PART-A-PHYSICS

SECTION-I(A)

1) sin15° cos15° is equal to

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

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

(C) $\frac{1}{4}$

(D) $\frac{1}{12}$

2) Angle between minute hand & hour hand at 9 : 40 is

(A) 30°

(B) 60°

(C) 50°

(D) 45°

3) If $\vec{A}$ and $\vec{B}$ are two non–zero vectors such that $|\vec{A}+\vec{B}| = \frac{|\vec{A}-\vec{B}|}{2}$ and $|\vec{A}| = 2|\vec{B}|$ then the angle between $\vec{A}$ and $\vec{B}$ is :

(A) 37º

(B) 53º

(C) $\cos^{-1}(-3/4)$

(D) $\cos^{-1}(-4/3)$

4) The resultant of $\vec{A}$ and $\vec{B}$ makes an angle α with $\vec{A}$ and β with $\vec{B}$. [Given : $|\vec{A}| = A \& |\vec{B}| = B$]

(A) α < β

(B) α < β if A < B

(C) α < β if A > B

(D) α < β if A = B

5) The ratio of maximum and minimum magnitudes of the resultant of two vectors $\vec{A}$ and $\vec{B}$ is 3:2. The relation between A and B is

(A) A = 5B

(B) 6A = B

(C) A = 3B

(D) A = 4B

6) The minimum value of dot product of two vectors of magnitudes 3 units and 5 units will be

(A) 15

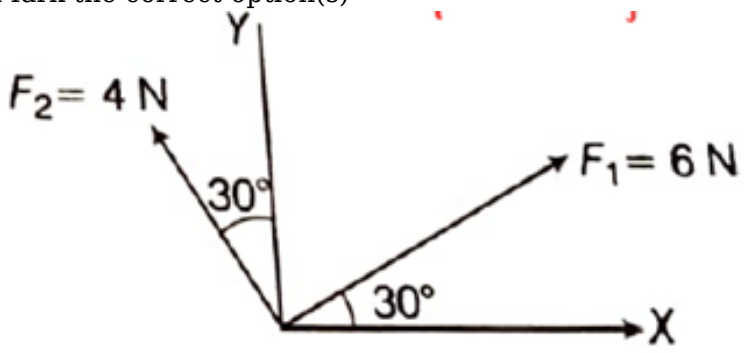
(B) –15

(C) 20

(D) zero

SECTION-I(B)

1) Mark the correct option(s)



(A) The x-component of F_1 is $3\sqrt{3}$ N

(B) The x-component of F_2 is –2 N

(C) The magnitude of resultant force is $\sqrt{52}$ N

(D) None of the above

2) What is necessary condition for equal vectors :-

(A) Two vectors must be parallel

(B) Two vectors must represent same physical quantity

(C) Two vectors must have same magnitude.

(D) Two vectors must not represent same physical quantities.

3) A vector when added to the resultant of $\vec{A} = 3\hat{i} - 5\hat{j} + 7\hat{k}$ and $\vec{B} = 2\hat{i} + 4\hat{j} - 3\hat{k}$ gives a unit vector along y-direction. The vector is

(A) $-5\hat{i} + 2\hat{j} - 4\hat{k}$

(B) $5\hat{i} - 2\hat{j} + 4\hat{k}$

(C) $-5\hat{i} - 2\hat{j} + 4\hat{k}$

(D) $-5\hat{i} - 2\hat{j} - 4\hat{k}$

4) Four pairs of force vectors are given, which pair of force vectors cannot be added to give a resultant vector of magnitude 10 N :-

(A) 2N, 13 N

(B) 7N, 8N

(C) 5N, 16 N

(D) 100 N, 105 N

5) $A = \frac{B}{C} + \frac{(D+E)}{F} + \frac{G(H-I)}{(J+K)}$ Where A, B, C, D, E, F, G, H, I, J & K are physical quantities. Which of the following statement(s) are correct ?

