap A)$
 (b) $P(A \cap B) + P(B \cap C) + P(C \cap A) - P(A \cap B \cap C)$
 (c) $P(A \cap B) + P(B \cap C) + P(C \cap A) - 2P(A \cap B \cap C)$
 (d) $P(A \cap B) + P(B \cap C) + P(C \cap A) - 3P(A \cap B \cap C)$

⊙ (c) If A, B and C are three events, then atleast two events occur i.e.
 $(A \cap B \cap C') \cup (A \cap B' \cap C) \cup (A' \cap B \cap C) \cup (A \cap B \cap C)$
 \therefore Required probability
 $= P(A \cap B) + P(B \cap C) + P(C \cap A) - 2P(A \cap B \cap C)$

107. If two variables X and Y are independent, then what is the correlation coefficient between them?

- (a) 1 (b) -1
 (c) 0 (d) None of these

⊙ (c) Correlation coefficient between two independent variables is zero.

108. Two independent events A and B are such that $P(A \cup B) = \frac{2}{3}$ and

$P(A \cap B) = \frac{1}{6}$. If $P(B) < P(A)$, then

what is $P(B)$ equal to ?

- (a) $\frac{1}{4}$ (b) $\frac{1}{3}$
 (c) $\frac{1}{2}$ (d) $\frac{1}{6}$

⊙ (b) Given, $P(A \cup B) = \frac{2}{3}$

and $P(A \cap B) = \frac{1}{6}$

$$\Rightarrow P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

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

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

$$\Rightarrow P(A) + P(B) = \frac{5}{6} \dots (i)$$

And also, $P(A \cap B) = \frac{1}{6}$

$$\Rightarrow P(A)P(B) = \frac{1}{6} \dots (ii)$$

From Eqs. (i) and (ii), we get

$$P(A) \text{ or } P(B) = \frac{1}{2} \text{ or } \frac{1}{3}$$

Also, given $P(B) < P(A)$

$$\therefore P(B) = \frac{1}{3}$$

109. The mean of 100 observations is 50 and the standard deviation is 10. If 5 is subtracted from each observation and then it is divided by 4, then what will be the new mean and the new standard deviation respectively ?

- (a) 45, 5
 (b) 11.25, 1.25
 (c) 11.25, 2.5
 (d) 12.5, 2.5

⊙ (c) Given, mean $(\bar{x}) = 50$

$$\text{The new mean} = \frac{50 - 5}{4}$$

$$= \frac{45}{4} = 11.25$$

And standard deviation $(\sigma) = 10$

$$\therefore \text{The new standard deviation}$$

$$= \frac{10}{4}$$

$$= 2.5$$

Since, addition and subtraction does not effect standard deviation.

110. If two fair dice are rolled, then what is the conditional probability that the first dice lands on 6, given that the sum of numbers on the dice is 8?

- (a) $\frac{1}{3}$
 (b) $\frac{1}{4}$
 (c) $\frac{1}{5}$
 (d) $\frac{1}{6}$

⊙ (c) Let E_1 = Event of first dice on 6

E_2 = Event of the sum of numbers on dices 8

\therefore Total number of sample space of two dices are rolled, $n(s) = 36$

Possible outcomes of E_1 (6, 2)

Possible outcomes of E_2 (2, 6) (3, 5) (4, 4) (5, 3) (6, 2)

$$\therefore P(E_1 \cap E_2) = \frac{1}{36}$$

$$\text{and } P(E_2) = \frac{5}{36}$$

$$\therefore \text{Required probability} = P\left(\frac{E_1}{E_2}\right)$$

$$= \frac{P(E_1 \cap E_2)}{P(E_2)}$$

when $P(E_2 \neq 0)$

$$= \frac{1}{\frac{5}{36}} = \frac{1}{5}$$

111. Two symmetric dice flipped with each dice having two sides painted red, two painted black, one painted yellow and the other painted white. What is the probability that both land on the same colour ?

- (a) $\frac{3}{18}$ (b) $\frac{2}{9}$
 (c) $\frac{5}{18}$ (d) $\frac{1}{3}$

⊙ (c) P (two sides painted red) = $\frac{2}{6} \times \frac{2}{6}$

$$P \text{ (two sides painted black)} = \frac{2}{6} \times \frac{2}{6}$$

$$P \text{ (one side painted yellow)} = \frac{1}{6} \times \frac{1}{6}$$

$$\text{and } P \text{ (other side painted white)} = \frac{1}{6} \times \frac{1}{6}$$

\therefore Required probability that both land on the same colour

$$= \frac{2}{6} \times \frac{2}{6} + \frac{2}{6} \times \frac{2}{6} + \frac{1}{6} \times \frac{1}{6} + \frac{1}{6} \times \frac{1}{6}$$

$$= \frac{4 + 4 + 1 + 1}{36}$$

$$= \frac{10}{36} = \frac{5}{18}$$

112. There are n socks in a drawer, of which 3 socks are red. If 2 of the socks are chosen randomly and the probability that both selected socks are red is $\frac{1}{2}$, then what is the value

of n ?

- (a) 3
 (b) 4
 (c) 5
 (d) 6

⊙ (b) Total number of socks = n

$$P \text{ (first socks is red)} = \frac{3}{n}$$

$$P \text{ (second socks is red)} = \frac{2}{n-1}$$

According to the question,

$$\frac{3}{n} \times \frac{2}{n-1} = \frac{1}{2}$$

$$\Rightarrow n^2 - n = 12$$

$$\Rightarrow n^2 - n - 12 = 0$$

$$\Rightarrow n^2 - 4n + 3n - 12 = 0$$

$$\Rightarrow n(n-4) + 3(n-4) = 0$$

$$\Rightarrow (n-4)(n+3) = 0$$

$$\therefore n = 4, -3$$

113. Two cards are chosen at random from a deck of 52 playing cards. What is the probability that both of them have the same value ?

- (a) $\frac{1}{17}$ (b) $\frac{3}{17}$
 (c) $\frac{5}{17}$ (d) $\frac{7}{17}$

⊙ (a) ∴ Required probability = $\frac{{}^4C_2 \times 13}{{}^{52}C_2}$
 $= \frac{4 \times 3 \times 13}{52 \times 51}$
 $= \frac{1}{17}$

114. In eight throws of a die, 5 or 6 is considered a success. The mean and standard deviation of total number of successes is respectively given by

- (a) $\frac{8}{3}, \frac{16}{9}$ (b) $\frac{8}{3}, \frac{4}{3}$
 (c) $\frac{4}{3}, \frac{4}{3}$ (d) $\frac{4}{3}, \frac{16}{9}$

⊙ (b) We have, $p(\text{success}) = \frac{1}{6} + \frac{1}{6} = \frac{1}{3}$
 ∴ $q = 1 - p = \frac{2}{3}$

Given, $n = 8$

∴ Mean = $np = 8 \times \frac{1}{3} = \frac{8}{3}$

Standard deviation = \sqrt{npq}
 $= \sqrt{8 \times \frac{1}{3} \times \frac{2}{3}}$
 $= \sqrt{\frac{16}{9}} = \frac{4}{3}$

115. A and B are two events such that \bar{A} and \bar{B} are mutually exclusive. If $P(A) = 0.5$ and $P(B) = 0.6$, then what is the value of $P(A/B)$?

- (a) $\frac{1}{5}$ (b) $\frac{1}{6}$
 (c) $\frac{2}{5}$ (d) $\frac{1}{3}$

⊙ (b) Given, $P(\bar{A} \cap \bar{B}) = 0$

$\Rightarrow P(\overline{A \cup B}) = 0$
 $\Rightarrow 1 - P(A \cup B) = 0$
 $\Rightarrow P(A \cup B) = 1$

We know that,

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$\Rightarrow 1 = 0.5 + 0.6 - P(A \cap B)$

$\Rightarrow P(A \cap B) = 0.1$

∴ $P\left(\frac{A}{B}\right) = \frac{P(A \cap B)}{P(B)}$
 $= \frac{0.1}{0.6} = \frac{1}{6}$

116. Consider the following statements

- The algebraic sum of deviations of a set of values from their arithmetic mean is always zero.
- Arithmetic mean > Median > Mode for a symmetric distribution.

Which of the above statements is/are correct?

- (a) Only 1
 (b) Only 2
 (c) Both 1 and 2
 (d) Neither 1 nor 2

⊙ (a) We know that, the algebraic sum of deviations of a set of values from their arithmetic mean is always zero.

117. Let the correlation coefficient between X and Y be 0.6. Random variables Z and W are defined as $Z = X + 5$ and $W = \frac{Y}{3}$. What is the correlation coefficient between Z and W ?

- (a) 0.1 (b) 0.2
 (c) 0.36 (d) 0.6

⊙ (d) Since, the correlation coefficient is independent of change of origin and scale. It is given that correlation coefficient between X and Y be 0.6. So, correlation coefficient between Z and W be 0.6.

118. If all the natural numbers between 1 and 20 are multiplied by 3, then what is the variance of the resulting series?

- (a) 99.75 (b) 199.75
 (c) 299.25 (d) 399.25

⊙ (c) Variance of first n natural number
 $= \frac{n^2 - 1}{12} = \frac{20^2 - 1}{12}$
 $= \frac{399}{12} = 33.25$

If all the natural number between 1 and 20 multiplied by 3, then

∴ Required variance = 9×33.25
 $= 299.25$

119. What is the probability that an interior point in a circle is closer to the centre than to the circumference?

- (a) $\frac{1}{4}$ (b) $\frac{1}{2}$
 (c) $\frac{3}{4}$

(d) It cannot be determined

⊙ (a) Let radius of circle be r , then the points closer to centre if circumference will lie within radius of $\frac{r}{2}$.

So, the favourable outcome would be the points inside the area of circle with radius $\frac{r}{2}$ whereas the total possible outcomes could be all the points inside the area of circle with radius r .

∴ Required probability = $\frac{\pi \left(\frac{r}{2}\right)^2}{\pi r^2} = \frac{1}{4}$

120. If A and B are two events, then what is the probability of occurrence of either event A or event B ?

- (a) $P(A) + P(B)$ (b) $P(A \cup B)$
 (c) $P(A \cap B)$ (d) $P(A)P(B)$

⊙ (b) If A and B are two events, then the probability of occurrence of either event A or event B is $P(A \cup B)$.

