DAY FIVE

Unit Test 1

(General Chemistry)

1 A gaseous mixture contains oxygen and nitrogen in the ratio of 1 : 4 by weight. Therefore, the ratio of their number of molecules is

(a) 1 : 4 (b) 1 : 8
(c) 7 : 32 (d) 3 : 16

2 The iron (III) oxide, Fe_2O_3 reacts with CO to give iron and CO_2

$$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$$

The reaction of 480.0 g Fe_2O_3 with excess of CO yields 252.0 g iron. Thus, percentage yield is (Fe = 56)

(a) 100.0% (b) 91.2%
(c) 75.0% (d) 50.0%

3 When same amount of zinc is treated separately with excess of sulphuric acid and excess of sodium hydroxide, the ratio of volumes of hydrogen evolved is

(a) 1 : 1 (b) 1 : 2
(c) 2 : 1 (d) 9 : 4

4 The equivalent weight of $MnSO_4$ is half of its molecular weight, when it is converted to

(a) Mn_2O_3 (b) MnO_2
(c) MnO_4^- (d) MnO_4^{2-}

5 The number of moles of $KMnO_4$ that will be needed to react with one mole of sulphite ion in acidic solution is

(a) $\frac{2}{5}$ (b) $\frac{3}{5}$
(c) $\frac{4}{5}$ (d) 1

6 Match the following and choose the correct option.

	Column I		Column II
A.	Mole fraction	1.	Candela
B.	Luminous intensity	2.	mol kg^{-1}
C.	Molality	3.	Unit less
D.	Molarity	4.	mol L^{-1}

Codes

	A	B	C	D		A	B	C	D
(a)	4	1	2	3	(b)	3	4	2	1
(c)	3	1	2	4	(d)	3	2	4	1

7 If the equivalent weight of an element is 32, percentage of oxygen in its oxide is

(a) 16 (b) 40
(c) 32 (d) 20

8 According to kinetic theory of gases for a diatomic molecule

(a) the pressure exerted by the gas is proportional to mean velocity of the molecule
(b) the pressure exerted by the gas is proportional to the root mean velocity of the molecule
(c) the root mean square velocity of the molecule is inversely proportional to the temperature
(d) the average translational kinetic energy of the molecule is proportional to the absolute temperature

9 X mL of H_2 gas effuses through a hole in container in 5 s. The time taken for the effusion of the same volume of the gas specified below under identical conditions is

(a) 10 s : He (b) 20 s : O_2
(c) 25 s : CO (d) 55 s : CO_2

10 The rms velocity of hydrogen is $\sqrt{7}$ times the rms velocity of nitrogen. If T is the temperature of the gas,

(a) $T(H_2) = T(N_2)$
(b) $T(H_2) > T(N_2)$
(c) $T(H_2) < T(N_2)$
(d) $T(H_2) = \sqrt{7}\,T(N_2)$

11 The ratio of rate of diffusion of helium and methane under identical conditions of pressure and temperature will be

(a) 4 (b) 2
(c) 1 (d) 0.5

12 The root mean square velocity of an ideal gas at constant pressure varies with density (d) as

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

13 The compound with longest bond length is ➞ NCERT Exemplar

(a) NO^- (b) NO^+ (c) CN^- (d) CN

14 The numbers of σ and $d\pi - p\pi$ bonds in pyrophosphoric acid, $(H_4P_2O_7)$ are ➞ NCERT Exemplar

(a) 6 and 2 (b) 8 and 2 (c) 12 and 0 (d) 12 and 2

15 Match the Column I (quantum numbers) with the Column II (information provided) and choose the correct option.

	Column I (Quantum number)		Column II (Information provided)
A.	Principal quantum number	1.	Orientation of the orbital
B.	Azimuthal quantum number	2.	Energy and size of orbital
C.	Magnetic quantum number	3.	Spin of electron
D.	Spin quantum number	4.	Shape of the orbital

