Required Given

1. $N = n \times N_A \rightarrow N = ?$, $n = 0.03$ mol, $N_A = 6.022 \times 10^{23}$

Solution

$N = n \times N_A$

$= 0.03(6.022 \times 10^{23})$

$= 1.8066 \times 10^{22}$

$\because$ sigfigs

$\therefore N = 2 \times 10^{23}$ grains of sand

$\therefore$ The number of grains of sand is 2×10^{23}

2. a)

Given

$n = 3.5$ mol Na

$N_A = \frac{6.022 \times 10^{23} \text{ atoms Na}}{\text{mol Na}}$

Required

$N_{Na} = ?$

Solution

$N = n \times N_A$

$N_{Na} = n \times N_A$

$= 3.5 \text{ mol Na} \times \frac{6.022 \times 10^{23} \text{ atoms Na}}{\text{mol Na}}$

$= 2.1077 \times 10^{24}$

$N_{Na} = 2.1 \times 10^{24}$ atoms Na

$\therefore$ The number of atoms in 3.5 moles sodium is 2.1×10^{24} atoms Na

3. a)

Given

$N = 2.7 \times 10^{24}$ atoms Ne

$N_A = \dfrac{6.022 \times 10^{23} \text{ atoms Ne}}{\text{mol Ne}}$

Required

$n = ?$

Solution

$N = n \times N_A$

$n = \dfrac{N}{N_A}$

$n = \dfrac{2.7 \times 10^{24} \text{ atoms Ne}}{6.022 \times 10^{23} \text{ atom Ne/mol Ne}}$

$= 4.4835603$

$n = 4.5$ mol Ne

∴ there are 4.5 moles of Ne atoms

4. a)

Given

Atomic mass of $C = 12.011\,u$

Atomic mass of $O = 15.999$

molar mass = molecular mass

Required

molar mass of $CO_2 = ?$

~~molar~~

Solution

~~molar mass = 12.0~~

molar mass = atomic mass of C + 2(atomic mass of O)

$= 12.011u + 2(15.999u)$

molar mass $= 44.009\ g/mol \doteq 44.0\ g/mol$

∴ the molar mass of CO_2 is 44.0 g/mol

b) Given

Atomic mass of $H = 1.008\,u$

Atomic mass of $N = 14.007\,u$

Atomic mass of $O = 15.999\,u$

molar mass = molecular mass

Required

molar mass of $HNO_3 = ?$

Solution

molar mass = atomic mass of H + atomic mass of N + 3(atomic mass of O)

$= 1.008u + 14.007u + 3(15.999)u$

molar mass $= 63.012\ g/mol$

$\doteq 63.0\ g/mol$

∴ the molar mass of HNO_3 is 63.0 g/mol

7

5. a)

Given

$n = 3.5 \text{ mol } H_2O$

$N_A = \dfrac{6.022 \times 10^{23} \text{ molecules } H_2O}{\text{mol } H_2O}$

Required

$N_{water} = ?$

Solution

$N = n \times N_A$

$N_{water} = 3.5 \text{ mol } H_2O \times \dfrac{6.022 \times 10^{23} \text{ molecules } H_2O}{\text{mol } H_2O}$

$= 2.1077 \times 10^{24}$

$N_{water} = 2.1 \times 10^{24}$ molecules of water

$\therefore$ there are 2.1×10^{24} molecules of water

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b) Given

$m_{O_3} = 100 \text{ g}$

$M_{O_3} = 15.999(3) = 47.997 \text{ g/mol}$

$N_A = \dfrac{6.022 \times 10^{23} \text{ molecules } O_3}{\text{mol } O_3}$

Required

$N_{O_3} = ?$

Solution

$N_{O_3} = \dfrac{m_{O_3}}{M_{O_3}} \times N_A$

$= \dfrac{100 \text{ g}}{47.997 \text{ g/mol}} \times \dfrac{6.022 \times 10^{23} \text{ molecules } O_3}{\text{mol } O_3}$

$= 1.25466 \times 10^{24}$

$N_{ozone} = 1.3 \times 10^{24}$ molecules of O_3 $\rightarrow$ $\therefore$ There are 1.3×10^{24} molecules of ozone

9

6.10)

Given

$N_{Fe} = 1.8 \times 10^{20}$ atoms

$M_{Fe} = 55.845$ g/mol

$N_A = \dfrac{6.022 \times 10^{23} \text{ atoms Fe}}{\text{mol Fe}}$

Required

$m_{Fe} = ?$

Solution

$$m = \frac{N \times M}{N_A}$$

$$m_{Fe} = \frac{1.8 \times 10^{20} \text{ atom Fe} \times 55.845 \text{ g/mol}}{6.022 \times 10^{23} \text{ atoms Fe / mol Fe}}$$

$$= 0.016692295 \text{ g}$$

$$= 0.017 \text{ g}$$

∴ The mass is 0.017 grams of Fe

7. a)