PAPER II English Language and General Studies

Part A (English Language)

1. Opening his letters, (a)/ reading them carefully and sending for his clerk, (b)/ he dictated answers with them. (c)/ No error (d)
- ⊗ (c) Here, the use of preposition 'with' is incorrect here. Replace it with 'to', to make the given sentence grammatically correct. 'Dictated to' refers 'to say something aloud so that somebody else can write or type it.'
2. He was my school-friend, (a)/ but becoming a great man, (b)/ he has grown proud enough to forget his old friends. (c)/ No error (d)
- ⊗ (b) Here 'but becoming' is incorrect in part (b). It should be replaced with 'but after becoming' as preposition 'after' indicates 'at a later time' which makes the given sentence grammatically correct.
3. Rabindranath Tagore, (a)/ a Nobel laureate and the author of the National Anthem, (b)/ found Shantiniketan. (c)/ No error (d)
- ⊗ (c) As the given sentence is in Simple Past Tense, verb 'found' should be replaced with its past form 'founded' to make the given sentence grammatically correct.
4. The art of printing was introduced into England (a)/ during the reign of Edward IV (b)/ by William Caxton, a native of Kent. (c)/ No error (d)
- ⊗ (a) Here part (a) has an error. Use of preposition 'into' is incorrect. Replace it with preposition 'in' as it is used to indicate a location or place while preposition 'into' is used to indicate movement toward the inside of a place.
5. From thirty years (a)/ he devoted himself to public affairs (b)/without taking a holiday. (c)/ No error (d)
- ⊗ (a) Here, use 'for' in place of 'from' to start the sentence. Use of preposition 'for' shows time period, which is grammatically correct.
6. If Ramesh will be promoted (a)/ he will get (b)/ a higher salary. (c) No error (d)
- ⊗ (a) Here use of 'is promoted' in place of 'will be promoted' make the sentence grammatically correct. In conditional sentences, condition is expressed by 'If' clause and Simple Present tense is used to show a future result of that activity.
7. My brother goes (a)/ to the office (b)/ five day week. (c) No error (d)
- ⊗ (c) Here, the use of 'Five days a week' is more appropriate in place of 'five day week' to make the given sentence grammatically correct. Five is plural, so days should be used and 'a' is used for denoting one week.
8. If you lend Mohan a pen (a)/ he will lend it to someone else (b)/ and never you will get it back. (c)/ No error (d)
- ⊗ (c) Here, part (c) of the given sentence has an error. 'And never you will get it back' is incorrect because adverb should be followed by helping verb. So, the correct phrase will be - 'and you will never get it back'.
9. One of most widely spread (a)/ bad habits (b)/ is the use of tobacco. (c) No error (d)
- ⊗ (a) Here part (a) has an error. Article 'the' should be used before superlative degree (most). 'One of the most' is the correct phrase to make the given sentence grammatically correct.
10. A great part (a)/ of Arabia (b)/ is desert. (c) No error (d)
- ⊗ (d) There is no error. The sentence is grammatically correct.
11. Some people complain when they encounter a small misfortune in the course of their thoroughly happy life.
- (a) run into (b) run away
(c) run down (d) run with
- ⊗ (a) 'Run into' means the same as 'encounter'. Both words mean 'meet someone unexpectedly'. Some other synonyms are-'collide with' or 'bump into.'
12. This world is full of miseries.
- (a) indifferent love
(b) perfect happiness
(c) great suffering
(d) moderate sympathies
- ⊗ (c) 'Great suffering' is a perfect synonym of word 'miseries'. 'Miseries' means 'a state or feeling of great physical or mental distress'. Some other synonyms are-unhappiness, distress, etc.
13. A glance at a beautiful object gives us delight.
- (a) wisdom (b) happiness
(c) purity (d) peace
- ⊗ (b) 'Happiness' is the appropriate synonym of word 'delight'. Both words mean 'a feeling of great pleasure and satisfaction.' Some other synonyms are-pleasure, joy, etc.
14. It is terrible for people to die of starvation.
- (a) starch (b) staple
(c) plenty (d) hunger
- ⊗ (d) 'Hunger' is the correct synonym of word 'starvation'. 'Starvation' means 'the state of having no food for a long period, often causing death'. Some other synonyms are-lack of food, famine, deprivation, etc.
15. The university has constituted a grievance redressal committee to look into the matter.
- (a) depression (b) complaint
(c) abrasion (d) gratefulness
- ⊗ (b) 'Complaint' means the same as the word 'grievance'. 'Grievance' means 'an official statement of a complaint over something believed to be wrong or unfair'. Some other synonyms are - grudge, grumble, etc.
16. Rakesh delivered a slanderous speech.
- (a) abusive (b) praiseworthy
(c) moderate (d) inspiring
- ⊗ (a) 'Abusive' is similar in meaning to the word 'slanderous'. 'Slanderous' means 'a false spoken statement about someone that damages their reputation'. Some other synonyms of 'slanderous' are - malicious, damaging, derogatory, etc.
17. Suddenly, the sky was darkened by a gigantic bird.
- (a) winged (b) small
(c) tiny (d) enormous
- ⊗ (d) 'Enormous' means the same as 'gigantic'. The word 'gigantic' means 'something of very great size or extent'. Some other synonyms of the word are - huge, vast, expansive, etc.
18. To abolish poverty would be to destroy the soil upon which mankind produces the virtues conducive to higher civilisation.
- (a) detest (b) eradicate
(c) nurture (d) assimilate

- ⊗ (b) 'Eradicate' is similar word in meaning to the word 'abolish'. Both words mean 'to remove forever'.
Some other synonyms are – eliminate, wipe out, terminate, get rid of, etc.
- 19.** The Arabs who are not in the cities live in the desert throughout the year, shifting from one oasis to another.
(a) sandbank (b) mound
(c) dune (d) spring
- ⊗ (d) 'Spring' is the most suitable synonym from the given options. 'Oasis' means 'a fertile spot in a desert where water is found'.
Some other synonyms can be – watering hole, watering place, etc.
- 20.** The various facets of life can be found reflected in large city.
(a) several (b) similar
(c) valuable (d) singular
- ⊗ (a) 'Various' means 'several or different'. So, 'several' is a perfect synonym of word 'various'.
Some other synonyms are – varied, varying, etc.
- 21.** Ramesh is a very dubious character.
(a) shady (b) suspicious
(c) trustworthy (d) doubtful
- ⊗ (c) 'The word 'dubious' means 'of doubtful character'. Hence, its antonym is 'trustworthy' which means 'reliable or dependable'.
- 22.** Do not indulge in unmindful activities, please.
(a) vigilant (b) careless
(c) stupid (d) fatuous
- ⊗ (a) The word 'unmindful' means 'paying no heed or being careless'. Its antonym is 'vigilant', which means 'watchful or observant, alert' etc.
- 23.** He is suffering from a curable disease.
(a) remediable (b) treatable
(c) terminal (d) operable
- ⊗ (c) The word 'curable' means 'treatable or remediable'. Its antonym is 'terminal' which means 'incapable of being treated or untreatable'.
- 24.** He was born on a very auspicious day.
(a) propitious (b) fortunate
(c) ominous (d) opportune
- ⊗ (c) 'Auspicious' means 'favourable or conducive to success'. Its antonym is 'ominous' which means 'something sinister or inauspicious or doomy, unfavourable'.
- 25.** He had deeper hostility towards Mohan.
(a) animosity (b) belligerence
(c) malice (d) friendship
- ⊗ (d) 'The word 'hostility' means 'malice or unfriendliness or opposition'. Its antonym is 'friendship' which means 'close association or bond'.
- 26.** His life is rather monotonous.
(a) exciting (b) dreary
(c) tedious (d) uneventful
- ⊗ (a) The word 'monotonous' means 'boring or unexciting'. Its antonym is 'exciting' which means 'thrilling or stimulating'.
- 27.** Macbeth is a morally repulsive character.
(a) abominable (b) attractive
(c) obnoxious (d) ugly
- ⊗ (b) The word 'repulsive' means 'arousing intense distaste'. Its antonym is 'attractive' which means 'pleasing or agreeable'.
- 28.** The serene beauty of Kashmir had a soothing effect on his mind.
(a) placid (b) pleasing
(c) tranquil (d) turbulent
- ⊗ (d) 'The word 'serene' means 'peaceful or calm'. Its antonym is 'turbulent' which means 'unstable, chaotic or stormy'.
- 29.** Life is transient in nature.
(a) brief (b) momentary
(c) eternal (d) short-lived
- ⊗ (c) The word 'transient' means 'temporary or short lived'. Its antonym is 'eternal', which means 'everlasting or immortal, perpetual'.
- 30.** Sohan is a vain person.
(a) modest (b) arrogant
(c) conceited (d) proud
- ⊗ (a) The word 'vain' means 'proud or arrogant'. Its antonym is 'modest' which means 'humble or unpretentious'.
- 31.** A dark horse
(a) A black coloured horse
(b) A person who wins a race or competition although no one expected him to
(c) A person who keeps secrets
(d) An ignorant person
- ⊗ (b) Idiom 'a dark horse' means 'an unknown and unexpected winner of a race or contest'. Hence, option (b) expresses the correct meaning of given idiom.
- 32.** A show-stopper
(a) Someone who stops the show
(b) Someone who organises the show
(c) A performance that is extremely good
(d) A fashionable person
- ⊗ (c) Idiom 'A show-stopper' means 'a performance in a show that is extremely good'. So, option (c) expresses the correct meaning of the given idiom.
- 33.** A jack of all trades
(a) Someone who has many skills
(b) A confident and not very serious young man
(c) Someone who has hit the jackpot
(d) a great businessman
- ⊗ (a) Idiom 'A jack of all trades' means 'someone who has many skills'. So, option (a) is a suitable choice.
- 34.** Fight tooth and nail
(a) To quarrel with someone
(b) To attack someone with a lot of force
(c) To try hard to prevent something from happening
(d) To try very hard to achieve something
- ⊗ (d) Idiom 'Fight with tooth and nail' means 'to try very hard to achieve something'. So, option (d) is a suitable choice.
- 35.** Fair and square
(a) in an honest way
(b) in a critical way
(c) neither very good nor very bad
(d) in a foolish way
- ⊗ (a) Idiom 'Fair and square' means 'in a honest way and according to the rules'. So, option (a) expresses the correct meaning of the given idiom.
- 36.** S1 : We do not know what to do with our knowledge.
S6 : In the course of time they may rule over us altogether.
P : For example, we are unable to manage our machines.
Q : We already find it difficult to do without machines.
R : Machines should be fed properly and waited upon attentively; otherwise they refuse to work or cause destruction.
S : Science has given us superhuman powers, which we do not use properly.
The proper sequence should be
(a) S P R Q (b) P S Q R
(c) Q R P S (d) S R P Q
- ⊗ (a) SPRQ is the correct sequence of the given sentences to form a meaningful passage.
- 37.** S1 : The British rule in India has brought about moral, material, cultural and spiritual ruination of this great country.
S6 : We are not to kill anybody but it is our *dharma* to see that the curse of this government is blotted out.

P : I regard this rule as a curse.
 Q : Sedition has become my religion.
 R : Ours is a non-violent battle.
 S : I am out to destroy this system of government.