Codes

	A	B	C	D		A	B	C	D
(a)	1	3	4	2	(b)	2	4	1	3
(c)	2	3	4	1	(d)	3	1	2	4

16 The ratio of energy of a photon of 2000Å wavelength radiation to that of 4000Å radiation is

(a) 1/4 (b) 4
(c) 1/2 (d) 2

17 For a d-electron, the orbital angular momentum is

(a) $\sqrt{6}\left(\frac{h}{2\pi}\right)$ (b) $\sqrt{2}\left(\frac{h}{2\pi}\right)$
(c) $\left(\frac{h}{2\pi}\right)$ (d) $2\left(\frac{h}{2\pi}\right)$

18 The wavelength associated with a golf ball weighing 200 g and moving at a speed of 5 m/h is of the order

(a) 10^{-10}m (b) 10^{-20}m
(c) 10^{-30}m (d) 10^{-40}m

19 Which of the following emissions will generate an isotope?

(a) Neutron particle emission (b) Positron particle emission
(c) α-particle emission (d) β-particle emission

20 In which of the following molecules ion of all the bonds are not equal? ➞ NCERT Exemplar

(a) XeF_4 (b) BF_4^- (c) C_2H_4 (d) SiF_4

21 Which of the following statements in relation to the hydrogen atom is correct?

(a) 3s, 3p and 3d orbitals all have the same energy
(b) 3s and 3p orbitals are of lower energy than 3d orbital
(c) 3p orbital is lower in energy than 3d orbital
(d) 3s orbital is lower in energy than 3p orbital

22 The potential energy of an electron in the first Bohr orbit in the He^+ ion is

(a) – 13.6 eV (b) – 27.2 eV
(c) – 54.4 eV (d) – 108.8 eV

23 **Assertion** (A) Significant figures for 0.200 is 3 whereas for 200 it is 1.

Reason (R) Zero at the end or right of a number are significant provided they are not on the right side of the decimal point. ➞ [NCERT Exemplar]

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true but R is false
(d) Both A and R are false

24 What electronic transition in a hydrogen atom starting from the orbit $n = 7$ will produce infrared light of wavelength 2170 nm? $(\overline{R}_H = 1.09677 \times 10^7 \text{ m}^{-1})$

(a) $n = 7$ to $n = 5$ (b) $n = 7$ to $n = 4$
(c) $n = 7$ to $n = 3$ (d) $n = 7$ to $n = 2$

25 Photoelectrons are liberated by ultraviolet light of wavelength 3000 Å from a metallic surface for which the photoelectric threshold is 4000 Å. The de-Broglie wavelength of electron emitted with maximum kinetic energy is

(a) 1.2×10^{-9} m (b) 5.49×10^{-25} m
(c) 7.28×10^{-7} m (d) 1.65×10^{-19} m

26 Carbon suboxide (C_3O_2) has recently been shown as a component of the atmosphere of Venus. Which of the following formulation represents the correct ground state Lewis structure for carbon suboxide?

(a) :O: C:: C : C: O: (b) : O :: C:: C: C :: O:
(c) :Ö:: C:: C:: C ::Ö: (d) : O: C: C: C: O:

27 The atomic weight of an element is double of its atomic number. If there are four electrons in 2p orbital, the element is isotonic with

(a) ${}_{20}Ca^{40}$ (b) ${}_{7}N^{15}$
(c) ${}_{7}N^{14}$ (d) ${}_{8}O^{17}$

28 In PO_4^{3-} ion, the formal charge on the oxygen atom of P—O bond is ➞ NCERT Exemplar

(a) +1 (b) –1 (c) –0.75 (d) + 0.75

29 The compound which contains both ionic and covalent bonds is

(a) CH_4 (b) H_2 (c) KCN (d) KCl

30 The total number of electrons that take part in forming the bond in N_2 is

(a) 2 (b) 4 (c) 6 (d) 10

31 Carbon tetrachloride has no net dipole moment because of

(a) its planar structure
(b) its regular tetrahedral structure
(c) similar sizes of carbon and chlorine atoms
(d) similar electron affinities of carbon and chlorine atoms