(A) $[A] = \left[\frac{B}{C}\right]$

(B) $[A] = \left[\frac{G.I}{K}\right]$

(C) $\left[\frac{D}{F}\right] = \left[\frac{G \cdot H}{J}\right]$

(D) $[BC] = \left[\frac{G}{K}\right]$

6) If the distance covered is zero, the displacement :

(A) must be zero

(B) may or may not be zero

(C) cannot be zero

(D) depends upon the particle

SECTION-III

1) Viscous force acting on a spherical ball is given by F = 6πηrv, where r is radius of the ball, v is the velocity of the ball & η is coefficient of viscosity. Dimension formula of η is given by $[\eta] = M^aL^{-b}T^{-c}$. Find the value of a + b + c.

2) A dust particle oscillates in air with a time period which depends on atmospheric pressure P, density of air d and energy of particle E. Time period is proportional to $(P)^a$ $(d)^b$ $(E)^c$. Find the value of (–6a + 2b + 3c).

3) Force acting on a particle is 5N. If unit of length and time are doubled and unit of mass is halved then one tenth of the numerical value of the force in the new system will be

4) If mass is expressed as v^x d^y a^z where v is velocity; d is density and a is acceleration then the value of x + y + z is

5) Energy of body is simple harmonic motion depends upon mass (m), frequency (f) and amplitude (A).
As $E \propto m^a f^b A^c$ then 2a + b + c is _____.

PART-B-CHEMISTRY

SECTION-I(A)

1) Find out the % by mass of Ca in 137 g of $CaCO_3$.

(A) 40%
(B) 60%
(C) 29.197%
(D) 45%

2) A gas is found to have the formula $(CO)_x$. It's Vapour Density is 70. The value of x must be :-

(A) 7
(B) 4
(C) 5
(D) 6

3) For the reaction : $A + 2B \rightarrow C$
5 mole of A and 8 mole of B will produce -

(A) 5 mole of C
(B) 4 mole of C
(C) 8 mole of C
(D) 13 mole of C

4) A sample of protein was analysed for metal content and analysis revealed that it contains magnesium and titanium in equal amounts, by mass. If these are the only metallic species present in the protein and it contains 0.004% metal by mass, the minimum possible molar mass of the protein is : [Mg = 24, Ti = 48]

(A) 6×10^5
(B) 1.5×10^5
(C) 3×10^5
(D) 24×10^5

5) From 2 mg calcium, 1.2×10^{19} atoms are removed. The number of g-atoms of calcium left is (Ca = 40, $N_A = 6 \times 10^{23}$)

(A) 5×10^{-5}
(B) 2×10^{-5}
(C) 3×10^{-5}
(D) 5×10^{-6}

6) For the reaction,

$2x + 3y + 4z \rightarrow 5w$
Initially 1 mole of x, 3 mole of y and 4 mole of z is taken. If 1.25 mole of w is obtained then % yield of this reaction is

(A) 50

(B) 25

(C) 15

(D) 100

SECTION-I(B)

1) Solution(s) having 40 g NaOH is / are

(A) 50 g 80% (w/w) NaOH

(B) 50 g 80% (w/v) NaOH [$d_{soln.}$ = 1.2 g/ml]

(C) 50 g 20 M NaOH [$d_{soln.}$ = 1 g/ml]

(D) 50 g 5 molal NaOH

2) A solution of C_2H_5OH & water contains 54% water by mass, then which option(s) are correct for the given solution -
[Given density of solution = 1 gm/ml]

(A) $\text{Molality}_{(C_2H_5OH)} = 18.52$

(B) $\%\ w/w_{(C_2H_5OH)} = 46$

(C) $X_{(C_2H_5OH)} = 0.25$

(D) $\%\ w/v_{(C_2H_5OH)} = 46$

3) PF_3 reacts with XeF_4 to give PF_5.
$2PF_3(g) + XeF_4(s) \rightarrow 2PF_5(g) + Xe(g)$
If 100.0 g of PF_3 and 50.0 gm of XeF_4 react, then which of the following statement(s) is/are correct?
(Xe = 131, P = 31)

(A) XeF_4 is the limiting reagent.

(B) PF_3 is the limiting reagent.

(C) 1.0137 mol of PF_5 are produced.

(D) 0.482 mol of PF_5 are produced.

