**PART (A) : PHYSICS**

**SECTION-I : (SINGLE ANSWER CORRECT TYPE)**

This section contains 20 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONLY ONE is correct.

1. A man of mass $m$ is standing on a plank of mass $M$ kept on a rough surface. When the man walks from left to right on the plank, the centre of mass (man + plank) of the system:
   (A) remains stationary
   (B) shift towards left
   (C) shift towards right
   (D) shifts towards right if $M > m$ and toward left if $M < m$

2. A stationary pulley carries a rope one end of which supports a ladder with a man and the other a counter weight of mass $M$. The man of mass $m$ climbs up a distance $l$ w.r.t. the ladder and then stops. The displacement of the centre of mass of this system is:
   (A) $\frac{ml}{M + m}$
   (B) $\frac{ml}{2M}$
   (C) $\frac{ml}{M + 2m}$
   (D) $\frac{ml}{2M + m}$

2. (B)

Mass of man = $m$
Mass of ladder = $M - m$

$$\Delta x_{CM} = \frac{Mx - (M - m)x + ml(l - x)}{2m}$$

$$= \frac{mx + ml - mx}{2M} = \frac{ml}{2M}$$

3. A particle is projected at an angle $37^\circ$ with the inclined plane in upward direction with speed 10 m/s. The angle of inclined plane is given as $53^\circ$. Then the maximum distance from the inclined plane attained by the particle will be –
   (A) 4 m
   (B) 5 m
   (C) 3 m
   (D) 1 m

3. (C)

$$OB = \frac{u^2}{2g} = 5cm$$

$$\therefore AB = OB \sin 37^\circ = 3m.$$
4. In the arrangement shown, a bar $AB$ is connected through a rotating drum via a massless string which is attached to the end $B$ of the bar. The portion of the rod near end $A$ rests on a horizontal surface. The drum rotates with a uniform angular speed $\omega_0$. The angular speed of bar $AB$ at given position is

(A) $\frac{\omega_0 r x}{\sqrt{x^2 + h^2}}$

(B) $\frac{\omega_0 r h}{(x^2 + h^2)}$

(C) $\frac{\omega_0 r h}{\sqrt{x^2 + h^2}}$

(D) $\frac{\omega_0 r x}{(x^2 + h^2)}$

4. (B)

$$\omega_{AB} = \frac{v \sin \theta}{CB} = \frac{\omega_0 r h}{(x^2 + h^2)}$$

5. Two blocks A and B of masses 4 kg and 8 kg respectively are placed on a smooth plane surface. A force $F$ of 12 N is applied on A as shown. Find the force of contact (in N) between A and B?

(A) 8 N  

(B) 6 N  

(C) 10 N  

(D) None of these

5. (A)

$$F = 12N$$

$$a = \frac{F}{M} = \frac{12}{8 + 4} = 1m/s^2$$

$$12N$$

$$\Rightarrow 12 - N_{AB} = 4 (1)$$

$$\Rightarrow 12 - N_{AB} = 4 (1)$$

$$N_{AB} = 8N$$
6. A body of mass $8 \text{ kg}$ is hanging from another body of mass $12 \text{ kg}$. The combination is being pulled by a string with an acceleration of $2.2 \text{ m/s}^2$. The tension $T_1$ and $T_2$ will be respectively: (use $g = 9.8 \text{ m/s}^2$)

(A) $200 \text{ N}, 80 \text{ N}$
(B) $220 \text{ N}, 90 \text{ N}$
(C) $240 \text{ N}, 96 \text{ N}$
(D) $260 \text{ N}, 96 \text{ N}$

6. (C)

\[ T_2 = 8 \times 2.2 + 8 \times 9.8 = 96 \text{ N} \]
\[ T_1 - 12g - T_2 = 12a \]
\[ T_1 = 12 \times 2.2 + 12 \times 9.8 + 96 \]
\[ T_1 = 240 \text{ N} \]

7. 8 small cubes of length $\ell$ are stacked together to form a single cube. One cube is removed from this system. The distance between the centre of mass of remaining 7 cubes and the original system is:

(A) $\frac{7\sqrt{3}\ell}{16}$
(B) $\frac{\sqrt{3}\ell}{16}$
(C) $\frac{\sqrt{3}\ell}{14}$
(D) zero

7. (C)

\[ 7M \left( x\hat{i} + y\hat{j} + z\hat{k} \right) = M \left( \frac{\ell}{2}\hat{i} + \frac{\ell}{2}\hat{j} + \frac{\ell}{2}\hat{k} \right) \]

Shifting \( = \sqrt{x^2 + y^2 + z^2} = \frac{\sqrt{3}\ell}{14} \)

8. Two blocks of masses $m_1$ and $m_2$ are connected as shown in the figure. The acceleration of the block $m_2$ is (pulleys and strings are ideal):
Major Test - 2 (Main)  

Physics (Code : 1)

\[
\text{(A) } \frac{m_2 g}{m_1 + m_2} \\
\text{(B) } \frac{m_1 g}{m_1 + m_2} \\
\text{(C) } \frac{4m_2 g - m_1 g}{m_1 + m_2} \\
\text{(D) } \frac{m_2 g}{m_1 + 4m_2}
\]

8. \text{(A)}

Let \( a \) = acceleration of \( m_1 \)

Then acceleration of pulley \( = \frac{a + 0}{2} = \frac{a}{2} \)

If acceleration of \( m_2 = b \)

Then \( 0 + \frac{b}{2} = \frac{a}{2} \)

Hence \( a = b \)

\( T = m_1 a, m_2 g - T = m_2 a \)

\[ a = \frac{m_2 g}{m_1 + m_2} \]

9. V-T diagram for a process of a given mass of an ideal gas is as shown in the figure. During the process, pressure of gas :-

(A) first increases then decreases

(B) continuously decreases

(C) continuously increases

(D) first decreases then increases

9. \text{(B)}

\[ V = KT + C \]

\[ P = \frac{nRT}{V} \]

\[ \Rightarrow P = \frac{nRT}{KT + C} \Rightarrow \frac{dP}{dT} = \frac{nRC}{(KT + C)^2} \]

As \( C < 0 \) by diagram

\[ \frac{dP}{dT} < 0 \text{ for all } T \]

\[ \Rightarrow P \text{ continuously decreases.} \]