32 On hybridisation of one *s*-and one *p*-orbital, we get

(a) two mutually perpendicular orbitals
(b) two orbitals at 180°
(c) four orbitals directed tetrahedrally
(d) three orbitals in a plane

33 The molecule having one unpaired electron, is

(a) NO (b) CO (c) CN^- (d) O_2

34 The species in which the central atom uses sp^2 hybrid orbitals in its bonding is

(a) PH_3 (b) NH_3 (c) CH_3^+ (d) SbH_3

35 Among the following species, identify the isostructural pairs.

$$NF_3, NO_3^-, BF_3, H_3O^+, N_3H$$

(a) $[NF_3, NO_3^-]$ and $[BF_3, H_3O^+]$
(b) $[NF_3, N_3H]$ and $[NO_3^-, BF_3]$
(c) $[NF_3, H_3O^+]$ and $[NO_3^-, BF_3]$
(d) $[NF_3, H_3O^+]$ and $[N_3H, BF_3]$

36 10^{21} molecules are removed from 200 mg of CO_2. Thus, number of moles left is

(a) 1.73×10^{21} (b) 2.87×10^{-3}
(c) 0.287×10^{-4} (d) 2.73×10^{21}

37 What per cent of a sample of nitrogen must be allowed to escape if its temperature, pressure and volume are to be changed as given?

$$\boxed{\begin{matrix}273°C, 3.00\text{ atm}\\ 1.65\text{ L}\end{matrix}} \rightarrow \boxed{\begin{matrix}0°C, 0.75\text{ atm}\\ 0.55\text{ L}\end{matrix}}$$

(a) 16.67% (b) 83.64% (c) 75.00% (d) 25.00%

38 If E_e, E_α and E_p represent the kinetic energies of an electron, alpha particle and a proton respectively, each moving with same de-Broglie wavelength then

(a) $E_e = E_\alpha = E_p$ (b) $E_e > E_\alpha > E_p$
(c) $E_\alpha > E_p > E_e$ (d) $E_e > E_p > E_\alpha$

39 Surface tension of water is 73 dyne cm^{-1} at 20°C. If surface area is increased by 0.10 m^2, workdone is

(a) 7.3 erg (b) 7.3×10^4 erg
(c) 73 J (d) 0.73 J

40 Phosphorus pentachloride dissociates in the vapour phase according to the equation

$$PCl_5 \rightleftharpoons PCl_4^+ + Cl^-$$

The hybridisation of phosphorus in PCl_5 is sp^3d. What is the hybridisation of P in PCl_4^+?

(a) sp^3d (b) sp^3d^2 (c) sp^3 (d) dsp^3

41 Among the species: CO_2, CH_3COO^-, CO, CO_3^{2-}, HCHO which has the weakest C—O bond?

(a) CO (b) CO_2, (c) CO_3^{2-} (d) CH_3COO^-,

42 A gas bulb of 1 mL capacity contains 2.0×10^{21} molecules of nitrogen exerting a pressure of 7.57×10^3 Nm^{-2}. The root mean square speed of the gas molecules is

(a) 274 ms^{-1} (b) 494 ms^{-1}
(c) 690 ms^{-1} (d) 988 ms^{-1}

43 A vessel contains 1.6 g of dioxygen at STP (273.15 K, 1 atm pressure). The gas is now transferred to another vessel at constant temperature, where pressure becomes half of the original pressure. The volume of the new vessel and number of molecules of dioxygen are respectively. ➞ NCERT Exemplar

(a) 2.24, 6.02×10^{23} (b) 1.12, 3.01×10^{22}
(c) 2.24, 3.01×10^{21} (d) 2.24, 3.01×10^{22}

44 1.020 g of metallic oxide contains 0.540 g of the metal. If the specific heat of the metal, *M* is 0.216 cal $deg^{-1}g^{-1}$, the molecular formula of its oxide is