4) The number of g-atom of oxygen in its 8 g oxygen atoms is equal to number of g-atom in
[At mass of Mg = 24, Fe = 56, Ca = 20, Hg = 200] :

(A) 12 g Mg

(B) 3.01×10^{22} atoms of He

(C) 20 g Ca

(D) 5.6 □ HCl(g) at 1 atm and 273 K

5) 5.6 g N_2 and 0.6 g H_2 is taken to react and form NH_3

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
CORRECT statements is/are -

(A) $H_2(g)$ is limiting reactant

(B) 2.8 g $N_2(g)$ is left

(C) 3.4 g $NH_3(g)$ is formed

(D) 1.7 g $NH_3(g)$ is formed

6) Which of the following pertains to the statement: "one-half mole of hydrogen peroxide, H_2O_2" ?

(A) 1 mole of H atoms

(B) 6.0×10^{23} oxygen atoms

(C) 3.0×10^{23} H_2O_2 molecules

(D) 17 grams of H_2O_2

SECTION-III

1) Calculate mass of phosphoric acid (in gm) required to obtain 29.06g pyrophosphoric acid.
$2H_3PO_4 \rightarrow H_4P_2O_7 + H_2O$
phosphoric acid pyrophosphoric acid
(Round off to closest integer and fill the sum of digits of your answer in OMR sheet. e.g. if your answer is 22 then fill the same as 2 + 2 = 4)

2) Calculate the total moles of atoms of each element present in 122.5 g of $KClO_3$.

3) 20 mol of N_xH_y gas is decomposed completely into 20 mol N_2 and 40 mol H_2 gases. The value of (x + y) is.

4) 40 mg of gaseous substance (X_2) occupies 4.8 mL of volume at 1 atm and 27°C. Atomic mass of element X is : (R = 0.08 atm L/mole-K)
(Fill the sum of digits of your answer in OMR sheet. e.g. if your answer is 1233 then fill the same as 1+2+3+3 = 9)

5) Calculate the number of Na^+ ion present in 710 mg of Na_2SO_4 in aqueous solution.
"($N_A = 6 \times 10^{23}$)"
If your answer is x × 10^y then fill 'x' in OMR. Where 'x' is single digit number.

PART-C-MATHEMATICS

SECTION-I(A)

1) If $(x - y)^3 + (y - z)^3 + (z - x)^3 = k(x - y)(y - z)(z - x)$, the value of k is

(A) 2

(B) 3

(C) 4

(D) 5

2) If $\frac{x^2+6x-7}{x^2+1} \leqslant 2$ then x belongs to ?

(A) $(3, \infty)$

(B) $[2, \infty)$

(C) $(-\infty, \infty)$

(D) ϕ

3) If $x + \frac{1}{x} = 3$. Find the value of $x^3 + \frac{1}{x^3}$:

(A) 9

(B) 18

(C) 27

(D) 6

4) In a group of 40 students, 26 take tea, 18 take coffee and 8 take neither of the two, how many take only tea or only coffee?

(A) 5

(B) 12

(C) 20

(D) 32

5) If $(x + 1)^4 (x - 2)^3 \leq 0$, then $x \in$ _____

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

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

(C) R

(D) [-1, 2]

6) Let $P(x) = 7x^4 + 8x^2 - 3x + \lambda$, when divided by x + 1 gives remainder 3 then λ is :

(A) 12

(B) 15

(C) -15

(D) -12

SECTION-I(B)

1) If $x+\frac{1}{x}=3$ (x is real number) then value of $x^2-\frac{1}{x^2}$ is/are equal to

(A) $3\sqrt{5}$
(B) $-5\sqrt{3}$
(C) $-3\sqrt{5}$
(D) $5\sqrt{3}$

2) Value(s) x of satisfying the equation $|x-3|^{x^2+17} = |x-3|$ is/are -

(A) 2
(B) 3
(C) 4
(D) -4

3) $x^2-3|x|+2=0$

(A) Number of real values of x satisfying given equation is 2.
(B) Sum of all real values of x satisfying given equation is 3.
(C) Product of all real values of x satisfying given equation is 2.
(D) Product of all real values of x satisfying given equation is 4.

4) Which of the following statement are true

(A) The sum of a rational number with an irrational number is always irrational.
(B) The product of two rational numbers is always rational.
(C) The product of two irrational numbers is always irrational.
(D) The sum of two rational is always rational.