Given

$M_{H_2O} = M_{H_2} + M_O = 2(1.008) + 15.999 = 18.015\ g/mol$

$m_{H_2O} = 250\ g$

Required

$n = ?$

Solution

$m = n \times M$

$$n = \frac{m}{M}$$

$$n = \frac{250 g}{18.015 g/mol}$$

$= 13.877324\ mol$

$n = 14\ mol\ H_2O$

∴ There are 14 moles of water molecules

13

7. C

Given

$N_{CH_4} = 3.5 \times 10^{24}$ molecule CH_4

$$N_A = \frac{6.022 \times 10^{23} \text{ molecules } CH_4}{\text{mol } CH_4}$$

Required

$n = ?$

Solution

$m = n \times M$

$n = \dfrac{m}{M}$ → sub in eqn for m, $m = \dfrac{N \times M}{N_A}$

$$= \frac{\frac{N \times M}{N_A}}{M}$$

$$= \frac{N \times \cancel{M}}{N_A} \times \frac{1}{\cancel{M}}$$

$$= \frac{N}{N_A}$$

$$= \frac{3.5 \times 10^{24} \text{ molecules } CH_4}{6.022 \times 10^{23} \text{ molecules } CH_4/\text{mol } CH_4} = 5.812022 = 5.8 \text{ mol } CH_4$$

∴ There are 5.8 moles of CH_4

8. a)

Given

$n = 3.8$ mol CH_4

$N_A = \frac{6.022 \times 10^{23}\ CH_4\ fu}{mol\ CH_4}$

# of C in $CH_4 = 1$

Required

$N_c = ?$

Solution

$N_c = n \times N_A \times \#\text{of C}$

$= \frac{3.8\ \cancel{mol\ CH_4}}{} \times \frac{6.022 \times 10^{23}\ \cancel{CH_4\ fu}}{\cancel{mol\ CH_4}} \times \frac{1\ C\ atoms}{\cancel{CH_4\ fu}}$

$= 3.8 \times 6.022 \times 10^{23} \times 1$ C atoms

$= 2.28836 \times 10^{24}$

$= 2.3 \times 10^{24}$

∴ There are 2.3×10^{24} carbon atoms in 3.8 moles of CH_4

9.

Given

$n = 2\ mol\ CCl_4$

Ratio of Cl to CCl_4 = 4:1

$M_{Cl} = 35.453\ \frac{g\ Cl}{mol\ Cl}$

Required

$m_{Cl} = ?$

Solution

$$m_{Cl} = n \times M_{Cl} \times \frac{4\ mol\ Cl}{1\ mol\ CCl_4}$$

$$= 2\ \cancel{mol\ CCl_4} \times \frac{35.453\ g\ Cl}{\cancel{mol\ Cl}} \times \frac{4\ \cancel{mol\ Cl}}{1\ \cancel{mol\ CCl_4}}$$

$$= 2 \times 35.453 \times \frac{4}{1}\ g\ Cl$$

$$= 283.624\ g\ Cl$$

$$\doteq 300\ g\ Cl$$

∴ The mass of chlorine in 2 mole CCl_4 is 300 grams

2. b)

Given

$n = 0.5$ mol He

$N_A = \frac{6.022 \times 10^{23} \text{ atoms He}}{\text{mol He}}$

Required

$N_{He} = ?$

Solution

$N = n \times N_A$

$N_{He} = 0.5 \text{ mol He} \times \frac{6.022 \times 10^{23} \text{ atoms He}}{\text{mol He}}$

$= 3,011 \times 10^{23}$

$N_{He} = 3 \times 10^{23}$ atoms He

∴ the number of helim atoms is 3×10^{23}

3. b)

Given

$N = 3.2 \times 10^{12}$ atoms H

$N_A = \frac{6.022 \times 10^{23} \text{ atoms H}}{\text{mol H}}$

Required

$n = ?$

Solution

$N = n \times N_A$

$n = \frac{N}{N_A}$

$= \frac{3.2 \times 10^{12} \text{ atoms H}}{6.022 \times 10^{23} \text{ atoms H/mol H}}$

$= 5.3138492 \times 10^{-12}$

$n = 5.3 \times 10^{-12}$ mol H

∴ there are 5.3×10^{-12} moles of H atoms

4. C)

Given

Atomic mass of Al = 26.982 U

Atomic mass of O = 15.999 U

Atomic mass of H = 1.008 U

molecular mass = molar mass

Required:

molar mass of $Al(OH)_3$ = ?

