Revision - Moles and Molecules

1) Types of Matter

- Pure Substances
  - Elements
    - e.g. copper
    - Carbon
    - Aluminium
  - Compounds
    - e.g. Salt
    - Water
    - ~~Aluminium~~
- Mixtures
  - Homogenous
    - e.g. Salt water
    - Brass
  - Heterogenous
    - e.g. Pizza
    - concrete

2) $m_{sucrose} = 500g$

$N_{sucrose} = ?$

$$M_w = (12 \times 12) + (22 \times 1) + (11 \times 16)$$

$$= 144 g/mol + 22 g/mol + 176 g/mol$$

$$= 342 \, g/mol$$

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

$$n_{sucrose} = \frac{500g}{342 g/mol}$$

$$= 1.46 \text{ mol}$$

$$N_{sucrose} = n \times N_A$$

$$= 1.46 \text{ mol} \times 6.022 \times 10^{23} \text{ molecules/mol}$$

$$= 8.79 \times 10^{23} \text{ molecules}$$

3) $m_{glucose} = ?$

$n_{glucose} = 0 \cdot 63 mol$

$$M_w(glucose) = (6 \times 12) + (12 \times 1) + (6 \times 16)$$
$$= 72 g/mol + 12 g/mol + 96 g/mol$$
$$= 180 g/mol$$

$$m = n \times M_w$$
$$= 0 \cdot 63 mol \times 180 g/mol$$
$$= 113 \cdot 4 \; g$$

4) $n_{NaOH} = 0 \cdot 05 mol$

$m_{NaOH} = ?$

$$M_w(NaOH) = (1 \times 22 \cdot 99) + (1 \times 16) + (1 \times 1)$$
$$= 22 \cdot 99 g/mol + 16 g/mol + 1 g/mol$$
$$= 39 \cdot 99 g/mol$$

$$m = n \times M_w$$
$$= 0 \cdot 05 mol \times 39 \cdot 99 g/mol$$
$$= 1 \cdot 9995 g$$
$$\simeq 2 \cdot 0 g.$$

5) $m = 27$ metric tonnes

$= 27\ t \times 1000\,000\ g/t$

$= 27\,000\,000\ g$

$N_{Cu} = ?$ $M_w(Cu) = 63.55\ g/mol$

$n_{Cu} = ?$

$n_{Cu} = \frac{m}{M_w}$

$= \frac{27\,000\,000\ g}{63.55\ g/mol}$

$= 424\,862.31\ mol$

$N_{Cu} = n \times N_A$

$= 424862.31\ mol \times 6.022 \times 10^{23}$

$= 2.56 \times 10^{29}$ atoms

6) $\% N = ?$ $M_w(NH_3) = 14.01\ g/mol + 3 \times 1\ g/mo$

Ammonia → NH_3 $= 17.01\ g/mol$

$M_w(N) = 14.01\ g/mol$

$\% N$ by mass $= \frac{14.01\ g/mol}{17.01\ g/mol} \times 100$

$= 82.4\%$

7) $\% Fe$ by mass $= \frac{M_w(Fe)}{M_w(heme)} \times 100$

$M_w(Fe) = 55.9\ g/m$

$M_w(heme) = 851.9\ g/m$

$= \frac{55.9\ g/mol}{851.9\ g/mol} \times 100$

$= 6.56\%$

8) $m_{NaCl} = ?$

$N_{NaCl} = 1.5 \times 10^{22}$ molecules

$Mw(NaCl) = 22.99 + 35.45$

$= 58.44 g/mol$

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

$$= \frac{1.5 \times 10^{22} \text{ molecules}}{6.022 \times 10^{23} \text{ molecules/mol}}$$

$$= 0.025 \text{ mol}$$

$$m_{NaCl} = n \times Mw$$

$$= 0.025 \text{ mol} \times 58.44 \text{ g/mol}$$

$$= 1.46 \text{ g}$$

9) $m_c = 200g$

$Mw(C) = 12.01 g/mol$

$$n_c = \frac{m}{Mw}$$

$$= \frac{200g}{12.01 g/mol}$$

$$= 16.65 \text{ mol}$$

$$N_c = n \times N_A$$

$$= 16.65 \text{ mol} \times 6.022 \times 10^{23} \text{ atoms/mol}$$

$$= 1.0 \times 10^{25} \text{ atoms}$$

10) $m_{EtOH} = 100.0g$ $\quad$ $M_w(EtOH) = (2\times12) + (6\times1) + (1\times16)$

$= 46 g/mol$

(a) $n_{EtOH} = \frac{m}{M_w}$

$= \frac{100.0g}{46 g/mol}$

$= 2.17 \text{ mol}$

(b)

C_2H_6O	:	C	:	H	:	O
1	:	2	:	6	:	1
2.17mol	:	2×2.17mol $= 4.34$mol	:	6×2.17mol $= 13.02$mol	:	2.17mol

(c) $m_{EtOH} = \cancel{46}\ 100.0g$

$n_{EtOH} = 2.17 mol$

	C	H	O
n	4.34mol	13.02mol	2.17mol
Mw	12.01g/mol	1 g/mol	16.0g/mol
m	$n \times M_w$ $= 4.34mol \times 12 g/mol$ $= 52.08 g$	$13.02mol \times 1g/mol$ $= 13.02 g$	$2.17mol \times 16.0g/mol$ $= 34.72 g$

Check → $52.08g + 13.02g + 34.72g$
$= 99.82g \sim 100 g$ ✓✓

11) $m_{glycerine} = 0.500g$ $N_c = ?$

$M_w(glycerine) = 2\times C + 5\times H + 2\times O + 1\times N$

$= (2\times 12g/mol) + (5\times 1g/mol) + (2\times 16g/mol) + (1\times 14.01g/mol)$

$= 75g/mol$

$n_{glycerine} = \frac{0.500g}{75g/mol}$

$= 0.0067\ mol$

To calculate moles of carbon:

H_2NCH_2COOH : C

1 : 2

0.0067mol : $2\times 0.0067mol$

$= 0.0134mol$

Jumber of C atoms →

$N = n \times N_A$

$= 0.0134\ mol \times 6.022\times 10^{23}\ atoms/mol$

$= 8.07\times 10^{21}\ atoms$

12) (a) $M_w(NH_3) = 14\,g/mol + 3 \times 1\,g/mol$
$= 17\,g/mol$

$M_w(H_2O) = 16\,g/mol + 2 \times 1\,g/mol$
$= 18\,g/mol$

FALSE → H_2O has a molar mass of 18g/mol > NH_3 at 17g/mol.

(b) TRUE → 1.09mol CO_2 > 1 mol C

$m_{CO_2} = 48g$
$M_w(CO_2) = 12 + 2 \times 16$
$= 44\,g/mol$
$n_{CO_2} = \frac{48g}{44\,g/mol}$
$= 1.09\,mol$

$m_C = 12g$
$M_w(C) = 12\,g/mol$
$n_C = \frac{12g}{12\,g/mol}$
$= 1\,mol$

(c) FALSE → One mole of NH_3 contains 1 mol N compared to 2 mol N in 1mol N_2.

$NH_3 : N$
$1 : 1$

$N_2 : N$
$1 : 2$

(d) FALSE → CuO is heavier than Cu ∴ there will be less Cu atoms in 100g CuO than in 100g Cu.

(e) TRUE

$Ni : Ni$
$1 : 1$

$NiCl_2 : Ni$
$1 : 1$

(f) FALSE

$NH_3 : H$
$1 : 3 \rightarrow 6\,moles$

$CH_4 : H$
$1 : 4 \rightarrow 8\,moles$