The proper sequence should be

- (a) S P R Q (b) P S Q R
 (c) Q R P S (d) S R P Q

(b) PSQR is the correct sequence of the given sentences to form a meaningful passage.

- 38.** the urban local body elections (P)/unidentified gunmen (Q)/and injured another during (R)/ shot dead two workers (S)

- (a) Q S R P (b) P Q S R
 (c) S P R Q (d) R P S Q

⊗ (a) QSRP is the correct sequence.

- 39.** both intense political and (P)/ this state has a history of (Q)/of syncretic accomplishments (R)/ religious contestation and (S)

- (a) S Q P R (b) P Q S R
 (c) S Q R P (d) Q P S R

⊗ (d) QPSR is the correct sequence.

- 40.** the father also (P)/in his quest for justice (Q)/ by the system (R)/ feels let down (S)

- (a) S Q P R (b) P S R Q
 (c) S Q R P (d) P Q R S

⊗ (b) PSRQ is the correct sequence.

Passage 2

I do not wish to suggest that because we were one nation, we had no differences, but it is submitted that our leading men travelled throughout India either on foot or in bullockcarts. They learned one another languages and there was no aloofness amongst them. What do you think could have been the intention of those farseeing ancestors of ours who established Setubandha (Rameshwar) in the South, Jagannath in the East and Haridwar in the North as places of pilgrimage? You will admit they were no fools. They knew that worship of God could have been performed just as well at home. They taught us that those whose hearts were aglow with righteousness had the Ganges in their own homes. But they saw that India was one undivided land so made by nature. They, therefore, argued that it must be one nation.

Arguing thus, they established holy places in various parts of India and fired the

people with an idea of nationality in a manner unknown in other parts of the world. And we Indians are one as no two Englishmen are. Only you and I and others who consider ourselves civilised and superior persons imagine that we are many nations. It was after the advent of railways that we began to believe in distinctions and you are at liberty now to say that it is through the railways that we are beginning to abolish those distinctions.

An opium-eater may argue the advantage of opium-eating from the fact that he began to understand the evil of the opium habit after having eaten it. I would ask you to consider well what I had said on the railways.

- 41.** According to the author, India

- (a) has never been one nation
 (b) has been an aggregate of several nations
 (c) has always been one nation along with differences
 (d) became a nation after the British came

⊗ (c) The author has stated in the passage that India has always been one nation along with diversities or differences.

- 42.** Why did the great sages of India establish pilgrimages in the different corners of the country?

- (a) Because they wanted to push people to travel to different places.
 (b) Because they could observe the underlying unity of the country as made by nature.
 (c) Because they themselves had travelled to these places.
 (d) Because they wanted people to be religious everywhere.

⊗ (b) The great sages of India established pilgrimages in the different corners of the country because they could observe the underlying unity of the country as made by nature. For them, India was one undivided nation.

- 43.** In the passage, the author's attitude towards the railways is

- (a) critical (b) sympathetic
 (c) indifferent (d) apathetic

⊗ (a) The author's attitude towards the railways is critical. According to the author, due to railways people have been able to see the diversities of nature, people, food, etc. But railways have also helped to unite people of different states.

- 44.** What does the author mean when he says that "Whose hearts were aglow with righteousness had the Ganges in their own homes"?

- (a) One need not visit the Ganges to take holy bath
 (b) The Ganges had been polluted, so one should bath at home
 (c) One should take a holy dip in the Ganges to purify one's heart
 (d) The purity of heart is superior to observance of any ritual

⊗ (d) According to the author, if one's heart is pure, there is no need to observe any rituals like going on pilgrimages or visiting different temples and other prayer structures. God resides in a pure heart.

- 45.** The passage is written in a

- (a) dialogic style (b) prescriptive style
 (c) descriptive style (d) analytical style

⊗ (c) The passage is written in a descriptive style. In descriptive writing style, the author specifies an event, an object or a thing.

- 46.** forest prevent erosion.

- (a) Lean (b) Dense (c) Sparse (d) Tidy

⊗ (b) 'Dense' is the appropriate word for the blank as it means 'containing a lot of things (trees) close together.' Other words do not fit in the blank.

- 47.** Three people were arrested and an illegal arms unit was by the police in a raid.

- (a) revealed (b) searched
 (c) discovered (d) busted

⊗ (d) 'Busted' is the appropriate word for the blank. It means 'raid or search by the police where illegal activity is suspected.' Other words do not fit in the blank to make the sentence meaningful.

- 48.** A woman got into the car and

- (a) drove off (b) broke down
 (c) rode in (d) drove in

⊗ (a) 'Drove off' is the correct phrase to make the sentence meaningful. It means 'force someone to go away and to stop attacking or threatening you.'

- 49.** The lecture was not very interesting. Infact I in the middle of it.

- (a) showed off (b) put off
 (c) dozed off (d) plugged off

⊗ (c) 'Dozed off' is correct phrasal verb to be filled in the blank. It means 'to fall into a light sleep unintentionally.'

- 50.** The cops murder by kin.

- (a) suspect (b) afford
 (c) manage (d) administer

⊗ (a) 'Suspect' is the appropriate word for the blank to make the sentence meaningful. Suspect means 'to have doubts or mistrust.' Other words are not relevant here.

Part B (General Studies)

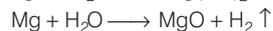
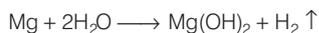
- 51.** Which one of the following cell organelles does not possess nucleic acid?
 (a) Nucleolus (b) Chloroplast
 (c) Ribosome (d) Plasma membrane
- ⊗ (d) The cell organelle given in option (d), i.e. plasma membrane does not contain nucleic acids. It is made up of lipids and proteins. Chloroplast contains deoxyribonucleic acid whereas ribosomes are made up of ribonucleic acids and proteins. Nucleolus is made up of proteins and ribonucleic acids (RNA) and the site for the synthesis of ribosomal RNA.
- 52.** Which one of the following cell organelles does not possess its own genetic material encoding proteins?
 (a) Ribosome (b) Nucleus
 (c) Mitochondria (d) Chloroplast
- ⊗ (a) Ribosome is the cell organelles, which does not possess its own genetic material (DNA) encoding proteins. Nucleus, mitochondria and chloroplast contain DNA which code for proteins needed by these cell organelles.
- 53.** Which one of the following is not a component of conducting tissue in plants?
 (a) Fibres (b) Tracheids
 (c) Pericycle (d) Sieve tubes
- ⊗ (c) Pericycle is not the component of conducting tissue. It is a part of the innermost layer of cortex. Xylem and phloem both contain fibres. Tracheids are the part of xylem whereas sieve tubes are found in phloem.
- 54.** Which one of the following organisms has vascular tissues?
 (a) *Cladophora* (b) *Penicillium*
 (c) *Marsilea* (d) *Anabaena*
- ⊗ (c) *Marsilea* is pteridophytic plant, which has primitive vascular tissues. *Cladophora* is an algae, *Penicillium* is a fungi. *Anabaena* is Blue-Green Algae (BGA).
- 55.** Which one of the following organisms represents the primary consumer category in an ecosystem?
 (a) Caterpillar (b) Crabapple tree
 (c) Frog (d) Sparrowhawk
- ⊗ (a) Caterpillar is primary consumer in an ecosystem. It is because it feeds on leaves and is a herbivore. Crabapple tree is a producer. Frog is a secondary consumer. Sparrowhawk is a top consumer.
- 56.** Spring tides refer to
 (a) greatest difference in the sea level at high and low tides
 (b) lowest difference in the sea level at high and low tides
 (c) no difference in the sea level at high and low tides
 (d) counteraction of gravitational pull of the Sun to that of Moon
- ⊗ (a) The periodic rise & fall of sea level, once or twice a day, is called a Tide. When the Sun, the Moon and the Earth are in a straight line, the height of tides will be higher than normal. These are called spring tides, which occur on new Moon or full Moon day. At these times, high tides are very high & low tides are very low. Thus, spring tides refer to the greatest difference in the sea level at high and low tides.
- 57.** Which one of the following energy is stored in the links between the atoms?
 (a) Nuclear energy (b) Chemical energy
 (c) Potential energy (d) Thermal energy
- ⊗ (b) **Chemical energy** is stored in the bonds of atoms and molecules. **Nuclear energy** is stored in the nucleus of an atom. **Potential energy** is the energy of position or gravitational potential energy. **Thermal energy** or heat is the vibration or movement of atoms and molecules in substances.
- 58.** The light energy escaping from the sun can be spread by
 (a) a shower of rain drops
 (b) a plane mirror
 (c) a convex lens
 (d) a combination of a convex lens and a concave lens
- ⊗ (a) The light energy escaping from the sun can be spread by a shower of rain drops. The sunlight shines on a water droplet. As the light passes into the droplet, the light bends or refracts, a little because light travels slower in water than in air (because water is denser). Then, the light bounces off the back of water droplet and goes back the way it came, bending again as it speeds up when it exits the water droplet. Hence, the light energy escaping from the sun can be spread. A disperse the light into VIBGYOR and spread it.
- 59.** The correct sequence of energy transfer that occurs when an apple falls to the ground is
 (a) gravitational potential energy → heat energy to air → kinetic energy → heat energy to ground and apple → sound energy
 (b) gravitational potential energy → sound energy → kinetic energy → heat energy to air → heat energy to ground and apple
 (c) gravitational potential energy → kinetic energy → heat energy to air → heat energy to ground and apple → sound energy
 (d) gravitational potential energy → kinetic energy → sound energy → heat energy to air → heat energy to ground and apple
- ⊗ (c) When apple is on highest position, then it has only gravitational potential energy. When, it falls to the ground the first its gravitational potential energy starts converting into kinetic energy. Due to air friction some kinetic energy losses and converts into heat energy to air. When apple falls on the ground, then its remaining energy converts into heat energy to ground and sound energy. Hence, option (c) is correct.
- 60.** Which one of the following mineral is used as a fuel in nuclear power stations?
 (a) Bauxite (b) Quartz
 (c) Feldspar (d) Pitchblende
- (d) Uraninite, formerly known as pitchblende is a radioactive uranium rich mineral which is used as a fuel in nuclear power stations. It is an ore with a chemical composition that is largely UO_2 , but due to oxidation the mineral typically contains variable proportions of U_3O_8 .
- 61.** Which one of the following is not a synthetic detergent?
 (a) $CH_3(CH_2)_{10}CH_2OSO_3^-Na^+$
 (b) $[CH_3(CH_2)_{15}-N-(CH_3)_3]^+Br^-$
 (c) $CH_3(CH_2)_{16}COO^-Na^+$
 (d) $CH_3(CH_2)_{16}COO(CH_2CH_2O)_n \cdot CH_2CH_2OH$
- ⊗ (d) Synthetic detergents are chemically alkyl sulphate or sulphonate or ammonium salt of long chain fatty acids. Thus, $CH_3(CH_2)_{16}COO(CH_2CH_2O)_n \cdot CH_2CH_2OH$, option (d) is not a synthetic detergent, while the remaining options contain synthetic detergents.
- 62.** Which one of the following is an example of a clean fuel?
 (a) Coke (b) Propane
 (c) Petrol (d) Wax

- ⊗ (b) Clean fuels are fuels that have a lower carbon intensity than the standard for the fuel it replaces. Examples of clean fuels include ethanol, biodiesel, natural gas, biogas, propane and hydrogen.