(a) MO (b) M_2O_3
(c) M_2O_4 (d) M_2O

45 A liquid of density 850 kg / m^3 having a surface tension of 0.055 N/m will rise how far in a glass capillary of 1.40 mm inside diameter in N/m

(a) 18.86 (b) 14.34
(c) 17.89 (d) 15.38

46 Assuming that Hund's rule is violated, the bond order and magnetic nature of the diatomic molecule B_2 is

(a) 1 and diamagnetic
(b) 0 and diamagnetic
(c) 1 and paramagnetic
(d) 0 and paramagnetic

Direction (Q. Nos. 47-50) *Each of these questions contains two statements : A (Assertion) and R (Reason). Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Both A and R are true and R is a correct explanation for Statement I
(b) Both A and R are true. But R is not a correct explanation for Statement I
(c) A is true; R is false
(d) Both A and R are false

47 **Assertion** (A) The value of van der Waals' constant *'a'* is larger for ammonia than for nitrogen.

Reason (R) Hydrogen bonding is present in ammonia.

48 **Assertion** (A) Cathode rays consist of negatively charged particles, called electrons.

Reason (R) In the presence of electrical/magnetic field, the behaviour of cathode rays is similar to the negatively charged particles.

49 **Assertion** (A) In H_2O molecule, O-atom has two lone pairs of electrons.

Reason (B) The geometry of H_2O is tetrahedral due to two sp^3-hybrid orbitals.

50 **Assertion** (A) Sulphur forms many compounds in which the octet rule is obeyed.

Reason (R) Due to the absence of *d*-orbitals in sulphur, it follows the octet rule.

ANSWERS

1 (c)	**2** (c)	**3** (a)	**4** (b)	**5** (a)	**6** (c)	**7** (d)	**8** (d)	**9** (b)	**10** (c)
11 (b)	**12** (d)	**13** (a)	**14** (d)	**15** (b)	**16** (d)	**17** (a)	**18** (c)	**19** (a)	**20** (c)
21 (a)	**22** (d)	**23** (c)	**24** (b)	**25** (a)	**26** (c)	**27** (b)	**28** (c)	**29** (c)	**30** (c)
31 (b)	**32** (b)	**33** (a)	**34** (c)	**35** (c)	**36** (b)	**37** (b)	**38** (d)	**39** (b)	**40** (c)
41 (c)	**42** (b)	**43** (d)	**44** (b)	**45** (a)	**46** (a)	**47** (a)	**48** (a)	**49** (c)	**50** (c)

Hints and Explanations

1 Let the weight of oxygen $= x$

$\therefore$ The weight of nitrogen $= 4x$

Number of molecules of oxygen

$$= \frac{x \times N_0}{32}$$

Number of molecules of nitrogen

$$= \frac{4x}{28} \times N_0$$

$$\frac{\text{Number of molecules of oxygen}}{\text{Number of molecules of nitrogen}} = \frac{x \times 28}{32 \times 4x} = \frac{7}{32}$$

2 $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

160 g Fe_2O_3 give = 112 g Fe

480 g Fe_2O_3 give $= \frac{112}{160} \times 480$ g Fe

= 336 g Fe (theoretical)

But actual yield is = 252.0 g

Thus, % yield

$$= \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

$$= \frac{252}{336} \times 100 = 75\%$$

3 $Zn + H_2SO_4 \longrightarrow ZnSO_4 + \underset{1\text{ mol}}{H_2} \uparrow$

$Zn + NaOH \longrightarrow Na_2ZnO_2 + \underset{1\text{ mol}}{H_2} \uparrow$

Hence, the ratio of volumes of hydrogen evolved = 1 : 1

4 Equivalent weight

$$= \frac{\text{molecular weight}}{\text{valency factor}}$$

When $\overset{+2}{Mn}SO_4$ is converted into $\overset{+4}{Mn}O_2$, the valency factor is 2 and the equivalent weight of $MnSO_4$ will be half of its molecular weight.

