GCE A LEVEL CHEMISTRY

S21-A410

Assessment Resource H

Physical and Inorganic Chemistry

1. A radioactive sample of sodium-24 decays with a half-life of 15 hours to produce magnesium-24.

(a) Identify the type of radioactive decay occurring. [1]

.....

(b) A sample of 0.276 g of ^{24}Na decays for 45 hours. Calculate the mass of magnesium-24 produced in this time. [2]

Mass = ... g

2. Magnesium and sodium lie adjacent to each other in the Periodic Table.

(a) The melting temperature of sodium is 98 °C and magnesium has a melting temperature of 639 °C.

Explain why magnesium has a much higher melting temperature than sodium. [2]

.....

.....

.....

.....

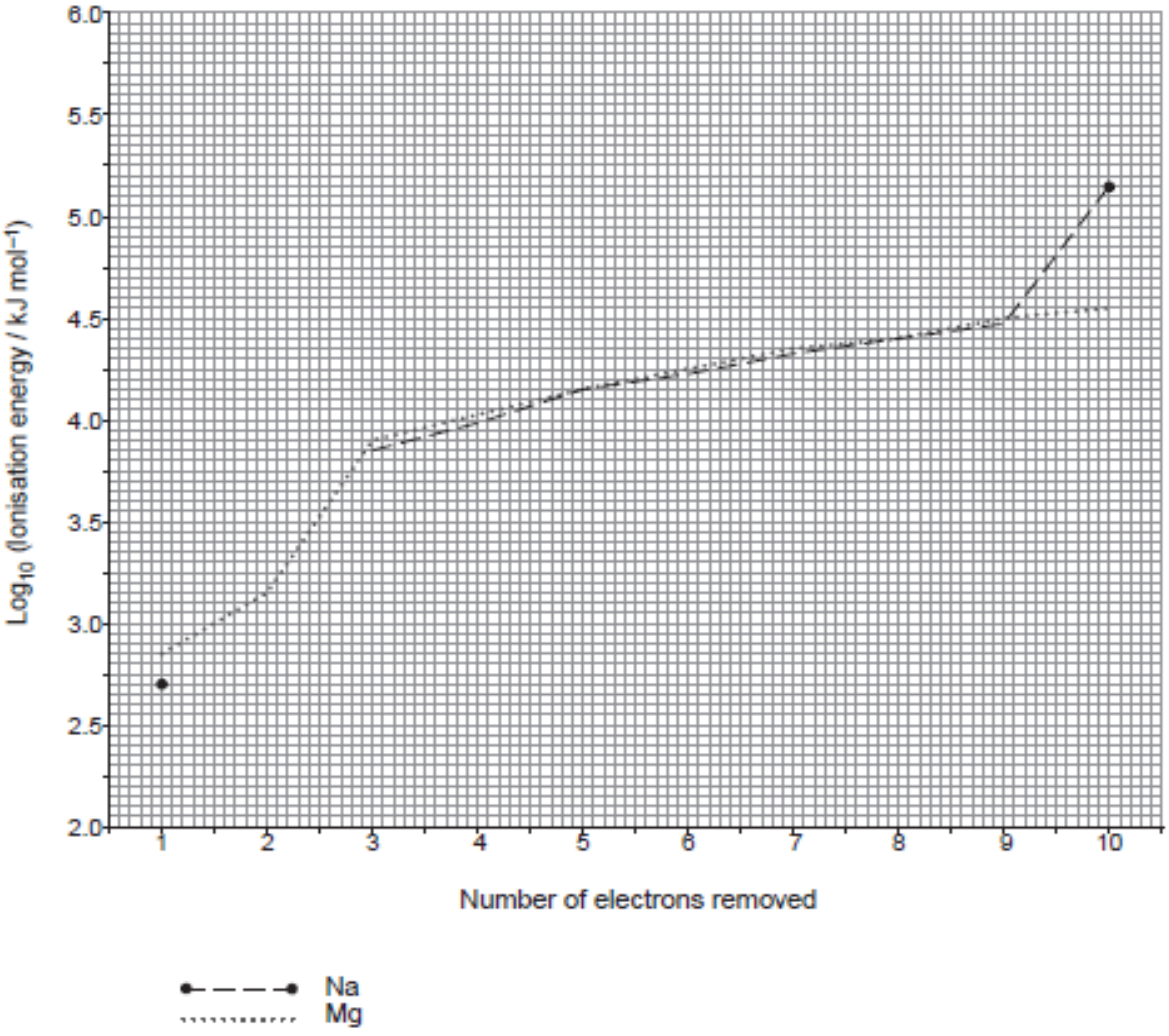
.....

