Q1.
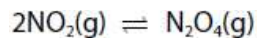
The equilibrium reaction shown in the equation was studied by placing the components into a sealed glass container.

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

At equilibrium, which of the following statements is **not** true?

(1)

☐ **A** the concentrations of the $NO_2(g)$ and $N_2O_4(g)$ both remain constant

☐ **B** the total number of molecules is constant

☐ **C** the forward and reverse reactions have both stopped

☐ **D** the rate of the forward reaction is equal to the rate of the reverse reaction

(Total for question = 1 mark)

Q2.

Iodine monochloride, ICl, is a covalent compound produced by the reaction of iodine with chlorine. Iodine monochloride is a dark brown liquid at room temperature.

The equipment shown can be used to pass chlorine over solid iodine to produce iodine monochloride.

chlorine gas, Cl_2
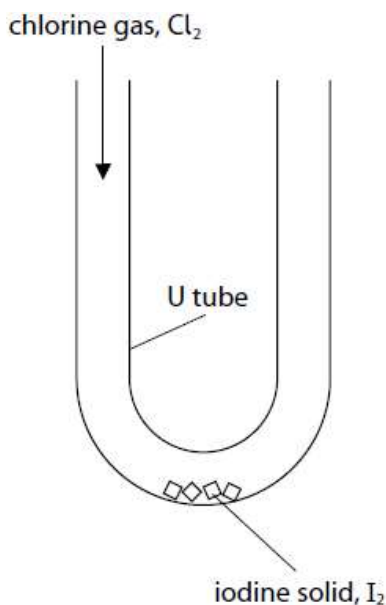
When excess chlorine is passed through the U tube, the iodine monochloride reacts to produce iodine trichloride in an equilibrium reaction.

(a) Write a chemical equation for the reaction of iodine with chlorine to produce iodine monochloride. Include state symbols.

(2)

(b) The iodine monochloride molecule has a permanent dipole. Complete the following table using the electronegativity data from your Data Booklet and hence show the dipole on the diagram of the iodine monochloride molecule.

(1)

Element	Electronegativity
Cl	
I	

I — Cl

(c) Iodine monochloride reacts with propene to form two isomeric products. This is an addition reaction that is similar to the reaction of propene with hydrogen halides.

(i) Draw the skeletal formulae of both isomers.

(2)

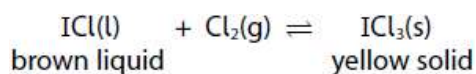(ii) Explain which of these isomers is the major product.

(3)

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(d) The equation for the reaction between iodine monochloride and chlorine is:

$$ICl(l) \quad + \quad Cl_2(g) \rightleftharpoons \quad ICl_3(s)$$
brown liquid $\qquad\qquad\qquad$ yellow solid

(i) State and justify **one** precaution that must be taken when preparing iodine trichloride.

(2)

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(ii) Give the oxidation number of iodine in both iodine-containing compounds in the equilibrium.

(1)

I in ICl

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I in ICl_3

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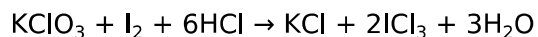
(iii) Iodine trichloride can also be made by reacting potassium chlorate(V) with iodine in hydrochloric acid. The equation for the reaction is

$$KClO_3 + I_2 + 6HCl \rightarrow KCl + 2ICl_3 + 3H_2O$$

By considering oxidation numbers for chlorine, explain whether or not this reaction is a disproportionation.

(2)

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(e) Chlorine gas has a molar volume of 24 000 cm^3 mol^{-1} under the conditions used in this reaction.

(i) Show that the density of chlorine gas is approximately 3 g dm^{-3}.

(2)

(ii) Air has an average density of 1.25 g dm^{-3}. If the U-tube used in part (d) is inverted, as shown in the diagram, the solid yellow iodine trichloride produced in the equilibrium reaction turns to a brown liquid.

inverted U tube
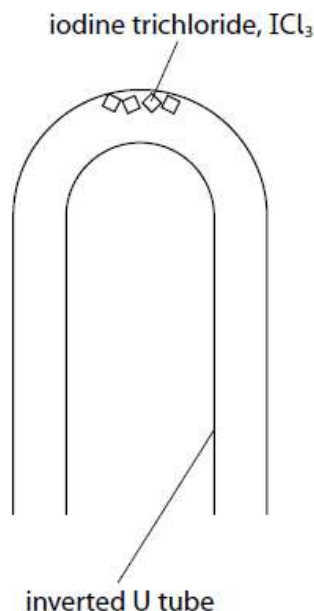
Explain this observation.

(3)

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(f) A mass of 0.64 g of iodine reacted with fluorine to form 1.31 g of a fluoride of iodine.

Calculate the empirical formula of this compound of iodine and fluorine.

(2)

(Total for question = 20 marks)