63. Which one of the following metals does not react with cold water?

- (a) Calcium (Ca) (b) Potassium (K)
(c) Magnesium (Mg) (d) Sodium (Na)

- ⊗ (c) Magnesium (Mg) does not react with cold water, but reacts with hot water,



On the other hand, calcium (Ca), potassium (K) and sodium (Na) are react with cold water.

Thus, option (c) is correct.

64. In which of the following pairs are the isoelectronic ions?

- (a) Mg^{2+} , Ar (b) Na^+ , O^{2-}
(c) Al^{3+} , Cl^- (d) K^+ , Ne

- ⊗ (b) According to question,

Ion	Atomic Number	Number of Electrons
Mg^{2+}	12	$12 - 2 = 10$
Ar	18	18
Na^+	11	$11 - 1 = 10$
O^{2-}	8	$8 + 2 = 10$
Al^{3+}	13	$13 - 3 = 10$
Cl^-	17	$17 + 1 = 18$
K^+	19	$19 - 1 = 18$
Ne	10	10

The species containing same number of electrons are isoelectronic. Thus, Na^+ and O^{2-} are isoelectronic species. Hence, option (b) is correct.

65. Which one of the following is used as a binder in paints?

- (a) Titanium dioxide (b) Novolac
(c) Phthalocyanine (d) Silicones

- ⊗ (d) Binder refers to the substances that hold the particles of pigment together in paints.

Silicones are used as a binder in paints. They are synthetic organo-silicon polymers containing repeated R_2SiO units.

66. Which one of the following is NOT true in reference to Air mass?

- (a) Air mass forms either in tropical or in polar region
(b) Air mass develops on continents as well as over ocean
(c) Air mass develops in a cyclonic condition
(d) Air mass changes the weather condition

- ⊗ (c) "Air mass develops in a cyclonic condition" this option are not true in reference of air mass. Air mass is a

volume of air defined by its temperature and water vapour content. Air masses cover many hundreds or thousands of miles, and adapt to the characteristic of the surface below them. They are classified according to latitude and their continental or maritime source regions. When air masses reaches a new region, it might clash with another air mass that has a different temperature and humidity. There are four type of air masses-Polar, tropical, continental and maritime.

67. National Water Academy, a centre of excellence in training and capacity building in water resource, is located at

- (a) New Delhi (b) Kolkata
(c) Pune (d) Chennai

- ⊗ (c) National Water Academy (NWA), a centre of excellence in training and capacity building in water resource, is located in Pune (Maharashtra). It was set-up under Central Water Commission by the Ministry of Water Resources in 1988.

The NWA is envisaged to function as 'Centre of Excellence' for in-service training of water resources engineering personnel.

It is addressing the wider training needs of water resources engineers of State and Central Agencies in the field of planning, design, evaluation, construction, operation and monitoring of water resources projects.

68. 'Campos' and 'Llanos', Tropical Savanna grasslands are generally found in

- (a) Australia (b) Central Africa
(c) South America (d) East Asia

- ⊗ (c) 'Campos' and 'Llanos' are the tropical savanna grasslands found in South America. Campos is located in Brazilian Highlands and Llanos in Orinoco basin. Tropical Grasslands are located near the Equator, between the tropic of Cancer and the tropic of Capricorn. They are also known as 'Savannas'. It is a transitional zone found between the equatorial rainforests and the hot deserts. They includes savannas of Africa and Campos and Llanos of South America.

69. 'Viticulture' is a common feature of which one of the following Australian cities?

- (a) Adelaide (b) Darwin
(c) Hobart (d) Brisbane

- ⊗ (a) Viticulture is a common feature of Adelaide, which is the capital of South Australia. Viticulture is the cultivation and harvesting of grapes. The Adelaide Hills

wine region is a famous economic region of country for production of wine from grapes.

70. 'Shamal' warm and dry wind is a Local wind found in

- (a) East Asia
(b) West Coast of Africa
(c) Sahara of Africa
(d) Mesopotamia

- ⊗ (d) 'Shamal local' winds are found in Mesopotamia. Mesopotamia is a region covering Iraq, Iran and the Arabian Peninsula. Shamal is a hot, dusty and dry wind which blows from the North or North-West in Mesopotamia. Other important warm local winds are Chinook in North America, Foehn in the Alps, Khamsin in Egypt, Sirocco in North Africa and Harmattan in West Africa.

71. 'Inversion of Rainfall' is associated with

- (a) Orographic rainfall
(b) Convectional rainfall
(c) Cyclonic rainfall (Tropical)
(d) Cyclonic rainfall (Temperate)

- ⊗ (a) 'Inversion of Rainfall' is associated with orographic rainfall. The orographic rainfall occurs due to the ascent of air forced by a mountain barrier. The mountain barrier should be across the wind direction, so that the moist air is forced in obstruction to move upward and get cooled. The amount of the rainfall increases with increasing height of the barrier, but this is up to certain limit. After that there is a marked decrease due to lesser moisture content of the air and this phenomenon is called 'Inversion of Rainfall'.

72. Who was the author of the book 'History of British India'?

- (a) Charles Grant (b) John Stuart Mill
(c) James Mill (d) William Jones

- ⊗ (c) James Mill (1773-1836) was the author of the book 'History of British India'. This book is a history of company rule in India. Hence, option (c) is correct

73. The Azamgarh Proclamation of 25th August, 1857 stressed on which one of the following issues?

- (a) Hindu-Muslim divide
(b) Support to the English government
(c) The return of the Badshahi
(d) The imposition of heavy Jumas (revenue demand)

- ⊗ (a) The Azamgarh Proclamation of 25th August, 1857 stressed on Hindu-Muslim divide. It was published in Delhi Gazette in the midst of the Sepoy Mutiny (1857). The author was most probably Firoz Shah (grandson of Bahadur Shah Zafar), who

fought against the British in Lucknow and Awadh (Oudh). The original document was published in Urdu.

74. Which Viceroy had made the observation, 'It's a beautiful world if it wasn't for Gandhi ...'?

- (a) Lord Irwin (b) Lord Wavell
(c) Lord Mountbatten (d) Lord Willingdon

⊙ (d) Lord Willingdon was 22nd Viceroy of India from 1931 to 1936. He mentioned Mahatma Gandhi in a letter written in 1933 by saying, "It's a beautiful world if it was not for Gandhi who is really a perfect nuisance." Hence option (d) is correct. The important events of his period include Second and Third Round Table Conferences, relaunching of Civil Disobedience Movement, Communal Award by Ramsay MacDonald (1932), Poona Pact (1932), the Government of India Act, 1935 and Separation of Burma from India.

75. Which Indian businessman favoured 'healthy capitalism' in helping Gandhiji to work towards a 'common object'?

- (a) Ghanshyam Das Birla
(b) Ambalal Sarabhai
(c) Sir Biren Mukherjee
(d) TT Krishnamachari

⊙ (a) Ghanshyam Das Birla, an Indian businessman favoured 'healthy capitalism' in helping Gandhiji to work towards a 'common object.' Birla was a close associate and a steady supporter of Mahatma Gandhi, whom he met for the first time in 1916. Gandhiji stayed at Birla's home in New Delhi during the last four months of his life. In 1957, GD Birla was awarded India's second highest civilian honour, the Padma Vibhushan by the Government of India.

76. The art piece 'In Memoriam' was a creation of which one of the following European painters?

- (a) Thomas Jones Barker
(b) Joseph Noel Paton
(c) Thomas Daniell
(d) Charles D'Oyly

⊙ (b) The art piece 'In Memoriam' was a creation of the European painter, Joseph Noel Paton. He was a Scottish artist, illustrator and sculptor. In 1844, Paton's first painting, **Ruth Gleaning**, was exhibited at the Royal Scottish Academy.

77. Which one of the following can charge an insulator?

- (a) Current electricity
(b) Static electricity
(c) Magnetic field
(d) Gravitational field

⊙ (b) Static electricity can charge an insulator. Charging of insulator by induction process, static charge is required.

A static electric charge can be created whenever two surfaces contact and separate at least one of the surfaces has a high resistance to electric current.

78. At 20°C, the speed of sound in water is approximately

- (a) 330 m/s (b) 800 m/s
(c) 1500 m/s (d) 5000 m/s

(c) The speed of sound in water at 20°C is approximately 1500 m/s.

79. Which one of the following could be the melting point of iron?

- (a) 25°C (b) 37°C
(c) 500°C (d) 1500°C

(d) Iron (Fe) is a chemical element with atomic number 26. It is a metal that belongs to the first transition series and group 8 of the periodic table. Its melting point is 1538°C (~1500°C) or 1811 K.

80. Let us consider a copper wire having radius r and length l . Let its resistance be R . If the radius of another copper wire is $2r$ and the length is $l/2$, then the resistance of this wire will be

- (a) R (b) $2R$
(c) $R/4$ (d) $R/8$

⊙ (d) Given, length of copper wire = l and radius of copper wire = r

∴ Resistance,

$$R = \rho \frac{l}{A} = \rho \cdot \frac{l}{\pi r^2} \quad (\because A = \pi r^2) \dots (i)$$

For second wire,

length, $l_1 = \frac{l}{2}$ and radius, $r_1 = 2r$

Resistance of wire,

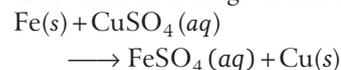
$$\begin{aligned} R_1 &= \rho \cdot \frac{l_1}{\pi r_1^2} = \rho \cdot \frac{l/2}{\pi (2r)^2} \\ &= \rho \cdot \frac{l}{2 \times \pi \cdot 4r^2} = \frac{1}{8} \cdot \rho \cdot \frac{l}{\pi r^2} \\ &= \frac{1}{8} \cdot R \quad [\text{from Eq. (i)}] \\ &= \frac{R}{8} \end{aligned}$$

81. Basic scientific principle behind a nuclear reactor is

- (a) nuclear fusion
(b) controlled nuclear fusion
(c) uncontrolled nuclear fission
(d) controlled nuclear fission

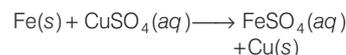
(d) Basic scientific principle behind a nuclear reactor is controlled nuclear fission, in which a heavy atomic nucleus splits into two smaller nuclei and a large amount of energy is released in this process.