5 $2MnO_4^- + 6H^+ + 5SO_3^{2-} \longrightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$

$\because$ 5 moles of SO_3^{2-} required = 2 moles of MnO_4^-

$\therefore$ 1 mole of SO_3^{2-} will require $= \frac{2}{5}$ moles of MnO_4^-

6 A $\to$ 3, B $\to$ 1, C $\to$ 2, D $\to$ 4

A. Mole fraction = Unitless

B. Luminous Intensity = Candela

C. Molality = Concentration in mole per kg solvent

D. Molarity = Concentration in mol L^{-1}.

7 Equivalent weight of element = 32 g and that of oxygen = 8 g

Thus, one equivalent of oxide = 40 g

Percentage of oxygen in oxide

$$= 8 \times \frac{100}{40} = 20\%$$

8 According to kinetic theory of gases, for a diatomic molecule, the average translational kinetic energy of the molecule is proportional to the absolute temperature.

9 $r_{H_2} = \frac{\text{volume of } H_2}{\text{used time}} = \frac{X}{5}$ mL/s

$$\frac{r_{H_2}}{r_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{H_2}}} = \sqrt{\frac{32}{2}} = 4$$

$\therefore \quad r_{H_2} = 4 \times r_{O_2}$

$$= \frac{X}{4 \times 5} = \frac{X}{20} \text{ mL/s}$$

10 $U_{rms} H_2 = \sqrt{7} \times U_{rms} N_2$

or $\sqrt{\frac{3RT_{H_2}}{2}} = \sqrt{7} \times \sqrt{\frac{3RT_{N_2}}{28}}$

$$\left(\because U_{rms} = \sqrt{\frac{3RT}{M}}\right)$$

$$\frac{3RT_{H_2}}{2} = 7 \times \frac{3RT_{N_2}}{28}$$

$$T_{N_2} = 2T_{H_2}$$

$\therefore \quad T_{N_2} > T_{H_2}$

11 By Graham's diffusion law,

$$\frac{r_{He}}{r_{CH_4}} = \sqrt{\frac{M_{CH_4}}{M_{He}}}$$

$$\Rightarrow \quad \frac{r_{He}}{r_{CH_4}} = \sqrt{\frac{16}{4}} = \sqrt{\frac{4}{1}} = 2$$

Hence, ratio of rate of diffusion of He and CH_4 is 2.

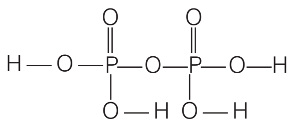
12 $U_{rms} = \sqrt{\frac{3pV}{M}} = \sqrt{\frac{3p}{M/V}} = \sqrt{\frac{3p}{d}}$

(where, d = density)

Hence, at constant pressure,

$$U_{rms} \propto \frac{1}{\sqrt{d}}.$$

13 Bond length is inversely proportional to their bond order. The bond order for NO^-, NO^+, CN^- and CN are 2, 3, 3, 2.5. Therefore, NO^- has highest bond length.

14 

$\Rightarrow$ 12σ and $2\,d\pi - p\pi$ bonds.

15 A $\to$ 2, B $\to$ 4, C $\to$ 1, D $\to$ 3

16 $E_1 = \frac{hc}{\lambda_1}$ and $E_2 = \frac{hc}{\lambda_2}$

$$\frac{E_1}{E_2} = \frac{hc}{\lambda_1} \times \frac{\lambda_2}{hc}$$

$$\Rightarrow \frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1} = \frac{4000}{2000} = 2$$

17 For d-electron, $l = 2$

Angular momentum

$$= \frac{h}{2\pi}\sqrt{l(l+1)} = \frac{h}{2\pi}\sqrt{2(2+1)} = \frac{h}{2\pi}\sqrt{6}$$

18 $\lambda = \frac{h}{p}$ or $\frac{h}{mv}$

$$= \frac{6.626 \times 10^{-34}\ \text{Js}}{200 \times 10^{-3} \times \text{kg} \times \frac{5}{60 \times 60}\ \text{m/s}}$$

$$= \frac{6.626 \times 10^{-34} \times 60 \times 60}{200 \times 10^{-3} \times 5}$$

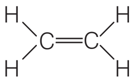
$$= 2.385 \times 10^{-30} \text{m}$$

19 ${}^{A}_{Z}X \longrightarrow {}^{A-1}_{Z}X + {}^{1}_{0}n$

Isotopes are the species having same number of protons but different number of neutrons, i.e. different mass number.