(b) Sodium and magnesium both conduct electricity. State which of these two metals you would expect to be the better conductor of electricity. Give a reason for your answer. [1]

.....

.....

(c) The graph below shows the first ten log molar ionisation energies of sodium and magnesium.



(i) Give the equation for the **third** ionisation energy of magnesium. [1]

.....

(ii) Explain why the tenth ionisation energy of sodium is much larger than the tenth ionisation energy of magnesium. [2]

.....

.....

.....

.....

(iii) The plot for the log of the second ionisation energy of sodium is missing from the graph. Estimate its value and hence calculate an approximate second ionisation energy. [2]

Second ionisation energy = ... $kJ\,mol^{-1}$

(d) (i) Heating magnesium carbonate causes the compound to decompose forming magnesium oxide and carbon dioxide. The equation for this process is:

$$MgCO_3(s) \longrightarrow MgO(s) + CO_2(g)$$

	Standard enthalpy change of formation, $\Delta_f H^\theta$ / kJ mol^{-1}	Standard entropy, S^θ / J mol^{-1} K^{-1}
$MgCO_3(s)$	–1113	66
$MgO(s)$	–602	27
$CO_2(g)$	–394	214

Calculate the minimum temperature required, in °C, for the thermal decomposition to occur. [4]

Minimum temperature = ... °C

(ii) The element calcium lies below magnesium in Group 2. Suggest a value for the minimum temperature required for the thermal decomposition of $CaCO_3$. Give a reason for your answer. [1]

.....

.....

.....

3. Copper and cobalt are both considered to be transition elements whilst zinc is not.

(a) Give a reason why zinc is not considered to be a transition element. [1]

.....

.....

(b) Transition elements are able to form complex ions and these ions are usually coloured.

Give the colour of the $[Co(H_2O)_6]^{2+}$ ion. [1]

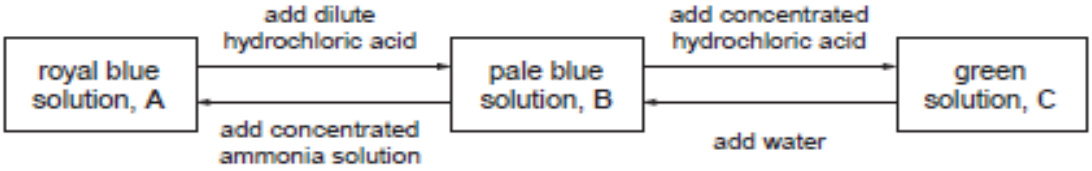
.....

(c) When an aqueous solution containing Cu^{2+} ions is treated with a concentrated aqueous solution of ammonia a pale blue precipitate forms. This dissolves when more ammonia is added to form a royal blue solution, labelled A in the scheme below.

(i) Identify the pale blue precipitate. [1]

.....

(ii) Some of the colour changes observed when other solutions are added to solution A are given in the following scheme.



Identify the species causing these colours and use Le Chatelier's principle to explain the changes that occur. Your answer should include appropriate equations.
[6 QER]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(d) Give another typical property of transition elements and use it to show that copper is a typical transition element but zinc is not. [2]

