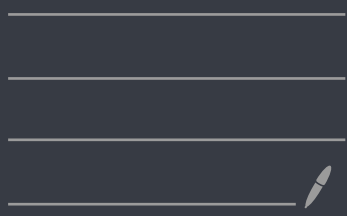


EXERCISE – 1

1. Which of the following expressions is correct (n = no. of moles of the gas, N_A = Avogadro constant, m = mass of 1 molecule of the gas, N = no. of molecules of the gas) ?

(A) $n = mN_A$ (B) $m = N_A$ (C) $N = nN_A$ (D) $m = n/N_A$

Hint = $N = n \times N_A$

2. The maximum number of molecules is present in–

(A) 15 L of H_2 gas at STP (B) 5 L of N_2 gas at STP

(C) 0.5 L of H_2 gas STP (D) 10 L of O_2 gas STP

moles $\propto$ volume

3. In which of the following pairs do 1 g of each have an equal number of molecules : $= mole \times N_A$

(A) N_2O and CO (B) N_2 and C_3O_2 (C) N_2 and CO (D) N_2O and C_2O

$$(Mole)_1 = \frac{mass}{Molar\ mass} = \frac{1}{M_1}$$

$$(mole)_2 = \frac{1}{M_2} \qquad (Mole)_1 = (moles)_2 \Rightarrow M_1 = M_2$$

4. A quantity of aluminium has a mass of 54.0 g. What is the mass of the same number of magnesium atoms ?

(At. wt. Al = 27, Mg = 24)

(A) 12.1 g (B) 23.3 g (C) 48 g (D) 97.2 g

$$No\ of\ atoms = \left(\frac{54}{27}\right) \times N_A \times 1 = (2N_A)$$

$$\Rightarrow moles\ of\ Mg = \frac{2N_A}{N_A} = 2$$

$$Mass\ of\ Mg = 2 \times 24 = 48$$

5. Which of the following samples contains the largest number of atoms ?

(A) 1 g of Ni(s) (59) (B) 1 g of Ca(s) (40) (C) 1 g of N_2(g) (28) (D) 1 g of Br(s) (80)

= Mole × N_A × atomicity

= $\frac{1}{M}$ × N_A × atomicity

M is less then no of atoms more

6. If the percentage of water of crystallization in $MgSO_4.x\,H_2O$ is 13%. What is the value of x :

(A) 1 (B) 4 (C) 5 (D) 7

$$\% \text{ Composition} = \frac{\text{Atomicity} \times \text{atomic weight}}{\text{Molecular mass}} \times 100$$

$$13 = \frac{x \times 18}{120 + 18x} \times 100 \Rightarrow x = 0.98$$

$$x \simeq 1$$

7. A pure gas that is 14.3% hydrogen and 85.7% carbon by mass has a density of 2.5 g L^{-1} at 0°C and 1 atm pressure. What is the molecular formula of the gas :

(A) CH_2 (B) C_2H_4 (C) C_4H_8 (D) C_6H_{12}

		mole	(SR)
C	85.7	7.15	1
H	14.3	14.3	2

CH_2 $(12+2) = 14 g/mol$

$MF = n(EF)$

$MF = 4(CH_2)$

$= C_4H_8$

$PM = dRT$

$M = \frac{dRT}{P} = \frac{2.5 \times 0.0821 \times 273}{1}$

$= 56 \cdot g/mol$

$n = \frac{56}{14} = 4$

8. One atomic mass unit in kilogram is

(A) $1/N_A$ (B) $12/N_A$ (C) $1/1000\,N_A$ (D) $1000/N_A$

$$\frac{1\,amu(g)}{1000} = \frac{1}{N_A \times 1000} \Rightarrow 1\,amu(kg) = \frac{1}{1000 N_A}$$

9. The mass of 1 mole of protons ($m_p = 1.672 \times 10^{-27}$ kg) is :

(A) 1.800×10^{-3} kg (B) 1.008×10^{-4} kg (C) 1.080×10^{-3} kg (D) 1.007×10^{-3} kg

Molar mass proton $= 1.672 \times 10^{-27} \times N_A$

10. 2 isotopes of an element are present in 1 : 2 ratio of number, having mass number M and (M + 0.5) respectively. The mean mass number of element will be

(A) 3M + 1 (B) 1.5 M + 0.5 (C) 0.5 M + 0.5 (D) M + 1/3

$$M_{avg} = \frac{M \times 1 + (M+0.5) \times 2}{1+2} = \frac{M + 2M + 1}{3} = M + \frac{1}{3}$$

11. From 2 mg calcium, 1.2×10^{19} atoms are removed. The number of g-atoms of calcium left is

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

Moles of Ca $\frac{2 \times 10^{-3}}{40} = 5 \times 10^{-5}$ $- \frac{1.2 \times 10^{19}}{6 \times 10^{23}} = 2 \times 10^{-5}$ $= 3 \times 10^{-5}$ mole.

12. The number of electron in 3.1 mg NO_3^- is -

(A) 32 (B) 1.6×10^{-3} (C) 9.6×10^{20} (D) 9.6×10^{23}

$$\text{No of } e^- = \left[\frac{3.1 \times 10^{-3}}{62}\right] \times N_A \times (7 + 8 \times 3 + 1)$$

$$= 5 \times 10^{-5} \times 6 \times 10^{23} \times 32 = 9.6 \times 10^{20}$$

13. The number of neutrons in 0.45 g water, assuming that all the hydrogen atoms are H^1 atoms and all the oxygen atoms are O^{16} atoms, is

(A) 8 (B) 0.2 (C) 1.2×10^{23} (D) 4.8×10^{24}

$_1H^1$ & $_8O^{16}$

$$\text{No of Neutrons} = \left(\frac{0.45}{18}\right) \times N_A \times 8$$

$$= 0.2 \times 6.02 \times 10^{23}$$

$$= 1.2 \times 10^{23}$$

H_2O

(0 × 2 + 8) = 8

14. A gaseous mixture contains CO_2 (g) and N_2O (g) in a 2 : 5 ratio by mass. The ratio of the number of molecules of CO_2 (g) and N_2O (g) is

(A) 5 : 2 (B) 2 : 5 (C) 1 : 2 (D) 5 : 4

$N_2O = 28+16 = 44$

$CO_2 = 12+32 = 44$

$(M_1 = M_2)$

Moles Ration $= \frac{2}{M_1} : \frac{5}{M_2}$

Ratio of molecules = 2 : 5

---

15. 1.61 gm of $Na_2SO_4.10H_2O$ contains same number of oxygen atoms as present in

(A) 0.98 gm H_2SO_4 (B) 0.08 gm SO_3 (C) 1.78 gm $H_2S_2O_7$ (D) 0.05 gm $CaCO_3$