20 $XeF_4 = 4\,bp + 2\,lp \Rightarrow$ square planar $\Rightarrow$ all bonds are equal

$BF_4^- = 4\,bp + 0\,lp \Rightarrow$ tetrahedral $\Rightarrow$ all bonds are equal

C_2H_4 = 

$\Rightarrow$ C$=$C bond is not equal to C — H bond

$SiF_4 = 4\,bp + 0 lp \Rightarrow$ tetrahedral $\Rightarrow$ all bonds are equal.

21 Hydrogen atom has $1s^1$ configuration and these 3*s*, 3*p* and 3*d*-orbitals will have same energy with respect to 1*s*-orbital.

22 PE $= -2 \times$ total energy

$$= -2 \times \left(\frac{13.6 Z^2}{n^2}\right)$$

For helium, $Z = 2$, and $n = 1$ in first Bohr orbit.

Thus, $\quad \text{PE} = -2 \times \frac{13.6 \times (2)^2}{1^2}$

$$= -108.8\,\text{eV}$$

23 0.200 contains 3 while 200 contains only one significant figure because zero at the end or right of a number are significant provided they are on the right side of the decimal point.

24 $\bar{\nu} = \frac{1}{\lambda} = \bar{R}_H Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\lambda = 2170\,\text{nm}$

For H-atom, $\quad Z = 1$

and $\quad n_2 = 7 \quad$ (given)

$$\therefore \frac{1}{2170 \times 10^{-9}\ \text{m}} = 1.09677 \times 10^7\,\text{m}^{-1} \left[\frac{1}{n_1^2} - \frac{1}{7^2}\right]$$

$$\therefore \frac{1}{n_1^2} = \frac{1}{49} + \frac{1}{\left[\begin{array}{l}2170 \times 10^{-9}\ \text{m} \\ \times 1.09677 \times 10^7 \text{m}^{-1}\end{array}\right]}$$

$$= \frac{1}{49} + 0.042$$

$$\frac{1}{n_1^2} = 0.0624$$

$$n_1^2 = 16.02$$

$$n_1 = 4$$

25 KE $=$ quantum energy – threshold energy

$$= \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{3000 \times 10^{-10}} - \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{4000 \times 10^{-10}}$$

$$= 6.626 \times 10^{-19} - 4.9695 \times 10^{-19}$$

$$= 1.6565 \times 10^{-19}\ \text{J}$$

$$\text{KE} = 1.6565 \times 10^{-19} = \frac{1}{2}\ mv^2$$

$$\therefore m^2v^2 = 2 \times 1.6565 \times 10^{-19} \times 9.1 \times 10^{-31}$$

$$mv = 5.49 \times 10^{-25}$$

de-Broglie wavelength,

$$\lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34}}{5.49 \times 10^{-25}}$$

$$= 1.2 \times 10^{-9}\ \text{m}$$

26 In structure (c), all the atoms have complete octet. Thus, it is the correct representation of carbon suboxide.

27 Since, there are four electrons in $2p$ orbital, the outer configuration of the element is $2s^2, 2p^4$. The complete configuration of the element is $1s^2, 2s^2, 2p^4$.

The element contains total 8 electrons, so its atomic number is 8.

Then, the number of neutrons

$$= 16 - 8 = 8$$

It is isotonic with ${}_7N^{15}$ (as it also contains 8 neutrons).

