GCE A LEVEL CHEMISTRY

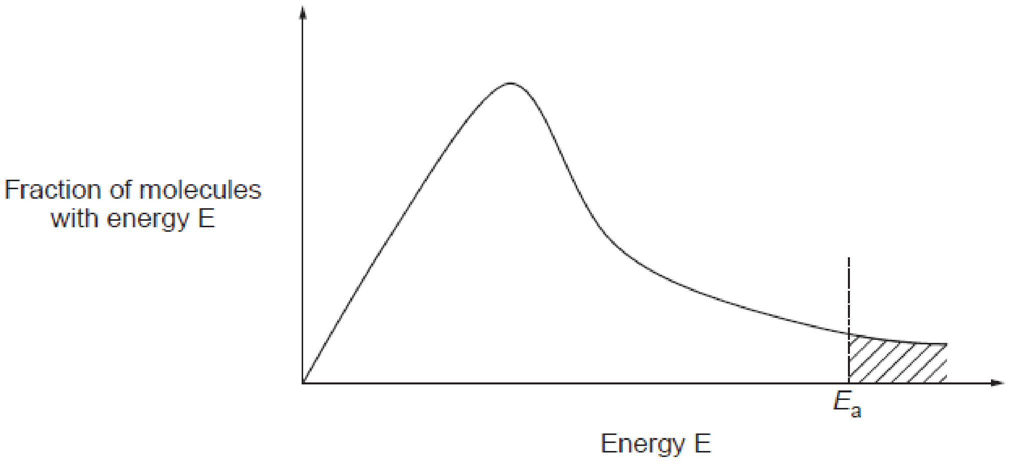
S21-A410

Assessment Resource E

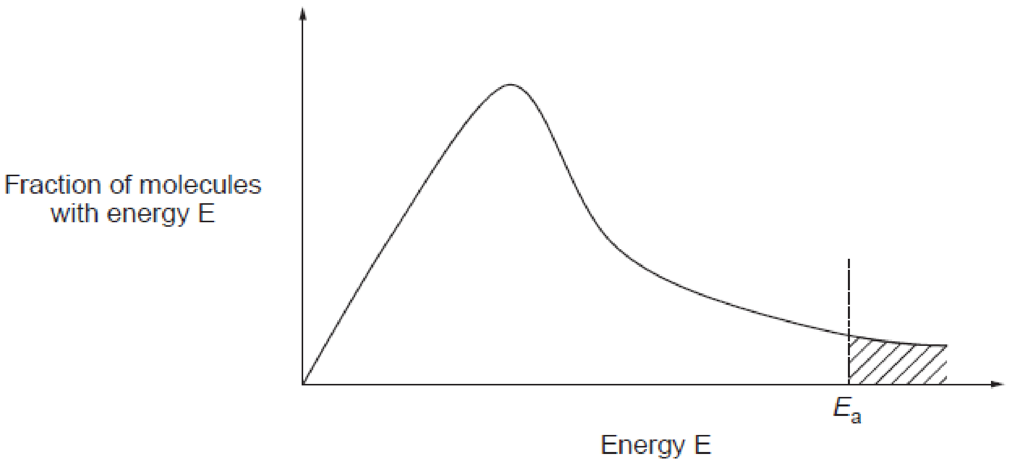
Physical and Inorganic Chemistry

1. (a) The graph below shows the energy distribution of particles at a temperature of 298 K.

Sketch the distribution at a higher temperature on the same axes. [1]



(b) Use the diagram below to show how a catalyst can affect the number of particles with sufficient energy to react. [1]



2. Both iodine and diamond contain covalent bonding. Explain why their melting temperatures are very different. [2]

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3. Potassium manganate(VII) can be used to oxidise Fe^{2+} ions to Fe^{3+} ions in a redox titration. The following reaction occurs.

$$MnO_4^- + 5Fe^{2+} + 8H^+ \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$

In an experiment 25.00 cm^3 portions of Fe^{2+}(aq) were titrated against a standard acidified potassium manganate(VII) solution of concentration 0.0200 mol dm^{-3}.

The results were as follows.

	Titration 1	Titration 2	Titration 3	Titration 4
Volume of acidified potassium manganate(VII) solution added / cm^3	27.20	27.10	27.30	26.80

(a) Calculate the mean volume of acidified potassium manganate(VII) solution added. [1]

Mean volume = ... cm^3

(b) Calculate the number of moles of Fe^{2+} present in each 25.00 cm^3 portion. [2]

Number of moles = ... mol

4. The green mineral atacamite contains three different ions, $M_a(OH)_bX_c$. It is insoluble in water but can form a solution when added to acid.

A student planned to analyse a sample of atacamite using the following method.

STEP 1: Add 1.00 g of atacamite to 150 cm^3 of strong acid of concentration 0.100 mol dm^{-3}, and then make this up to exactly 250 cm^3 with more of the same acid.

STEP 2: Take exactly 25.0 cm^3 of the solution from step 1 and add excess silver nitrate solution. If any precipitate forms, filter it off and dry completely. Record its colour and the mass formed.

STEP 3: Take exactly 25.0 cm^3 of the solution from step 1 and add excess barium chloride solution. If any precipitate forms, filter it off and dry completely. Record its colour and the mass formed.

STEP 4: Take exactly 25.0 cm^3 of the solution from step 1 and add excess sodium hydroxide solution. If any precipitate forms, filter it off and dry completely. Record its colour and the mass formed.

STEP 5: To find the amount of acid remaining in the solution, use a pH probe to find the precise pH of the solution prepared in step 1.

(a) The student had to select an appropriate strong acid from the common laboratory reagents.

