Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Chemistry 8CH0

Resource Set 1 – 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- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.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.

4 This question is about trends within Group 2 of the Periodic Table.

(a) Which of the following describes the trends in thermal stability of the Group 2 carbonates and nitrates going down the group?

(1)

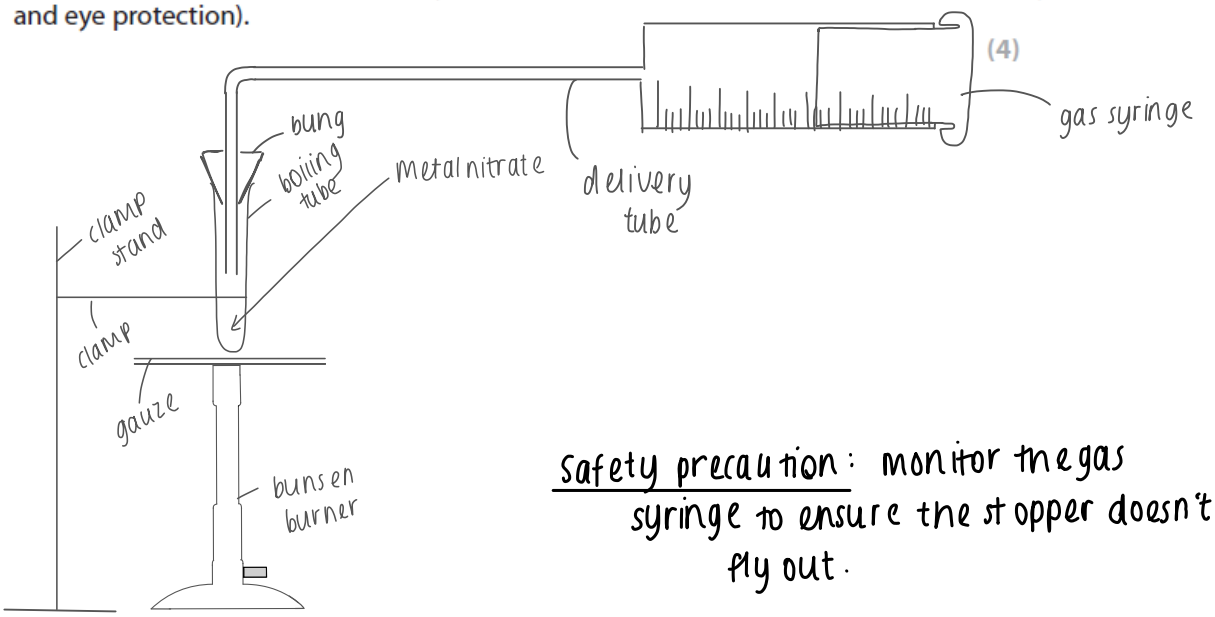
		Thermal stability	
		Carbonates	Nitrates
☒	**A**	increases	increases
☐	**B**	increases	decreases
☐	**C**	decreases	increases
☐	**D**	decreases	decreases

$Mg(NO_3)_2 \rightarrow MgO + NO_2 + O_2$

(b) Describe, with the aid of a labelled diagram, how you would compare the thermal stability of two different Group 2 nitrates using simple laboratory equipment.

Your answer **must** include **one** safety precaution (excluding the use of gloves, laboratory coat and eye protection).

(4)



Safety precaution: monitor the gas syringe to ensure the stopper doesn't fly out.

Transfer 5.00g of one metal nitrate into a boiling tube and use a clamp and clamp stand to fix it into place above a Bunsen burner and gauze. Place a bung inside the tube with a delivery tube attached and insert this into a gas syringe. Heat the metal nitrate for 1 minute using a stopwatch, and after 1 minute determine and record the volume of gas collected. The metal nitrate that produced more gas is the less stable one.

(c) Which of the following describes the trends in the solubility in water of the Group 2 hydroxides and sulfates going down the group?

(1)

	Solubility in water	
	Hydroxides	Sulfates
☐ **A**	increases	increases
☒ **B**	increases	decreases
☐ **C**	decreases	increases
☐ **D**	decreases	decreases

(Total for Question 4 = 6 marks)

5 This question is about the reactions of the halogens and halide ions.

(a) (i) When chlorine gas is bubbled through an aqueous solution of potassium iodide, the reaction involves

(1)

$$\overset{0}{Cl_2} + 2\overset{-1}{Br^-} \rightarrow \overset{0}{Br_2} + 2\overset{-1}{Cl^-}$$

- ☐ **A** oxidation only
- ☐ **B** reduction only
- ☒ **C** redox
- ☐ **D** disproportionation

(ii) Cyclohexane was added to the resulting solution from (a)(i). The mixture was shaken and then allowed to stand for a few minutes. Two layers were formed.

