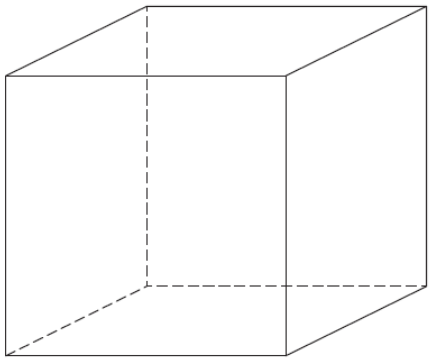
GCE A LEVEL CHEMISTRY

S21- A410

Assessment Resource A

Physical and Inorganic Chemistry

1. Draw the arrangement of ions in the structure of CsCl. [1]



2. Standard electrode potentials are measured by comparison with the standard hydrogen electrode.

Describe the standard hydrogen electrode. You may include a diagram as part of your answer. [2]

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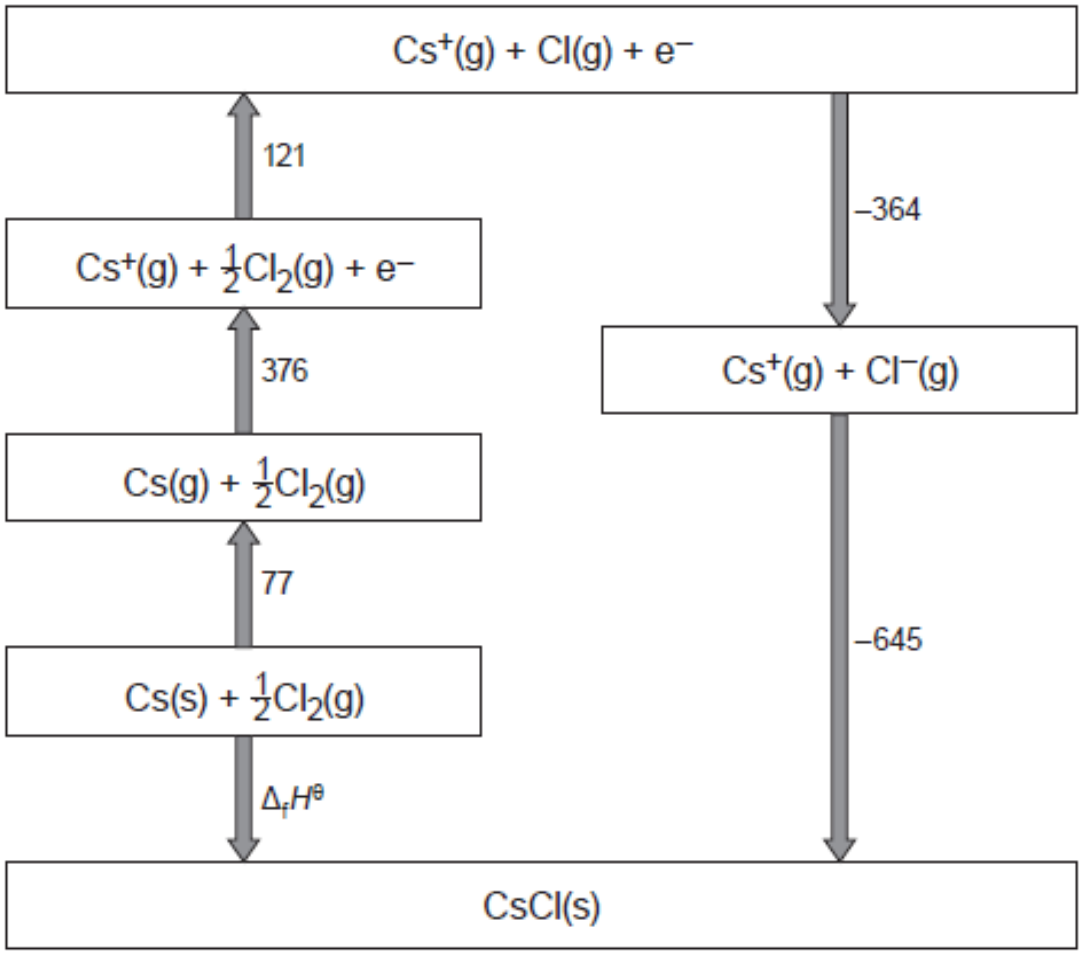
3. Caesium chloride is an ionic solid that is transparent to a wide range of frequencies of electromagnetic radiation, from infrared to ultraviolet.