Suggest an appropriate acid to use. Explain your choice. [2]

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(b) In step 2 a white precipitate of mass 0.0672 g was produced.

State which ion this step identifies and calculate the number of moles of this ion present in the original 250 cm^3 of solution. [3]

Ion ....

Number of moles = ... mol

(c) After completing step 2, the student decides that he does not need to carry out step 3.

Is he correct? Give a reason for your answer. [2]

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(d) A pale blue precipitate is formed in step 4.

(i) Give the **formula** of the **ion** identified from this observation. [1]

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(ii) When the student heats the precipitate to ensure it is dry, a colour change is seen with some of the solid turning black but most of it remaining blue. He did not record a mass for the sample.

Suggest why he would not have been able to use the mass of the solid to calculate the number of moles of the ion in the original compound. [1]

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(e) In step 5, the pH of a 25.0 cm^3 portion of the remaining solution was found to be 1.36.

(i) Calculate the number of moles of acid remaining in 25.0 cm^3 of the solution. [2]

Number of moles = ... mol

(ii) Calculate the number of moles of hydroxide ion present in the original 1.00 g of atacamite. [3]

Number of moles = ... mol

(f) Deduce the formula of atacamite. [3]

Formula of atacamite ....

5. Chlorine is one of the most widely used elements, and compounds containing chlorine atoms have a huge range of uses in the home and in industry.

(a) Give **one** large scale use of the **element** chlorine. [1]

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(b) Chlorine reacts with hot concentrated sodium hydroxide solution to form two chlorine-containing products. Write the equation for this reaction. [1]

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(c) Chlorine can be used to produce bromine from the bromide ions present in seawater. An excess of chlorine is usually used in this process.

In one experiment, a volume of 2.00 dm^3 of chlorine gas was bubbled into seawater at 298 K under 1 atm pressure. A mass of 9.4 g of bromine was produced.

Calculate the percentage of chlorine that remains unreacted at the end of the experiment, giving your answer to an **appropriate** number of significant figures. [3]

Percentage of chlorine unreacted = ... %

(d) Chlorine-containing compounds can be studied using mass spectrometry.

(i) Explain how ions are formed and separated in the mass spectrometer. [2]

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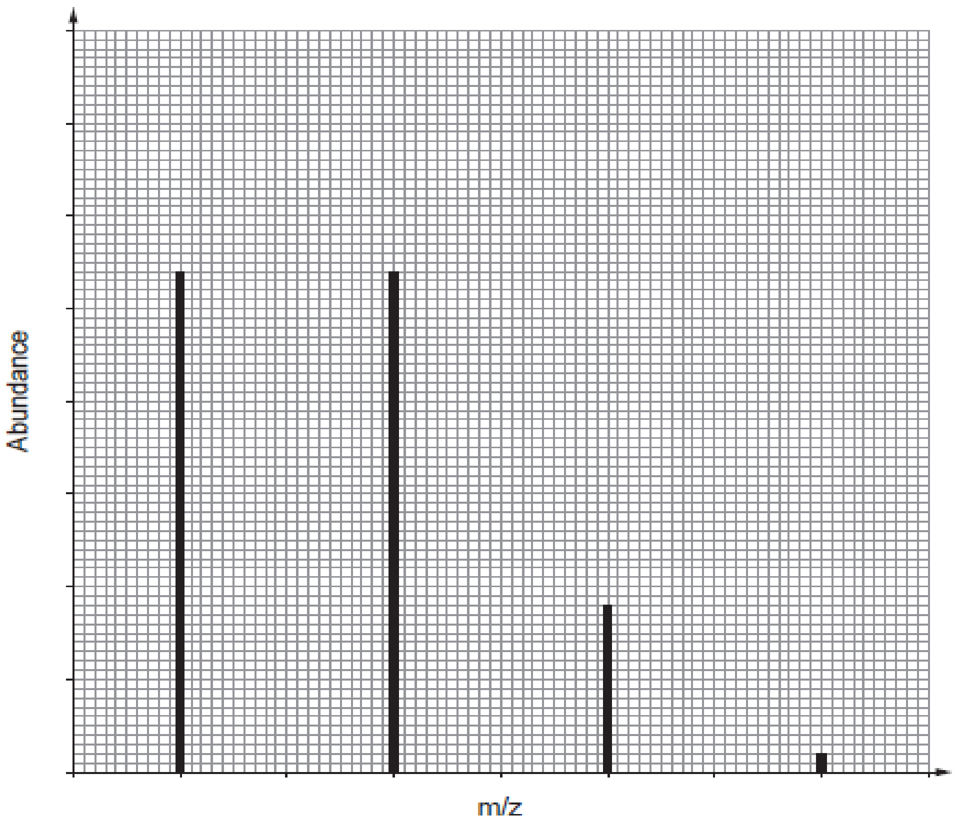
(ii) The diagram below shows part of the mass spectrum of a chlorine-containing compound. There are no other significant peaks near this group of peaks and adjacent peaks are two atomic mass units apart.



I. State how many chlorine atoms are present in these ions, giving a reason for your answer. [2]

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II. The height of the first peak is 54 and the height of the final peak is 2.

Explain the ratio of these peak heights. [2]

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(e) Chlorine can form many compounds of general formula AB_3, for example $AlCl_3$ and ClF_3.

(i) Draw the shape of the $AlCl_3$ molecule, giving its bond angle(s). [1]

(ii) Explain why the molecule $AlCl_3$ often forms dimers. [2]

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(iii) Use the principles of valence shell electron pair repulsion theory to explain why the shape of ClF_3 is not the same as that of BF_3.

You do not need to identify the shape of the ClF_3 molecule. [2]

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