No of oxygen atom $= \frac{1.61}{322} \times N_A \times 14 = \frac{7N_A}{100}$

(B) $\frac{0.08}{80} \times N_A \times 3 = \frac{3N_A}{1000}$

(A) $= \frac{0.98}{98} \times N_A \times 8 = \frac{4N_A}{100}$

(C) $\frac{1.78}{178} \times N_A \times 7 = \frac{7N_A}{100}$

16. Which of the following contain largest number of carbon atoms?

(A) 15 gm ethane, C_2H_6

(B) 40.2 gm sodium oxalate, $Na_2C_2O_4$

(C) 72 gm glucose, $C_6H_{12}O_6$

(D) 35 gm pentene, C_5H_{10}

(A) No of Carbon atoms $= \frac{15}{30} \times N_A \times 2 = N_A$

(B) $= \frac{40.2}{134} \times N_A \times 2 = 0.6\, N_A$

(C) $= \frac{72}{180} \times N_A \times 6 = 2.4\, N_A$

(D) $= \frac{35}{70} \times N_A \times 5 = 2.5\, N_A$

17. If the mass of proton is doubled and that of neutron is halved, the molecular weight of CO_2, consisting only C^{12} and O^{16} atoms, will

(A) not change (B) increase by 25% (C) decrease by 25% (D) increase by 50%

$P = x$

$n = x$ CO_2

$A = 44x$

Change → $P = 2x$, $n = x/2$

$A = 12 \times 2x + 22 \times \frac{x}{2} = 35x$

$\% \Delta A = \frac{11x}{44} \times 100 = 25\%$

18. The number of g-molecules of oxygen in 6.02×10^{24} CO molecules is

(A) 1 g-molecule (B) 0.5 g-molecule (C) 5 g-molecule (D) 10 g-molecule

See class Notes.

19. Which of the following will occupy greater volume under the similar conditions of pressure and temperature?

(A) 6 gm oxygen (B) 0.98 gm hydrogen (C) 5.25 gm nitrogen (D) 1.32 gm helium

moles $A = \frac{6}{32} = 0.1875$ $C = \frac{5.25}{28} = 0.18$

$B = \frac{0.98}{2} = 0.49$ $D = \frac{1.32}{4}$ 0.33

20. The volume of one mole of water at 277 K is 18 ml. One ml of water contains 20 drops. The number of molecules in one drop of water will be

(A) 1.07×10^{21} (B) 1.67×10^{21} (C) 2.67×10^{21} (D) 1.67×10^{20}

No of drops in 18 ml = 360

360 drops means = N_A molecules

1 drop = $\left(\frac{N_A}{360}\right)$

21. It is known that atom contain protons, neutrons and electrons. If the mass of neutron is assumed to half of its original value where as that of proton is assumed to be twice of its original value then the atomic mass of $^{14}_{6}C$ will be -

(A) same (B) 25% more (C) 14.28 % more (D) 28.5% less

Try by yourself

22. 0.250 g of an element M, reacts with excess fluorine to produce 0.547 g of the hexafluoride MF_6. What is the element: [Cr = 52, Mo = 96, S = 32, Te = 127.6]

(A) Cr (B) Mo (C) S (D) Te

initial atoms = final atoms

$$\frac{0.250}{M} = \frac{0.547 \times 4}{M + 19 \times 6} \Rightarrow M + 114 = 2.188M$$

$$1.188M = 114$$

$$M = \frac{114}{1.188} \Rightarrow 96$$

23. A 1000 gram sample of NaOH contains 3 moles of O atoms, what is the % purity of NaOH :

(A) 14% (B) 100% (C) 12% (D) 24%

(NaOH) : Na : O : H

1 : 1 : 1 : 1

3

3 moles, mass of pure NaOH = $3 \times 40 = 120$g

% purity = $\frac{120}{1000} \times 100$

= 12%

24. The quantum numbers of four electrons (e1 to e4) are given below :-

		n	ℓ	m	s
(n+ℓ)					
3	e1	3	0	0	+1/2
4	e2	4	0	0	1/2
5	e3	3	2	2	–1/2
4	e4	3	1	–1	1/2

The correct order of decreasing energy of these electrons is :

(A) e4 > e3 > e2 > e1 (B) e2 > e3 > e4 > e1 (C) e3 > e2 > e4 > e1 (D) none of these

$e_3 > e_2 > e_4 > e_1$

25. The correct set of quantum numbers for the unpaired electron of chlorine atom is

	n	*l*	*m*
(A)	2	1	0
(C)	3	1	1

	n	*l*	*m*
(B)	2	1	1
(D)	3	0	0

3p
n = 3
l = 1

26. Principal quantum number of an atom represents

(A) Size of the orbital

(B) Spin angular momentum

(C) Orbital angular momentum

(D) Space orientation of the orbital

27. The maximum number of electrons that can be accommodated in the M^{th} shell is

(A) 2 (B) 8 (C) 18 (D) 32

$n = 1$ 2 3

K L M

orbitals = $(3)^2 = 9$

electrons = $2n^2 = 18$

28. Which electronic level would allow the hydrogen atom to absorb a photon but not to emit a photon :-

(A) 3s (B) 2p (C) 2s (D) 1s

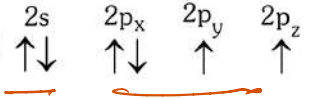
29. Correct set of four quantum numbers for valence electron of rubidium (Z = 37) is :-

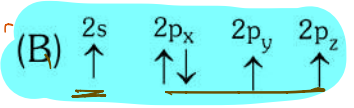
(A) $5, 0, 0, +\frac{1}{2}$ (B) $5, 1, 0, +\frac{1}{2}$ (C) $5, 1, 1, +\frac{1}{2}$ (D) $6, 0, 0, +\frac{1}{2}$

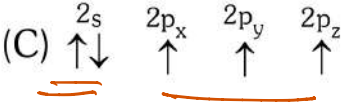
Cs → $5s^1$ →

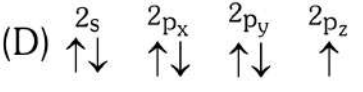
$n = 5,\ \ell = 0,\ m = 0,$ 

30. The orbital diagram in which the Aufbau's principle is violated is :-

(A) 

(B) 

(C) 

(D) 

31. Which of the following sets of quantum numbers represent an impossible arrangement :-

	n	l	m	m_s
(A)	3	2	–2	$\frac{1}{2}$
(B)	4	0	0	$\frac{1}{2}$
(C)	3	2	–3	$\frac{1}{2}$
(D)	5	3	0	$\frac{1}{2}$

Reason $|m| \leq l$

32. The explanation for the presence of three unpaired electrons in the nitrogen atom can be given by :-

(A) Pauli's exclusions principle

(B) Hund's rule ✓

(C) Aufbau's principle

(D) Uncertainty principle

Hund's maximum multiplicity

33. The electronic configuration of an element is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$. This represents its :-

