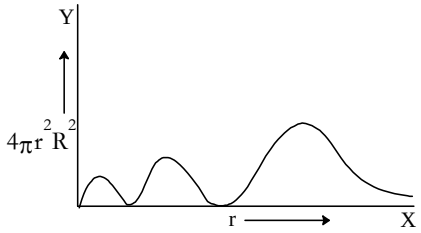
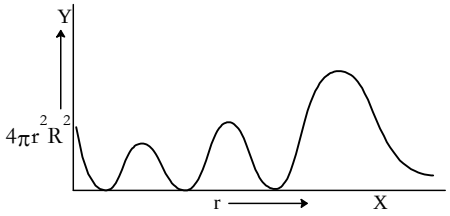
PART (B) : CHEMISTRY

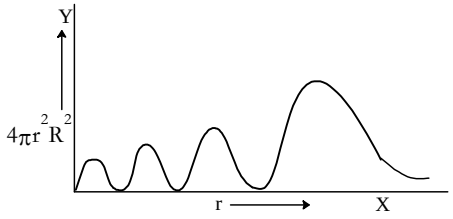
SECTION I: (SINGLE CHOICE QUESTIONS)

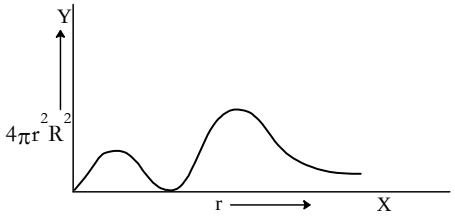
This section contains **06 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

19. Which of the following is the correct representation of plot of radial probability ($4\pi r^2R^2$) in Y-axis vs distance from the nucleus in X-axis for 1-electron of 4d-atomic orbital?

(A) 

(B) 

(C) 

(D) 

19. (D)

No. of radial nodes = $n - l - 1$

20. Suppose you want to carry an acidic solution to carry out a chemical reaction with 2 moles of NaOH. Which sample of the acid is the best choice for you?

(A) 1 M H_2SO_4 (50 Rs. per L) (B) 1 M H_2SO_4 (56Rs. per L)

(C) 1 M HCl (30 Rs. per L) (D) 1 M HCl (27Rs. per L)

20. (A)

2 moles of NaOH will require a mole of H_2SO_4 or 2 moles of HCl.

(A) 50 Rs (B) 56 Rs. (C) 60 Rs (D) 54 Rs.

21. The angular momentum of an electron in a given orbit is J, its kinetic energy will be:

(A) $\frac{1}{2}\frac{J^2}{mr^2}$ (B) $\frac{Jv}{r}$ (C) $\frac{J^2}{2m}$ (D) $\frac{J^2}{2\pi}$

21. (A)

$J = mvr$

$J^2 = m^2v^2r^2$

$\frac{J^2}{2} = \frac{m}{2}v^2mr^2$

$\frac{J^2}{2} = K.E.mr^2$

$K.E. = \frac{J^2}{2}\frac{1}{mr^2}$

22. Which of the following is the correct order of stability?

(A) $Tl^{+3} > Bi^{+3}$ (B) $PbO_2 < PbO$ (C) $BiI_5 > BiI_3$ (D) $Sn^{+2} = Ge^{+2}$

22. **(B)**
Because of inert pair effect PbO is more stable than PbO_2.

23. Two closed vessels of equal volume containing air at pressure P_1 and temperature T_1 are connected to each other through a narrow tube. If the temperature in one of the vessels is now maintained at T_1 and that in the other at T_2, what will be the pressure in the vessels

(A) $\frac{2P_1T_1}{T_1+T_2}$ (B) $\frac{T_1}{2P_1T_2}$ (C) $\frac{2P_1T_2}{T_1+T_2}$ (D) $\frac{2P_1}{T_1+T_2}$

23. **(C)**
Moles of gas are conserved.
Final moles = Initial Moles

$$\frac{P_fV}{RT_1}+\frac{P_fV}{RT_2}=\frac{P_1V}{RT_1}+\frac{P_1V}{RT_1}$$

$$P_f=\frac{2P_1T_2}{T_1+T_2}$$

24. In which of the following pairs hybridisation of the central atoms are different?

(A) ClF_3, ClF_3O (B) ClF_3O, ClF_3O_2

(C) $[ClF_2O]^+, [ClF_4O]^-$ (D) $[ClF_4O]^-, [XeOF_4]$

24. **(C)**
$ClF_3 = sp^3d$; $ClF_3O = sp^3d$; $ClF_3O_2 = sp^3d$; $[ClF_2O]^+ = sp^3$
$[ClF_4O]^- = sp^3d^2$; $[XeOF_4] = sp^3d^2$.

