Section 1.1 – The particulate nature of matter and chemical change

Exercises

1. Write balanced chemical equations for the following reactions:
   a) The decomposition of copper carbonate ($CuCO_3$) into copper(II) oxide (CuO) and carbon dioxide (CO_2)
   b) The combustion of magnesium (Mg) in oxygen (O_2) to form magnesium oxide (MgO).
   c) The neutralisation of sulfuric acid (H_2SO_4) with sodium hydroxide (NaOH) to form sodium sulfate (Na_2SO_4) and water (H_2O)
   d) The synthesis of ammonia (NH_3) from nitrogen (N_2) and hydrogen (H_2).
   e) The combustion of methane (CH_4) to produce carbon dioxide (CO_2) and water (H_2O).

2. Write balanced chemical equations for the following reactions:
   a) $K + H_2O \rightarrow KOH + H_2$
   b) $C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$
   c) $Cl_2 + KI \rightarrow KCl + I_2$
   d) $CrO_3 \rightarrow Cr_2O_3 + O_2$
   e) $Fe_2O_3 + C \rightarrow CO + Fe$

3. Balance the following examples:
   a) $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$
   b) $NH_3 + O_2 \rightarrow NO + H_2O$
   c) $Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO + H_2O$
   d) $H_2O_2 + N_2H_4 \rightarrow N_2 + H_2O + O_2$
   e) $C_2H_7N + O_2 \rightarrow CO_2 + H_2O + N_2$

4. Classify the following mixtures as homogeneous or heterogeneous:
   a) Sand and water
   b) Smoke
   c) Sugar and water
   d) Salt and iron filings
   e) Ethanol and water in wine
   f) Steel

5. Write balanced equations for the following reactions and apply state symbols to all reactants and products, assuming room temperature and pressure unless stated otherwise. If you are not familiar with the aqueous solubilities of some of these substances, you may have to look them up.
   a) $KNO_3 \rightarrow KNO_2 + O_2$ (when heated to 500 °C)
   b) $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + CO_2 + H_2O$
   c) $Li + H_2O \rightarrow LiOH + H_2$
   d) $Pb(NO_3)_2 + NaCl \rightarrow PbCl_2 + NaNO_3$ (all reactants are in aqueous solutions)
   e) $C_3H_6 + O_2 \rightarrow CO_2 + H_2O$ (combustion reaction)

6. A mixture of two gases, X and Y, which both have strong but distinct smells, is released. From across the room the smell of X is detected more quickly than the smell of Y. What can you deduce about X and Y?

7. Ice floats on water. Comment of why this is not what you would expect from the kinetic theory of matter.

8. A closed flask contains a pure substance, a brown liquid that is at its boiling point. Explain what you are likely to observe in the flask, and distinguish between the inter-particle distances and the average speeds of the particles in the two states present.

9. During very cold weather, snow often gradually disappears without melting. Explain how this is possible.

10. Explain why a burn to the skin caused by steam is more serious than a burn caused by the same amount of boiling water at the same temperature.

11. Which of the following occurs at the melting point when solid sulfur is converted to its liquid form?

    I Movement of the particles increases
    II Distance between the particles increases

A I only **B** II only **C** Both I and II **D** Neither I nor II

12. You are given a liquid substance at 80 °C and told that it has a melting point of 35 °C. You are asked to take its temperature at regular time intervals while it cools to room temperature (25 °C). Sketch the cooling curve that you would expect to obtain.