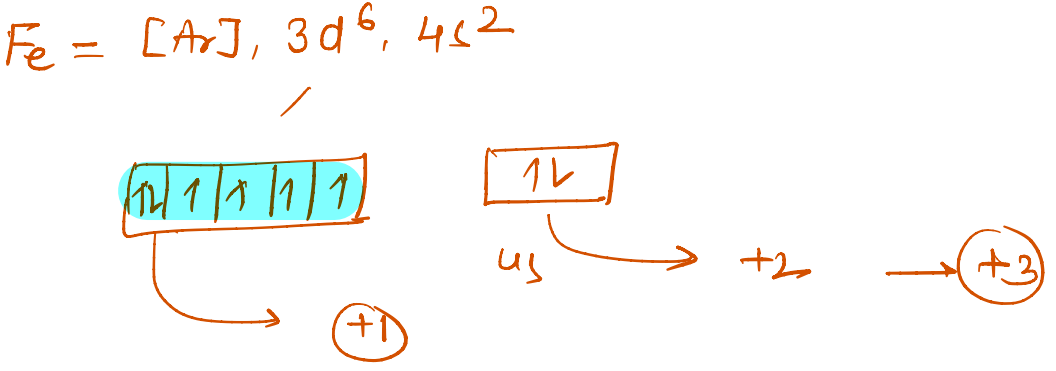
(A) Excited state (B) Ground state (C) Cationic form (D) None

34. Which of the following has maximum number of unpaired electron (atomic number of Fe 26) :-

(A) Fe (B) Fe (II) (C) Fe (III) (D) Fe (IV)

35. Which quantum number is not related with Schrodinger equation :-

(A) Principal (B) Azimuthal (C) Magnetic (D) Spin



36. Give the correct order of initials T (true) or F (false) for following statements :-

(I) If an ion has 2 electrons in K shell, 8 electrons in L shell and 6 electrons in M shell, then number of electrons present in that element is 6. T

(II) The maximum number of electrons in a subshell is given by $2n^2$ F

(III) If electron has magnetic quantam number –1, then it cannot be present in s-orbital. T

(IV) Only one radial node is present in 3p orbital. T $(n-\ell-1)$ = Radial Node

(A) TTFF (B) FTTF (C) TFTT (D) FFTF

n = 1 2 3 4 5 6

K L M N O P

2 8 6

$1s^2 + 2s^2 + 3s^2 = 6$

$2p^6 \quad 3p^4$

Subshell = $4\ell+2$ or $2(2\ell+1)$

Radial Node = $3-1-1=1$

EXERCISE – 2

1. Same mass of glucose ($C_6H_{12}O_6$) and acetic acid (CH_3COOH) contain :

(A) Same number of carbon atoms

(B) Same number of Hydrogen atoms

(C) Same number of oxygen atoms

✓ (D) All of above

→ Compounds having same empirical formula then they have composition of each element

2. Two flask of equal capacity contain NH_3 & SO_2 gases respectively, are kept under similar conditions of temperature & pressure. Select the correct option on the basis of above information:

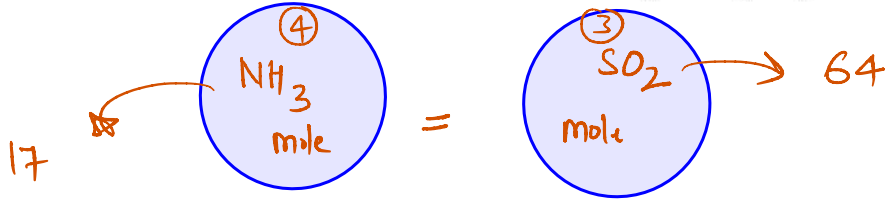
(A) More moles are present in flask contain NH_3

✓ (B) Flask of SO_2 has more mass

✓ (C) Flask of NH_3 has more number of atoms.

✓ (D) Both flask contain same number of molecules of NH_3 & SO_2 respectively

Mass = mole × Molar mass



3. Which of the following contains the same number of molecules ?

(A) 1 g of O_2, 2 g of SO_2 $\left(\frac{1}{32}\right)$ $\left(\frac{2}{64}=\frac{1}{32}\right)$

(B) 1 g of CO_2, 1 g of N_2O $\left(\frac{1}{44}\right)$ $\left(\frac{1}{44}\right)$

$P_1V_1 = P_2V_2$

$0.5 \times 224 = 1 \times V_2$

$V_2 = 112$

(C) 11.2 ml of O_2 at STP, 224 ml of He at 0.5 atm and 273 K

(D) 1 g of oxygen, 1 g of ozone

0.5 mmol

$\frac{11.2}{224} = 5$ mmol

$3NH_4^+$ PO_4^{-3}

3 : 1

4. Select the correct statement(s) for $(NH_4)_3PO_4$.

(A) Ratio of number of oxygen atom to number of hydrogen atom is 1 : 3.

(B) Ratio of number of cation to number of anion is 3 : 1.

(C) Ratio of number of nitrogen atom to number of oxygen atom is 3 : 4.

(D) Total number of atoms in one mole of $(NH_4)_3PO_4$ is 20.

5. 1 mol of $^{24}_{12}Mg^{2+}$ ions contains :

(A) $12 \times 6.023 \times 10^{23}$ electrons

(B) $12 \times 6.023 \times 10^{23}$ protons

(C) $12 \times 6.023 \times 10^{23}$ neutrons

(D) $14 \times 6.023 \times 10^{23}$ protons

6. 8g O_2 has same number of molecules as that in :

(A) 14g CO (B) 7 g CO (C) 11 g CO_2 (D) 22 g CO_2

No of moles = mole × N_A

moles = $\frac{8g}{32g/m} = \frac{1}{4}$

A = $\frac{14}{28} = \frac{1}{2}$

B = $\frac{7}{28} = \frac{1}{4}$

C = $\frac{11}{44} = \frac{1}{4}$

D = $\frac{22}{44} = \frac{1}{2}$

2 : 16 = 1 : 8

H_2O

7. Which of the following statements(s) is/are correct for water ?

(A) H and O are in 2 : 1 atomic ratio (B) H and O are in 2 : 1 weight ratio

(C) H and O are in 1 : 8 weight ratio (D) H and O are in 1 : 16 weight ratio

8. 1 g atom of nitrogen represents

(A) 6.023×10^{23} N_2 molecules

(B) 22.4 *L* of N_2 at 1 atm and 273 K

(C) 11.2 *l* of N_2 at 1 atm and 273 K

(D) 14 g of N_2

No of moles of Nitrogen atom = 1

Nitrogen molecule = $\frac{1}{2}$

8 8

9*. A sample of oxygen contains O^{16} & O^{18} isotopes only with percentage abundance respectively as 90% & 10%. Identify the correct option(s) : 8, 10

(A) Average atomic mass of sample is 16.2.

(B) Average number of protons per atom is 8.

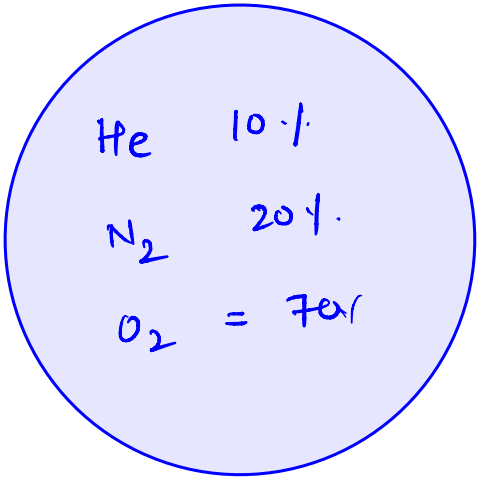
(C) Average number of neutrons per atom is 8.2.