28 In PO_4^{3-} ion, formal charge on each O-atom of P— O bond

$$= \frac{\text{Total charge}}{\text{Number of O -atom}} = \frac{-3}{4} = -0.75$$

29 KCN molecule contains both ionic and covalent bonds as follows

$$K^+\ [C \equiv N]^-$$

$\uparrow$

covalent bond

30 In nitrogen molecule, triple bond is present between two nitrogen atoms, i.e. $N \equiv N$.

So, number of electrons take part in forming bond in $N_2 = 3 \times 2 = 6$.

31 Carbon tetrachloride has no net dipole moment because of its regular tetrahedral structure which is symmetrical.

32 Bond angle between two *sp* hybrid orbitals is 180°.

33 NO (15) $= \sigma 1s^2, \overset{*}{\sigma}\ 1s^2, \sigma 2s^2, \overset{*}{\sigma}\ 2s^2, \sigma 2p_z^2, \pi 2p_x^2, \approx \pi 2p_y^2, \overset{*}{\pi}\ 2p_x^1 \approx \overset{*}{\pi}\ 2p_y^0$

34 In CH_3^+, carbon atom is in sp^2-hybridised state.

35 Both $[NF_3, H_3O^+]$ are pyramidal and sp^3-hybridised and $[NO_3^-, BF_3]$ are triangular planar.

36 200 mg or 0.2 g of CO_2 contains molecules

$$= \frac{6.023 \times 10^{23}}{44} \times 0.2 = 2.73 \times 10^{21}$$

10^{21} molecules are removed, hence molecules left

$$= 2.73 \times 10^{21} - 10^{21} = 1.73 \times 10^{21}$$

The moles of CO_2 left $= \frac{1.73 \times 10^{21}}{6.023 \times 10^{23}}$

$$= 2.87 \times 10^{-3}\ \text{mol}$$

37 Number of moles of nitrogen gas in 1.65 L at 273°C and 3 atm,

$$n_1 = \frac{pV}{RT} = \frac{3 \times 1.65}{0.0821 \times 546} = 0.11\,\text{mol}$$

Number of moles of nitrogen gas in 0.55 L at 0°C and 0.75 atm,

$$n_2 = \frac{pV}{RT} = \frac{0.75 \times 0.55}{0.0821 \times 273}$$

$$= 0.018\,\text{mol}$$

Hence, % of nitrogen escaped, when temperature, pressure and volume is converted.

$$= \frac{(0.11 - 0.018)}{0.11} \times 100$$

$$= 83.64\%$$

38 de-Broglie wavelength,

$$\lambda = \frac{h}{mv} \qquad \ldots \text{(i)}$$

$$\text{KE} = \frac{1}{2}\ mv^2 \qquad \ldots \text{(ii)}$$

Now, putting the value of *v* from Eq. (i), we get,

$$\text{KE} = \frac{1}{2}\ m \times \left[\frac{h}{m \times \lambda}\right]^2 = \frac{1}{2} \times \frac{h^2}{m\lambda^2}$$

i.e. $\text{KE} \propto \dfrac{1}{m}$ $\qquad$ [$\because \lambda$ are same.]

$\therefore \quad E_e > E_p > E_{\propto}$

39 Workdone = Surface tension $\times$ increase in area

$$= 73 \text{ dyne cm}^{-1} \times 0.10 \text{ m}^2$$
$$= 73 \text{ dyne cm}^{-1} \times 0.10 \times 10^4 \text{ cm}^2$$
$$= 7.3 \times 10^4 \text{ erg}$$

40 PCl_4^+ is isostructural with NH_4^+. Hence, the central atom in both have the same type of hybridisation,i.e. sp^3.

41 Among the given species, the bond dissociation energy of C—O bond is minimum in case of CO_3^{2-} by which C—O bond become more weaker in CO_3^{2-} or the bond order of CO_3^{2-}(1.33) is minimum so, the bond become weaker.