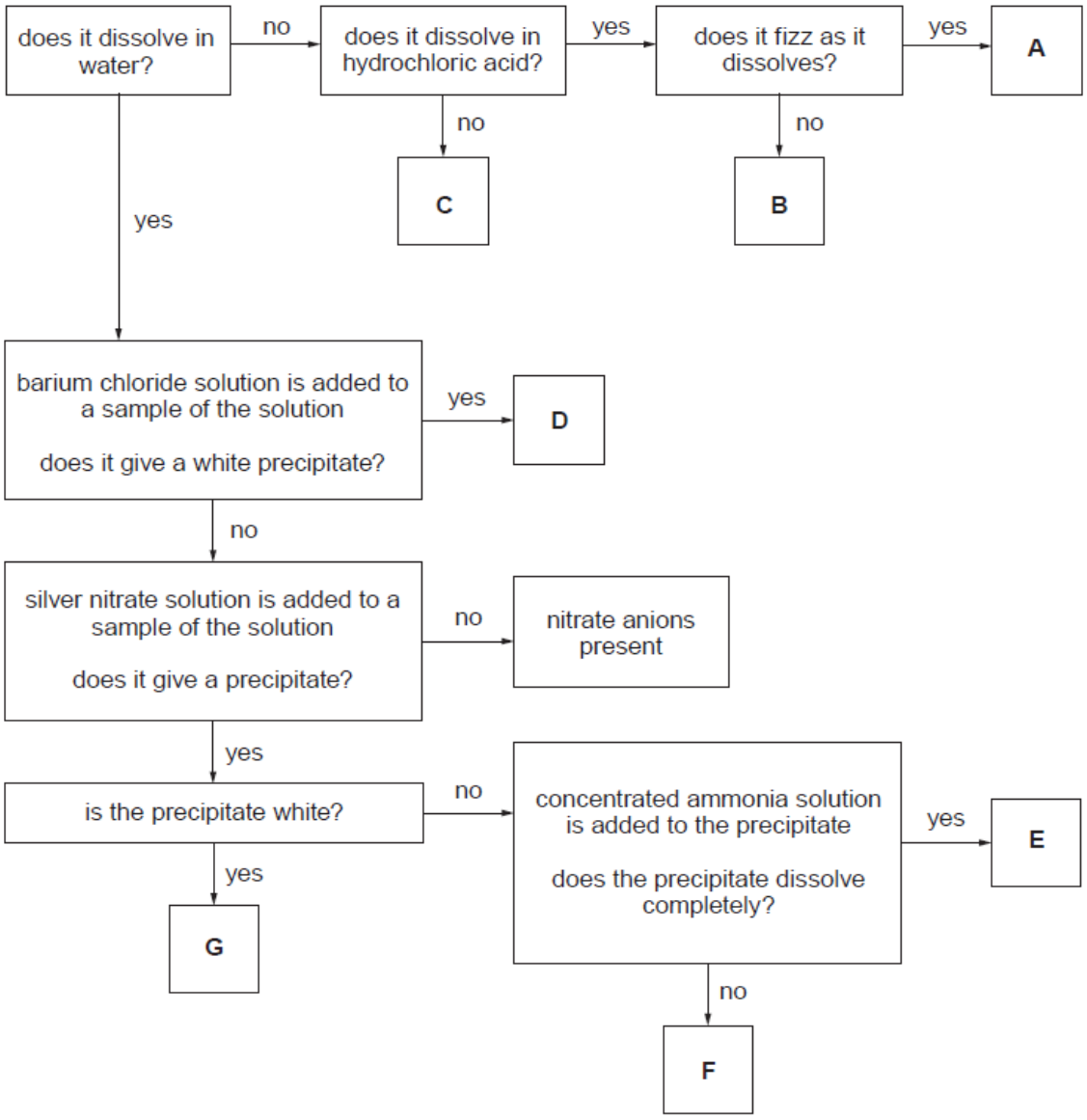
.....

.....

.....

.....

4. A student is given several magnesium compounds containing common anions and designs the scheme below to identify the anion present in each compound.



(a) The student labels seven possible results as A-G. He is able to suggest likely identities for anions that would give six of these results, and his teacher said that none of the common anions that he had studied would give the seventh result.

Suggest possible anions for six of the seven results below. Write '**UNKNOWN**' for the result that would not correspond to a common anion. [4]

A .....

B .....

C .....

D .....

E .....

F .....

G .....

(b) The planned method would not be suitable for identifying **all** these anions in **sodium** compounds. Explain why the method would not be suitable and suggest how it could be modified to make it suitable. [3]

.....

.....

.....

.....

.....

(c) Concentrated aqueous ammonia solution at 298 K contains 31.0 % ammonia by mass. The density of this solution is 0.900 g cm^{-3}.

Calculate the concentration of this solution in mol dm^{-3}. [3]

Concentration = ... mol dm^{-3}

(d) The student is provided with a solution containing chloride as the only anion. He is told that the solution also contains sodium ions, magnesium ions, or a mixture of both sodium and magnesium ions.

He proposes using a flame test to identify the cation(s) present in the mixture.

State the observations expected for each possibility and explain whether this method would be appropriate. [3]

.....

.....

.....

.....

.....

.....