(D) Molecular mass of oxygen gas which can be formed from the sample can vary from 32 to 36.

O_2	O_2
(32)	(36)
100	0
0	100

$$\frac{8 \times 90 + 10 \times 10}{100} = 7.2 + 1 = 8.2$$

Ex.



$$\rightarrow M_{avg} = \frac{4\times10 + 28\times20 + 32\times70}{100}$$

HW which gas is heavier

① Dry air

O_2 N_2 (H_2O)

20% 80%

$$M_{avg} = \frac{32\times20 + 80\times28}{100}$$

② wet air

H_2O (18)

N_2 (28)

O_2 (32)

Dry air heavier than wet air.

10. Which of the following will have same mass of the substance ?

(A) 11.2 litre of O_2 gas at NTP $= 0.5 \Rightarrow 16g$

(B) 44.8 litre of H_2 gas at NTP $2 \quad mas = 4g$

(C) 22.4 litre of CH_4 gas at NTP $= 1 \quad = 16g$

(D) 16 ml of H_2O at NTP $16 ml \times 1 g/ml = 16g$

11. Which of the following sample/s must have molar mass greater than that of a mixture of CO & CO_2 ?

(A) Pure Ne (20)

(B) Pure O_3 (48)

(C) Mixture of SO_2 & N_2O_5

64 min — 108 max.

(D) Mixture of SO_2 & F_2

64 max — 38 min

28 min — 44 max.

(100.1)

12. Which of the following have equal no. of atoms ?

(A) 12 g $MgSO_4$ (B) 0.2 mole CO_2 (C) 5.6 L SO_2 at STP (D) 24 g Ca

moles $= \frac{12}{120} = \frac{1}{10}$ 0.2 $\frac{5.6}{22.4} = \frac{1}{4}$ $\frac{24}{40} = \frac{6}{10}$

No of atoms $= \frac{1}{10} \times N_A \times 6 = \frac{6}{10} N_A$ $= 0.2 \times N_A \times 3 = \frac{6}{10} N_A$ $\frac{1}{4} \times N_A \times 3 = \frac{3}{4} N_A$ $= \frac{6}{10} \times N_A$

13. The number of d- electrons in Mn^{2+} is equal to that of

(A) p-electrons in N (B) s-electron in Na (C) d-electrons in Fe^{+3} (D) p-electrons in O^{-2}

$Mn = [Ar], 3d^5, 4s^2$

$Mn^{+2} = [Ar], 3d^5,$

$N = 1s^2, 2s^2, 2p^3$ (3)

$Na, 1s^2, 2s^2, 2p^6, 3s^1$ (5)

$[Fe], [Ar], 3d^6, 4s^2$

$[Fe^{+3}] = [Ar], 3d^5, 4s^0$ (5)

$O^{-2}, 1s^2, 2s^2, 2p^6$ (6)

14. For $_{24}Cr$ which of the following statements is/are correct.

(A) Number of electrons with principle quantum number '3' are 13.

(B) Number of electrons with azimuthal quantum number '1' are 12.

(C) Number of electrons with magnetic quantum number '0' are 12.

(D) Number of minimum or maximum electrons with same spin quantum number are '9' or 15 respectively.

$Cr = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$

$\ell = 1$ (p)

for $m = 0$: 2, 2, 2, 2, 2 (13), 1, 1 $= 12$

$= 12$

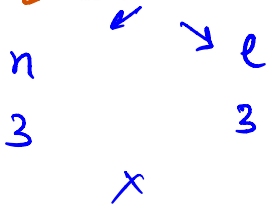
18 $\begin{cases} +\frac{1}{2}\ (9) \\ -\frac{1}{2}\ (9) \end{cases}$

+6 unpaired ($+\frac{1}{2}$ or $-\frac{1}{2}$)

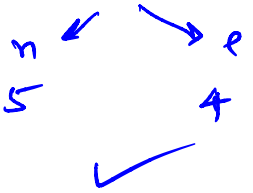
$\begin{cases} max = 15 \\ min = 9 \end{cases}$

15. Which of the following energy level can not exist according to quantum theory ?

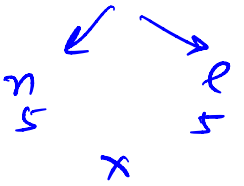
(A) 3f



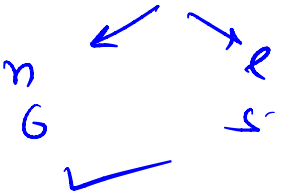
(B) 5g



(C) 5h

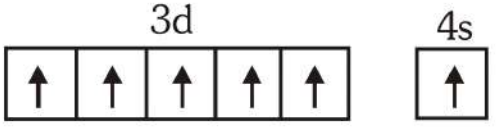


(D) 6h

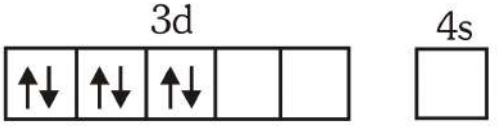


16. Which of the following configuration violates Hund's Rule ?

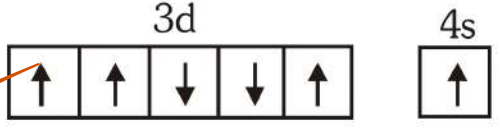
(A)



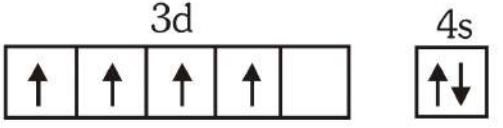
(B)



(C)



(D)



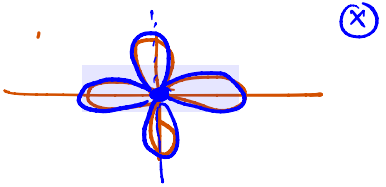
17. Choose the correct statement.

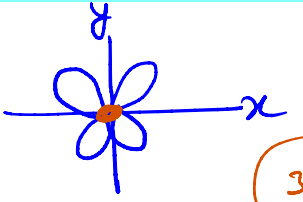
(A) d_{yz} orbital lies in the xz plane.

(B) p_z orbital lies along x–axis

(C) Lobes of $d_{x^2-y^2}$ orbital are at 90° with z–axis

(D) Lobes of d_{xy} orbital are at 90° with z-axis.





18. An element has mass number 23 and its unipositive ion has electronic configuration $1s^2 2s^2 2p^6$. Select the corect statement(s).

(A) It is isotonic with Mg^{24}.

(B) The ratio of n to ℓ for last electron in atom of above element is 2.

(C) Atom of the above element is isoelectronic with H_2O.

(D) Atom of the above element is paramagnetic.

Match the Column

19.