5) If A, B be any two sets, then (A ∪ B)' is equal to-

(A) A' ∩ B'
(B) U – (A ∪ B)
(C) ((A – B) ∪ (B – A))'
(D) A' ∩ (U – B)

6) Which of the following is/are true ?

(A) $(A\cup B)-(A\cap B)=(A-B)\cup(B-A)$
(B) $A\subseteq B\Leftrightarrow B'\subseteq A'$
(C) $A\cap(A\cup B)=\phi$
(D) None of these

SECTION-III

1) The number of positive integral solutions of $\frac{x^2(3x-4)^3(x-2)^4}{(x-5)^5.(2x-7)^6} \leqslant 0$ is

2) If $(x^4 + 5x^2 + 7x - 8)$ is divided by $(x - 1)$ then remainder is 'a' and when divided by $(x + 2)$ then remainder is 'b' then value of $(b - a)$ is

3) If $x = \sqrt{\frac{5+2\sqrt{6}}{5-2\sqrt{6}}}$. Find the value of $x^2(x - 10)^2$.

4) The number of possible ordered pairs (x,y) (where x and y are integers) which satisfy $xy - 2x - y - 4 = 0$ is (are)

5) If set A = {a,b,c,d,e,f} then total number of subsets of A is n^2, then n is

ANSWER KEYS

PART-A-PHYSICS

SECTION-I(A)

Q.	1	2	3	4	5	6
A.	C	C	C	C	A	B

SECTION-I(B)

Q.	7	8	9	10	11	12
A.	A,B,C	A,B,C	A	A,C	A,B,C	A

SECTION-III

Q.	13	14	15	16	17
A.	3	7	2	4	6

PART-B-CHEMISTRY

SECTION-I(A)

Q.	18	19	20	21	22	23
A.	A	C	B	D	C	A

SECTION-I(B)

Q.	24	25	26	27	28	29
A.	A,C	A,B,C,D	A,D	A,C,D	A,B,C	A,B,C,D

SECTION-III

Q.	30	31	32	33	34
A.	5	5	6	1	6

PART-C-MATHEMATICS

SECTION-I(A)

Q.	35	36	37	38	39	40
A.	B	C	B	C	A	C

SECTION-I(B)

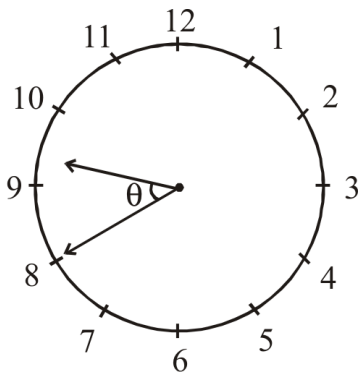
Q.	41	42	43	44	45	46
A.	A,C	A,B,C	D	A,B,D	A,B,D	A,B

SECTION-III

Q.	47	48	49	50	51
A.	3	9	1	8	8

SOLUTIONS

PART-A-PHYSICS



2)

$$\theta = 30 + \left(\frac{30}{60} \times 40\right) = 50$$

3)

JA11PHVE01SCE
JA11PHVE01SCE

7)

(1) The x-component of F_1 is

$$F_1\cos 30^\circ = 6\cos 30^\circ = 6 \times \frac{\sqrt{3}}{2} = 3\sqrt{3}\text{N}$$

(2) The x-component of F_2 is

$$-F_2\sin 30^\circ = -4 \times \frac{1}{2} = -2\text{N}$$

(3) Here, sum of x-component of forces

$$F_x = 6\cos 30^\circ - 4\sin 30^\circ = \left(3\sqrt{3} - 2\right)\text{N}$$

And the sum of y-component of forces is

$$F_y = 6\sin 30^\circ + 4\cos 30^\circ = \left(3 + 2\sqrt{3}\right)\text{N}$$

The magnitude of resultant is

$$F = \sqrt{F_x^2 + F_y^2} = \sqrt{52}\text{N}$$

9) Given $\vec{A} + \vec{B} + \vec{C} = 1\hat{j}$

So $3 + 2 + C_x = 0$ and $-5 + 4 + C_y = 1$

and $7 - 3 + C_z = 0$

$\Rightarrow \vec{C} = C_x\hat{i} + C_y\hat{j} + C_z\hat{k}$

$= -5\hat{i} + 2\hat{j} - 4\hat{k}$

10) for (A) $11\ \text{N} \le F \le 15\ \text{N}$

for (B) 1 N ≤ F ≤15 N
for (C) 11 N ≤ F ≤ 21 N

for (D) 5 N ≤ F ≤ 205 N

11)

Dimension of quantities in addition and subtraction will be same.