10. Q amount of heat is given to 0.5 mole of an ideal monoatomic gas by processes \( TV^n = \text{constant} \). Following graph shows variation of temperature with Q. Find the value of \( n \).
10. (B) 
\[ \Delta Q = \Delta U + \Delta W \]
\[ \Delta Q = \frac{f}{2} nR \Delta T + \frac{nR \Delta T}{1-n_0} \]
\[ 15 \times 10^3 = \frac{3}{2} \times \frac{1}{2} \times \frac{25}{3} \times 200 + \frac{0.5 \times 25/3 \times 200}{1-n_0} \]
\[ 150 = \frac{25}{2} + \frac{25}{3(1-n_0)} \]
\[ 6 = \frac{1}{2} + \frac{1}{3(1-n_0)} \]
\[ 5.5 = \frac{1}{3(1-n_0)} \]
\[ 16.5 - 16.5n_0 = 1 \]
\[ -16.5n_0 = -15.5 \]
\[ n_0 = \left( \frac{155}{165} \right) \]
\[ TV_n^{-1} = \text{constant} \]
\[ n_0 - 1 = n \]
\[ \frac{155}{165} - 1 = n \]
\[ \frac{-1}{165} = n \]
\[ n = \left( \frac{-2}{33} \right) \]

11. The internal energy of an ideal gas in an adiabatic process is given by \( U = a + bPV \), Find \( \gamma \):-
   (A) \( \frac{a+1}{a} \)  (B) \( \frac{b+1}{b} \)  (C) \( \frac{b+1}{a} \)  (D) \( \frac{a}{b+1} \)

11. (B)
\[ U = a + bPV = a + bnRT \]
\[ \Rightarrow \Delta U = bnR \Delta T = nC_v \Delta T \]
\[ \Rightarrow C_v = bR \Rightarrow C_p = bR + R \]
\[ \Rightarrow \gamma = \frac{C_p}{C_v} = \frac{bR + R}{bR} = \frac{b+1}{b} \]
12. A gas is expanded from volume $V_0$ to $2V_0$ under three different processes. Process 1 is isobaric process, process 2 is isothermal and process 3 is adiabatic. Let $\Delta U_1, \Delta U_2$ and $\Delta U_3$ be the change in internal energy of the gas in these processes. Then:

(A) $\Delta U_1 > \Delta U_2 > \Delta U_3$
(B) $\Delta U_1 < \Delta U_2 < \Delta U_3$
(C) $\Delta U_2 < \Delta U_1 < \Delta U_3$
(D) $\Delta U_2 < \Delta U_3 < \Delta U_1$

12. (A)
$\Delta U_1 = +ve$
$\Delta U_2 = 0$
$\Delta U_3 = -ve$
$	herefore \Delta U_1 > \Delta U_2 > \Delta U_3$

13. An ideal monoatomic gas undergoes a cycle process $ABCA$ as shown in figure. The ratio of heat absorbed during $AB$ to the work done on the gas during $BC$ is:

(A) $\frac{5}{2\ln 2}$
(B) $\frac{5}{3}$
(C) $\frac{5}{4\ln 2}$
(D) $\frac{5}{6}$

13. (C)
$W_{AB} = (2V_0 - V_0)P_0 = P_0V_0$ [Isobaric process]
$W_{BC} = nR(2T_0)\ln \frac{V_0}{2V_0} = 2P_0V_0\ln 2$ [Isothermal process]

$\therefore \frac{Q_{AB}}{W_{BC}} = \frac{3}{2} \cdot \frac{P_0V_0 + P_0V_0}{2P_0V_0\ln 2} = \frac{5}{4\ln 2}$

14. Logarithms of readings of pressure (in Pa) and volume (in m$^3$) for an ideal gas were plotted on a graph as shown in figure. By measuring the gradient, it can be shown that the gas may be:

(A) Monoatomic and undergoing an adiabatic change
(B) Monoatomic and undergoing an isothermal change
(C) Diatomic and undergoing an adiabatic change
(D) Triatomic and undergoing an isothermal change

14. (C)
$PV^\gamma = C; \ln P + \gamma \ln V = \ln C$
$\Rightarrow \ln P = -\gamma \ln V + \ln C \Rightarrow y = mx + C$
\[ m = -\gamma = \frac{2.10 - 2.38}{1.30 - 1.10} = -1.4 \]

\[ \therefore \text{The gas is diatomic.} \]

15. Particle of mass 100 gm is projected with initial velocity 10 m/s at 53° angle from horizontal. During motion wind opposes in horizontal direction with acceleration \( \frac{g}{2} \). The magnitude of power (in watt) of wind force at which vertical and horizontal velocities are equal, is

\[ (A) \ 0 \quad (B) \ 1 \quad (C) \ 2 \quad (D) \ 3 \]

15. (C)

In vertical direction \( V_y = 8 - gt \)

In horizontal direction \( V_x = 6 - \frac{gt}{2} \)

\[ 8 - gt = 6 - \frac{gt}{2} \]

\[ t = \frac{4}{g} \]

\[ P = FV_x = \left( \frac{mg}{2} \right) \left( 6 - \frac{g}{2} \right) = \left( \frac{mg}{2} \right) \]

\[ = 2mg = 2 \times 10^{-4} \times 10 = 2W \]

16. 2 litre water kept in a kettle is heated by 1 KW power source. Kettle is open and it loses heat at the rate of 160 J/s. The time taken for the temperature of kettle to change from 27°C and 77°C is:

\[ (A) \ 8 \text{ min } 20 \text{ sec} \quad (B) \ 6 \text{ min } 20 \text{ sec} \quad (C) \ 5 \text{ min} \quad (D) \ 7 \text{ min} \]

16. (A)

Rate of heat production = 1000 J/s

Rate of heat loss = 160 J/s

Net heat retained in the kettle per second = \( (1000 - 160) = 840 \ J/s \)

Let \( t \) be the time taken for temperature of the kettle to changes from 27°C to 77°C, then

\[ 840t = \left[ 2000 \times 4.2 (77 - 27) \right] \]

\[ t = \frac{4.2 \times 10^5}{840} = 8 \text{ min } 20 \text{ sec} \]

17. A graph between the velocity and square root of distance travelled by a particle moving along a straight line is shown in the figure. The acceleration of particle is:

\[ (A) \ 2 \text{ m/s}^2 \]

\[ (B) \ 1 \text{ m/s}^2 \]

\[ (C) \ 3 \text{ m/s}^2 \]

\[ (D) \ 4 \text{ m/s}^2 \]

17. (A)

\[ v = \frac{8}{4} \sqrt{s} \]
\[ v = 2\sqrt{s} \]
\[ v^2 = 4S \]
\[ 2v \frac{dv}{ds} = 4 \]
\[ a = \frac{vdv}{ds} = 2\text{m/s}^2 \]

18. A particle moves in xy-plane. The position vector of particle at any time \( t \) is \( \vec{r} = \{(2t)\hat{i} + (2t^2)\hat{j}\} m \).

