1. Number of atoms in the following samples of substances is the largest in :
(1) 127.0g of iodine
(2) 48.0g of magnesium
(3) 71.0g of chlorine
(4) 4.0g of hydrogen

Solution:
1 mole represents 6.023×10^{23} particles.
1 mole of iodine atom= 6.023×10^{23}
Given 127.0g of iodine.
no. of iodine atom = 1 mole of iodine
1mole of magnesium = 24g of Mg = 6.023×10^{23}no.of Mg
Given 48g of Mg = $2\times6.023\times10^{23}$
no. of Mg = 2 moles of Mg
1 mole of chlorine atom= 6.023×10^{23}
no. of chlorine atom = 35.5g of chlorine atom
Given 71g of chlorine atom=$2\times 6.023\times 10^{23}$
no. of chlorine atom = 6.023×10^{23}
2 moles of chlorine atom.
Given that 4g of hydrogen atom.
will be equal to $4 \times 6.023 \times 10^{23}$
no. of atoms of hydrogen= 4 moles of hydrogen atom.
Hence option(4) is the answer.

2. The ratio of mass percent of C and H of an organic compound ($C_xH_yO_z$) is 6 : 1. If one molecule of the above compound ($C_xH_YO_Z$) contains half as much oxygen as required to burn one molecule of compound C_XH_Y completely to CO_2 and H_2O. The empirical formula of compound $C_xH_yO_z$ is :
(1) C_2H_4O
(2) $C_3H_4O_2$
(3) $C_2H_4O_3$
(4) $C_3H_6O_3$

Solution:
Given the ratio of mass percent of C and H of an organic compound ($C_xH_yO_z$) is 6 : 1.
Atomic mass of carbon = 12
Atomic mass of Hydrogen = 1
If we have x atoms of Carbon and y atoms of Hydrogen,
12*x = 6(1*y)
12x = 6y
So, y = 2x
Given one molecule of compound ($C_xH_yO_Z$) contains half as much oxygen as required to burn one molecule of compound C_XH_Y completely to CO_2 and H_2O

$C_xH_y + O_2 \rightarrow xCO_2 + (y/2)H_2O$
Put y = 2x in above equation
$C_xH_{2x} + O_2 \rightarrow xCO_2 + xH_2O$
Oxygen needed = 2x+x = 3x
z is half of oxygen required to burn.
So z = 3x/2 = 1.5 x
Check the given options which satisfies z = 1.5x.
So the empirical formula is $C_2H_4O_3$.
Hence option (3) is the answer.

3. The concentrated sulphuric acid that is peddled commercially is 95% H_2SO_4 by weight. If the density of this commercial acid is 1.834 g cm^{-3}, the molarity of this solution is :-
(1) 17.8 M
(2) 15.7 M
(3) 10.5 M
(4) 12.0 M

Solution:
Given Density = 1.834
1 ml solution contains 1.834 g
1000 ml solution will contain 1834 g
95% H_2SO_4 means 100 gm contain 95 gm H_2SO_4
Mass of solute = (95/100)×1834
Molecular weight of H_2SO_4 = 98
Molarity = No. of moles/ volume = mass of solute/98
= (95/100)×(1834/98)
= 17.8 M
Hence option (1) is the answer.

4. The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The ratio of number of their molecule is :
(1) 1 : 8
(2) 3 : 16
(3) 1 : 4
(4) 7 : 32

Solution:
Given ratio of masses of oxygen and nitrogen = 1:4
Let mass of O_2 = w
Mass of N_2 = 4w
Molecules of O_2 = w/(32×N_A)
Molecules of N_2 = 4w/(28×N_A)
Ratio of number of molecules = w/(32×N_A)÷4w/(28×N_A)

$= w/(32 \times N_A) \times (28 \times N_A)/4w$
$= 7/32$
So the ratio is 7:32.
Hence option (4) is the answer.