13) $F = 6\pi \eta r v$
$\Rightarrow [\eta] = [F][r]^{-1}[v]^{-1}$
$= [M^1L^1T^{-2}][L^{-1}][L^{-1}T^1] = [M^1L^{-1}T^{-1}]$
$\Rightarrow a + b + c = 3$

14)

$T=k[P]^x[d]^y[E]^z = k[ML^{-1}T^{-2}]^x[ML^{-3}]^y[ML^2T^{-2}]^2$
$M^0L^0T^1 = k[M]^{x+y+z}[L]^{-x-3y+2z}[T]^{-2x-2z}$
on comparing
$x + y + z = 0$ .....(i)
$-x - 3y + 2z = 0$ .....(ii)
$-2x - 2z = 1$ .....(iii)

16)

$m = R\, v^x\, d^y\, a^z$ (where k is dimensionless)
$[M] = [LT^{-1}]^x\, [ML^{-3}]^y\, [LT^{-2}]^z$
Solve for x, y and z.

17)

$E = M^aL^bA^c$
$ML^2T^{-2} = M^a(T^{-1})^b[L]^c$
a = 1
-b = -2 ; b = 2 ; c = 2
2a + b + c = 2 + 2 + 2 = 6

PART-B-CHEMISTRY

21) We have to find, minimum possible molar mass of protein :
Equal mass of Mg and Ti
It means, 1 mole of protein contains,
2 mole of Mg and 1 mole of Ti
2 mole of Mg = 24 × 2 = 48 g
1 mole of Ti = 1 × 48 = 48 g
Total mass of metal = (48 + 48)g = 96 g

$\therefore$ % Mass of metal $= \frac{\text{Mass of metal}}{\text{Molar mass of protein}} \times 100$

$\Rightarrow 0.008 = \frac{96}{\text{MM of protein}} \times 100$

 Molar mass of protein = 1200000 g/mole

Ans. (D)

26)

$$2PF_3 + XeF_4 \longrightarrow 2PF_5(g) + Xe(g)$$

$$\frac{100}{88} \quad \frac{50}{207}$$

Stoichiometric amount $(S.A)_{XeF_3} = \frac{100}{2\times 88} = 0.516\,\text{mol}$

Stoichiometric amount $(S.A)_{XeF_4} = \frac{50}{207} = 0.241$

XeF_4 has least stoichiometric amount so XeF_4 limiting reagent.

Moles of PF_5 formed $= 2 \times \frac{50}{207}\,\text{mol}$

= 0.482 mol

29)

In $\frac{1}{2}$ mole of H_2O_2

(A) moles of H atoms $= \frac{1}{2} \times 2 = 1$

(B) Number of O atoms $= \frac{1}{2} \times 2 \times 6.0 \times 10^{23} = 6.0 \times 10^{23}$ atoms

(C) Number of H_2O_2 molecules $= 3.0 \times 10^{23}$

(D) Mass of mol $H_2O_2 = \frac{1}{2} \times 34 = 17g$

30)

$$2H_3PO_4 \longrightarrow H_4P_2O_7 + H_2O$$

$$\underbrace{2\times 0.3}_{0.6\,\text{moles}} \qquad 53.4\ \text{gm}$$

$$= \frac{53.4}{178}\,\text{moles}$$

= 0.3 moles

Mass of H_3PO_4 = 0.6 × 98 = 58.80

≃ 59(round off)

31)

$$n_{KClO_3} = \frac{122.5}{122.5} = 1$$

Moles of atoms = 1 + 1 + 3 = 5

33) Molar mass of $X_2 = 2M_x$

$$PV = \frac{W}{M}RT$$

$$1 \times \frac{4.8}{1000} = \frac{40 \times 10^{-3}}{2M_x} \times 0.08 \times 300$$

