Pearson Edexcel

Additional Assessment Materials Summer 2021

Pearson Edexcel GCSE in Chemistry (1CH0) Higher

Resource Set Topic H: Quantitative analysis (H tier only, Chemistry Only)

Questions

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- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.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

(b) Lead can be obtained by heating its oxide with carbon.
The balanced equation for the reaction is

$$2PbO + C \rightarrow 2Pb + CO_2$$

Calculate the atom economy for the production of lead in this reaction.
(relative atomic masses: C = 12, O = 16, Pb = 207
relative formula masses: PbO = 223, CO_2 = 44)

Give your answer to two significant figures.

(4)

$\frac{2(207)}{2(223)+12} \times 100 = 90.39\ \%$

$\simeq 90\%$

atom economy = 90 %

(c) (i) In an experiment to produce lead, 7.67 g of lead are obtained.
The theoretical yield of lead for the experiment is 11.80 g.

Calculate the percentage yield of lead in this experiment.

(2)

$\frac{7.67}{11.80} \times 100 = 65\ \%$

percentage yield = 65 %

(ii) In most reactions, the percentage yield of any product is less than 100%.

Give **two** reasons why the percentage yield is less than 100%.

(2)

reason 1 reaction is incomplete

reason 2 not all products have been removed from the mixture

7 The industrial production of sulfuric acid involves several steps.

One of these steps is the reaction of sulfur dioxide, SO_2, with oxygen to form sulfur trioxide, SO_3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

(a) What volume of sulfur trioxide, in dm^3, is produced by the complete reaction of 750 dm^3 of sulfur dioxide?
(all volumes of gases are measured under the same conditions of temperature and pressure)

(1)

- ☐ **A** 375.5
- ☐ **B** 750
- ☐ **C** 1125.5
- ☐ **D** 1500

(b) Calculate the volume of oxygen needed to react completely with 750 dm^3 of sulfur dioxide.
(all volumes of gases are measured under the same conditions of temperature and pressure)

(1)

$\frac{750}{2} = 375\ dm^3$

volume of oxygen = 375 dm^3

(c) Calculate the mass, in kilograms, of 750 dm^3 of sulfur dioxide, measured at room temperature and pressure.
(relative formula mass: $SO_2 = 64$;
1 mol of any gas at room temperature and pressure occupies 24 dm^3)

(3)

$\frac{750}{24} = 31.25$ mol

$31.25 \times 64 = 2000$ g

$= 2$ kg

mass of sulfur dioxide = 2 kg

10 The concentration of dilute sulfuric acid can be determined by titration with sodium hydroxide solution of known concentration.

25.00 cm^3 of dilute sulfuric acid was measured out using a pipette and transferred to a conical flask.
A few drops of methyl orange indicator were added to the acid in the conical flask.
Sodium hydroxide solution was added to the acid from a burette until the indicator changed colour.
The titration was repeated until two concordant results were obtained.
The accurate result was the average of the two concordant results.

(a) Describe the colour change seen at the end point of the titration.

(1)

from red to orange

(b) A brief report of the practical method has been given above.
Further detail can be added to this method to ensure that anyone following the method will obtain an accurate result.

Explain **two** details that could be added to this practical method to ensure an accurate result is obtained.

(4)

1 gently shake the conical flask while adding the sodium hydroxide

2 concordant titre values are those within $0.20 cm^3$ of each other.

(c) In the titration, 25.00 cm^3 of dilute sulfuric acid reacted with 24.25 cm^3 of 0.200 mol dm^{-3} sodium hydroxide solution, NaOH.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of the dilute sulfuric acid, H_2SO_4, in mol dm^{-3}.

(4)

moles of NaOH : $\frac{24.25}{1000} \times 0.200$

$= 4.85 \times 10^{-3}$ mol

moles of H_2SO_4 = $4.85 \times 10^{-3} \div 2$

$= 2.425 \times 10^{-3}$ mol

concentration of H_2SO_4 = $\frac{2.425 \times 10^{-3}}{25 \times 10^{-3}}$

$= 0.097$ mol dm^{-3}

concentration of sulfuric acid = 0.097 mol dm^{-3}

(d) The concentration of some dilute sulfuric acid, H_2SO_4, is 0.250 mol dm^{-3}.

Calculate the concentration of sulfuric acid in this solution in g dm^{-3}.
(relative formula mass: H_2SO_4 = 98)

(2)

$0.250 \times 98 = 24.5\ g\ dm^{-3}$

concentration of sulfuric acid = 24.5 g dm^{-3}

4 Calcium carbonate decomposes on heating to form calcium oxide and carbon dioxide.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

(a) 8.000 g of $CaCO_3$ was heated strongly for about 10 minutes. 6.213 g of solid remained. Calculate the mass of carbon dioxide gas given off.

(1)

8.000 - 6.213 = 1.787

mass of carbon dioxide = 1.787 g

(b) A second sample of calcium carbonate is strongly heated in a crucible until there is no further loss in mass.
The mass of calcium oxide remaining in the crucible is 5.450 g.