[Density: aqueous layer solution = 1.10 g cm^{-3}, cyclohexane layer = 0.78 g cm^{-3}]

The colour of the **lower** layer was

(1)

- ☒ **A** pale yellow
- ☐ **B** purple
- ☐ **C** red
- ☐ **D** pale green

I_2, SO_2 S, H_2S

KI HI

(b) Concentrated sulfuric acid was added to a small quantity of solid potassium iodide in a test tube.

(i) In this exothermic reaction, which of the following mixtures of gases would be produced?

(1)

- ☐ **A** hydrogen iodide and sulfur dioxide only
- ☐ **B** hydrogen iodide and hydrogen sulfide only
- ☒ **C** hydrogen iodide, sulfur dioxide and hydrogen sulfide
- ☐ **D** hydrogen iodide, hydrogen sulfide and iodine

$HCl + NH_3 \rightarrow NH_4Cl$

(ii) Hydrogen iodide is a gas which reacts in a similar way to hydrogen chloride.

State the observation when the hydrogen iodide gas is passed over the mouth of an open bottle of concentrated ammonia solution.
Write an equation, including state symbols, for the reaction.

(3)

Observation white solid formed

Equation $HI_{(g)} + NH_{3(g)} \rightarrow NH_4I_{(s)}$

(c) Potassium iodate(V) can be prepared by adding solid iodine to a **hot** aqueous solution of potassium hydroxide.

The equation for the reaction is

$$3I_2 + 6KOH \rightarrow \overset{+5}{KIO_3} + 5\overset{-1}{KI} + 3H_2O$$

Potassium iodate(V) can be separated from the other reaction product using their differing solubilities in water.

	Solubility in water at 25 °C / mol dm^{-3}
KI	8.92
KIO_3	0.43

(i) Outline a procedure that you could use to obtain a sample of dry, solid potassium iodate(V) from the reaction mixture.

(3)

Add 100cm^3 of distilled water to the reaction mixture and pour this mixture into a separating funnel. clamp the funnel and allow the two mixtures to separate. Pour off the lower, aqueous layer containing KI and then transfer the layer containing KIO_3 to an evaporating basin. Heat using a Bunsen Burner until most of the water has evaporated and then leave to dry for 24hrs until solid KIO_3 has formed.

(ii) Describe how you would show that iodide ions are present in an aqueous solution of potassium iodide.

(2)

add $AgNO_3$ acidified with nitric acid to the solution. If I^- ions are present, a yellow ppt will form. The yellow ppt will not dissolve upon addition of dilute and then concentrated ammonia solution.

(d) Fluorine is an element in Group 7.

Group 7 includes the elements chlorine, bromine and iodine.

Some information about the melting and boiling temperatures of Group 7 elements is shown in the table.

Element	Melting temperature / K	Boiling temperature / K
chlorine	172	238
bromine	266	332
iodine	387	457

Which is the expected boiling temperature of fluorine, in kelvin, K?

(1)

- ☐ **A** 4
- ☒ **B** 85
- ☐ **C** 575
- ☐ **D** 610

(Total for Question 5 = 12 marks)

4 This question is about redox chemistry.

(a) (i) Write an ionic half-equation for the reduction of chlorine molecules to chloride ions.
State symbols are not required.

(1)

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

(ii) Write an ionic half-equation for the oxidation of chlorine molecules to chlorate(I) ions in the presence of cold, aqueous hydroxide ions.
State symbols are not required.

(1)

$OH^- + Cl_2 \longrightarrow 2ClO^- + 2e^- + H^+$

(iii) Combine the two equations in (a)(i) and (ii) to give the ionic equation for the reaction of chlorine molecules with cold, aqueous hydroxide ions.

(1)

$2Cl_2 + OH^- \longrightarrow 2ClO^- + 2Cl^- + H^+$

(iv) Use your answer to (a)(iii) to explain why the reaction is described as a **disproportionation** reaction.

(2)

chlorine is both oxidised and reduced in the same reaction. Chlorine's oxidation state in ClO^- is +1, and in Cl^- it's −1, so chlorine loses and gains electrons at the same time.