SECTION II : (MULTIPLE CHOICE QUESTIONS)

This section contains **06 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE than one is/are correct.**

25. The radial wave function for a p-orbital of H-atom is given as-

$$\Psi_{2P}=\frac{1}{\sqrt{24a_0^3}}\left(\frac{r}{r_0}\right)\cdot e^{\frac{-r}{2a_0}}$$

And its angular wave function is given as

$\Psi(\theta,\phi)=\sqrt{\frac{3}{4\pi}}\cos\theta$, then which of the following is/are correct-

(A) Its radial wave function Vs 'r', graph has one maxima.
(B) It represents $2P_z$ orbital
(C) It represents $2P_x$ orbital
(D) Its radial wave function Vs 'r' has one minima if the minima at infinity is excluded

25. **(ABD)**

26. A 5L vessel contains 2.8 g N_2. When heated to 1800K, 30% molecules are dissociated into atoms.
(A) Total number of moles of atoms and molecules in the container will be 0.13
(B) Total number of molecules in the container will be close to 0.4221×10^{23}.

(C) Total number of moles of atoms and molecules in the container will be 0.098
(D) All of these are correct

26. (AB)

$N_2(g) \longrightarrow 2N(g)$

0.1mol	-
0.1-0.03	2 x 0.03=0.06
= 0.07mol	0.06 mol

Total moles = 0.07 + 0.06 = 0.13 moles
Total number of molecules = $0.07 \times 6.022 \times 10^{23} = 0.42 \times 10^{23}$.

27. Poor shielding of nuclear charge by d- or f-orbital electrons is responsible for which of the following facts?
(A) Atomic radius of Nb is comparable to that of Ta
(B) The 1st ionization enthalpy of Nitrogen is more than that of oxygen
(C) The value of electron gain enthalpy is more negative for sulphur than for oxygen
(D) The 1st ionization enthalpy of gold is greater than that of silver

27. (AD)

$r_{Nb} = r_{Ta}$ **(**Lanthanide contraction**)**
The 1st ionization enthalpy of gold is greater than that of silver. **(**Lanthanide contraction**)**

28. Amphoteric behaviour is shown by the oxides of :
(A) Al and Mg (B) Pb and Sn (C) Be and Al (D) Sn and Zn

28. (BCD)

Oxides of Be, Al, Zn, Sn and Pb are amphoteric.

29. Which of the following overlaps is/are correct?
[Assuming z-axis to be the internuclear axis]:
(i) $2p_y + 2p_y \rightarrow \pi$ (ii) $2p_z + 2p_z \rightarrow \sigma$
(iii) $2p_x + 2p_x \rightarrow \pi$ (iv) $1s + 2p_y \rightarrow \pi$
(v) $2p_y + 2p_z \rightarrow \pi$ (vi) $1s + 2s \rightarrow \sigma$
(A) 'i' & 'ii' (B) 'ii' & 'iv' (C) 'iv' & 'vi' (D) 'iii' & 'v'

29. (A)

If z-axis is the internuclear axis then $2P_z$ orbitals will form σ bond and $2P_y$ orbitals will form π bond.
1s orbital will not form bond with $2P_y$ orbital.
$2P_y$ and $2P_z$ cannot form bond.

30. Choose the molecules in which hybridisation occurs in the ground state?
(A) BCl_3 (B) NH_3 (C) PCl_3 (D) $BeCl_2$

30. (BC)

31. An ideal gas of certain mass is heated in a small vessel and then in a large vessel, such that their volume remains unchanged. The P-T curves are:
(A) parabolic with same curvature (B) parabolic with different curvatures
(C) linear with same slope (D) linear with different slopes

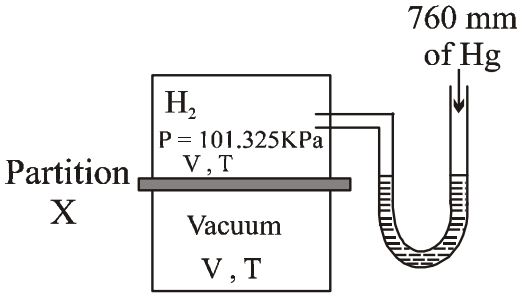
31. (D)

PV = nRT

$$P = \frac{nRT}{V}$$

Although moles are constant but Volume get changed.
Therefore, Linear graph with different slope.