The rate of change of \( \theta \) at \( t = 2 \) sec, where \( \theta \) is the angle made by the velocity vector from the positive x-axis, is

(A) \( \frac{1}{14} \) rad/sec  
(B) \( \frac{2}{17} \) rad/sec  
(C) \( \frac{4}{7} \) rad/sec  
(D) \( \frac{6}{5} \) rad/sec

18. (B)
\[ \vec{v}(t) = 2\hat{i} + (4t)\hat{j} \]
\[ \therefore \quad \tan \theta = 2t \]
\[ \frac{d\theta}{dt} = \frac{2}{\sec^2 \theta} = \frac{2}{17} \text{rad/sec} \quad \text{(at} \ t = 2 \text{sec}) \]

19. A man is rotating a stone of mass 10 kg tied at the end of a light rope in a circle of radius 1 m. To do this, he continuously moves his hand in a circle of radius 0.6 m. Assume, both circular motions to be occurring in the same horizontal plane. What is the maximum speed with which he can throw the stone, if he can exert a pull not exceeding 1250 N on the string.

(A) \( 10\sqrt{2} \) m/s  
(B) \( 5\sqrt{5} \) m/s  
(C) 10 m/s  
(D) 20 m/s

19. (C)
\[ T \cos \theta = \frac{mv^2}{R} \]
\[ \Rightarrow \quad v = \sqrt{\frac{TR\cos \theta}{m}} = 10 \text{m/s} \]

20. A circular road of radius \( R \) is banked for a speed \( v = 40 \text{ km/hr} \). A car of mass \( m \) attempts to go on the circular road, the friction coefficient between the tyre & road is negligible:

(A) The car cannot make a turn without skidding
(B) If the car runs at a speed less than 40 km/hr, it will slip up the slope
(C) If the car runs at the correct speed of 40 km/hr, the force by the road on the car is equal to \( mv^2/r \)
(D) If the car runs at the correct speed of 40 km/hr, the force by the road on the car is greater than \( mg \) as well as greater than \( mv^2/r \)

20. (D)
Car can make a turn without skidding at 40 km/hr. The car will slip down the slope if it runs at a speed less than 40 km/hr.

\[ N \sin \theta = \frac{mv^2}{r} \quad \text{&} \quad N \cos \theta = mg \]

### SECTION-II : (INTEGER ANSWER TYPE)

This section contains **05 questions.** The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 6.25, 7.00, 0.33, 30.27, 127.30)

21. \(A(3m, 4m)\) and \(B(7m, 1m)\) are two coins on a carrom board. The striker is placed at origin \(O\). If the striker can be shot with a speed of 5 m/sec, then find the minimum time (in sec) taken by striker to become collinear with coin \(A\) and \(B\).

\[ AB = \sqrt{(3-7)^2 + (4-1)^2} = 5 \, \text{m} \]

\[ \frac{1}{2} \times h \times AB = \frac{1}{2} |OA \times OB| \]

\[ \begin{vmatrix} i & j & k \\ 3 & 4 & 0 \\ 7 & 1 & 0 \end{vmatrix} \]

\[ \Rightarrow h = 5 \, \text{m} \]

\[ \therefore \quad t_{\min} = \frac{5}{5} = 1 \, \text{sec} \]
22. The resultant of two vectors $\vec{A} = 5\hat{i}$ and $\vec{B}$ is $\vec{R}$. The direction of $\vec{R}$ is such that it makes an angle $\frac{\pi}{6}$ with the positive $x$-axis in anticlockwise senses. Find the magnitude of $\vec{R}$ if $\vec{B}$ is perpendicular to $\vec{R}$. (Take $\sqrt{3} = 1.732$)

22. (4.33)

From triangular

$R = 5 \cos 30^\circ = \frac{5\sqrt{3}}{2}$

23. A body is projected vertically upwards from the ground with a speed of 20 m/s. After 1 s the body explodes into two parts in the ratio 1 : 3. After explosion the large mass starts moving horizontally. If the maximum height reached by smaller is $19x$ m then find the value of $x$. (Take $g = 10$ m/s$^2$)

23. (5.00)

\[
v = 20 - 10(1) = 10 \text{ m/s}
\]

\[
h = 20(1) - \frac{1}{2} 10(1)^2 = 15 \text{ m}
\]

\[
\text{Just before explosion}
\]

\[
v = 10 \text{ m/s}
\]

\[
u = 20 \text{ m/s}
\]

\[
h = 15 \text{ m}
\]

Conservation of linear momentum, Along vertical direction

\[mv_3 = 4m(10)\]

\[v_3 = 40 \text{ m/s} \Rightarrow H_{\text{max from ground}} = \frac{v_3^2}{2g} + h = \frac{1600}{20} + 15 = 95 \text{ m}\]

$\Rightarrow 19x = 95$ for smaller mass

$x = 5$

24. A particle having mass 1 kg is at origin. At $t = 0$, it is given a velocity of 1 m/s at angle of 30° with $y$-axis in $x$-$y$ plane. It is moved under the influence of a force $\vec{F} = \vec{V} \times \vec{A}$, where $\vec{A}$ is constant vector of magnitude $\pi$ units directed along positive $x$-axis. The $x$-coordinate of particle at $t = 2$ s is: ___ m ($\vec{V}$ - instantaneous velocity)

24. (1.00)
\[ \mathbf{F} = \mathbf{V} \times \mathbf{A} \] is in x-y plane & \( \mathbf{A} \) is along x-direction. So, \( \mathbf{F} \) would be along \( z \) direction. Hence velocity of particle along \( x \)-direction remains same.

\[ X = \mathbf{u}_t \]
\[ = \frac{1}{2} \times 2 = 1 \text{m} \]

25. A gas is taken from State-1 to State-2 along the path shown in the figure. If 70 cal of heat is rejected by the gas in the process. Find the magnitude of change in internal energy (in Joule) of the system. (Take, 1 cal = 4.2 J)

25. (241.50)

We know work done by a gas is given by the area under PV curve or the area between PV-curve and the volume axis. Generally we take in this process volume of gas decreases thus work is done on the gas and it is given as

\[ \Delta W = -\frac{1}{2} \times 1.5 \times 10^{-4} \times (2 + 5) \times 10^5 = -52.5 \text{ Joule} \]

It is given that heat rejected in the process is 70 cal. Thus \( \Delta Q = -70 \text{ cal} = 70 \times 4.2 \text{ J} = -294 \text{ J} \)

Now from first law of the thermodynamics, we have

\[ \Delta Q = \Delta W + \Delta U \]
\[ \Delta U = \Delta Q - \Delta W \]
\[ = (-294) - (-52.5) = -241.5 \text{ J} \]

Thus in the process, internal energy of gas decreases by 241.5 J
PART (B) : CHEMISTRY

SECTION-I : (SINGLE ANSWER CORRECT TYPE)

This section contains 20 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONLY ONE is correct.