Solution

molar mass = atomic mass of Al + 3(atomic mass of O) + 3(atomic mass H)

= 26.982 U + 3(15.999) U + 3(1.008) U

molar mass = 78.003 g/mol

≐ 78.0 g/mol

∴ The molar mass of $Al(OH)_3$ is 78.0 g/mol

D)

Given

Atomic mass of Si = 28.086 U

Atomic mass of Cl = 35.453 U

molecular mass = molar mass

Required:

molar mass of $SiCl_4$ = ?

Solution

molar mass = atomic mass of Si + 4(atomic mass of Cl)

= 28.086 U + 4(35.453) U

molar mass = 169.898 g/mol

≐ 169.9 g/mol

∴ The molar mass of $SiCl_4$ is 169.9 g/mol

6. a)

Given

$M_N = 14.007$ g/mol

$M_{O_2} = 2(15.999) = 31.998$ g/mol

$M_{NO_2} = M_N + M_{O_2} = 14.007 + 31.998 = 46.005$ g/mol

$n = 5$ mol NO_2

Required

$m_{NO_2} = ?$

Solution

$m = n \times M$

$m_{NO_2} = 5 \text{ mol } NO_2 \times 46.005 \text{ g/mol}$

$= 230.025$ g

$\doteq 200$ g

$\therefore$ The mass of NO_2 is 200 grams

10

6c)

Given

$N_{CO} = 7.5 \times 10^{25}$ molecules CO

$M_{CO} = M_C + M_O = 12.011 + 15.999 = 28.01$ g/mol

$N_A = \frac{6.022 \times 10^{23} \text{ molecules CO}}{\text{mol CO}}$

Required

$m_{CO} = ?$

Solution

$m = \frac{N \times M}{N_A}$

$m_{CO} = \frac{N_{CO} \times M_{CO}}{N_A}$

$= \frac{7.5 \times 10^{25} \text{ molecules CO} \times 28.01 \text{ g/mol}}{6.022 \times 10^{23} \text{ molecule CO / mol CO}}$

$= 3488.458984$

$= 3500$ grams

$\therefore$ The mass of CO is 3500 g

b) n

Given

$M_{NaOH} = M_{Na} + M_O + M_H = 22.990 + 15.999 + 1.008 = 39.997\ g/mol$

$m_{NaOH} = 50\ g$

Required

$n = ?$

Solution

$m = n \times M$

$n = \frac{m}{M}$

$n = \frac{50g}{39.997\ g/mol}$

$= 1.2500094\ mol$

$= 1\ mol\ NaOH$

∴ There ~~is~~ 1 mole of NaOH

8. a)

Given

$n = 3.8 \text{ mol } CH_4$

$M_{CH_4} = M_C + M_{H_4} = 12.011 + 4(1.008) = 16.043 \text{ g/mol}$

$N_A = \dfrac{6.022 \times 10^{23} \text{ } CH_4 \text{ fu}}{\text{mol } CH_4}$

$m = 3.8 \times 16.043 = 60.9634 \text{ g}$

Required

$N_C = ?$

Solution

$$N_C = \frac{m}{M} \times N_A \times \frac{C}{CH_4 \text{ fu}} \rightarrow \frac{m}{M} \times N_A \times \#\text{ of atoms}$$

$$= \frac{g}{\frac{g}{\text{mol } CH_4}} \times \frac{CH_4 \text{ fu}}{\text{mol } CH_4} \times \frac{C \text{ atoms}}{CH_4 \text{ fu}}$$

$$= \cancel{\text{mol } CH_4} \times \frac{\cancel{CH_4 \text{ fu}}}{\cancel{\text{mol } CH_4}} \times \frac{C \text{ atoms}}{\cancel{CH_4 \text{ fu}}}$$

8. b)

Given

$m = 100g$

$M_{C_2H_6} = M_{C_2} + M_{H_6} = 2(12.011) + 6(1.008) = 30.07 \, g/mol \, C_2H_6$

$N_A = \frac{6.022 \times 10^{23} \, C_2H_6 \, fu}{mol \, C_2H_6}$

$\# \text{ of } C \text{ in } C_2H_6 = 2$

Required

$N_c = ?$

$$N_c = \frac{m}{M} \times N_A \times \# \text{ of } C$$

$$= \frac{100 \cancel{g}}{30.07 \, \cancel{g/mol \, C_2H_6}} \times \frac{6.022 \times 10^{23} \cancel{C_2H_6 \, fu}}{\cancel{mol \, C_2H_6}} \times \frac{2 \, C \text{ atoms}}{\cancel{C_2H_6 \, fu}}$$

$$= \frac{100}{30.07} (6.022 \times 10^{23}) \times 2 \, C \text{ atoms}$$

$$\doteq 4.0053 \times 10^{24} \, C \text{ atom}$$

$$\doteq 4 \times 10^{24} \, C \text{ atoms}$$

$\therefore$ there are 4×10^{24} Carbon atoms in 100 g of ethane.