1. Household bleach contains a mixture of sodium chlorate (NaOCl), sodium chloride and water. It can be made by dissolving chlorine gas in solution of sodium hydroxide.

    a) (i) Write a balanced equation including state symbols for this reaction. (2)

        (ii) Deduce the oxidation state of chlorine in all of the chlorine-containing reactants and products. (1)

        (iii) State what specific type of redox reaction this reaction is. Explain your answer.(2)

    b) Consider the reaction below that is done in school laboratory by year 11 students.

        $2NH_3(aq) + 2ClO^-(aq) \rightarrow N_2H_4(aq) + Cl_2(g) + 2OH^-(aq)$

        (i) What are the oxidation states of the nitrogen atom NH_3 and in N_2H_4? (2)

        (ii) What is the oxidizing agent in this reaction? Explain your answer. (2)

        (iii) Why do the students make this experiment in a fume cupboard? (2)

    c) Consider the reaction in (b); calculate the amount in grams of N_2H_4 when 6 moles of $NH_3(aq)$ goes into reaction. (1)

    (Total 12 points)

2. a) Halide ions are identified by addition of nitric acid and then silver nitrate solution. The general equation for the reaction is:

$$AgNO_3(aq) + X^-(aq) \rightarrow AgX(s) + NO_3^-(aq)$$
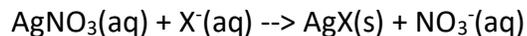
(i) Deduce the oxidation state of silver in $AgNO_3$ and AgX, and deduce the oxidation state of the halide in X^- and in AgX. (2)

(ii) Is the precipitation of silver halides a redox reaction? Explain your answer. (2)

(iii) Which halide is present when AgX is white and yellow in different samples of tests. (2)

b) Consider the reaction given;
$$Cl_2(aq) + NaBr(aq) \rightarrow NaCl(aq) + Br_2(aq)$$
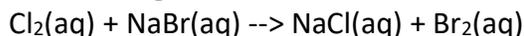
(i) Balance the reaction (1)

(ii) Deduce the half-equation for chlorine. State whether chlorine is oxidized or reduced. (2)

(iii) Deduce the half-equation for bromine. State whether bromine is oxidized or reduced. (2)

(iv) Use the reaction above to explain whether chlorine or bromine is stronger oxidizing agent. Explain your answer (2)

c) Chlorine helps reduce unwanted tastes and odors in water by reacting with organic chemicals in water.

(i) Write the overall redox reaction of chlorine with water (1)

(ii) Deduce the oxidation states of chlorine in all of the chlorine-containing compounds. (1)

(Total 15 points)

3. a) A Maxwell-Boltzmann distribution is a graph which shows the distribution of energy amongst particles within a chemical reaction.

Figure 1 below shows the Maxwell-Boltzmann distribution in a sample of gas at a fixed temperature, T_1.

Figure 1
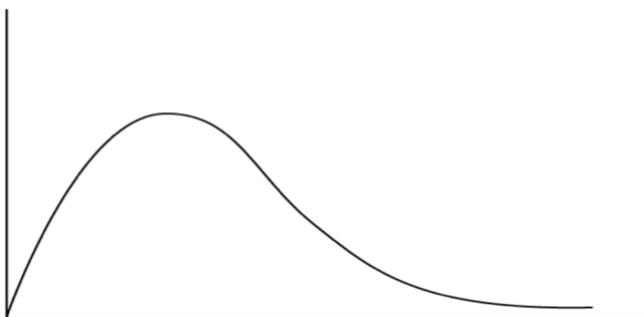
    i) Label the x and y axes of the graph. (2)

    ii) Sketch a distribution for this same sample of gas, at a higher temperature, T_2. (2)

b) State why a Maxwell_boltzmann distribution curve always starts at the origin and what the area under the curve represents. (2)

c) Chemical reactions take place at different speeds. For a chemical reaction to take place, particles must collide with each other in the correct orientation and with sufficient energy.

    i) Explain why most collisions between particles in the gas phases do not result in a reaction taking place. (1)

    ii) State and explain one way that the rate of reaction could be increases, other than increasing temperature. (2)

d) Give one reason why a reaction may be slow at room temperature. (1)
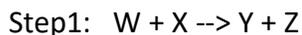
(Total 10 points)

4. a) The decomposition of hydrogen peroxide into water and oxygen is a very slow chemical reaction.

Write the balanced equation for the decomposition of hydrogen peroxide including state symbols. (2)

b) The rate of decomposition of hydrogen peroxide can be ascertained by collecting and measuring the volume of gas formed at specific time intervals.

   (i) Draw a labelled diagram to show the apparatus that you would use to collect and measure the volume of gas formed during this reaction. (4)

   (ii) Explain how you would use the results to determine the initial rate of the reaction. (3)

c) The decomposition of hydrogen peroxide is slow reaction so catalyst is added to speed up the reaction. The following shows a two- step reaction mechanism of a chemical reaction, where a catalyst is used.

   Step1: $W + X \rightarrow Y + Z$
   Step2: $Y + W \rightarrow Z + A + X$

   Overall reaction: $2W \rightarrow 2Z + A$

Which one is used as a catalyst? Explain your answer. (2)

(Total 11 points)

5. Ethanol is very common solvent. Ethanol can be oxidized to form carboxylic acid in a two step process.

       Ethanol --> compound X ---> Carboxylic acid

a) During a reaction, anti-bumping granules are used. Suggest why. (1)

b) (i) State the name of compound X and the name of the carboxylic acid. (2)

   (ii) How can you distinguish compound X and Carboxylic acid. (2)

c) Complete the following reaction that takes place. (2)

   (i)   Ethanol + propanoic acid -->
   (ii)   Methanol + ethanoic acid -->

(Total 7 points)

6. Strong heating of calcium nitrate will cause thermal decomposition to occur.

a) Write a balanced chemical equation for this reaction, including state symbols. (1)

b) A sample of 0.655g calcium nitrate was thermally decomposed. Calculate the amount, in moles, of calcium oxide which was produced. Give your answer to the appropriate number of significant figures. (2)

c) Calculate the amount, in moles, of gas which was produced during the thermal decomposition of the 0.655g sample of calcium nitrate. Give your answer to the appropriate number of significant figures. (2)

(Total 5 points)