26. What is the ratio of time periods (T/\(T_2\)) in second orbit of hydrogen atom to third orbit of He\(^+\) ion?
   (A) 8/27  
   (B) 32/27  
   (C) 27/32  
   (D) None of these

27. A hydrogen atom in the ground state is excited by monochromatic radiation of wavelength \(\lambda\) Å. The resulting spectrum consists of maximum 15 different lines. What is the wavelength \(\lambda\)?
   \((R_H = 109737 \text{ cm}^{-1})\)
   (A) 937.3 Å  
   (B) 1025 Å  
   (C) 1236 Å  
   (D) None of these

28. A gaseous mixture of H\(_2\) and CO\(_2\) gas contains 66 mass % of CO\(_2\). The vapour density of the mixture is:
   (A) 6.1  
   (B) 5.4  
   (C) 2.7  
   (D) 10.8

29. 1 M HCl and 2 M HCl are mixed in volume of ratio of 4 : 1. What is the final molarity of HCl solution?
   (A) 1.5  
   (B) 1  
   (C) 1.2  
   (D) 1.8

30. An open flask containing air is heated from 300 K to 500 K. What percentage of air will be escaped to the atmosphere, if pressure is keeping constant?
   (A) 80  
   (B) 40  
   (C) 60  
   (D) 20

31. In the cyclic process shown in P–V diagram, the magnitude of the work done is:

   ![Diagram](image)

   (A) \(\pi \left(\frac{P_2 - P_1}{2}\right)^2\)  
   (B) \(\pi \left(\frac{V_2 - V_1}{2}\right)^2\)  
   (C) \(\frac{\pi}{4}(P_2 - P_1)(V_2 - V_1)\)  
   (D) \(\pi(V_2 - V_1)^2\)
32. Consider the reaction at 300 K

$$C_6H_6(l) + \frac{15}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l); \Delta H = -3271 \text{ kJ}$$

What is $\Delta U$ for the combustion of 1.5 mole of benzene at 27°C?

(A) $-3267.25 \text{ kJ}$  (B) $-4900.88 \text{ kJ}$  (C) $-4906.5 \text{ kJ}$  (D) $-3274.75 \text{ kJ}$

32. (B)

33. Which of the following conditions regarding a chemical process ensures its spontaneity at all temperature?

(A) $\Delta H > 0$, $\Delta G > 0$  (B) $\Delta H < 0$, $\Delta S > 0$  (C) $\Delta H > 0$, $\Delta S > 0$  (D) $\Delta H > 0$, $\Delta S < 0$

33. (B)

34. IUPAC name of the following molecule is

\[
\text{CH}_2\text{OH} \\
\text{COOH}
\]

(A) 4-Hydroxymethyl-1-carboxy cyclohex-3-ene 
(B) 4-Hydroxymethyl-cyclohex-3-ene-1-carboxylic acid 
(C) 1-Hydroxymethyl-cyclohexene-4-carboxylic acid 
(D) 4-(Hydroxymethyl-cyclohex-3-enyl) methanionic acid

34. (B)

35. Which of the following is hetero cyclic compound?

(A) \[
\begin{array}{c}
\text{O} \\
\text{O}
\end{array}
\]

(B) \[
\begin{array}{c}
\text{O} \\
\text{O} \\
\text{C}
\end{array}
\]

(C) \[
\begin{array}{c}
\text{O} \\
\text{O}
\end{array}
\]

(D) \[
\begin{array}{c}
\text{O} \\
\text{H}
\end{array}
\]

35. (C)

36. The correct structure of 3-formyl-5-oxo cyclohex-3-ene-1-carbonylchloride.

(A) \[
\begin{array}{c}
\text{OHC} \\
\text{Cl} \\
\text{O}
\end{array}
\]

(B) \[
\begin{array}{c}
\text{OHC} \\
\text{Cl} \\
\text{O}
\end{array}
\]
36. (A)

37. In the structure of 4-Isopropyl-2,4,5-trimethyl heptane, number of 1°, 2° & 3° hydrogen are respectively.
   (A) 18, 5, 4       (B) 21, 4, 3       (C) 18, 4, 3       (D) 21, 5, 4
37. (B)

38. Specify the hybridisations of central atom in the following species respectively.
   \{N\_3^+, NOCl, N\_2O\}
   (A) \text{sp, sp}^2, \text{sp} \hspace{1cm} (B) \text{sp, sp, sp}^3 \hspace{1cm} (C) \text{sp}^2, \text{sp, sp} \hspace{1cm} (D) \text{sp}^2, \text{sp}^2, \text{sp}
38. (A)

39. The common features of the species N\_3^+, O\_2 and NO\^- are:
   (A) Bond order three and isoelectronic
   (B) Bond order two and isoelectronic
   (C) Bond order two but not isoelectronic
   (D) None of these
39. (B)

40. Among the following which one will have the largest O—O bond length?
   (A) KO\_2 \hspace{1cm} (B) O\_2 \hspace{1cm} (C) O\_2^{+}[\text{AsF}_5]^- \hspace{1cm} (D) K\_2O\_2
40. (D)

41. Decreasing (–I) effect of given group is:
   (i) \text{–SR}^+ \hspace{1cm} (ii) \text{–NR}_3 \hspace{1cm} (iii) \text{–NH}_2 \hspace{1cm} (iv) \text{–F}
   (A) (iii) > (ii) > (i) > (iv) \hspace{1cm} (B) (ii) > (iii) > (iv) > (i)
   (C) (iii) > (ii) > (iv) > (i) \hspace{1cm} (D) (ii) > (i) > (iv) > (iii)
41. (D)