5. 3g of activated charcoal was added to 50 mL of acetic acid solution (0.06N) in a flask. After an hour it was filtered and the strength of the filtrate was found to be 0.042 N. The amount of acetic acid adsorbed (per gram of charcoal) is :
(1) 42 mg
(2) 54 mg
(3) 18 mg
(4) 36 mg

Solution:
Molarity of CH_3COOH solution = mass of acetic acid/molar mass)/volume of solution in litre
Acetic acid is monobasic.
$0.042 = W/(60 \times 0.05)$
$W = 0.042 \times 60 \times 0.05 = 0.126$ g
Amount of acetic acid actually adsorbed = 0.180-0.126 = 54mg
Amount of charcoal available = 3 g
So amount of acetic acid adsorbed per gram of charcoal = 54mg×1g/3.0g = 18 mg
Hence option (3) is the answer.

6. The density of a solution prepared by dissolving 120 g of urea (mol. mass = 60 u) in 1000 g of water is 1.15 g/mL. The molarity of this solution is
(1) 2.05 M
(2) 0.50 M
(3) 1.78 M
(4) 1.02 M

Solution:
Given density of solution = 1.15g/mL
mass of solution = 1000+120 = 1120 gm
Molar mass = 60
Volume = mass /density of solution
= 1120/1.15
No. of moles = 120/60 = 2
Molarity = No. of moles/ volume
$= 2 \div (1120 \times 10^{-3}/1.15)$
$= 2 \times 1.15 \times 1000 /1120)$
= 2.05 M
Hence option (1) is the answer.

7. The ratio of number of oxygen atoms (O) in 16.0g oxygen (O), 28.0 g carbon monoxide (CO) and 32.0g oxygen (O_2) is :

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

(1) 3 : 1 : 1

(2) 1 : 1 : 2

(3) 3 : 1 : 2

(4) 1 : 1 : 1

Solution:

Molar mass of O_3 = 48

Given 16 g O_3 . So no. of moles of O_3 = 16/48 = ⅓

1 mole = 3 ×N_A oxygen atoms

So 1/3 mole = N_A×3×1/3 no of atoms

= N_A oxygen atoms

Molar mass of CO = 28

Given 28 g CO. So no of moles = 28/28 = 1

No. of atoms = 1×N_A = N_A

Molar mass of O_2 = 32

Given 32g O_2

No. of moles = 32/32 = 1

No.of atoms = 1×N_A = N_A

So the ratio is 1:1:1

Hence option (4) is the answer.

8. When CO_2 (g) is passed over red hot coke it partially gets reduced to CO(g). Upon passing 0.5 litre of CO_2 (g) over red hot coke, the total volume of the gases increased to 700 mL. The composition of the gaseous mixture at STP is :

(1) CO_2 = 200 mL: CO = 500mL

(2) CO_2 = 350 mL: CO = 350mL

(3) CO_2 = 0.0 mL: CO = 700mL

(4) CO_2 = 300 mL: CO = 400mL

Solution:

CO_2 (g) + C (s) → 2CO (g)

Total volume = 700 ml = 0.7 L

0.5+x = 0.7

x = .2L = 200 mL

CO_2 (g) = 0.5-0.2 = 300ml

CO (g) = 2x = 400 mL

Hence option (4) is the answer.

9. An open vessel at 300 K is heated till ⅖ th of the air in it is expelled. Assuming that the volume of the vessel remains constant, the temperature to which the vessel is heated is :
(1) 750 K
(2) 400 K
(3) 500 K
(4) 1500K

Solution:
At constant V and P, $n_1T_1 = n_2T_2$
$n_1 = n$
$n_2 = n-2n/5 = 3n/5$
$T_1 = 300$ K
$300 n = (3n/5) T_2$
$T_2 = 300×5/3 = 500$ K
Hence option (3) is the answer.