(b) A different ion containing chlorine is formed if the solution of aqueous hydroxide ions is hot.

$3Cl_2 + 6NaOH \rightarrow NaClO_3 + 5NaCl + 3H_2O$

Give the formula of the chlorine-containing ion **and** the oxidation number of chlorine in this ion.

(2)

ClO_3^-

oxidation number = +5

$x + 3(-2) = -1$

$x - 6 = -1$

$x = +5$

(c) (i) Bromine can be extracted from seawater containing bromide ions using chlorine.

Write the ionic equation for this reaction. State symbols are not required.

(1)

$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$

(ii) Identify **one** hazard associated with carrying out this reaction in a school laboratory and a safety precaution other than wearing a laboratory coat and eye protection.

(2)

carry out the experiment in a fume cupboard as bromine gas is toxic

(Total for Question 4 = 10 marks)

5 This question is about iron(II) salts.

(a) What is the percentage by mass of iron in anhydrous iron(II) sulfate, $FeSO_4$, to 3 significant figures?

(1)

- ☐ **A** 21.3%
- ☐ **B** 35.1%
- ☒ **C** 36.7%
- ☐ **D** 53.8%

$$100 \times \frac{55.8}{151.9} = 36.73$$

(b) Describe a chemical test, and the expected result, to show that sulfate ions are present in a solution of iron(II) sulfate in water.

(2)

add acidified barium chloride solution to the iron sulfate and a white solid (precipitate) will form if SO_4^{2-} ions are present

(c) Mohr's salt is another compound containing iron(II) ions.

It has the formula $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$.

What is the molar mass, in $g\,mol^{-1}$, of Mohr's salt?

(1)

- ☐ **A** 392.0
- ☒ **B** 312.0
- ☐ **C** 302.0
- ☐ **D** 284.0

$$[(14+4)\times 2] + [55.8 + (32+16+16+16+16)\times 2] + 6(2+16)$$
$$= 312.0$$

(Total for Question 5 = 4 marks)

3 The reaction of sulfuric acid with potassium hydroxide is a neutralisation.
The equation for this reaction is

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

A titration was carried out using the following method.

1. Potassium hydroxide solution of unknown concentration was placed in a burette and the initial reading was recorded.
2. 25.0 cm^3 of sulfuric acid solution, concentration 0.0800 mol dm^{-3}, was transferred to a conical flask.
3. Three drops of phenolphthalein indicator were added to the sulfuric acid.
4. Potassium hydroxide was added from the burette until the solution just changed colour and then the burette reading was recorded.
5. Repeat titrations were carried out until concordant titres were obtained.

(a) Select the most appropriate piece of apparatus to measure the 25.0 cm^3 of sulfuric acid.

(1)

☐ **A** burette

☐ **B** measuring cylinder

☒ **C** pipette

☐ **D** volumetric flask

(b) What is the colour of the solution when neutralisation has just occurred?

(1)

☐ **A** colourless

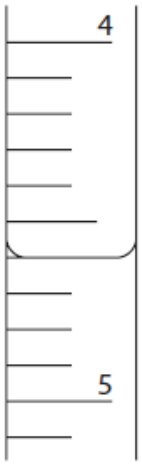
☐ **B** orange

☒ **C** pale pink

☐ **D** red

(c) (i) Complete the table of results for titration number 1, using the diagrams to find the initial and final burette readings.

(2)



4.6

Initial reading

32.35

Final reading

Table of results

Titration number	Final reading / cm^3	Initial reading / cm^3	Titration volume / cm^3
1	32.35	4.60	27.75
2	28.05	1.10	26.95
3	37.65	10.20	27.45
4	32.05	5.00	27.05

(ii) The best value for the mean titre of this reaction is

(1)

☒ **A** 27.00 cm^3

☐ **B** 27.15 cm^3

☐ **C** 27.25 cm^3

☐ **D** 27.30 cm^3

(iii) Calculate the concentration, in mol dm^{-3}, of the potassium hydroxide solution, giving your answer to an appropriate number of significant figures.

(3)

	$H_2SO_4(aq)$	$2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$
n	0.002	0.004
C	0.08	?
V	0.025	0.027

concentration of KOH = $\frac{0.004}{0.027}$ = 0.14814...

0.148 mol dm^{-3}

(Total for Question 3 = 8 marks)

Total for Test = 40 marks