42. In which of the following species, incorrect direction of inductive effect is shown?
   (A)
   \[
   \begin{array}{c}
   \text{HC} \equiv \text{CH}_2 \\
   \text{F} \\
   \end{array}
   \]
   (B)
   \[
   \begin{array}{c}
   \text{NO}_2 \\
   \end{array}
   \]
42. (D)

43. Arrange the following compounds in increasing order of their acidic strength.

(I) \( \text{COOH} \)

(II) \( \text{COOH} \)

(III) \( \text{COOH} \)

(A) \( \text{I} < \text{II} < \text{III} \)  (B) \( \text{I} < \text{III} < \text{II} \)  (C) \( \text{III} < \text{I} < \text{II} \)  (D) \( \text{III} < \text{II} < \text{I} \)

44. (A)

44. The correct decreasing order of ionic size of \( \text{K}^+ \), \( \text{Cl}^- \), \( \text{Ca}^{2+} \) and \( \text{S}^{2-} \) is

(A) \( \text{S}^{2-}, \text{Cl}^-, \text{K}^+, \text{Ca}^{2+} \)   (B) \( \text{Ca}^{2+}, \text{K}^+, \text{Cl}^-, \text{S}^{2-} \)

(B) \( \text{Ca}^{2+}, \text{K}^+, \text{S}^{2-}, \text{Cl}^- \)

44. (A)

For isoelectronic ions, the size of ion decreases with increasing the charge.

\( \text{Ca}^{2+}, \text{K}^+, \text{Cl}^-, \text{S}^{2-} \)

Charge: +2, +1, −1, −2

45. Consider the following statements:

(I) For inert gases, atomic radius means Vander Waal’s radius.

(II) Effective nuclear charge of atom or ion = \( \frac{\text{Total number of protons}}{\text{Total number of neutrons}} \)

(III) Atomic radius decreases from left to right in a given period. However, on moving from halogen to the noble gases, the radius increases

(IV) In moving from left to right across the period. The nuclear charge increases and effective nuclear charge decreases.

The correct statement(s) are:

(A) I, II, III and IV   (B) I and III  (C) II and IV  (D) I, II and IV

45. (B)
SECTION-II : (INTEGER ANSWER TYPE)

This section contains 05 questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 6.25, 7.00, 0.33, 30.27, 127.30)

46. The vander Waal’s constants for a gas are \( a = 3.6 \) atm \( \text{L}^2 \text{mol}^{-2} \), \( b = 0.6 \) L mol\(^{-1} \). If \( R = 0.08 \) L atm K\(^{-1} \) mol\(^{-1} \) and \( T_B \) is the Boyle’s temperature of this gas, then what is the value of \( \frac{T_B}{15} \)?

46. \((5.00)\)

\[
T_B = \frac{a}{R \cdot b}
\]

\[
T_B = \frac{3.6}{0.08 \times 0.6} = 75
\]

So, \( \frac{T_B}{15} = 5 \)

47. A flask has 10 gas particles out of which four particles are moving at \( 7 \) ms\(^{-1} \) and the remaining are moving at the same speed of \( ‘X’ \) ms\(^{-1} \). If the r.m.s. of the gas is \( 5 \) ms\(^{-1} \), what is the value of \( X \)?

47. \((3.00)\)

\[
U_{rms} = \sqrt{\frac{4 \times (7)^2 + 6x^2}{10}}
\]

\[
(5)^2 = \frac{49 \times 4 + 6x^2}{10}
\]

\[
x = \sqrt{\frac{10 \times 25 - 196}{6}} = \sqrt{9} = 3
\]

48. A diatomic ideal gas is expanded according to \( PV^3 = \) constant, under very high temperature (Assume vibration mode active). Calculate the molar heat capacity of gas (in cal/mol K) in this process.

48. \((6.00)\)

At high temperature for diatomic molecule
Translation energy = 3
Rotational energy = 2
Vibrational energy = 2
Degree of freedom \( f = 3 + 2 + 2 = 7 \)

\[
C_v = \frac{f}{2} R = \frac{7}{2} R
\]

\[
C_{Process} = C_v + \frac{R}{1 - m}
\]

\[
= \frac{7}{2} R + \frac{R}{1 - 3}
\]

\[
= \frac{7 \times 2 + 2}{1 - 3}
\]

\[
= 6
\]
49. If enthalpy of neutralisation of HCl by NaOH is $-57 \text{ kJ mol}^{-1}$ and with \( \text{NH}_4\text{OH} \) is $-50 \text{ kJ mol}^{-1}$. Calculate enthalpy of ionisation of \( \text{NH}_4\text{OH} \)(aq).

\[
\Delta H_m = -57 + \text{I.E.} \\
-50 = 57 + \text{I.E.} \\
\text{I.E.} = 7
\]

50. One mole ideal monoatomic gas is heated according to path \( AB \) and \( AC \). If temperature of state \( B \) and state \( C \) are equal. Calculate \( \frac{q_{AC}}{q_{AB}} \times 10 \).

\[
\begin{align*}
\Delta H_n &= -57 + \text{I.E.} \\
\text{I.E.} &= 7
\end{align*}
\]

50. (8.00)

Process \( AC \) = polytropic process \((P = KV)\)
Molar Heat capacity \( c_m = c_v + R/2 = 2R \)

Process \( AB \) = Isobaric

\[
c_m = c_p = 5R/2
\]

\[
\begin{align*}
\frac{q_{AC}}{q_{AB}} &= \frac{\int_{T_a}^{T_b} nC_m \cdot dT}{\int_{T_a}^{T_b} nC_{p,m} \cdot dT} \\
&= \frac{2R}{5/2} = 0.8
\end{align*}
\]

\[
\frac{q_{AC}}{q_{AB}} \times 10 = 0.8 \times 10 = 8
\]
This section contains 20 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONLY ONE is correct.