Column-I	***Column-II***
(A) 32 g each of O_2 and S	(p) 2 moles of Fe
(B) 2 gram-molecule of $K_3[Fe(CN)_6]$	(q) 3 moles of ozone molecule
(C) 144 g of oxygen atom	(r) one mole
(D) From 168 g of iron, 6.022×10^{23} atoms of iron are removed, the iron left	(s) 12 moles of carbon atoms

$\frac{144}{16} = 9$ O $\rightarrow 3O_3$, $4.5O_2$

$\frac{168}{56}$ 3 − 1 = 2 mole Fe

20. Match the following:

	Column I	**Column II**
(A)	Same number of unpaired electrons are present in	(p) Na^+, Mg^{2+}, F^-
(B)	Same number of electron in s & p subshells.	(q) F^-, Mg, O^{2-}
(C)	Same number of electrons with the $l = 1$	(r) Mg, Ne, O^{2-}
(D)	Same number of total electrons	(s) Li, Na, K → group (1)

Comprehension Based Questions

Comprehension-1

9×10^{22} atoms of Ar and n moles of O_2 are kept in a vessel of capacity 5 L at 1 atm and 27°C. (Consider $N_A = 6 \times 10^{23}$) :

21. Find the mass of O_2 in vessel -

(A) 16 gm (B) 3.2 gm (C) 1.6 gm (D) 32 gm

22. If all the O_2 is converted to O_3 in vessel -

(A) moles of gas remain same (B) molecules in vessel remain same

(C) pressure in vessel remain same (D) total atoms in vessel remain same

23. If 3×10^{22} molecules of O_2 are added in vessel. Find the new pressure in vessel at same temperature in vessel-

(A) 1.23 atm (B) 2.23 atm (C) 0.23 atm (D) None of the above

Oxygen → Ozone

$3O_2 \rightarrow 2O_3$ (atoms)

moles of O_2 added = $\frac{3 \times 10^{22}}{6 \times 10^{23}} = 0.05$

moles of Ar = 0.15

moles of oxygen = n

$\frac{9 \times 10^{22}}{6 \times 10^{23}}$

total moles = $(0.15 + n)$

$PV = nRT$

$1 \times 5 = (n + 0.15) \times 0.082 \times 300$

$n + 0.15 = 0.20$

$n = 0.05$

mass of $O_2 = 0.05 \times 32 =$

Now total moles $= 0.15 + 0.05 + 0.05$

$= 0.25$

$PV = nRT$

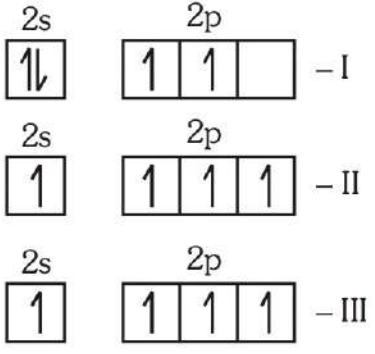
$$\left\{ P = \frac{0.25 \times 0.082 \times 300}{5L} \right\}$$

Comprehension-2

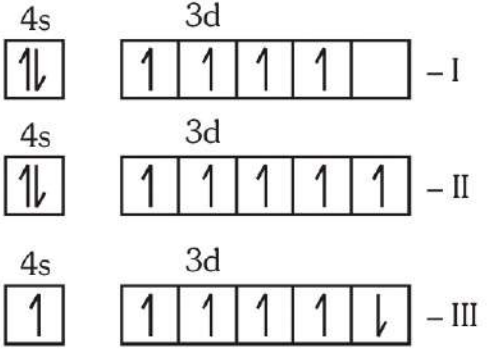
Electronic configuration of elements give an idea about various properties of elements and hence it is one of the basis for periodic classification of elements. An element prefers to stay in that configuration in which its energy is least. A substance is said to show "Paramagnetic properties" if it has unpaired electrons.

24. Which of the following options correctly mention the configuration which is most stable among Q and R.

Q



R



Q – I, Q – II ✗

Q – III ✗

R – I ✗

R – II → more stable because Half filled

R – III ✗

(A) Q – I and R – I

(B) Q – I and R – II ✓

(C) Q – II and R – I

(D) None of the above options

25. Which of the following is expected to be paramagnetic :

(A) Fe (B) Zn (C) Ne (D) Be

$3d^{10}, 4s^2$ $2p^6$,

26. Specie having configuration same as ns^2np^4 where 'n' represents last shell is/are :

(A) $_{16}O^{32}$ (B) $_{34}Se^{79}$

(C) $_{9}F^{19}$ (D) Both $_{16}O^{32}$ and $_{34}Se^{79}$

oxygen family

O
S
Se
Te
Po

EXERCISE - 3

1. Calculate the % by mass of 'H' in 1 ml of H_2O^{18} at 1 atm and 27°C.

(Express your answer as sum of all digits.)

$\%\ H = \frac{2}{20} \times 100 = 10\%$ [Irrespective to source and conditions)

2. Calculate the mass of urea (NH_2CONH_2) containing 1gm-atom H.

(Express your answer as sum of all digits.)

(NH_2CONH_2) : N : H : C : O

1 : 2 : 4 : 1 : 1

x : 1

$\Rightarrow (\frac{1}{4})$ moles of urea

mass $= \frac{1}{4} \times 60 = 15g$

3. The average mass of one gold atom in a sample of naturally occuring gold is 3.2707×10^{-22} g. Use this to calculate the molar mass of gold.

Molar mass $= 3.2707 \times 10^{-22} \times 6.023 \times 10^{23}$

$= 196.62$

4. A plant virus is found to consist of uniform symmetrical particles of 150 Å in diameter and 5000 Å long. The specific volume of the virus is 0.75 cm^3/g. If the virus is considered to be a single particle, find its molecular weight.

$\rho = \frac{1}{0.75}$ g/cm³ (molar mass)

Molar mass $= 3.14 \times (75 \times 10^{-8})^2 \times 5000 \times 10^{-8} \times \frac{100}{0.75} \times 6.02 \times 10^{23}$

$= 3.14 \times 75 \times 75 \times 5000 \times 10^{-24} \times \frac{100}{75} \times 6.02 \times 10^{23} = 7.088 \times 10 \times 10^{7}$

5. A chemical commonly called "dioxin" has been very much in the news in the past few years. (It is the by product of herbicide manufacture and is thought to be quite toxic.) Its formula is $C_{12}H_4Cl_4O_2$. If you have a sample of dirt (28.3 g) that contains 1.0×10^{-4} % dioxin, how many moles of dioxin are in the dirt sample?

↳

$$\text{mass of dioxin} = \frac{28.3 \times 1.0 \times 10^{-4}}{100}$$

$$= 28.3 \times 10^{-6} \text{ g}$$

$$\text{moles of dioxin} = \frac{28.3 \times 10^{-6}}{322}$$

6. The action of bacteria on meat and fish produces a poisonous compound called cadaverine. As its name and origin imply, it stinks ! It is 58.77% C, 13.81 % H, and 27.42 % N. Its molar mass is 102 g/mol. Determine the molecular formula of cadaverine.

		mole	SR	
C	58.77	4.89	2.5	5
H	13.81	13.81	7.05	14
N	27.42	1.95	1	2

$C_5H_{14}N_2$

$EF\ mass = 60 + 14 + 28 = 102$

$n = \frac{102}{102} = 1$

$MF = (EF) \times 1$

$= C_5H_{14}N_1$

7. Given the following empirical formulae and molecular weight, compute the true molecular formulae :

	Empirical formula	***Molecular weight***
(a)	CH_2	84
(b)	CH_2O	150
(c)	HO	34
(d)	HgCl	472
(e)	HF	80

8. 1 mole of diatomic gas A_2 contain 32 and 36 moles of electrons and neutrons respectively. The representation of the element.