42 Number of moles of the gas

$$= \frac{2.0 \times 10^{21}}{6.023 \times 10^{23}} \text{ mol}$$
$$= 3.32 \times 10^{-3} \text{ mol}$$

From, $pV = nRT$

$$T = \frac{pV}{nR}$$
$$= \frac{7.57 \times 10^3 \times 10^{-3}}{3.32 \times 10^{-3} \times 8.314}$$
$$= 274.25 \text{ K}$$

$\because$ Root mean square speed,

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$
$$\therefore \quad v_{\text{rms}} = \sqrt{\frac{3 \times 8.314 \times 274.25}{28 \times 10^{-3}}}$$
$$= 494.26 \text{ ms}^{-1}$$

43 (i) $p_1 = 1$ atm $\quad T_1 = 273\text{K}, \; V_1 = ?$

32 g of oxygen occupies 22.4 L of volume at STP.

Hence, 1.6 g of oxygen will occupy,

$$1.6 \text{ g oxygen} \times \frac{22.4 \text{ L}}{32 \text{ g oxygen}}$$
$$= 1.12 \text{ L volume}$$
$$V_1 = 1.12\text{L}$$
$$p_2 = \frac{p_1}{2} = \frac{1}{2} = 0.5 \text{ atm}$$
$$V_2 = ?$$

According to Boyle's law,

$$p_1V_1 = p_2V_2$$
$$\therefore \quad V_2 = \frac{p_1 \times V_1}{p_2}$$
$$= \frac{1 \text{ atm} \times 1.12 \text{ L}}{0.5 \text{ atm}}$$
$$= 2.24\text{L}$$

(ii) Number of molecules of oxygen in the vessel

$$= \frac{6.022 \times 10^{23} \times 1.6}{32}$$
$$= 3.011 \times 10^{22}$$

44 Mass of oxygen in the oxide

$$= (1.020 - 0.540) = 0.480 \text{ g}$$

Equivalent mass of the metal

$$= \frac{0.540}{0.480} \times 8 = 9.0$$

According to Dulong and Petit's law,

Approx, atomic mass

$$= \frac{6.4}{\text{sp. heat}} = \frac{6.4}{0.216}$$
$$= 29.63$$

Valency of the metal

$$= \frac{\text{at. mass}}{\text{eq. mass}}$$
$$= \frac{29.63}{9.0} \approx 3$$

Hence, the formula of the oxide is M_2O_3.

45 $\gamma = \dfrac{rh\rho g}{2}, \; \gamma = 0.055$ N/m

$r = \dfrac{1.40}{2} = 0.70 \text{ mm} = 0.70 \times 10^{-3}$ m,

$\rho = 850 \text{ kg / m}^3$,

$g = 9.80 \text{ m / s}^2, h = ?$

$$h = \frac{2\gamma}{r\rho g} = \frac{2 \times 0.055}{0.70 \times 10^{-3} \times 850 \times 9.8}$$
$$= 0.01886 \text{ m} = 18.86 \text{ mm}$$

46 B_2 : Total electrons = 10

Configuration:

$$\sigma 1s^2, \overset{*}{\sigma} 2s^2, \sigma 2s^2, \overset{*}{\sigma} 2s^2, \pi 2p_x^1 \approx \pi 2p_y^1$$

If Hund's rule is violated, then

$$\sigma 1s^2, \overset{*}{\sigma} 1s^2, \sigma 2s^2, \overset{*}{\sigma} 2s^2, \pi 2p_x^2 \approx \pi 2p_y^0$$

So, diamagnetic,

$$\text{bond order} = \frac{6-4}{2} = 1$$

47 The value of van der Waals' constant 'a' is larger for ammonia than for nitrogen due to presence of hydrogen bonding. This is because value of 'a' is a measure of intermolecular interaction.

48 Most probably the cathode rays consist of negatively charged particles called electrons because in the presence of electrical/magnetic field, the behaviour of cathode rays are similar to the negatively charged particles.

49 The H_2O molecule has sp^3-hybridisation with two lone pair of electrons, due to which its geometry is bent.

50 Sulphur has vacant d-orbital so it can expand its octet. In general, it forms many compounds which obey octet rule.