10. The density of 3M solution of sodium chloride is 1.252 g mL^{-1}. The molality of the solution will be (molar mass, NaCl = 58.5 g mol^{-1})
(1) 2.18 m
(2) 3.00 m
(3) 2.60 m
(4) 2.79 m

Solution:
Given Molar mass of NaCl = 58.5 g
M = 3 mol L^{-1}
Mass of weight W_2 of NaCl in 1L solution $W_2 = 3×58.5 = 175.5$g
Mass of L solution = V × d
= 1000 ×1.25 = 1250g
Mass of H_2O in solution (W_1) = 1250-175.5 = 1074g
$m = W_2×1000/M_{w2} ×W_1 = (175.5×1000)/58.5×1074.5 = 2.79$m
Hence option (4) is the answer.

11. 0.6 g of urea on strong heating with NaOH evolves NH_3. Liberated NH_3 will combine with which of the following HCl solution?
(1) 100 mL of 0.2 N HCl
(2) 400 mL of 0.2 N HCl
(3) 100 mL of 0.1 N HCl
(4) 200 mL of 0.2 N HCl

Solution:
$NH_2CONH_2 + 2NaOH \rightarrow Na_2CO_3 + 2NH_3$
2 mole of urea ≡ one mole of NH_3

one mole of NH_3 = one mole of HCl
So one mole of HCl = 2 mole of urea = 2×0.6/60 = 0.02 mol.
Hence option (1) is the answer.

12. Calculate the mass of $FeSO_4.7H_2O$ which must be added in 100 kg of wheat to get 10 PPM of Fe.

Solution:
Ppm = (Mass of Fe/total mass)×10^6
Total mass = 100 kg = 100 × 1000 g
Mass of Fe = (ppm × total mass)/10^6
= 10× 100 × 1000/10^6 = 1 g
Molecular mass of $FeSO_4.7H_2O$ = 278
Mass of one Fe = 56 g
56 g of Fe → 278 g of $FeSO_4.7H_2O$
So 1 g of Fe → 278/56 = 4.96 g
Hence 4.96 g is the answer.

13. Given a solution of HNO_3 of density 1.4 g/mL and 63% w/w. Determine the molarity of HNO_3 solution.

Solution:
Density = mass/volume of solution
Volume = mass / density = 100g/1.4 g/ml = (100/1.4)ml
Molarity = no. of moles of solute /Volume of solution(l) = 1.4×1000/100 = 14 M
Hence 14 M is the answer.

14. 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
(1) MCl_2
(2) MCl_4
(3) MCl_5
(4) MCl_3

Solution:
Given vapour density = 94.8
Vapour density = molecular mass/2
Molecular mass = 94.8×2 = 189.6
Given 74.75% chlorine.
So 74.75/100 * 189.6 = 141.72 g of chloride is there.
Then the number of atoms of chloride will be 141.72/35.5 =3.97 which is approximately 4.
So the formula of metal chloride will be MCl_4.
Hence option (2) is the answer.

15. 10 mL of 2(M) NaOH solution is added to 200 mL of 0.5 (M) of NaOH solution. What is the final concentration?

(1) 0.57 M

(2) 5.7 M

(3) 11.4 M

(4) 1.14 M

Solution:

No. of moles of NaOH in 10 mL of 2 M solution = (10/1000)×2 = 0.02 mol

Number of moles of NaOH in 200 mL of 0.5M solution = (200/1000)×0.5 = 0.1 mol

Total number of moles of NaOH = 0.02+0.1 = 0.12 mol

Total volume = 10+200 = 210 mL = 0.210 L

Final concentration = 0.12/0.210 = 0.57 M

Hence option (1) is the answer.

16. A 5.2 molar aqueous solution of methyl alcohol, CH_3OH, is supplied. What is the mole fraction of methyl alcohol in the solution?

(1) 0.086

(2) 0.050

(3) 0.100

(4) 0.190

Solution:

We know mole fraction = (moles of solute)/(moles of solute + moles of solvent)

Let mass of water is 1 kg . Moles of CH_3OH is 5.2

X_{solute} = 5.2/(5.2+1000/18) = 5.2/(5.2+55.556) = 5.2/60.756 = 0.086

Hence option (1) is the answer.