51. The value of the expression \( \frac{1 - 4 \sin 10^\circ \sin 70^\circ}{2 \sin 10^\circ} \) is
   (A) \( \frac{1}{2} \) \hspace{1cm} (B) 1 \hspace{1cm} (C) 2 \hspace{1cm} (D) None

51. (B)
\[
1 - 2 \left( \cos 60^\circ - \cos 80^\circ \right) \\
= \frac{2 \cos 80^\circ}{2 \sin 10^\circ} = 1
\]

52. The value of \( \frac{1}{81^n} \left[ - \frac{10}{81^n} C_1 + \frac{10^2}{81^n} C_2 - \frac{10^3}{81^n} C_3 + \cdots + \frac{10^{2n}}{81^n} \right] \) is
   (A) 2 \hspace{1cm} (B) 0 \hspace{1cm} (C) \( \frac{1}{2} \) \hspace{1cm} (D) 1

52. (D)
\[
\frac{1}{81^n} \left[ 1 - 10 \right]^{2n}
\]

53. Given \( (1 - 2x + 5x^2 - 10x^3)(1 + x)^n = 1 + a_1x + a_2x^2 + \cdots \) and that \( a_1^2 = 2a_2 \) then the value of \( n \) is
   (A) 6 \hspace{1cm} (B) 2 \hspace{1cm} (C) 5 \hspace{1cm} (D) 3

53. (A)
\[
(1 - 2x + 5x^2 + 10x^3) \left[ C_0 + C_1x + C_2x^2 + \cdots \right] = 1 + a_1x + a_2x^2 + \cdots
\]
   \( a_1 = n - 2 \) and \( a_2 = \frac{n(n-1)}{2} - 2n + 5 \)

Put \( a_1^2 = 2a_2 \)
\[
(n - 2)^2 = n(n - 1) - 4n + 10
\]
\[
n^2 - 4n + 4 = n^2 - 5n + 10
\]
\[
n = 6
\]

54. If \( \sqrt{3} \sin x - \cos x = \min \{2, e^x, \pi, \alpha^2 - 4\alpha + 7\} (\alpha \in R) \), then find \( x \)?
   (A) \( x = 2n\pi; \ n \in I \) \hspace{1cm} (B) \( x = 2n\pi + \frac{2\pi}{3}; \ n \in I \)
   (C) \( x = n\pi + (-1)^n \frac{\pi}{4} + \frac{\pi}{6}; \ n \in I \) \hspace{1cm} (D) \( x = n\pi + (-1)^n \frac{\pi}{4} - \frac{\pi}{3}; \ n \in I \)
54. \( \alpha^2 - 4\alpha + 7 = \alpha^2 - 4\alpha + 4 + 3 \)
\[= (\alpha - 2)^2 + 3 \geq 3 \]
Minimum value of \( \alpha^2 - 4\alpha + 7, \alpha \in R \), is 3.
Also, \( e \in (2, 3) \Rightarrow e^2 \in (4, 9) \)
And \( \pi = 3.14 \)
So, \( \min \{2, e^2, \pi, \alpha^2 - 4\alpha + 7\} = 2 \)
\( \alpha \in R \)
\[\Rightarrow \sqrt{3} \sin x - \cos x = 2 \]
\[\Rightarrow \frac{\sqrt{3}}{2} \sin x - \frac{1}{2} \cos x = 1 \]
\[\Rightarrow \sin \left( x - \frac{\pi}{6} \right) = 1 \]
\[\Rightarrow x - \frac{\pi}{6} = 2n\pi + \frac{\pi}{2} \]
\[\Rightarrow x = 2n\pi + \frac{2\pi}{3}; n \in I \]

55. In how many ways can 6 persons be selected from 4 officers and 8 constables, if at least one officer is to be included
\( (A) \ 224 \quad (B) \ 672 \quad (C) \ 896 \quad (D) \ None \ of \ these \)

55. \( (C) \)
Required number of ways
\[= ^4 C_1 \times ^8 C_3 + ^4 C_2 \times ^8 C_4 + ^4 C_3 \times ^8 C_5 + ^4 C_4 \times ^8 C_6 \]
\[= 4 \times 56 + 6 \times 70 + 4 \times 56 + 1 \times 28 \]
\[= 224 + 420 + 224 + 28 = 896 \]

56. There are 6 boxes numbered 1, 2, ..... 6. Each box is to be filled up with 1 ball which is either a red or a green ball in such a way that at least 1 box contains a green ball and the boxes containing green balls are consecutive. The total number of ways in which this can be done, is
\( (Balls \ of \ same \ colour \ are \ identical) \)
\( (A) \ 21 \quad (B) \ 33 \quad (C) \ 60 \quad (D) \ 6 \)

56. \( (A) \)
\[
\begin{array}{cccccc}
& & & & & \\
B_1 & B_2 & B_3 & B_4 & B_5 & B_6 \\
\end{array}
\]

all six green 1
5 green 2
4 green 3
3 green 4
2 green 5
57. A variable line drawn through the point (1, 3) meet \( x \)-axis at \( A \) and \( y \)-axis at \( B \). If the rectangle \( OAPB \) is completed, where \( O \) is the origin, find locus of \( P \)?

(A) \( \frac{1}{y} + \frac{3}{x} = 1 \) \hspace{1cm} (B) \( x + 3y = 1 \) \hspace{1cm} (C) \( \frac{1}{x} + \frac{3}{y} = 1 \) \hspace{1cm} (D) \( 3x + y = 1 \)

57. (C)

Let \( P(h, k) \)

\[ \therefore A(h, 0) \text{ & } B(0, k) \]

Line \( AB \rightarrow \frac{x}{h} + \frac{y}{k} = 1 \)

\((1, 3)\) lies on is \( \therefore \frac{1}{h} + \frac{3}{k} = 1 \)

\[ \Rightarrow \frac{1}{x} + \frac{3}{y} = 1 \]

58. The value of \( \sum_{r=0}^{n} \binom{n}{r} \sin(rx) \cos[(n-r)x] \) is equal to

(A) \( 2^n \cos(nx) \) \hspace{1cm} (B) \( 2^{n-1} \sin(nx) \) \hspace{1cm} (C) \( 2^n \sin(nx) \) \hspace{1cm} (D) None of these

58. (B)

Let \( S = \sum_{r=0}^{n} \binom{n}{r} \sin(rx) \cos[(n-r)x] \)

Replace \( r \rightarrow n-r \)

\[ s = \sum_{r=0}^{n} \binom{n}{r} \sin[(n-r)x] \cos(rx) \]

Add \( 2S = \sum \binom{n}{r} \sin(nx) \)

\[ \Rightarrow S = 2^{n-1} \sin(nx) \]

59. The value of \( \tan(\log_2 6) \cdot \tan(\log_2 3) \cdot \tan1 \) is always equal to:

(A) \( \tan(\log_2 6) + \tan(\log_2 3) + \tan1 \) \hspace{1cm} (B) \( \tan(\log_2 6) - \tan(\log_2 3) - \tan1 \)

(C) \( \tan(\log_2 6) - \tan(\log_2 3) + \tan1 \) \hspace{1cm} (D) \( \tan(\log_2 6) + \tan(\log_2 3) - \tan1 \)

59. (B)