82. Which one of the following statements is not correct for the given reaction?



- (a) Iron is the reducing agent
(b) The solution turns green in colour after the reaction
(c) Copper is a more reactive metal than iron
(d) The reaction is an example of a redox reaction

⊙ (c) A more reactive metal displaces a less reactive metal from its solution.



In the above given reaction, iron (Fe) displaces copper (Cu) from its solution (CuSO_4), thus copper is less reactive than iron. Therefore, option (c) is incorrect, while the remaining options are correct.

83. Which one of the following is an organic acid?

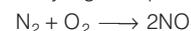
- (a) Hydrochloric acid (b) Nitric acid
(c) Acetic acid (d) Sulphuric acid

⊙ (c) An organic acid is an organic compound with acidic properties. The most common organic acids are the carboxylic acids. Among the given options, acetic acid (CH_3COOH) is an organic acid. The remaining options contains inorganic acids.

84. Dinitrogen (N_2) and dioxygen (O_2) are the main constituents of air, but they do not react with each other to form oxides of nitrogen because,

- (a) the reaction requires initiation by a catalyst
(b) oxides of nitrogen are unstable
(c) the reaction is endothermic and requires very high temperature
(d) the stoichiometry of N_2 and O_2 in air is not ideal for the reaction to take place

⊙ (c) The reaction of dinitrogen (N_2) and dioxygen (O_2) is endothermic and requires very high temperature.



It is because, the nitrogen-nitrogen triple bond ($\text{N} \equiv \text{N}$) is very strong.

The energy cost to break that bond as well as the $\text{O} = \text{O}$ is not compensated by the formation of nitrogen-oxygen ($\text{N} = \text{O}$) double bond.

Thus, they do not react with each other.

85. Who among the following has explained the phenomenon of photoelectric effect?

- (a) Max Planck (b) Albert Einstein
(c) Neils Bohr
(d) Ernest Rutherford

- ⊗ (b) The experiment of photoelectric effect is performed by Heinrich Hertz, but the phenomenon was explained by Albert Einstein. It is the phenomenon of ejection of electrons from the structure of a metal when light of suitable frequency strikes it.

86. The equivalent weight of oxalic acid in $C_2H_2O_4 \cdot 2H_2O$ is

- (a) 45 (b) 63
(c) 90 (d) 126

- ⊗ (b) Equivalent weight of an acid

$$= \frac{\text{Molecular weight}}{\text{Basicity}}$$

Molecular weight of $C_2H_2O_4 \cdot 2H_2O$
 $= 2 \times 12 + 2 \times 16 + 4 \times 16 + 2 \times 18 = 126$
 \therefore Equivalent weight of $C_2H_2O_4 \cdot 2H_2O$
 $= \frac{126}{2} = 63$

87. Which one of the following is not a west flowing river?

- (a) Periyar (b) Bharathapuzha
(c) Pamba (d) Tamraparni

- ⊗ (d) Tamraparni is not a West flowing river while others are west flowing rivers. Tamraparni river originates from Pothigai hills of Western Ghats (Tamil Nadu). It flows through Tamil Nadu and falls into Gulf of Mannar. It has been historically known as 'Podhigai'. It is mentioned in the ancient Sangam and Tamil texts.

88. Which one of the following rivers was earlier known as 'Vitasta'?

- (a) Tista (b) Jhelum
(c) Tungabhadra (d) Bharathapuzha

- ⊗ (b) 'Jhelum river' was earlier known as 'Vitasta', while Tista was known as 'Trisrota', Tungabhadra as 'Pampa' and Bharathapuzha as 'Pratichi'. Jhelum river rises from northern slopes of Pir Panjal ranges at Verinag Spring. It flows through Srinagar and Wular lake before entering Pakistan. It is a tributary of the Indus river.

89. River Sharda drains in the Northern Plains of Uttar Pradesh. Before entering in the Plains, Sharda is known as

- (a) Saraswati (b) Bhagirathi
(c) Kali (d) Pindar

- ⊗ (c) The Sharda river originates from the greater Himalayas at Kalapaani in the Pithoragarh district of Uttarakhand. The river is named after the Goddess Kali whose temple is situated in Kalapaani. It drains the Northern plains of Uttar Pradesh and Uttarakhand. It is known as 'River Sharda', when it reaches the plains of Uttarakhand and Uttar Pradesh. It forms India's continuous border between India and Nepal.

90. 'Mission Indradhanush' is related to

- (a) Bullet train project
(b) Agriculture development
(c) Women empowerment
(d) Full immunisation

- ⊗ (d) 'Mission Indradhanush' is related to full immunisation. This health mission was launched by the Ministry of Health and Family Welfare on 25th December, 2014.

The scheme seeks to drive towards 90% full immunisation coverage of India and sustain same by year 2020. Vaccination is being provided against eight vaccine preventable diseases, i.e.

Diphtheria, Pertussis, Tetanus, Polio, Measles, Tuberculosis, Hepatitis B, Meningitis, Rotavirus, Diarrhea and Japanese Encephalitis.

91. Which of the following is/are environmental effects of Rotation of the Earth?

1. Daily or diurnal rhythm in day-light and air temperature
2. Flow path of both air and water are turned consistently in a sideward direction.
3. The movement of the tides

Select the correct answer using the codes given below:

- (a) 1 and 2 (b) 1 and 3
(c) 1, 2 and 3 (d) Only 3

- ⊗ (c) Statement 1, 2 and 3 all are correct. The rotation of the earth causes day and night. This results in the diurnal changes in day-light and air temperature. So, statement 1 is correct.

Earth's rotation results in the Coriolis effect. This deflects winds and streams of water to the right in Northern Hemisphere and to the left in Southern Hemisphere. So, statement 2 is correct.

Tides are caused by the gravitational attractive forces of the moon and the sun as well as the centrifugal force due to the Earth's rotation. So, statement 3 is also correct.

92. Who among the following historians have described the Quit India Movement as a 'spontaneous revolution'?

- (a) Gordon Johnson
(b) David Arnold
(c) FG Hutchins
(d) Peter Robb

- ⊗ (c) FG Hutchins described the Quit India Movement as a 'spontaneous revolution'. Quit India Movement, 1942 was an important event of the Indian freedom struggle.

Directions (Q. Nos. 93-95) The following questions items consist of two statements, statement I and statement II. Examine these two statements carefully and select the correct answer using the codes given below.

Codes

- (a) Both the statements are individually true and statement II is the correct explanation of statement I.
(b) Both the statements are individually true and statement II is not the correct explanation of statement I.
(c) Statement I is true, but statement II is false.
(d) Statement I is false, but statement II is true.

93. Statement I Abul Fazl shaped, represented and articulated the ideas associated with the reign of Akbar.

Statement II The qualities of Abul Fazl impressed Akbar who found the former suitable as an adviser and spokesperson for his policies.

- ⊗ (a) Abul Fazl shaped, represented and articulated the ideas associated with the reign of Akbar because the qualities of Abul Fazl impressed Akbar, who found the former suitable as an adviser and spokesperson for his policies. So, Both the given statements are individually true and statement II is the correct explanation of statement I.

94. Statement I The Kisan Manifesto adopted by the All India Kisan Sabha in August, 1936 contained radical demands.

Statement II The All India Kisan Sabha was a part of the Congress and maintained close relationship with the Provincial Congress Committees.

- ⊗ (d) The kisan manifesto released in August 1936, demanded abolition of the zamindari system and cancellation of rural debts.

All India Kisan Sabha was separate entity. It was founded at Lucknow in 1936 with Swami Sahajanand as its first President and NG Ranga as its General Secretary. So, statement I is false, but statement II is true. Hence, option (d) is correct.

95. Statement I The British ruled India through a modern bureaucracy headed by the Indian Civil Service, whose members were recruited through merit based on open competition.

Statement II The Indian Civil Service was based on the whole hearted participation of Indians.

- ⊙ (c) The British ruled India through a modern bureaucracy headed by the Indian Civil Service, whose members were recruited through merit based on open competition. Hence, statement (1) is correct.

The Indian Civil Services was not based on the whole hearted participation of Indians. Hence, statement (2) is not correct. So, the statement I is true. But, the statement II is not true. Thus, option(c) is correct here.

- 96.** Two metallic wires A and B are made using copper. The radius of wire A is r while its length is l . A DC voltage V is applied across the wire A, causing power dissipation P . The radius of wire B is $2r$ and its length is $2l$ and the same DC voltage V is applied across it causing power dissipation P_1 . Which one of the following is the correct relationship between P and P_1 ?

- (a) $P = 2P_1$ (b) $P = P_1/2$
(c) $P = 4P_1$ (d) $P = P_1$

- ⊙ (b) For metallic wire A,

$$\text{resistance, } R_A = \rho \cdot \frac{l}{\pi r^2}$$

Therefore, power dissipation in wire A, when a DC voltage V is applied,

$$P = \frac{V^2}{R_A} = \frac{V^2}{\rho \cdot \frac{l}{\pi r^2}} = \frac{V^2 \cdot \pi r^2}{\rho l}$$

$$P = \frac{\pi r^2 V^2}{\rho l} \quad \dots(i)$$

For metallic wire B,

$$l_B = 2l, r_B = 2r, \text{ then resistance of wire B, } R_B = \rho \cdot \frac{l_B}{\pi r_B^2} = \rho \cdot \frac{2l}{\pi(2r)^2} = \rho \cdot \frac{2l}{4\pi r^2}$$

∴ Power dissipation in wire B,

$$P_1 = \frac{V^2}{R_B} = \frac{V^2}{\frac{\rho \cdot 2l}{4\pi r^2}} = \frac{2\pi r^2 V^2}{\rho l} = 2P$$

[from Eq. (i)]

$$\therefore P = \frac{P_1}{2}$$

- 97.** Consider the following statements about a solenoid.
- The magnetic field strength in a solenoid depends upon the number of turns per unit length in the solenoid.
 - The magnetic field strength in a solenoid depends upon the current flowing in the wire of the solenoid.

3. The magnetic field strength in a solenoid depends upon the diameter of the solenoid.

Which of the statements given above are correct?

- (a) 1, 2 and 3 (b) 1 and 3
(c) 2 and 3 (d) 1 and 2

- ⊙ (d) Magnetic field strength in a solenoid is given by

$$B = \mu_0 n i$$

where, μ_0 = permeability of free space,

n = number of turns per unit length

and i = current flowing through solenoid.

So, it is clear that magnetic field strength B in a solenoid depends on n and i only, it does not depend on diameter of solenoid. Therefore, statements 1 and 2 are correct.