32. According to the data in the figure, if "partition X" is removed. The incorrect statement(s) is/are



(A) The pressure of H_2 gas is 101.325 Kpa
(B) The level of Hg in the open end limb will be higher
(C) The difference in the Hg level in both limbs will be 38 cm.
(D) The level of Hg in the open end limb will be lower

32. (AB)

After Removal of Partition barrier Pressure will drop to $\frac{1}{2}$ atm

SECTION III : (PARAGRAPH TYPE)

This section contains **4 multiple choice questions** relating to **TWO** paragraphs with **TWO questions on each paragraph.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

PARAGRAPH FOR QUESTIONS NO. 33 & 34

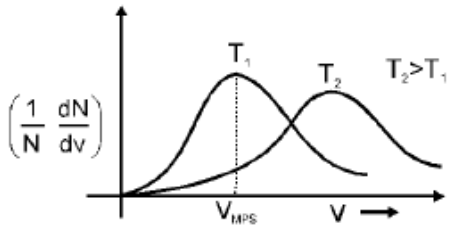
The speed of a molecule of a gas changes continuous as a result of collisions with other molecules and with the walls of the container. The speeds of individual molecules therefore change, but it is expected that the distribution of molecular speeds does not change with time.
A direct consequence of the distribution of speeds is that the average kinetic energy is constant for a given temperature.
The average K.E., is defined as

$$\overline{KE} = \frac{1}{N}\left(\frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2 + ... + \frac{1}{2}mv_N^2\right) = \frac{1}{2N}m\left(v_1^2 + v_2^2 + ... + v_N^2\right) = \frac{1}{2}m\overline{V^2}$$

Alternatively it may be defined as $\overline{KE} = \frac{1}{N}\left(\frac{1}{2}m\sum dN_i v_i^2\right) = \frac{1}{2}m\left(\sum \frac{dN_i}{N}\cdot v_i^2\right)$

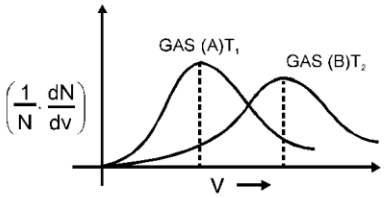
Where $\frac{dN_i}{N}$ is the fraction of molecules having speeds between v_i and $v_i + dv$ and as proposed by Maxwell

$$\frac{dN}{N} = 4\pi\left(\frac{m}{2\pi KT}\right)^{3/2} \exp\left(\frac{-mv^2}{2kT}\right) \cdot v^2 \cdot dv$$



The plot of $\left(\frac{1}{N}\frac{dN}{dv}\right)$ is plotted for a particular gas at two different temperatures against 'v' as shown. The majority of molecules have speeds which cluster around v_{MPS} in the middle of the range of v. The area under the curve between any two speeds v_1 and v_2 is the fraction of molecules having speeds between v_1 and v_2. The speed distribution also depends on the mass of the molecules. As the area under the curve is the same (equal to unity) for all gas samples, samples which have the same v_{MPS} will have identical Maxwellian plots. On the basis of the above passage answer the questions that follow.

33. For the following graph drawn for two different samples of gases at two different temperatures T_1 and T_2, which of the following statement is necessarily true:



(A) If $T_2 > T_1$, M_A is necessarily greater than M_B
(B) If $T_1 > T_2$, M_B is necessarily greater than M_A
(C) $\frac{T_2}{M_B} > \frac{T_1}{M_A}$
(D) Nothing can be predicted

33. (C)

34. Two gases 'A' and 'B' are at temperatures T_A and T_B respectively have identical Maxwellian plots, then which of the following statement is correct:
(A) $T_B = T_A$
(B) $M_B = M_A$
(C) $\frac{T_A}{M_A} > \frac{T_B}{M_B}$
(D) Gases A and B may be O_2 and SO_2 at 27^oC and 327^oC respectively

34. (D)

$v \propto \frac{T}{M}$

PARAGRAPH FOR QUESTIONS NO. 35 & 36

A mixture of CH_4 and O_2 is used as an optimal fuel if O_2 is present in thrice the amount required theoretically for combustion of CH_4. The calorific value (heat evolved when one gram of substance is optimally burnt) of CH_4 is 6.25 cal/gram.

35. If 10 effusion steps are required to convert a mixture containing 1 part CH_4 in 193 part mixture (by moles) into optimal mixture which gives 1000 cal of heat, then determine the initial moles of CH_4 and O_2 required. Assume 50% of CH_4 is collected after each effusion step.

(A) 10240, 1966080 (B) 5120, 983040

(C) 40960, 7864320 (D) 2560, 491520

35. (A)

For 100 cal, moles of CH_4 required = 10

If final moles of $CH_4 = 10$

Initial moles of $CH_4 = \dfrac{10}{(0.5)^{10}} = 10240$

Moles of $O_2 = 192 \times 10240 = 1966080$

36. Determine the total moles of gases collected in 5^{th} chamber before they are allowed to effuse into the 6^{th} chamber.

(A) 31360 (B) 11181 (C) 4000 (D) 70

36. (A)

5^{th} chamber $\Rightarrow$ 4^{th} effusion step

$$n_{CH_4} = 10240 \times \left(\frac{1}{2}\right)^4 = 640$$

$$n_{O_2} = 1966080 \times \left(\frac{1}{2\sqrt{2}}\right)^4 = 30720$$

$$n_{Total} = 640 + 30720 = 31360$$