$A \Rightarrow e = 16 = P = Z$

$A \Rightarrow n = 18$

mass Number $= 16 + 16 = 34$

$^{34}_{16}A$

9. A sample of nitrogen contains 90% N^{14} and 10% N^{15} isotopes. The average number of neutron per atom is

$n = 7$ $\quad$ $n = 8$

$$n_{avg} = \frac{7 \times 90 + 8 \times 10}{100}$$

10. If molecular weight of glucose-1-phosphate is 260 and its density is 1.5 g/ml. What is the average volume occupied by 1 molecule of this compound?

Molar mass = 260 g/mol

Volume of 1 mole = $\left(\frac{260}{1.5}\right)$

Volume of 1 molecule = $\frac{260}{1.5 \times N_A}$ ml

11. Find total no. of orbitals in nickel which have $|m| \leq 1$ and at least one electron is present, where 'm' is magnetic quantum number.

(Given your ans. as sum digits for example. If your ans is 57 then 5 + 7 = 12 and 1 + 2 =3)

$|m| \leq 1$

$m = +1, -1, 0$

(28) → $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^8, 4s^2$

→ s = (4)

p = (6)

d = 3

13

12. Calculate total number of orbitals having ***(n + ℓ) value = 8 and magnetic quantum number a non-zero*** quantity.

$n+\ell = 8$

$8+0 = 8s$ ✗

$7+1 = 7p \longrightarrow -1, 0, +1 \quad (2)$

$6+2 = 6d \longrightarrow -2, -1, 0, +1, +2 \quad (4)$

$5+3 = 5f \longrightarrow -3, -2, -1, 0, +1, +2, +3 \quad (6)$

13. Maximum number of electrons in parallel spin in the group state of Chromium atom is:

Ans (15)

ground

14. If the magnetic quantum number for an electron is –3, the minimum value for its principal quantum number is :

$m = -3$,

$\ell \Rightarrow 3, 4, 5, 6$

$n = 4, 5, 6, 7$

Ans

EXERCISE – 4

1. The weight of 2.01×10^{23} molecules of CO is **[AIEEE-2002]**

(A) 9.3 g (B) 7.2 g (C) 1.2 g (D) 3 g

$$\text{Moles} = \frac{2.01 \times 10^{23}}{6.02 \times 10^{23}} = \frac{1}{3}\text{ mol.} \qquad \text{mass} = \frac{1}{3} \times 28 = 9.3\text{ g}$$

2. In an organic compound of molar mass 108 g mol^{-1} C, H and N atoms are present in 9 : 1 : 3.5 by weight. Molecular formula can be : **[AIEEE-2002]**

(A) $C_6H_8N_2$ (B) $C_7H_{10}N$ (C) $C_5H_6N_3$ (D) $C_4H_{18}N_3$

			SR
C	$\frac{9x}{12}$	$0.75x$	3
H	$\frac{x}{1}$	x	4
N	$\frac{3.5x}{14}$	$0.25x$	1

C_3H_4N

Empirical formula mass $= 54$

$n = 108/54 = 2$

$MF = 2(EF) = C_6H_8N_2$

3. The number of d-electrons retained in Fe^{2+} (At. no. of Fe = 26) ion is : ***[AIEEE-2003]***

(A) 6 (B) 3 (C) 4 (D) 5

$Fe = [Ar], 3d^6, 4s^2$

$Fe^{+2} = [Ar], 3d^6, 4s^0$

No of d electron retained = 6

4. 6.02×10^{21} molecules of urea are present in 100 ml of its solution. The concentration of urea solution is - ***[AIEEE-2004]***

(A) 0.001 M (B) 0.01 M (C) 0.02 M (D) 0.1 M

$$\text{Molarity} = \frac{\text{mole}}{\text{Vol(L)}}$$

$$\text{mole} = \frac{6.02 \times 10^{21}}{6.02 \times 10^{23}} = 10^{-2}$$

$V(L) = 0.1\,L$

$$M = \frac{10^{-2}}{0.1} = 0.1\,M$$

5. Which of the following sets of quantum number is correct for an electron in 4f orbital ? ***[AIEEE-2004]***

(A) $n = 3, l = 2, m = -2, s = +\frac{1}{2}$

(B) $n = 4, l = 4, m = -4, s = -\frac{1}{2}$

(C) $n = 4, l = 3, m = +1, s = +\frac{1}{2}$

(D) $n = 4, l = 3, m = +4, s = +\frac{1}{2}$

4f → $n = 4$, $l = 3$

6. Consider the ground state of Cr atom (Z = 24). The numbers of electrons with the azimuthal quantum numbers, $l = 1$ and 2 are, respectively ***[AIEEE-2004]***

(A) 16 and 5 (B) 12 and 5 (C) 16 and 4 (D) 12 and 4

$Cr = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$

$6+6=12$ $= 5$

$l = 1$, p

$l = 2$ = d

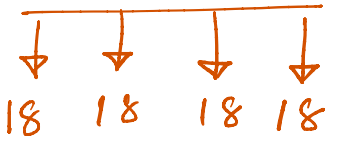
7. Which one of the following sets of ions represents the collection of isoelectronic species ? ***[AIEEE-2004]***

(A) Na^+, Mg^{2+}, Al^{3+}, Cl^-

(B) Na^+, Ca^{2+}, Sc^{3+}, F^-

(C) K^+, Cl^-, Mg^{2+}, Sc^{3+}

(D) K^+, Ca^{2+}, Sc^{3+}, Cl^-



8. In a multi-electron atom, which of the following orbitals described by the three quantum members will have the same energy in the absence of magnetic and electric fields? ***[AIEEE-2005]***

(a) n = 1, l = 0, m = 0 (b) n = 2, l = 0, m = 0 (c) n = 2, l = 1, m = 1 (d) n = 3, l = 2, m = 1

(e) n = 3, l = 2, m = 0

(A) (d) and (e) (B) (c) and (d) (C) (b) and (c) (D) (a) and (b)

P X

$2P_x = 2P_y = 2P_z$

$3P_x = 3P_y = 3P_z$

$3d_{xy} = 3d_{xz} = 3d_{yz} \Rightarrow 3d_{x^2-y^2} = 3d_{z^2}$

(n, ℓ) → same energy

if n and have same value

then orbitals have same energy in absence of Electric and magnetic field.