If \( A + B + C = 0 \)

\[ \tan A + \tan B + \tan C = \tan A \cdot \tan B \cdot \tan C \]

Since \( \log_2 6 + (-\log_2 3) + (-1) = 0 \)

Therefore, \( \tan(\log_2 6) - \tan(\log_2 3) - \tan1 = \tan(\log_2 6) \cdot \tan(\log_2 3) \cdot \tan1 \)

60. The point \((4, 1)\) undergoes the following-three transformation successively

(i) Reflection in the line \( y = x \)

(ii) Translation through a distance 2 units along the positive direction of \( x \)-axis
(iii) Rotation through an angle $\pi/4$ about the origin in the counter clockwise direction

Then the final position of the point is given by the coordinates

(A) $\left( \frac{1}{\sqrt{2}}, \frac{7}{\sqrt{2}} \right)$  
(B) $\left( -2\sqrt{7}, 7\sqrt{2} \right)$  
(C) $\left( -\frac{1}{\sqrt{2}}, \frac{7}{\sqrt{2}} \right)$  
(D) $\left( \sqrt{2}, 7\sqrt{2} \right)$

60. (C)

Reflection about the line $y = x$, changes the point $(4, 1)$ to $(1, 4)$

On translation of $(1, 4)$ through a distance of 2 units along $+ve$ direction of $x$-axis the point becomes $(1 + 2, 4)$, i.e., $(3, 4)$

On rotation about origin through an angle $\pi/4$ the point $P$ takes the position $P'$ such that $OP = OP'$

Also $OP = 5 = OP'$ and $\cos \theta = \frac{3}{5}, \sin \theta = \frac{4}{5}$

Now, $x = OP' \cos \left( \frac{\pi}{4} + \theta \right)$

$$= 5 \left( \cos \frac{\pi}{4} \cos \theta - \sin \frac{\pi}{4} \sin \theta \right)$$

$$= 5 \left( \frac{3}{5\sqrt{2}} - \frac{4}{5\sqrt{2}} \right) = -\frac{1}{\sqrt{2}}$$

$y = OP' \sin \left( \frac{\pi}{4} + \theta \right)$

$$= 5 \left( \sin \frac{\pi}{4} \cos \theta + \cos \frac{\pi}{4} \sin \theta \right)$$

$$= 5 \left( \frac{3}{5\sqrt{2}} + \frac{4}{5\sqrt{2}} \right) = \frac{7}{\sqrt{2}}$$

$\therefore P' = \left( -\frac{1}{\sqrt{2}}, \frac{7}{\sqrt{2}} \right)$

61. If $a, b, c \in R$ and the quadratic equation $ax^2 + bx + c = 0$ has no real roots, then

(A) $(a + b + c)c > 0$  
(B) $c < 0$  
(C) $a + b + c > 0$  
(D) $a + b + c < 0$

61. (A)

62. A die is rolled three times, the probability of getting a larger number than the previous number is
62. **B**  
\( n(s) = 6 \times 6 \times 6 = 216 \)  
Total number of favorable ways  
\( =^6 C_3 \)  
Hence probability  
\[ \frac{20}{216} = \frac{5}{54} \]

63. Two vertices of a triangle are \((5, -1)\) and \((-2, 3)\). If origin is the orthocentre of this triangle, then find the third vertex?  
(A) (−4, −7)  
(B) (4, −7)  
(C) (4, 7)  
(D) (−4, 7)  

63. (A)  
Let \( A(h, k) \) be the third vertex and \( B(5, -1), C(-2, 3) \) are two given vertices. \( H(0, 0) \) is the orthocentre.  
So, \( AH \perp BC \Rightarrow \left( \frac{k}{h} \right) \left( \frac{3+1}{-2-5} \right) = -1 \)  
\[ \Rightarrow 4k = 7h \quad \text{ ........(1)} \]  
Also, \( BH \perp AC \Rightarrow \left( \frac{-1}{5} \right) \left( \frac{k-3}{h+2} \right) = -1 \)  
\[ \Rightarrow 3-k = -5(h+2) \quad \text{ ........(2)} \]  
From equation (1) and (2); we get  
\( h = -4 \) and \( k = -7 \)  
\( \Rightarrow \) \( A(-4, -7) \) is the third vertex.

64. The value of  
\[ \sum_{r=1}^{n} \frac{1}{\sqrt{a+rx} + \sqrt{a+(r-1)x}} \]  
(A) \( \frac{x}{\sqrt{a} + \sqrt{a+nx}} \)  
(B) \( \frac{\sqrt{a+nx}-\sqrt{a}}{x} \)  
(C) \( \frac{n(\sqrt{a+nx}-a)}{x} \)  
(D) None of these  

64. (B)  

65. Total number of ways, in which 22 different books can be given to 5 students, so that two students get 5 books each and all the remaining students get 4 books each, is equal to  
(A) \( \frac{22!}{2!3!5!(4!)^3} \)  
(B) \( \frac{22!}{3!(3!)^2 2!5!} \)  
(C) \( \frac{22!}{3!2!5!4!} \)  
(D) None of these  

65. (A)  
It is same as dividing 22 books in 5 packets such that two packets have 5 books, each and remaining three have four books each and then the distributing these packets thus total ways of distributing these books  
\[ = \frac{22!}{(5!)^2 (4!)^3 2!3!5!(4!)^3} = \frac{22!}{2!3!5!(4!)^3} \]
66. If \( t_n \) denotes the \( n \)th term of the series \( 2 + 3 + 6 + 11 + 18 + \ldots \), then \( t_{50} \) is
   (A) 49² - 1  (B) 49²  (C) 50² + 1  (D) 49² + 2

66. (D)

67. Let \( T_n \) be the number of all possible triangles formed by joining the vertices of an \( n \)-sided regular polygon. If \( T_{n+1} - T_n = 10 \), then the value of \( n \) is
   (A) 8  (B) 10  (C) 7  (D) 5

67. (D)
\[
T_n = ^nC_3 \\
T_{n+1} - T_n = ^{n+1}C_3 - ^nC_3 = ^nC_2 \\
\Rightarrow ^nC_2 = 10 \Rightarrow n = 5
\]

68. If \( a_1, a_2, a_3, \ldots, a_{50} \) are terms of an A.P. Given \( a_1 + a_{50} = 100 \), then \( \sum_{i=2}^{49} a_i \) is
   (A) 2200  (B) 2300  (C) 2400  (D) None of these

68. (C)

Equidistant property
\[
\sum_{i=2}^{49} a_i = 24(a_1 + a_{50}) = 2400
\]