(a) The Born-Haber cycle below shows the formation of caesium chloride from its elements. All values shown are standard values in $kJ\,mol^{-1}$.



(i) State the value of the standard enthalpy change of lattice breaking of CsCl. [1]

..... $kJ\,mol^{-1}$

(ii) Calculate the standard enthalpy of formation of CsCl, $\Delta_f H^\theta$. [2]

$\Delta_f H^\theta$ = ... kJ mol^{-1}

(iii) The standard enthalpy change of solution of CsCl is +18 kJ mol^{-1} and the enthalpy of hydration of a chloride ion is –364 kJ mol^{-1}.

I. Calculate the enthalpy change of hydration of a caesium ion. [2]

$\Delta_{hyd} H^\theta$ = ... kJ mol^{-1}

II. A student says "Caesium chloride must be insoluble as the enthalpy change of solution is endothermic. Endothermic reactions do not occur readily."

The teacher shows the student that caesium chloride is soluble.

State what other factor(s) must be considered when deciding whether a reaction is feasible and explain why these would favour the formation of the solution. [3]

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(b) The first ionisation energy of caesium is 376 kJ mol^{-1}. This value can be found from the frequency of a line in the atomic spectrum of caesium. Calculate the frequency of this line in THz. [3]

(1 THz = 1000 GHz)

Frequency = ... THz

4. Radioisotopes of elements are often used in the study of biological molecules. One such radioisotope is fluorine-18.

(a) Give the numbers of protons and neutrons in the nucleus of a fluorine-18 atom. [1]

Protons ..... Neutrons .....

(b) This radioisotope decays to form oxygen-18 only. Identify the type of radiation that must be emitted for this change to occur and identify any other type(s) of radiation that may also be emitted at the same time. [2]

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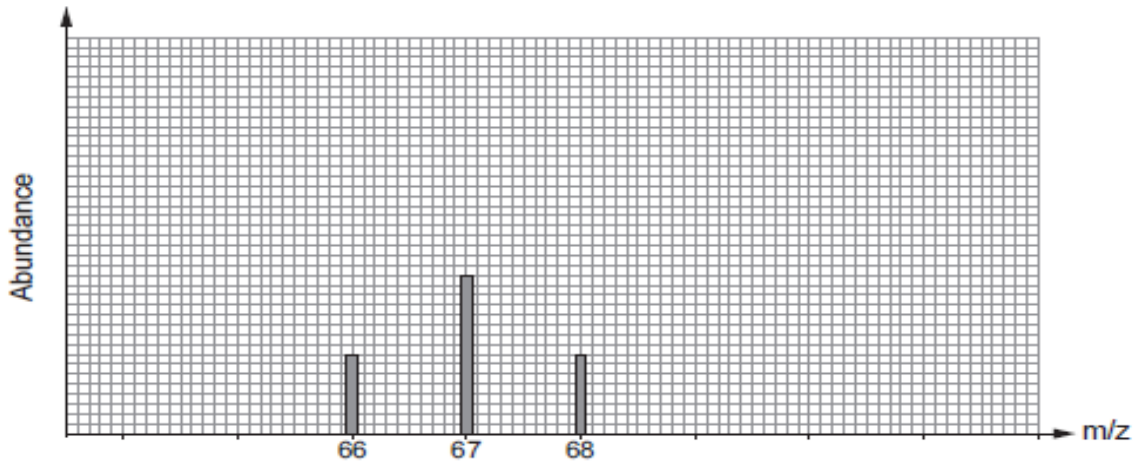
(c) A sample of fluorine gas contains four ^{18}F atoms for every ^{19}F atom. This was used to produce difluoromethanol, CHF_2OH.

A mass spectrum was taken as soon as the difluoromethanol had been synthesised. Part of the mass spectrum is shown below.