9. Of the following sets which one does not contain isoelectronic species ? **[AIEEE-2005]**

(A) BO_3^{3-}, CO_3^{2-}, NO_3^- (B) SO_3^{2-}, CO_3^{2-}, NO_3^- (C) CN^-, N_2, C_2^{2-} (D) PO_4^{3-}, SO_4^{2-}, ClO_4^-

$(5 + 8\times3+3)$ $(6+8\times3+2)$ $7+8\times3+1$

32 32 $=32$

10. Which of the following statements in relation to the hydrogen atom is correct ? **[AIEEE-2005]**

(A) 3s, 3p and 3d orbitals all have the same energy

(B) 3s and 3p orbitals are of lower energy than 3d orbitals

(C) 3p orbital is lower in energy than 3d orbital

(D) 3s orbitals is lower in energy than 3p orbital

↳ hydrogen and hydrogen like

Energy depends only on n

$(3s = 3p = 3d)$

↳ have same energy

11. If we consider that 1/6, in place of 1/12, mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of the substance will :- ***[AIEEE-2005]***

(A) be a function of the molecular mass of the substance

(B) remain unchanged

(C) increase two fold

(D) decrease twice

(5)

amu $= \frac{1}{12}$ (mass of C-12 atom)

amu' $= \frac{1}{6}$ mass of C-12 atom

$\frac{amu}{amu'} = \frac{1}{2}$, amu' = 2(amu) → function of mass

12. How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 mole of oxygen atoms?

[AIEEE-2006]

(A) 3.125×10^{-2} (B) 1.25×10^{-2} (C) 2.5×10^{-2} (D) 0.02

$Mg_3(PO_4)_2$: Mg : P : O

1 : 3 : 2 : 8

(x) 0.25

$\frac{1}{x} = \frac{8}{0.25}$

13. Which of the following sets of quantum numbers represents the highest energy of an atom ? ***[AIEEE-2007]***

(A) $n = 3, l = 1, m = 1, s = +½$ (B) $n = 3, l = 2, m = 1, s = +½$

(C) $n = 4, l = 0, m = 0, s = +½$ (D) $n = 3, l = 0, m = 0, s = +½$

See $(n+l)$

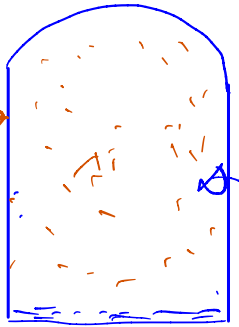
14. Which one of the following constitutes a group of the isoelectronic species? ***[AIEEE-2008]***

(A) C_2^{2-}, O_2^-, CO, NO (B) $NO^+, C_2^{2-}, CN^-, N_2$ (C) $CN^-, N_2, O_2^{2-}, C_2^{2-}$ (D) N_2, O_2^-, NO^+, CO

15. If 10^{-4} dm^3 of water is introduced into a 1.0 dm^3 flask at 300 K, how many moles of water are in the vapour phase when equilibrium is established ?

(Given : Vapour pressure of H_2O at 300 K is 3170 Pa ; R = 8.314 JK^{-1} mol^{-1}) :- ***[AIEEE-2010]***

(A) 1.27×10^{-3} mol (B) 5.56×10^{-3} mol (C) 1.53×10^{-2} mol (D) 4.46×10^{-2} mol



1 dm^3

10^{-3} m^3

T = 300K

at equilibrium pressure of vapour is called vapour pressure

P = V.P

= 3170 Pa =

1 dm^3 = 10^{-3} m^3

$PV = nRT$

$3170 \times 10^{-3} = n \times 8.314 \times 300$

$n = 1.27 \times 10^{-3}$ mol.

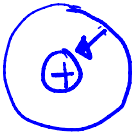
16*. The increasing order of the ionic radii of the given isoelectronic species is :- ***[AIEEE-2012]***

(A) K^+, S^{2-}, Ca^{2+} , Cl^- (B) Cl^-, Ca^{2+}, K^+, S^{2-} (C) S^{2-}, Cl^-, Ca^{2+}, K^+ (D) Ca^{2+}, K^+, Cl^-, S^{2-}

p = 20 19 17 16

↓ ↓ ↓ ↓

18 18 18 18



See protons

$IR \propto \frac{1}{\text{protons}}$

17. The electrons identified by quantum numbers n and ℓ :- ***[AIEEE-2012]***

(a) n = 4 , ℓ = 1 (5) (b) n = 4, ℓ = 0 (4) (c) n = 3, ℓ = 2 (5) (d) n = 3, ℓ = 1 (4)

Can be placed in order of increasing energy as

(A) (a) < (c) < (b) < (d) (B) (c) < (d) < (b) < (a) (C) (d) < (b) < (c) < (a) (D) (b) < (d) < (a) < (c)

$(n+\ell)$ Rule

18. A transition metal M forms a volatile chloride which has a vapour density of 94.8. If it contains 74.75% of chlorine the formula of the metal chloride will be ***[AIEEE 2012 (Online)]***

(A) MCl_2 (B) MCl_4 (C) MCl_5 (D) MCl_3

$MCl_x \rightarrow V.D \Rightarrow M_{wt} = 94.8 \times 2 = 189.6$

$$\% Cl = \frac{x \times 35.5}{189.6} \times 100 = 74.75$$

19. The ratio of number of oxygen atoms (O) in 16.0 g ozone (O_3), 28.0 g carbon monoxide (CO) and 16.0 g oxygen (O_2) is :-

(Atomic mass : C = 12, O = 16 and Avogadro's constant $N_A = 6.0 \times 10^{23}\ mol^{-1}$) ***[AIEEE 2012 (Online)]***

(A) 3 : 1 : 1 (B) 1 : 1 : 2 (C) 3 : 1 : 2 (D) 1 : 1 : 1

No of oxygen atom $= \left(\frac{16}{48} \times N_A \times 3\right) = N_A$, $= \frac{16}{32} \times N_A \times 2 = N_A$

$= \frac{28}{28} \times N_A \times 1 = N_A$

20. A gaseous hydrocarbon gives upon combustion 0.72 g of water and 3.08 g of CO_2. The empirical formula of the hydrocarbon is **[JEE(Main)-2013]**

(A) C_2H_4 (B) C_3H_4 (C) C_6H_5 (D) C_7H_8

moles of $H_2O = \frac{0.72}{18} = 0.04$

moles of H = 0.08

moles of $CO_2 = \frac{3.08}{44} = 0.07$

moles of C = 0.07

	moles	SR
C	0.07	7
H	0.08	8

C_7H_8

21. The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The ratio of number of their molecule is– ***[JEE Mains-2014]***

(A) 1 : 4 (B) 7 : 32 (C) 1 : 8 (D) 3 : 16

$\frac{1}{32} : \frac{4}{28} \Rightarrow \frac{1}{32} : \frac{1}{7} \Rightarrow 7 : 32$

22*. The correct set of four quantum numbers for the valence electrons of rubidium atom (Z = 37) is:

[JEE MAINS-2014]

(A) 5, 0, 0 + $\frac{1}{2}$ (B) 5, 1, 0 + $\frac{1}{2}$ (C) 5, 1, 1 + $\frac{1}{2}$ (D) 5, 0, 1 + $\frac{1}{2}$

23. If the principal quantum number n = 6, the correct sequence of filling of electrons will be:-

[JEE-MAIN, 2015]

