Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Chemistry 8CH0

Resource Set 2 – Topic Group 2

Topics included:

Topic 3: Redox I

Topic 4: Inorganic Chemistry and the Periodic Table

Topic 5: Formulae, Equations and Amounts of Substance

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

Answer ALL questions.

Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 How many **ions** are present in 306 g of aluminium oxide, Al_2O_3?

[Avogadro constant = 6.02×10^{23} mol^{-1} Molar mass of Al_2O_3 = 102 g mol^{-1}]

- ☐ **A** 6.02×10^{23}
- ☒ **B** 1.81×10^{24}
- ☐ **C** 3.01×10^{24}
- ☐ **D** 9.03×10^{24}

ions = moles x Avo's constant

$= \frac{306}{102} \times 6.02 \times 10^{23}$

(Total for Question 1 = 1 mark)

8 This question is about the thermal stability of Group 1 and Group 2 nitrates and carbonates.

(a) Complete the equations for the thermal decomposition of sodium nitrate, $NaNO_3$, and for the thermal decomposition of calcium nitrate, $Ca(NO_3)_2$.
State symbols are not required.

(2)

$2\,NaNO_3 \rightarrow 2NaNO_2 + O_2$

$2\,Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$

(b) The thermal stability of Group 1 nitrates increases down the group.
The decomposition temperatures of some Group 1 nitrates are shown.

Name	Formula	Decomposition temperature / K
sodium nitrate	$NaNO_3$	653
potassium nitrate	KNO_3	673
caesium nitrate	$CsNO_3$	687

Explain why the thermal stability of caesium nitrate is greater than that of sodium nitrate.

(3)

caesium has a larger ionic radius than sodium, and so the Cs^+ ion polarises the nitrate ion less strongly so $CsNO_3$ is more stable than $NaNO_3$ and requires more energy to decompose it than $NaNO_3$.

$CaCO_3$

(c) Calcium carbonate is thermally decomposed during the manufacture of cement.

(i) Write an equation, including state symbols, for the thermal decomposition of calcium carbonate.

(1)

$CaCO_3 \longrightarrow CaO + CO_2$

(ii) Name all the types of bond present in calcium carbonate.

(1)

covalent bonds and ionic bonds

(iii) Give a reason, in terms of the bonding, why a high decomposition temperature is required.

(1)

ionic and covalent bonds are very strong

(Total for Question 8 = 8 marks)

6 Chlorine and iodine are in the same group in the Periodic Table.

(a) (i) Complete the electronic configuration of chlorine using the s, p, d notation.

(1)

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

(ii) Explain why iodine and chlorine have many similar chemical reactions.

(2)

they are in the same group and so have the same number of electrons in their outer shell so both gain one electron when they react, forming 1- ions

(b) Members of the same group sometimes react in different ways.

Iodine and chlorine react differently with thiosulfate ions, $S_2O_3^{2-}$.
Iodine gives $S_4O_6^{2-}$, whilst chlorine gives SO_4^{2-}.

(i) Complete the table by identifying the oxidation numbers of sulfur in the three sulfur-containing ions.

(2)

Ion	Oxidation number of sulfur
$S_2O_3^{2-}$	+2
SO_4^{2-}	+6
$S_4O_6^{2-}$	+5

$2x + (-2 \times 3) = -2$
$2x - 6 = -2$
$x = +2$

$x + (-2 \times 4) = -2$
$x - 8 = -2$
$x = +6$

$4x + (-2 \times 6) = -2$
$4x - 12 = -2$
$x = +5$

(ii) The equation for the reaction of iodine with thiosulfate ions is

$$2S_2O_3^{2-} + I_2 \rightarrow 2I^- + S_4O_6^{2-}$$

State, in terms of electrons, why iodine is classified as an oxidising agent in this reaction.

(1)

iodine takes electrons from the thiosulfate ion, therefore causing the thiosulfate ion to lose electrons

(iii) Use your answer to b(i) to show that chlorine is a stronger oxidising agent than iodine.

(1)

Chlorine causes sulfur to lose 4 electrons, whereas iodine causes sulfur to lose 3 electrons so chlorine oxidises thiosulfate more strongly.

(iv) Chlorine reacts in aqueous solution with $S_2O_3^{2-}$ to give SO_4^{2-}.
The ionic half-equation for the reaction of chlorine is

$$Cl_2 + 2e^- \rightarrow 2Cl^-$$

Write the ionic half-equation for the reaction of aqueous $S_2O_3^{2-}$ to give SO_4^{2-}.
State symbols are not required.

(2)

$$5H_2O + S_2O_3^{2-} \longrightarrow 2SO_4^{2-} + 8e^- + 10H^+$$

(v) Use your answer to (b)(iv) and the half-equation for chlorine, to write the overall ionic equation for the reaction between chlorine and thiosulfate ions.
State symbols are not required.

(1)

$$4Cl_2 + 5H_2O + S_2O_3^{2-} \longrightarrow 2SO_4^{2-} + 10H^+ + 8Cl^-$$

(Total for Question 6 = 10 marks)

1 The presence of some ions in compounds can be identified using a Bunsen burner flame.

(a) (i) Some metal ions give characteristic colours in a flame test.

Describe how to carry out a flame test on an unknown solid.

(2)

Dip a nichrome wire into a solution of concentrated HCl and hold in a blue Bunsen burner flame to clean it. Dissolve the unknown solid in some distilled water and dip the wire into it. Hold in a blue Bunsen burner flame and observe the colour produced.

(ii) Which of the following ions does **not** give a red flame?