$M_x = 100$

Sum of digit = 1 + 0 + 0 = 1

34)

$$n_{Na_2SO_4} = \frac{710 \times 10^{-3}}{142} = 5 \times 10^{-3}$$

no of Na^+ ions = $2 \times 5 \times 10^{-3} \times 6 \times 10^{23}$

$= 6 \times 10^{21}$

PART-C-MATHEMATICS

35)

$(x - y)^3 + (y - z)^3 + (z - x)^3$

Let $a = x - y$, $b = y - z$, $c = z - x$

$a + b + c = 0$

So $a^3 + b^3 + c^3 - 3abc = (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ca) = 0$

$\Rightarrow a^3 + b^3 + c^3 = 3abc$

$\Rightarrow (x-y)^3 + (y - z)^3 + (z - x)^3 = 3(x - y)(y - z)(z - x)$

37)

$$x + \frac{1}{x} = 3$$

$$\Rightarrow x^3 + \frac{1}{x^3} + 3x.\frac{1}{x}\left(x + \frac{1}{x}\right) = 27$$

$$x^3 + \frac{1}{x^3} = 18$$

38)

$n(U) = 40 \quad n(T) = 20, n(C) = 18$

$n(T' \cap C') = 8$

$\Rightarrow n(T \cup C)' = 8$

$\Rightarrow n(U) - n(T \cup C) = 8$

$\Rightarrow n(T \cup C) = 32$

$\Rightarrow n(T) + n(C) - n(T \cap C) = 32$

$n(T \cap C) = 12$

Number of students who takes only tea or only coffee = 32 – 12 = 20.

40) P(–1) = 3

$7 + 8 + 3 + \lambda = 3$

$\lambda = -15$

42)

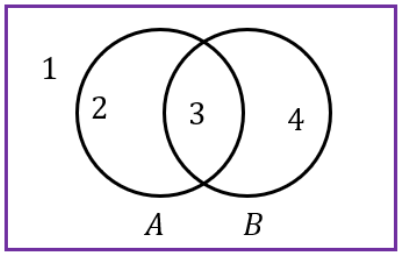
$x^2 + 17 = 1$ (not possible)

$|x - 3| = 1 \Rightarrow x - 3 = \pm 1 \Rightarrow x = 4,2$
$|x - 3| = 0 \Rightarrow x = 3$
So possible values of X are 4, 2 and 3.

44)

(A) $(1 + \sqrt{3}) + 1 = 2 + \sqrt{3}$ {So (A) is true}
(B) $2 \times 3 = 6$ {So (B) is true}
(C) $(\sqrt{3} + 1)(\sqrt{3} - 1) = 2$ {So (C) is not true}
(D) $2 + 3 = 5$ {So (D) is true}

45)



$(A \cup B)' = (1)$
(A) $A' = (1), (4)$
$B' = (1), (2)$
(B) $U - (A \cup B) = (1)$
(C) $A - B = (2)$, $B - A = (4)$
$((A - B) \cup (B - A))' = (1), (3)$
(D) $A' = (1), (4)$
$A' \cap (U - B) = (1)$

47)

$$\frac{x^2(3x-4)^3(x-2)^4}{(x-5)^5(2x-7)^6} \leqslant 0$$
$$\Rightarrow x \in \left[\frac{4}{3}, \frac{7}{2}\right) \cup \left(\frac{7}{2}, 5\right) \cup \{0\}$$

48) $f(x) = x^4 + 5x^2 + 7x - 8$
$a = f(1) = 5$

$b = f(-2) = 14$

49)

$$x = \sqrt{\frac{(5 + 2\sqrt{6})^2}{25 - 24}} = 5 + 2\sqrt{6}$$
$x - 10 = 2\sqrt{6} - 5 \Rightarrow 10 - x = 5 - 2\sqrt{6}$

$x^2(x-10)^2 = \left((5+2\sqrt{6})^2(5-2\sqrt{6})\right)^2 = (25-24)^2 = 1$

50)

$xy - 2x - y - 4 = 0$

$y = \frac{2x+4}{x-1} = 2 + \frac{6}{x-1}$

$\Rightarrow x - 1 = -1,1,-2,2,-3,3,-6,6$

Thus number of possible ordered pairs is 8.

51)

Number of subsets = $2^6 = 64$