(A) ns→(n−1)d→(n−2)*f*→np

(B) ns→np→(n−1)d→(n−2)*f*

(C) ns→(n−2)*f*→(n−1)d→np

(D) ns→(n−2)*f*→np→(n−1)d

6s 4f, 5d, 6p

ns (n-2)f, (n-1)d np

24. The total number of orbitals associated with the principal quantum number 5 is : ***[JEE-MAIN, 2016]***

(A) 25 (B) 5 (C) 20 (D) 10

n^2

25. The most abundant elements by mass in the body of a healthy human adult are : Oxygen (61.4%); Carbon (22.9%), Hydrogen (10.0%); and Nitrogen (2.6%). The weight which a 75 kg person would gain if all ^1H atoms are replaced by ^2H atoms is : ***[JEE MAINS-2017]***

(A) 10 kg (B) 15 kg (C) 37.5 kg (D) 7.5 kg

7.5 kg

$H^1 \longrightarrow H^2$

26. The group having isoelectronic species is : ***[JEE MAINS-2017]***

(A) O^-, F^-, Na^+, Mg^{2+} (B) O^{2-}, F^-, Na^+, Mg^{2+} (C) O^-, F^-, Na, Mg^+ (D) O^{2-}, F^-, Na, Mg^{2+}

27. An unknown chlorohydrocarbon has 3.55% of chlorine. If each molecule of the hydrocarbon has one chlorine atom only; chlorine atoms present in 1 g of chlorohydrocarbon are :

(Atomic wt. of Cl = 35.5 u; Avogadro constant = 6.023×10^{23} mol^{-1}) ***[JEE(Main)-2018]***

(A) 6.023×10^{21} (B) 6.023×10^{23} (C) 6.023×10^{20} (D) 6.023×10^{9}

Mass of Cl $= \left(\frac{1 \times 3.55}{100}\right)$ g

No. of atoms of Cl $= \frac{3.55}{100 \times 35.5} \times N_A$

28. An organic compound is estimated through Dumus method and was found to evolve 6 moles of $C0_2$. 4 moles of H_20 and 1 mole of nitrogen gas. The formula of the compound is: ***[JEE-MAIN-2019]***

(A) $C_{12}H_8N$ (B) $C_{12}H_8N_2$ (C) C_6H_8N (D) $C_6H_8N_2$

N_2

	mole	SR
C	6	$C_6H_8N_2$
H	8	
N	1	

29. The quantum number of four electrons are given below -

I. $n = 4, l = 2, m_l = -2, m_s = -\frac{1}{2}$ (6)

II. $n = 3, l = 2, m_l = 1, m_s = +\frac{1}{2}$ (5)

III. $n = 4, l = 1, m_l = 0, m_s = +\frac{1}{2}$ (5)

IV. $n = 3, l = 1, m_l = 1, m_s = -\frac{1}{2}$ (4)

The correct order of their increasing energies will be -

(A) IV < III < II < I (B) IV < II < III < I (C) I < II < III < IV (D) I < III < II < IV

(n+ℓ) Rule

30. The percentage composition of carbon by mole in methane is :

(A) 80% (B) 25% (C) 75% (D) 20%

CH_4

$\frac{1}{5} \times 100 = 20\%$

31. 5 moles of AB_2 weigh 125×10^{-3} kg and 10 moles of A_2B_2 weigh 300×10^{-3} kg. The molar mass of A(M_A) and molar mass of B(M_B) in kg mol^{-1} are :

(A) $M_A = 50 \times 10^{-3}$ and $M_B = 25 \times 10^{-3}$

(B) $M_A = 25 \times 10^{-3}$ and $M_B = 50 \times 10^{-3}$

(C) $M_A = 5 \times 10^{-3}$ and $M_B = 10 \times 10^{-3}$

(D) $M_A = 10 \times 10^{-3}$ and $M_B = 5 \times 10^{-3}$

X

Y

$$M_{AB_2} = \frac{125 \times 10^{-3}}{5} = 25 \times 10^{-3}$$

$$M_{A_2B_2} = \frac{300 \times 10^{-3}}{10} = 30 \times 10^{-3}$$

$$X + 2Y = 25 \times 10^{-3}$$

$$2X + 2Y = 30 \times 10^{-3}$$

$$X = 5 \times 10^{-3} \text{ kg/mol}$$

$$Y = 10 \times 10^{-3} \text{ kg/mol}$$

$$\text{mole} = \frac{\text{mass}}{\text{molar mass}}$$

$$\text{molar mass} = \frac{\text{mass (g)}}{\text{molar (g/m}}$$

A = X

B = Y

32. 25 g of an unknown hydrocarbon upon burning produces 88 g of CO_2 and 9 g of H_2O. This unknown hydrocarbon contains.

(A) 20g of carbon and 5 g of hydrogen

(B) 24g of carbon and 1 g of hydrogen

(C) 18g of carbon and 7 g of hydrogen

(D) 22g of carbon and 3 g of hydrogen

moles of CO_2 = 2

moles of C = 2

moles of H_2O = $\frac{1}{2}$

mole of H = 1

C_2H_1

24g C ⟶ 1g H

33. The isoelectronic set of ions is :

(A) N^{3-}, Li^+, Mg^{2+} and O^{2-} (B) Li^+, Na^+, O^{2-} and F^- (C) F^-, Li^+, Na^+ and Mg^{2+} (D) N^{3-}, O^{2-}, F^- and Na^+

EXERCISE – 5

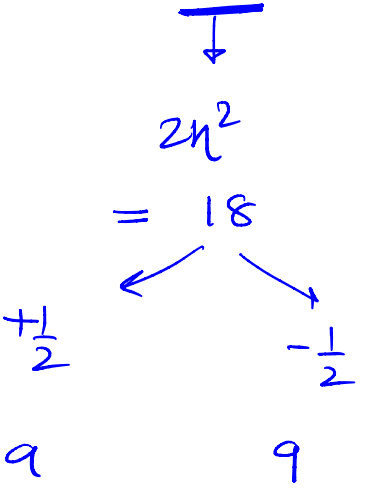
1. How many moles of e– weight one Kg : ***[JEE '2002 (Scr), 1]***

(A) 6.023×10^{23} (B) $\frac{1}{9.108} \times 10^{31}$ (C) $\frac{6.023}{9.108} \times 10^{54}$ (D) $\frac{1}{9.108 \times 6.023} \times 10^{8}$

2. Given that the abundances of isotopes ^{54}Fe, ^{56}Fe, ^{57}Fe are 5%, 90% and 5% respectively, the atomic mass of Fe is : ***[JEE 2009]***

(A) 55.85 u (B) 55.95 u (C) 55.75 u (D) 56.05 u

4. The maximum number of electrons that can have principal quantum number, n=3, and spin quantum number, $m_s = -1/2$, is **[JEE 2011]**



5. In an atom, the total number of electrons having quantum numbers n = 4 $|m_l| = 1$ and $m_s = -\frac{1}{2}$ is

[JEE 2014]

$+\frac{1}{2}$

$(-1, +1)$ <

$-\frac{1}{2}$

$n = 4$

$l =$ 0, 1, 2, 3

	0	1	2	3
			-2	-3
orbital		+1	-1	-2
		-1	0	-1
		0	+1	0
			+2	+1
				+2
				+3

total orbital = 6

total electrons = $6 \times 2 = 12$

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

$-\frac{1}{2} = 6$