CHEM1405 Answers to Problem Sheet 1

1.

liquid mercury	**element**	ice	**molecular compound**
neon gas	**element**	liquid nitrogen	**element**
milk	**mixture**	copper pipe	**element**
blood	**mixture**	air	**mixture**
gaseous CO_2	**molecular compound**	gaseous oxygen	**element**
solid sodium	**element**	brass	**mixture**

2. $^{234}_{90}$**Th** : t**he number of neutrons is 234 – 90 = 144.**

3. **O^{2-}, F^- and Ne have exactly 10 electrons.**

O^{2-}	**Atomic number 8 → -2 anion has $10e^-$**
He	**Atomic number 2 → $2e^-$**
Ar	**Atomic number 18 → $18e^-$**
F^-	**Atomic number 9 → -1 anion has $10e^-$**
Sr	**Atomic number 38 → $38e^-$**
S^{2-}	**Atomic number 16 → -2 anion has $18e^-$**
Cl^-	**Atomic number 17 → -1 anion has $18e^-$**
O	**Atomic number 8 → $8e^-$**
F	**Atomic number 9 → $9e^-$**
Ne	**Atomic number 10 → $10e^-$**

4. **(c) chromium, manganese, iron, cobalt, nickel**

5. **(d) fluorine, chlorine, bromine, iodine**

6. **Molecular mass of CH_3NH_2:**

$$12.01\ (C) + 3 \times 1.01\ (H) + 14.01\ (N) + 2 \times 1.01\ (H) = 31.06\ g\ mol^{-1}$$

Number of moles in 1 g:

number of moles = mass / molar mass = 1 / 31.06 = 0.03 mol

Note that the question asks for the number of moles in 1 g. Since this mass is given to only one significant figure, so is the answer.

7. **Molar mass of $CuSO_4{\cdot}5H_2O$:**

63.55 (Cu) + 32.07 (S) + 4 × 16.00 (O) + 5 × [2 × 1.01 (H) + 16.00 (O)]

= 249.72 g mol^{-1}

Number of moles in 24.9 g of $CuSO_4.5H_2O$:

number of moles = mass / molar mass = 24.9 / 249.72 = 0.100 mol.

1 mol of $CuSO_4{\cdot}5H_2O$ contains 1 mol of copper so,

number of moles of copper = 0.100 mol

Note that the question gave the mass as 24.9 g – three significant figures. The answer reflects this. The trailing zeros in 0.100 imply that the number is known to three significant figures.

8. **The relative atomic mass of silicon is the weighted average of the masses of its isotopes**:

$$\left(27.97693\times\frac{92.21}{100}\right)+\left(28.97649\times\frac{4.70}{100}\right)+\left(29.97376\times\frac{3.09}{100}\right)$$

$$=(25.80)+(1.36)+(0.926)=28.09\ \text{g mol}^{-1}$$

The numbers in brackets are given to four, three and three significant figures respectively since this is the precision of the relative abundances in the question. When these are added, the answer is precise to the second decimal place as this is where each term is known precisely.

9. (a) **As density is given by** $\text{density}(\rho)=\dfrac{\text{mass}(m)}{\text{volume}(V)}$.

The mass of 1.00 L (= 1000 mL) of water is:

$$m=\rho\times V=0.997\times 1000=997\ \text{g}$$

The molar mass of H_2O is:

2 × 1.01 (H) + 16.00 (O)=18.02 g mol^{-1}

Hence, the number of moles in 997 g is:

$$\text{number of moles}(n)=\frac{\text{mass}(m)}{\text{molar mass}(M)}=\frac{997}{18.02}=55.3\ \text{mol}$$

(b) **Concentration is given by:**

$$\text{concentration (c)} = \frac{\text{number of moles (n)}}{\text{volume (V)}}$$

From part (a), there are 55.3 mol of water in 1.00 L so the concentration is:

$$c = \frac{55.3}{1.00} = 55.3\,M$$

(c) **Neglecting the small changes in volume and density when NaCl is added to water, a 1.00 M NaCl solution will contain 1.00 mol of Na^+, 1.00 mol of Cl^- and 55.3 mol of H_2O. As the number of molecules (or ions) is directly proportional to the number of moles, the ratio of water molecules: Na^+ ions : Cl^- ions is roughly 55 : 1: 1.**