- 98.** Light year is a unit of measurement of

- (a) very large distances
(b) time interval in years
(c) amount of light received on earth in a year
(d) mass of atoms

- ⊙ (a) Light year is a unit of measurement of very large distances. It is a distance travelled by light in vacuum in one year.

$$1 \text{ light year} = 9.46 \times 10^{15} \text{ m}$$

- 99.** The focal length of the objective lens of a telescope is 50 cm. If the magnification of the telescope is 25, then the focal length of the eyepiece is

- (a) 12.5 cm (b) 5 cm
(c) 2 cm (d) 10 cm

- ⊙ (c) Given, focal length of objective lens, $f_o = 50$ cm and magnification of telescope $m = 25$

If f_e be the focal length of eyepiece, then

$$m = -\frac{f_o}{f_e}$$

$$\Rightarrow 25 = -\frac{50}{f_e}$$

$$\Rightarrow f_e = -\frac{50}{25} = -2 \text{ cm}$$

$$|f_e| = 2 \text{ cm}$$

- 100.** Which one of the following force is non-central and non-conservative?

- (a) Frictional force
(b) Electric force
(c) Gravitational force
(d) Mechanical force

- ⊙ (a) A force on body which does not always act towards a fixed point, is called non-central force.

The forces that do not store energy are called non-conservative forces.

Work done by non-conservative forces depends on the path of the body moving from one point to another point.

Therefore, frictional force is a non-central and non-conservative force.

- 101.** On exposure to moist air, copper gains a green coat on its surface due to formation of which one of the following compounds?

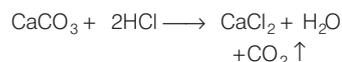
- (a) Copper carbonate
(b) Copper oxide
(c) Copper sulphate
(d) Copper nitrate

- ⊙ (a) On exposure to moist air, copper gains a green coat on its surface due to formation of copper carbonate.

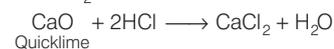
- 102.** Which one of the following will not produce carbon dioxide on reacting with an aqueous solution of hydrochloric acid?

- (a) Limestone (b) Quicklime
(c) Chalk (d) Marble

- ⊙ (b) Calcium carbonate occurs in nature in several forms like limestone, chalk, marble, etc. It reacts with aqueous solution of hydrochloric acid (HCl) to liberate carbon dioxide.



Quicklime on reaction with HCl does not liberate CO_2 .



- 103.** Which one of the following substances is not a mixture?

- (a) Ice (b) Ice-cream
(c) Air (d) Honey

- ⊙ (a) Mixtures are obtained by mixing two or more substances in any proportions. Thus, among the given options, ice is not a mixture as it contains only water (liquid). The other substances, i.e., ice-cream, air and honey are mixtures.

- 104.** Which one of the following is an example of Salt-Crystal growth?

- (a) Chemical weathering
(b) Physical weathering
(c) Biological weathering
(d) Bio-chemical weathering

- ⊙ (b) Physical weathering is an example of Salt-Crystal growth. Physical weathering is a term used in science that refers to the geological process of rocks breaking apart without changing their chemical composition. Over time, movements of the earth and environment can break apart rock formation, causing physical weathering. It can also refer to other things in the environment, breaking down, like soil and mineral, pressure, warm temperature, water and ice can cause physical weathering.

105. Which one of the following is the correct sequence of proved coal reserves in the Indian States in decreasing order?

- (a) Jharkhand, Chhattisgarh, Odisha, West Bengal
- (b) Jharkhand, Odisha, Chhattisgarh, West Bengal
- (c) Odisha, West Bengal, Jharkhand, Chhattisgarh
- (d) Odisha, Chhattisgarh, West Bengal, Jharkhand

⊗ (b) Coal is the main source of energy in India as it fulfils about 67% of the total commercial energy consumed in the country.

The decreasing order of proved coal reserve is given below

State	Proved Coal Reserve (million tonnes)
Jharkhand	45563
Odisha	37391
Chhattisgarh	20428
West Bengal	14156

Hence option (b) is correct answer.

106. Consider the following statements relating to Richter scale

1. It was devised in 1935 by Charles F Richter.
2. It describes the quantity of energy released by a single earthquake.
3. Richter scale has no upper limit.

Which of the statement(s) given above is/are correct?

- (a) Only 1
- (b) 1 and 2
- (c) 2 and 3
- (d) All of these

⊗ (b) Richter scale is a scale of number used to indicate the magnitude of earthquakes. Charles Francis Richter developed the Richter scale in 1935. This scale describes the quantity of energy released by earthquake. Numbers for the Richter scale range from 0 to 9. So, here statements (1) and (2) are correct.

107. Which one of the following ocean currents is not a cold ocean current?

- (a) Canary current
- (b) California current
- (c) Kuroshio current
- (d) Oyashio current

⊗ (c) Ocean current is a continuous movement of ocean water from one place to another. It is created by wind, water temperature, salt content and gravitational force of Moon. It is of two types; cold and warm ocean currents.

Examples of warm ocean current are Kuroshio, Alaskan, El Nino, East Australian, Florida, Gulf stream, Brazilian and Agulhas ocean currents. Examples of cold ocean current are Humboldt or Peruvian, Kuril or Oyashio, California, Antarctica, Okhotsk, Labrador, Canary

and Falkland ocean currents. Hence, option (c) is correct.

108. What is the time gap in occurrence of two successive tides at a given place on the ocean surface?

- (a) 12 hr
- (b) 12 hr 26 min
- (c) 24 hr
- (d) 24 hr 52 min

(b) A lunar day has a length of 24 hours and 52 minutes. Earth rotates through two tidal 'bulges' every lunar day. So, coastal areas experience two high and two low tides in every 24 hours and 52 minutes. There are two high tides occur in the interval of 12 hours and 26 minutes. Hence option (b) is correct answer.

109. Tooth enamel is made up of which one of the following calcium compounds?

- (a) Calcium carbonate
- (b) Calcium sulphate
- (c) Calcium hydroxide
- (d) Calcium phosphate

(d) Enamel is the hardest substance in the human body. It contains the highest percentage of minerals, 96% with water and organic material composing the rest. The primary mineral present in enamel is hydroxyapatite which is a crystalline calcium phosphate.

110. Suppose there are two planets, 1 and 2, having the same density, but their radii are R_1 and R_2 respectively, where $R_1 > R_2$. The accelerations due to gravity on the surface of these planets are related as

- (a) $g_1 > g_2$
- (b) $g_1 < g_2$
- (c) $g_1 = g_2$
- (d) Cannot say anything

⊗ (a) Acceleration due to gravity on the surface of first planet,

$$g_1 = \frac{GM_1}{R_1^2} \quad \dots(i)$$

where, M_1 is the mass of first planet.

$$\text{But, } M_1 = \frac{4}{3} \pi R_1^3 \cdot \rho_1$$

(∵ mass = volume × density)

where, ρ_1 = density of the first planet.

$$g_1 = \frac{G \cdot \frac{4}{3} \pi R_1^3 \cdot \rho_1}{R_1^2} \quad [\text{from Eq. (i)}]$$

$$g_1 = \frac{4}{3} G \pi \rho_1 R_1 \quad \dots(ii)$$

Similarly, acceleration due to gravity on the surface of second planet,

$$g_2 = \frac{4}{3} G \pi \rho_2 R_2 \quad \dots(iii)$$

∴ From Eqs. (ii) and (iii), we get

$$\frac{g_1}{g_2} = \frac{\rho_1 R_1}{\rho_2 R_2} = \frac{R_1}{R_2} \quad (\because \rho_1 = \rho_2)$$

Since, $R_1 > R_2$, hence $g_1 > g_2$.

111. The sun is seen little before it rises and for a short while after it sets. This is because of

- (a) total internal reflection
- (b) atmospheric refraction
- (c) apparent shift in the direction of sun
- (d) dispersion

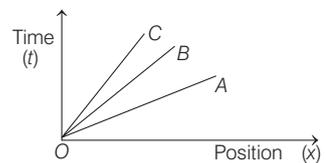
⊗ (b) The sun is seen little before it rises and for short while after it sets due to atmospheric refraction.

When light enters from vacuum to earth's atmosphere, it basically enters from rarer to denser medium and bends towards horizon.

During sunrise, when the sun is just below the horizon, our atmosphere causes the light rays to bend and we see the sun early.

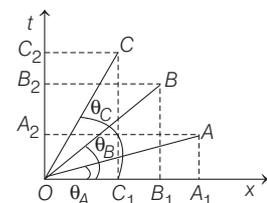
Similarly, at sunset, the apparent position of the sun is visible to us and not the actual position due to the same bending of light rays effect.

112. The figure shown below gives the time (t) versus position (x) graph of three objects A, B and C. Which one of the following is the correct relation between their speeds v_A , v_B and v_C , respectively at any instant ($t > 0$)?



- (a) $v_A < v_B < v_C$
- (b) $v_A > v_B > v_C$
- (c) $v_A = v_B = v_C \neq 0$
- (d) $v_A = v_B = v_C = 0$

⊗ (b) From figure,



Velocity of object A,

$$v_A = \frac{OA_1}{AA_1} = \cot \theta_A$$

Velocity of object B,

$$v_B = \frac{OB_1}{BB_1} = \cot \theta_B$$

Velocity of object C, $v_C = \frac{OC_1}{CC_1} = \cot \theta_C$

Since, $\theta_C > \theta_B > \theta_A$
 $\Rightarrow \cot \theta_A > \cot \theta_B > \cot \theta_C$
 $\Rightarrow v_A > v_B > v_C$

113. 1 dyne (a unit of force in CGS system) equals to

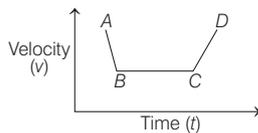
- (a) 10^3 g-cm/s^2 (b) 10^{-3} g-cm/s^2
 (c) 10^5 kg-cm/s^2 (d) 10^{-5} kg-m/s^2

⊙ (d) $1 \text{ dyne} = 1 \text{ g-cm/s}^2$

$$= \frac{1 \text{ g} \cdot 1 \text{ cm}}{1 \text{ s}^2} = \frac{10^{-3} \text{ kg} \cdot 10^{-2} \text{ m}}{1 \text{ s}^2}$$

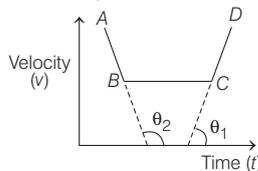
$$= 10^{-5} \text{ kg-m/s}^2$$

114. In the given velocity (v) versus time (t) graph, accelerated and decelerated motions are respectively represented by line segments



- (a) CD and BC (b) BC and AB
 (c) CD and AB (d) AB and CD

⊙ (c) The slope of velocity-time graph gives acceleration produced in the moving body.



From graph, slope of line segment $AB = \tan \theta_2$

which is negative because

$$90^\circ < \theta_2 < 180^\circ.$$

Therefore, line segment AB represents decelerated motion.