69. The value of \( \left( 1 + \cos \frac{\pi}{8} \right) \left( 1 + \cos \frac{3\pi}{8} \right) \left( 1 + \cos \frac{5\pi}{8} \right) \left( 1 + \cos \frac{7\pi}{8} \right) \) is
   (A) \( \frac{1}{4} \)  (B) \( \frac{1}{8} \)  (C) \( \frac{1}{16} \)  (D) None of these

69. (B)

The given expression
\[
= \left( 1 + \cos \frac{\pi}{8} \right) \left( 1 + \sin \frac{\pi}{8} \right) \left( 1 - \sin \frac{\pi}{8} \right) \left( 1 - \cos \frac{\pi}{8} \right)
\]
\[
\therefore \cos \frac{3\pi}{8} = \cos \left( \frac{\pi}{2} - \frac{\pi}{8} \right) = \sin \frac{\pi}{8},
\]
\[
\cos \frac{5\pi}{8} = \cos \left( \frac{\pi}{2} + \frac{\pi}{8} \right) = -\sin \frac{\pi}{8},
\]
\[
\cos \frac{7\pi}{8} = \cos \left( \frac{\pi}{2} - \frac{\pi}{8} \right) = -\cos \frac{\pi}{8},
\]
\[
= \left( 1 - \cos^2 \frac{\pi}{8} \right) \left( 1 - \sin^2 \frac{\pi}{8} \right) = \sin^2 \frac{\pi}{8} \cos^2 \frac{\pi}{8}
\]
\[
= \frac{1}{4} \left[ 2 \sin \frac{\pi}{8} \cos \frac{\pi}{8} \right]^2 = \frac{1}{4} \sin^2 \frac{\pi}{4} = \frac{1}{4} \left( \frac{1}{\sqrt{2}} \right)^2 = \frac{1}{8}
\]
70. Total number of words that can be formed using all letters of the word ‘BRIJESH’ that neither begins with ‘I’ nor ends with ‘B’ is equal to

(A) 3720  (B) 4920  (C) 3600  (D) 4800

70. (A)

Total 7 letters – begins with I – ends with B + begins with I & ends with B
= 7!−6!−6!+ 5! = 3720

SECTION-II: (INTEGER ANSWER TYPE)

This section contains 05 questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 6.25, 7.00, 0.33, 30.27, 127.30)

71. Let ABC be a triangle. Let A be the point (1, 2), y = x is the perpendicular bisector of AB and x − 2y + 1 = 0 is the angle bisector of ∠ACB. If equation of BC is given by ax + by − 5 = 0, then the value of a + b is?

71. (2.00)

B is image of A about perpendicular bisector y = x
∴ B (2, 1)
Also, if we take image of A about angle bisector of ∠C, we get point (D).

\[
\frac{x - 1}{1} = \frac{y - 2}{-2} = \frac{-2(1 - 4 + 1)}{5}
\]

D \left( \frac{9}{5}, \frac{2}{5} \right)
∴ equation BC is equation of line joining BD

y − 1 = 3(x − 2)
3x − y − 5 = 0

ax + by − 5 = 0
a = 3, b = -1
a + b = 2

72. Let ‘P’ any point on x − y + 3 = 0 and ‘A’ be fixed point (3, 4). If the family of lines given by

\[(3\sec \theta + 5\cosec \theta)x + (7\sec \theta - 3\cosec \theta)y + 11(\sec \theta - \cosec \theta) = 0\]

are concurrent at B for all permissible values of ‘θ’ and maximum of \[|PA − PB| = 2\sqrt{2}n (n \in N)\], then \(n = \)
72. (5.00)

\[ \text{FOC} \to \sec 0(3x + 7y + 11) + \cosec (5x - 3y - 11) = 0 \]

is concurrent at point \( B \), obtained by solving

\[
\begin{align*}
3x + 7y + 11 &= 0 \\
5x - 3y - 11 &= 0
\end{align*}
\]

\[ \therefore \quad B(1, -2) \]

Now, for \(|PA - PB|\) to be maximum

\[ |PA - PB| = AB \]

\[ = \sqrt{4 + 36} = 2\sqrt{10} = 2\sqrt{5} \]

\[ n = 5 \]

73. Let \( \alpha, \beta \in R \) if \( \alpha, \beta^2 \) be the roots of quadratic equation \( x^2 - px + 1 = 0 \) and \( \alpha^2, \beta \) be the roots of quadratic equation \( x^2 - qx + 8 = 0 \), then the value of \( (r - 80) \) if \( \frac{r}{8} \) be arithmetic mean of \( p \) and \( q \), is

73. (3.00)

\[
\begin{align*}
\alpha + \beta^2 &= p \\
\alpha^2 + \beta &= q \\
\alpha \cdot \beta^2 &= 1 \\
\alpha^2 \cdot \beta &= 8
\end{align*}
\]

Solving \( \alpha = 4, \beta = \frac{1}{2} \)

\[ \therefore \quad p = \frac{17}{4} \quad \& \quad q = \frac{33}{2} \]

Now, \( \frac{r}{8} = AM(p, q) \)

\[ \Rightarrow \quad \frac{r}{8} = \frac{p + q}{2} \]

\[ \Rightarrow \quad \frac{r}{4} = \frac{17 + 66}{4} \]

\[ \Rightarrow \quad r = 83 \]

\[ \therefore \quad r - 80 = 3 \]

74. Let \( X \) be the number of linear permutations of all the letters of the word \textit{SBISMART} in which the two \( S \)'s are always together, \( Y \) be the number of linear permutations of all the letters of the word \textit{SBISMART} in which the two \( S \)'s are never together, then \( \frac{Y}{X} \) is ________

74. (3.00)

75. The area of the quadrilateral formed by the lines \( 4x - 7y - 13 = 0, 8x - y - 39 = 0, 4x - 7y + 39 = 0, 8x - y + 13 = 0 \) is \( 13k \), then \( k = \)

75. (4.00)

\[ 4x - 7y - 13 = 0 \]

\[ 8x - y - 39 = 0 \]
\[ 4x - 7y + 39 = 0 \]
\[ 8x - y + 13 = 0 \]

Forms a parallelogram,
Area \[ = \frac{(c_1 - c_2)(d_1 - d_2)}{a_1 b_1 - a_2 b_2} \]
\[ = \frac{52 \times 52}{52} \]
\[ = 52 \]
\[ A = 52 = 13K \]
\[ \therefore K = 4 \]