(i) The theoretical yield of calcium oxide in this experiment is 5.600 g.

Calculate the percentage yield of calcium oxide.

(2)

$\frac{5.450}{5.600} \times 100 = 97.3\%$

percentage yield = 97.3 %

(ii) The mass of solid left in the crucible is less than the theoretical mass of calcium oxide that should be obtained.

A possible reason for this is that

(1)

☒ **A** some solid was lost from the crucible

☐ **B** the solid remaining absorbed some water from the air

☐ **C** some carbon dioxide remained in the crucible

☐ **D** the decomposition was incomplete

(d) (i) Calculate the relative formula mass of calcium carbonate, $CaCO_3$.
(relative atomic masses: C = 12, O = 16, Ca = 40)

(2)

$40 + 12 + 3(16) = 100$

relative formula mass = 100

(ii) Calculate the atom economy for the formation of calcium oxide in this reaction.

$$CaCO_3 \rightarrow CaO + CO_2$$

You must show your working.
(relative atomic masses: C = 12, O = 16, Ca = 40;
relative formula mass: calcium oxide = 56)

(2)

$\frac{56}{100} \times 100 = 56\%$

atom economy = 56 %

10

(b) In one stage of the production of nitric acid, nitrogen oxide, NO, is reacted with oxygen to make nitrogen dioxide, NO_2.

$$2NO + O_2 \rightarrow 2NO_2$$

Calculate the minimum volume of air, measured at room temperature and pressure, required to react with 1000 g nitrogen oxide to form nitrogen dioxide.

Assume that the air contains 20% oxygen by volume.
(relative atomic masses: N = 14, O = 16
1 mol of gas occupies 24 dm^3 at room temperature and pressure)

(4)

moles of NO = $\frac{1000}{14+16}$ = 33.33 mol

moles of O_2 required = $\frac{33.33}{2}$

= 16.67 mol

volume of O_2 required = 16.67 × 24

= 400.08 dm^3

volume of air required = 400.08 × 5

= 2000.4 dm^3

≈ 2000 dm^3

volume of air = 2000 dm^3

4 Potassium hydroxide reacts with hydrochloric acid to form potassium chloride and water.

potassium hydroxide + hydrochloric acid → potassium chloride + water

(a) A student carried out a titration to find the exact volume of dilute hydrochloric acid that reacted with 25.0 cm^3 of potassium hydroxide solution.

There were five steps in the titration.
The steps shown are not in the correct order.

step J pour the potassium hydroxide solution into a conical flask and add a few drops of indicator to this solution

step K fill a burette with the dilute hydrochloric acid and record the initial reading from the burette

step L use a measuring cylinder to obtain 25 cm^3 of potassium hydroxide solution

step M take a final reading from the burette and calculate the volume of the dilute hydrochloric acid reacted

step N run the dilute hydrochloric acid from the burette into the conical flask until the indicator changes colour

(i) Write the steps in the correct order.

Some of the steps have been completed for you.

(1)

first step				last step
K	L	J	N	M

(ii) Suggest an alternative piece of apparatus that could be used in step L to obtain exactly 25.0 cm^3 of potassium hydroxide solution.

(1)

pipette

10

(b) Ammonium sulfate and ammonium nitrate are used as fertilisers as they both contain nitrogen, which will increase the yield of crops.

(i) Suggest **one** other reason for using solid ammonium sulfate and solid ammonium nitrate as nitrogenous fertilisers.

(1)

Solid fertilisers are not easily washed away by rain

(ii) Ammonium nitrate can be made by the reaction of ammonia with nitric acid.

Write the balanced equation for this reaction.

(2)

$NH_3 + HNO_3 \rightarrow NH_4NO_3$

(iii) Describe **one** similarity and **one** difference between the industrial production of ammonium sulfate and the laboratory preparation of ammonium sulfate.

(2)

similarity ammonia and sulfuric acid react to form ammonium sulfate.

difference Laboratory preparation is a one-step process while the industrial production has multiple steps

(b) A student was then asked to produce a pure sample of solid potassium chloride.

After finding the volume of acid reacted in step M, the student added this volume of acid to a fresh 25.0 cm^3 sample of the potassium hydroxide solution.
This mixture was then evaporated.

(iv) The equation for the reaction between potassium hydroxide solution and dilute hydrochloric acid is

$$KOH + HCl \rightarrow KCl + H_2O$$

Calculate the atom economy for the production of potassium chloride from potassium hydroxide and hydrochloric acid.
(relative formula masses: KOH = 56.0, HCl = 36.5, KCl = 74.5, H_2O = 18.0)

Give your answer to one decimal place.

(4)

$\frac{74.5}{56.0+36.5} \times 100 = 80.5405\ \%$

$\simeq 80.5\ \%$

atom economy = 80.5 %

TOTAL FOR PAPER IS 47 MARKS