Slope of line segment $CD = \tan \theta_1$,

which is positive because

$$0^\circ < \theta_1 < 90^\circ.$$

Therefore, line segment CD represents accelerated motion.

115. Which one of the following statement regarding a thermo flask is not correct?

- (a) The walls of flask are separated by vacuum and made of glass which is a poor conductor of heat.
 (b) The glass walls themselves have shiny surfaces.
 (c) The surface of inner wall radiates good amount of heat and the surface of outer wall absorbs some of the heat that is radiated from the inner wall.
 (d) The cork supports are poor conductors of heat.

⊙ (c) The thermo flask has the silver coating on the inner surface which prevents heat transfer by radiation. The vacuum between its double wall prevents heat moving by convection. The thinness of

the glass walls stops heat entering or leaving the flask by conduction.

Hence, option (c) is not a correct statement regarding a thermo flask.

116. Black hole is a

- (a) huge black star which has zero acceleration due to gravity on its surface
 (b) star which has moderate acceleration due to gravity on its surface
 (c) star which has collapsed into itself and has large acceleration due to gravity on its surface
 (d) star which has collapsed into itself and has zero acceleration due to gravity on its surface

⊙ (c) A black hole is a star which has collapsed into itself and has large acceleration due to gravity on its surface.

A black hole forms when the center of a very massive star collapses in upon itself. The region in space of a black-hole, the pulling force of gravity is, so strong that light is not able to escape.

117. The formula for conversion between Fahrenheit and Celsius is $^\circ\text{F} = X + (1.8 \times ^\circ\text{C})$.

- (a) 32 (b) 22
 (c) 98 (d) 42

⊙ (a) The formula for conversion between Fahrenheit and Celsius is

$$\frac{^\circ\text{C}}{5} = \frac{^\circ\text{F} - 32}{9}$$

$$\Rightarrow \frac{9}{5} ^\circ\text{C} = ^\circ\text{F} - 32$$

$$\Rightarrow 1.8 ^\circ\text{C} = ^\circ\text{F} - 32$$

$$\Rightarrow ^\circ\text{F} = 32 + 1.8 ^\circ\text{C}$$

Comparing with given relation of

$$^\circ\text{F} = X + (1.8 \times ^\circ\text{C})$$

We get, $X = 32$

118. When a beam of white light passes through a glass prism, the colour of light beam that deviates the least is

- (a) blue (b) red (c) green (d) violet

⊙ (b) The wavelength of red colour of light is maximum, therefore when a beam of white light passes through a glass prism, then the light of red colour deviates the least.

119. LIGO stands for

- (a) Laser Interferometer Gravitational wave Observatory
 (b) Light Interferometer Gravitational wave Observatory
 (c) Light Induced Gravity Observatory
 (d) Laser Induced Gaseous Optics

⊙ (a) LIGO stands for Laser Interferometer Gravitational wave Observatory. It is a large scale physics experiment and observatory to detect cosmic gravitational waves and to develop gravitational waves observations as an astronomical tool.

120. A fuse wire must be

- (a) conducting and of low melting point
 (b) conducting and of high melting point
 (c) insulator and of high melting point
 (d) insulator and of low melting point

⊙ (a) Fuse wire should have high resistance and low melting point. It is because when high current pass through the circuit, at first, it will resist the high current.

A fuse wire protects our electric appliances from damaging due to sudden increase in electric current.

121. Kamarajar Port was commissioned in 2001 to handle thermal coal requirements. It is situated along the coast of which Indian State?

- (a) Andhra Pradesh (b) Odisha
 (c) Tamil Nadu (d) Karnataka

(c) Kamarajar (Ennore) Port is situated along the coast of Tamil Nadu. It is the 12th major port of India. This port was commissioned in 2001 to handle thermal coal requirement.

122. Which one of the following Union Territories of India is the smallest in terms of geographical area?

- (a) Daman and Diu
 (b) Chandigarh
 (c) Dadra and Nagar Haveli
 (d) Lakshadweep

(d) Lakshadweep is the smallest Union Territories of India in terms of geographical area. According to Census 2011, Lakshadweep has an area of 32 km^2 . It is an archipelago consisting of 36 islands and having the capital at Kavaratti. Among others, UTs Daman and Diu has an area of 112 km^2 whereas Chandigarh and Dadra and Nagar Haveli has an area of 114 km^2 and 491 km^2 respectively.

123. Which one of the following can be said to be essentially related to 'Polar Front Theory'?

- (a) Anticyclone
 (b) Tropical Cyclone
 (c) Temperate Cyclone
 (d) Inter Tropical Convergence

⊙ (c) The 'Polar Front Theory' of cyclogenesis was developed to explain the formation of mid-latitudes cyclone or Temperate cyclone. According to this theory, the warm-humid air masses from the tropics meet the dry-cold air masses from poles, and thus a polar front is formed. The cold air mass pushes the warm air mass upwards, forming a low pressure cyclonic system. A mid-latitude cyclone is a large-scale low pressure system that is developed. Hence, option (b) is correct.

124. Brahmaputra and Indus rivers are antecedent rivers. Which one of the following may be the true definition of an antecedent drainage?

- (a) Which follows the initial slope of the Himalaya
- (b) Which existed before the Himalayan range came into existence
- (c) Which followed the dip or rock beds of the Himalaya
- (d) Which followed the strikes of rock beds of the Himalaya

(b) An antecedent drainage is one whose path of flow neither in a valley was established before the mountainous structure was uplifted. Antecedent drainage existed before the Himalayan range came into existence. The rivers that existed before the upheaval of the Himalayas and cut their courses southward by making gorges in the mountains are known as the antecedent rivers. The Indus, Sutlej, Ganga, Kali, Arun, Tista and Brahmaputra are some of the important antecedent rivers originated from beyond the Greater Himalayas.

125. The Karachi Resolution of Congress in 1931 advocated which one of the following issues?

- (a) State shall not own or control key industries and services.
- (b) State shall handover the key industries and services to the Indian business groups.
- (c) State should allow the Indian business group to invest 50% of the capital.
- (d) State shall own or control key industries and services.

(d) The Karachi Resolution of Congress in 1931 advocated that, 'State shall own or control key industries and services'.

The Karachi Resolution was passed by the INC at its Karachi Session in 1931.

The session was conducted in the shadow of three major events—

First, Mahatma Gandhi had just been released from prison following his Salt Satyagraha.

Second, the Gandhi-Irwin pact had just been concluded which had brought the Civil Disobedience Movement to an end.

And third, the British Government had, a week before the session, executed Bhagat Singh and two of his associates in connection with the Kakori Conspiracy Case.

126. The treaty of Schonbrunn (1809) was signed after which one of the following battles?

- (a) Battle of Austerlitz
- (b) Battle of Tilsit
- (c) Battle of Wagram
- (d) Battle of Lisbon

(c) The treaty of Schonbrunn (1809) or treaty of Vienna was signed after the **Battle of Wagram**. This treaty was signed between Austria and France.

Battle of Austerlitz (2nd Dec-1805), the first engagement of the war of the third coalition and one of Napoleon's greatest victories.

Battle of Tilsit fought between French and Russia on 14th June, 1807.

The battle of Lisbon (1st July to 25th Oct, 1147) was the military action that brought the city of Lisbon under definitive Portuguese control and expelled its Moorish overlords.

127. Which of the following statements about the New Model Unions is/are correct?

- 1. The New Model Unions were formed in the 1850s.
- 2. The New Model Unions were formed in the 1880s.
- 3. The New Model Unions comprised a Labour Party idea.
- 4. The New Model Unions excluded women in the 1920s.

Select the correct answer using the codes given below.

- (a) Only 1
- (b) Only 2
- (c) 3 and 4
- (d) Only 3

(a) New Model Union or New Model Trade Union (NMTU) were a variety of Trade Union prominent in the United Kingdom. These were formed in the 1850s. These were generally tended to be restricted to individual trades. These unions were not comprised by a Labour Party idea and it also did not exclude women. So, here is only statement (1) is correct. Hence, option (a) is correct.

128. The Truman Doctrine of 1947 was announced to achieve which one of the following?

- (a) Containment of the USSR
- (b) Increasing agricultural production in the USA
- (c) Offering friendship to Europe
- (d) Strengthening the UNO

(a) The Truman Doctrine of 1947 was announced to achieve containment of the USSR. It was announced by Harry S Truman on 12th March, 1947 and further developed on 12th March, 1948.

129. Which of the following statements is/are correct?

- 1. In 1948, Burma was admitted to the United Nations and immediately supported the USA in the Cold War.
- 2. In 1948, Burma joined the United Nations, but refused to denounce China as the aggressor in the Korean War.

Select the correct answer using the codes, given below.

- (a) Only 1
- (b) Only 2
- (c) Both 1 and 2
- (d) Neither 1 nor 2

(b) On 4th Jan, 1948 Burma became an independent republic, under the terms of the Burma Independence Act, 1947. The new country was named the Union of Burma. Apart from this, in 1948, Burma joined the United Nations but refused to denounce China as the aggressor in the Korean war. Hence option (b) is correct answer.

130. Who among the following presented 'The April Thesis' to the Russian people in 1917?

- (a) Stalin
- (b) Trotsky
- (c) Bukharin
- (d) Lenin

(d) Vladimir Lenin presented 'The April Thesis' to the Russian people in 1917. It was the series of ten directives issued by Lenin. It was aimed at fellow Bolsheviks in Russia and returning to Russia from exile. The April Thesis influenced the October Revolution.

131. An Election Commissioner can be removed from office on the recommendation of

- (a) the Chief Justice of India
- (b) the Chief Election Commissioner
- (c) the President of India
- (d) the Parliament

(b) An Election Commissioner can be removed from office on the recommendation of the Chief Election Commissioner (CEC) by the President of India. Article-324 (5) of the Constitution safeguards the CEC from arbitrary removal. CEC can be removed only by the President, just like Judge of the Supreme Court.

132. Which one of the following statements regarding the Rajya Sabha is not correct?

- (a) Its members are elected by the elected members of the Legislative Assembly of a State.
- (b) The election follows the system of proportional representation by means of a single transferable vote.
- (c) 1/3rd of its members retire after every two years.
- (d) It is a permanent body, but can be dissolved earlier by the President.

(d) Option (d) is incorrect because Rajya Sabha (Article-80) is a permanent body and not the subject of dissolution. Its maximum strength is 250. Its members are elected by the elected member of the Legislative Assembly of the State.

The election of Rajya Sabha members follows the system of proportional representation by means of a single transferable vote. One-third (1/3rd) of its members retire after every two years.

133. Fundamental Rights guaranteed under which one of the following Articles of the Constitution of India is available only to the citizens of India?