(1)

- [x] **A** barium
- [ ] **B** calcium
- [ ] **C** lithium
- [ ] **D** strontium

(iii) Some anions can also be identified by heating in a Bunsen burner flame. A compound heated in a test tube in a Bunsen burner flame gave off a brown gas and caused a glowing splint to relight. The formula of the ion responsible is

(1)

- [ ] **A** Br^-
- [ ] **B** NO_2^-
- [x] **C** NO_3^-
- [ ] **D** O^{2-}

(b) A flame test on a white powder gave a lilac flame colour. Dilute hydrochloric acid was added to a second sample of the same powder in a boiling tube and the gas produced bubbled into limewater. The limewater turned cloudy.

potassium

CO_2

Give a possible **formula** for the white powder.

(2)

K_2CO_3

(Total for Question 1 = 6 marks)

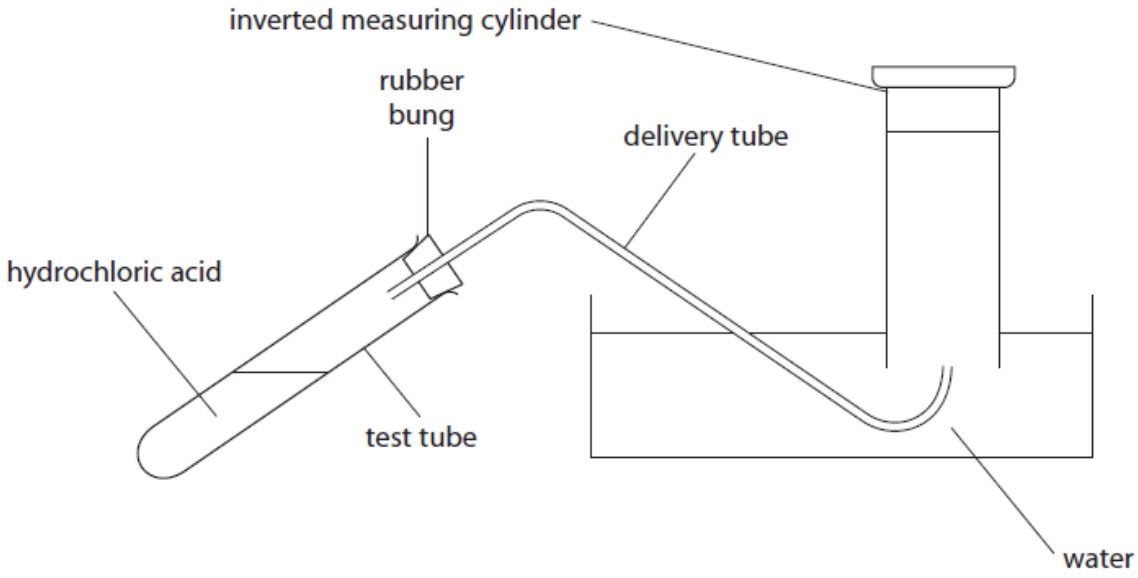
7 This question is about the reaction of magnesium with dilute hydrochloric acid.

(a) Write an equation for the reaction of magnesium with hydrochloric acid. Include state symbols.

(2)

$$Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$$

(b) The apparatus shown in the diagram can be used to collect the gas produced during the reaction of magnesium with dilute hydrochloric acid.



The following procedure was used.

Step **1** The apparatus was set up as shown in the diagram. The test tube contained 10.0 cm^3 of 0.20 mol dm^{-3} hydrochloric acid.

Step **2** A piece of magnesium ribbon was weighed. It had a mass of 0.12 g.

Step **3** The delivery tube and bung were removed from the test tube, the magnesium ribbon was added and the delivery tube and bung quickly replaced.

Step **4** When the reaction was complete, the final volume of gas was recorded.

(i) A measuring cylinder was used to measure the 10.0 cm^3 of dilute hydrochloric acid in Step **1**. The uncertainty for a volume measurement is ± 0.5 cm^3. Calculate the percentage uncertainty in the volume of hydrochloric acid.

(1)

$$\frac{0.5}{10.0} \times 100 = 5.0\ \%$$

(ii) Determine which reactant is in excess by calculating the number of moles of magnesium and of hydrochloric acid used in the experiment.

(3)

magnesium : HCl :

$\frac{0.12}{24.3} = 0.00494$ $0.01 \times 0.2 = 0.002$

Mg : HCl = 1 : 2 ∴ Mg is in excess as

$0.00494 \times 2 = 0.00988$ $0.00988 > 0.002$

(iii) Calculate the maximum number of moles of gas that could be produced, using your answers to (a) and (b)(ii).

(1)

maximum moles of H_2 = $0.002 \div 2$

$= 0.001$

(iv) Under the conditions of the experiment, the temperature was 23°C and the pressure 98 000 Pa.

Calculate the maximum volume of gas, **in cm^3**, that could be produced using your answer in (b)(iii).
Give your answer to an appropriate number of significant figures.

[The ideal gas equation is $pV = nRT$. Gas constant (R) = 8.31 J mol^{-1} K^{-1}]

(4)

$pV = nRT$

$V = \frac{nRT}{p}$

$V = \frac{0.001 \times 8.31 \times 296\,K}{98000}$

$V = 2.50996 \times 10^{-5}\ m^3$

$V = 25\ cm^3$

(c) (i) Deduce **two** possible reasons why the volume of gas collected in the experiment was smaller than that calculated in (b)(iv).

(2)

1. some of the gas escaped before the bung was replaced

2. the delivery tube was not completely in the inverted measuring cylinder

(ii) Describe **two** changes to the procedure that would enable the volume of gas collected to be closer to that calculated in (b)(iv).

(2)

1. repeat the experiment and calculate a mean volume of gas produced

2. collect the gas in a gas syringe rather than an inverted measuring cylinder

(Total for Question 7 = 15 marks)

Total for Test = 40 marks