(i) Identify the species that gives rise to the peak at m/z 66. [1]

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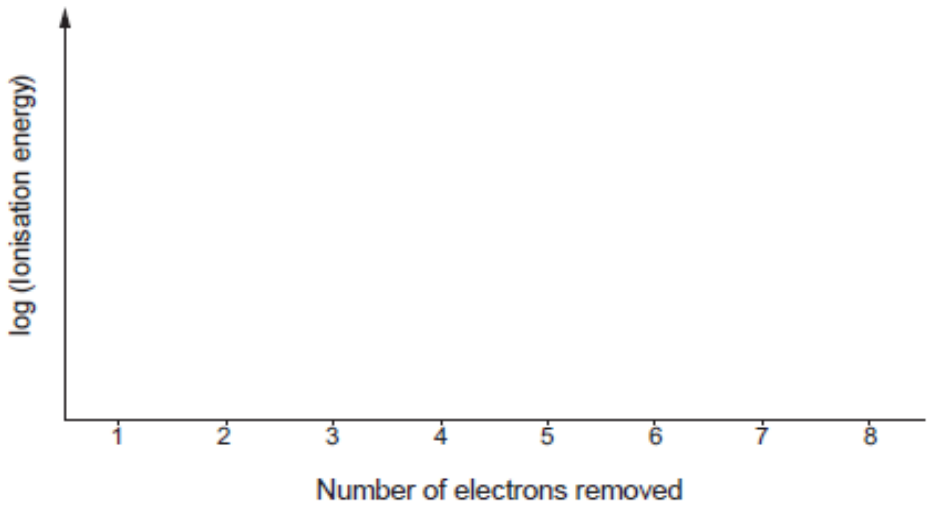
(ii) The half-life of the fluorine-18 isotope is 110 minutes, and the original fluorine sample contained four fluorine-18 atoms for every fluorine-19 atom. Find the time taken to synthesise the difluoromethanol. [4]

Time taken = ... minutes

(d) The electronic structure of the oxygen atoms produced in this decay process may be studied by measuring successive ionisation energies.

(i) Sketch a diagram showing the successive ionisation energies for oxygen. Show all **eight** ionisation energies. [2]



(ii) Explain how this diagram gives information regarding the position of the element in the Periodic Table. [2]

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5. Brass is an alloy of copper and zinc only. The copper content of the alloy can be found by volumetric or gravimetric analysis. The brass is dissolved by adding highly acidic mixtures to the alloy which forms $Cu^{2+}(aq)$ and amphoteric $Zn^{2+}(aq)$.

(a) Redox titration is one method to find the mass of copper in a known mass of alloy.

A 2.877 g sample of alloy is dissolved in concentrated nitric acid. The mixture is neutralised and then made up to a volume of 250.0 cm^3.

Samples of the solution with a volume of 25.00 cm^3 are removed and excess potassium iodide solution added, before titration with 0.105 mol dm^{-3} sodium thiosulfate solution. The mean volume of sodium thiosulfate needed to completely reduce the iodine in solution is 26.75 cm^3.

Calculate the percentage by mass of copper in this alloy. You **must** show your working. [4]

Percentage copper = ... %

(b) An alternative method is gravimetric analysis.

Another sample of alloy is dissolved in concentrated nitric acid. The solution is neutralised and aqueous sodium hydroxide is added until all the copper(II) and zinc(II) ions form metal hydroxide precipitates. This sample is then filtered, dried and weighed (weighing 1).

The solid sample is then treated with excess aqueous sodium hydroxide and the remaining solid is removed by filtration, dried and weighed (weighing 2).

The results are given below.

Mass of empty vessel = 23.34 g

Mass of vessel and precipitate (weighing 1) = 25.12 g

Mass of vessel and precipitate (weighing 2) = 24.45 g

Calculate the percentage by mass of copper in this alloy. You **must** show your working. [4]

Percentage copper = ... %

(c) A student suggests that the alloys in parts *(a)* and *(b)* are the same. State and explain whether the evidence supports this statement and suggest what further evidence should be collected to confirm your conclusion. [2]

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(d) (i) Concentrated nitric acid is used to dissolve the alloy in the experiments above. The pH of this strong acid is typically –1.2.

Calculate the concentration of this nitric acid. [2]

Concentration = ... $mol\,dm^{-3}$

(ii) The acidic solution is neutralised using aqueous sodium hydroxide of concentration 2.00 $mol\ dm^{-3}$.

Calculate the pH of this sodium hydroxide solution. [2]

[ionic product of water, $K_w = 1.00 \times 10^{-14}\ mol^2\,dm^{-6}$]

pH = ...