- (a) Article-19 (b) Article-20
(c) Article-21 (d) Article-22

- ⊙ (a) Under **Article-19** of the Constitution of India, Fundamental Rights are guaranteed only to the citizens of India. There are five fundamental articles which are only to Indian citizens i.e. Articles-15, 16, 19, 29, 30. This article guarantees the six rights. *These are*
1. Right to freedom of speech and expression
 2. Right to assemble peacefully and without arms.
 3. Right to form associations or unions or co-operations.
 4. Right to move freely throughout the territory of India.
 5. Right to reside and settle in any part of the territory of India.
 6. Right to practice any profession or to carry on any occupation, trade or business.

While **Article 20** deals with the protection of certain rights in case of conviction for offences. **Article 21** deals with the protection of life and personal liberty, and **Article 22** grants protection to persons who are arrested or detained.

134. The treaty of Yandabo was signed in

- (a) 1826 (b) 1825
(c) 1824 (d) 1823

- ⊙ (a) The treaty of Yandabo was signed on 24th February, 1826 between the Britishers and Burmese. It brought peace between East India Company and the king of Ava that ended the first Anglo-Burmese war. This treaty started the British Rule in Assam.

135. In the Manusmriti which form of marriage results from the "Voluntary union of a maiden and her lover"?

- (a) Eighth form
(b) Fifth form
(c) Seventh form
(d) Sixth form

- ⊙ (b) "Voluntary union of maiden and her lover" are the fifth form (Gandharava Marriage) of marriage result in the Manusmriti. In this marriage a groom and his bride will wed without their parents knowledge.

However, it is not correctly considered as type of marriage because it does not have the consent of the parents. According to Manusmriti there are eight types of Hindu marriages. These are - Brahma, Daiva, Arsha, Prajapatya, Gandharva, Asura, Rakshasa and Paischaca.

136. Consider the following description of the Samadhi of a former Prime Minister of India.

Central Samadhi Platform comprises nine square black polished granite solid stone blocks, capped with a 'Diya' in the centre. The number nine holds significance and represents the Navarasas, Navaratras and Navagrahas. Then placement of the Nine-Square Samadhi is in a circular lotus shaped pattern. The Nine-Square platform is accessed in four cardinal directions by pathways made in white composite tiles so that the floor does not get heated.

Identify the Samadhi.

- (a) Shakti Sthal (b) Shantivan
(c) Sadaiv Atal (d) Veer Bhumi

- ⊙ (c) The Samadhi, which is mentioned in above question, is **Sadaiv Atal**. It is the crematorium (Samadhi) of former Prime Minister of India, Atal Bihari Vajpayee (1924-2018). He served three terms as the Prime Minister of India. He was the first Indian Prime Minister who was not a member of the Indian National Congress party to have served a full five year term in office.

Shakti Sthal is a memorial of former Prime Minister Indira Gandhi.

Shantivan is the Samadhi or Cremation spot of Prime Minister Jawaharlal Nehru and the **Veer Bhumi** is a memorial dedicated to the former Prime Minister Rajiv Gandhi.

137. IMBEX is a joint exercise conducted regularly between Armies of India and

- (a) Malaysia (b) Maldives
(c) Mauritius (d) Myanmar

- ⊙ (d) India-Myanmar Bilateral Army Exercise (IMBEX) is a joint exercise conducted regularly between Armies of India and Myanmar. The first edition of this exercise was held in 2017 and 2nd edition was conducted on 14th January 2019 in Haryana.

This joint exercise is also the first of its kind military training exercise on United Nations Peacekeeping Operations between India and Myanmar.

138. Who among the following was awarded The Hindu Prize in Fiction category for the year 2018?

- (a) Neelum Saran Gour
(b) N. Kalyan Raman
(c) Manoranjan Byapari
(d) Arunav Sinha

- ⊙ (a) Neelum Saran Gour was awarded The Hindu Prize in Fiction category for the year 2018. Neelum Gour got this award for her novel 'Requiem in Raga Janki'. She is the author of five novels, four collection of short stories and one work of literary non-fiction. She has also edited a pictorial volume on the history and culture of Allahabad.

139. Who among the following was appointed as Head of the seven Members committee to look into revenue shortfall being faced by the States after the GST rollout in India and suggest steps for augmenting collections?

- (a) Himanta Biswa Sharma
(b) Thomas Isaac
(c) Sushil Modi
(d) Capt. Abhimanyu

- ⊙ (c) Sushil Modi was appointed as Head of the seven members committee to look into revenue shortfall being faced by the States after the GST rollout in India and suggest steps for augmenting collections by the States, since July, 2017.

As per the term of reference of the Group of Ministers, the Modi led committee will undertake data analysis using econometric and statistical tools and suggest suitable measures for course correction for revenue augmentation.

140. The 15th Pravasi Bharatiya Divas, 2019 was held in

- (a) New Delhi (b) Gandhi Nagar
(c) Prayagraj (d) Varanasi

- ⊙ (d) The 15th Pravasi Bharatiya Divas, 2019 was held in Varanasi (Uttar Pradesh) from 21st to 23rd January, 2019. It was inaugurated by the Prime Minister Narendra Modi and Prime Minister of Mauritius, Pravind Jugnauth.

The theme of this Pravasi Bharatiya Divas was 'Role of Indian Diaspora in building a new India'. On 9th January, 2020, 16th Pravasi Bharatiya Divas was celebrated.

141. Which one of the following cities was named by UNESCO as World Capital of Architecture for 2020?

- (a) Tokyo
(b) Johannesburg
(c) Rio-de-Janerio
(d) New Delhi

- ⊗ (c) Rio-de-Janerio (Brazil) was named by UNESCO as World Capital of Architecture for 2020. Rio-de-Janerio will be hosting the World Congress of the International Union of Architects in July, 2020.
- 142.** Who among the following was named ICC's emerging player of the year 2018?
 (a) Rishabh Pant (b) Josh Hazlewood
 (c) Hasan Ali
 (d) Mustafizur Rahman
- ⊗ (a) India's fast-rising wicket keeper batsman Rishabh Pant was on Tuesday named the International Cricket Council's emerging player of the year in the world body's annual awards. The 21 year old Pant was picked by the ICC's voting academy for a stellar show in his break through test you in 2018.
- 143.** India's first private sector Howitzer gun-making unit is located at
 (a) Jamshedpur (b) Kolkata
 (c) Hazira (d) Gwalior
- ⊗ (c) India's first private sector Howitzer gun-making unit is located at Hazira in Surat (Gujarat). It was inaugurated by the Prime Minister Narendra Modi on 19th January, 2019 as India's first Armoured System Complex (ASC). It is built by a private company-Larsen and Toubro (L & T).
- 144.** Which of the following pairs of old names and new names of islands in India is/are correctly matched?
 1. Ross Island-Shaheed Dweep
 2. Neil Island-Netaji Subhas Chandra Bose Dweep
 3. Havelock Island-Swaraj Dweep
Select the correct answer using the codes given below.
 (a) 1, 2 and 3 (b) 2 and 3
 (c) 1 and 2 (d) Only 3
- ⊗ (d) Ross, Neil and Havelock Islands have been renamed on 75th anniversary of freedom fighter Subhash Chandra Bose. *The new names of these islands are as follows:*
 Ross Island — Netaji Subhash Chandra Bose Dweep
 Neil Island — Shaheed Dweep
 Havelock Island — Swaraj Dweep
 Hence option (d) is correct.
- 145.** Who among the following was posthumously conferred with the Ashoka Chakra, India's highest peacetime gallantry award, in 2019?
 (a) Jyoti Prakash Nirala
 (b) Nazir Ahmad Wani
 (c) Hangpan Dada
 (d) Mohan Nath Goswami
- ⊗ (b) Lance Naik Nazir Ahmad Wani was posthumously conferred with the Ashoka Chakra, India's Highest Peacetime Gallantry Award, in 2019. He is the first recipient of the Ashoka Chakra award from Kashmir region of the Indian State Jammu and Kashmir. He was from Jammu and Kashmir Light Infantry of the Indian Army.
- 146.** As per the code of the nomenclature, which one of the following is the correct way of writing a biological name?
 (a) *Amoeba Proteus*
 (b) *Amoeba proteus*
 (c) *amoeba proteus*
 (d) *Amoeba Proteus*
- ⊗ (b) Name written in option (b), i.e. *Amoeba proteus* is the correct way of writing biological name of *Amoeba*. The first name represents genus and its first letter is capital. The second name represents species and its first letter is small. Both names are underlined separately when hand written and written in Italics when typed.
- 147.** Which one of the following statements regarding electrocardiogram is correct?
 (a) Electrocardiogram is graphical representation of electrical activity of cornea
 (b) Electrocardiogram is graphical representation of activity of kidney
 (c) Electrocardiogram is graphical representation of activity of brain
 (d) Electrocardiogram is graphical representation of electrical activity of heart
- ⊗ (d) Statement (d) is correct regarding *electrocardiography*. Electrocardiogram is graphical representation of electrical activity of heart. Electrodes are placed on patient's limbs and on the surface of the chest and connected to a machine called electrocardiograph. It detects any abnormality in the functioning of the heart.
- 148.** Which one of the following statements regarding penicillin is correct?
 (a) Penicillin resistant bacteria can store this antibiotic in vacuole
 (b) Penicillin resistant bacteria can degrade this antibiotic by an enzyme called β -lactamase
 (c) Penicillin resistant bacteria can degrade this antibiotic by an enzyme called lactic acid dehydrogenase
 (d) Penicillin is not absorbed by bacteria, so most bacteria are resistant
- ⊗ (b) Statement (b) regarding penicillin is correct. The bacteria which produce enzyme β -lactamase can degrade penicillin. Most of the bacteria are sensitive for penicillin as it interferes cell wall synthesis.
- 149.** Which one of the following organelles of mammalian cell is rich in hydrolytic enzymes?
 (a) Mitochondria (b) Ribosomes
 (c) Lysosome (d) Nucleus
- ⊗ (c) Cell organelle **lysosome** is rich in hydrolytic enzymes. These enzymes degrade the cell debris and recycle its components within the cells. **Mitochondria** is powerhouse of the cell. **Ribosomes** are called protein factory. **Nucleus** is referred as head of the cell which controls all cellular activities.
- 150.** Which one of the following statements regarding cholera is correct?
 (a) Cholera is a disease that causes loss of memory
 (b) Cholera is a disease of muscles due to consumption of alcohol
 (c) Cholera is a disease due to the consumption of contaminated food or water
 (d) Cholera is a genetic disease
- ⊗ (c) Statement (c) regarding cholera is correct. It is a waterborne disease and also spread through contaminated food. It is caused by bacterium *Vibrio cholerae*. Cholera does not cause loss of memory. The consumption of alcohol does not cause cholera and it does not affect the functioning of muscles. This is also not a hereditary disease. Hence, statement (c) is correct, rest of the statements are incorrect.