Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2015

GCSE Chemistry

Unit 2

Higher Tier

GCH22

[GCH22]
WEDNESDAY 17 JUNE, MORNING

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in blue or black ink only. **Do not write with a gel pen.**
Answer **all seven** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 115.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in Questions **2(a)** and **5(b)(vi)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

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1 **(a)** Solid calcium chloride absorbs moisture from the air and dissolves in it to form a solution. In solution, calcium chloride causes permanent hardness in water.

(i) What is meant by hard water?

_____

_____

_____ [2]

(ii) What term is used to describe a solid which absorbs moisture from the air and dissolves in it?

_____ [1]

(iii) Explain the difference between temporary hardness and permanent hardness in water.

_____

_____

_____ [2]

[Turn over

(b) Hydrated sodium carbonate can be used to remove permanent hardness from water.

(i) What is the common name of hydrated sodium carbonate?

_____ [1]

(ii) Write an ionic equation to show how hydrated sodium carbonate removes permanent hardness from water. Include state symbols.

_____ [3]

(iii) State one **other** method which is used to remove permanent hardness from water.

_____ [1]

(iv) State one **advantage** of hardness in a domestic water supply.

_____ [1]

2 **(a)** Ethanol can be manufactured by fermentation.

Describe the production of ethanol by fermentation.

In your answer you should include:

- the names of the starting materials
- the conditions required
- the names of any other products (apart from ethanol)

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

[6]

[Turn over

(b) In some countries ethanol is mixed with petrol to make fuels for use in cars. Petrol is mainly octane (C_8H_{18}), an alkane with 8 carbon atoms. Octane is a hydrocarbon fuel.

(i) What is the general formula of the alkanes?

_____ [1]

(ii) What is meant by the term hydrocarbon?

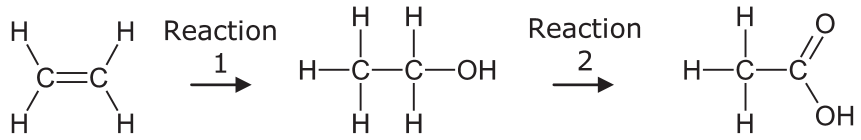
_____

_____ [1]

(iii) Write a balanced symbol equation for the complete combustion of octane.

_____ [3]

(c) The diagram below shows a series of organic reactions.



A **B** **C**

A is converted into **B** by reaction 1 and **B** is converted into **C** by reaction 2.

(i) Name **A**, **B** and **C**.

A _____

B _____

C _____ [3]

(ii) Name the substance which reacts with **A**, in reaction 1, to form **B**.

_____ [1]

(iii) Reaction 2 may be carried out using acidified potassium dichromate solution. What colour change would be observed during this reaction?

From _____ to _____ [1]

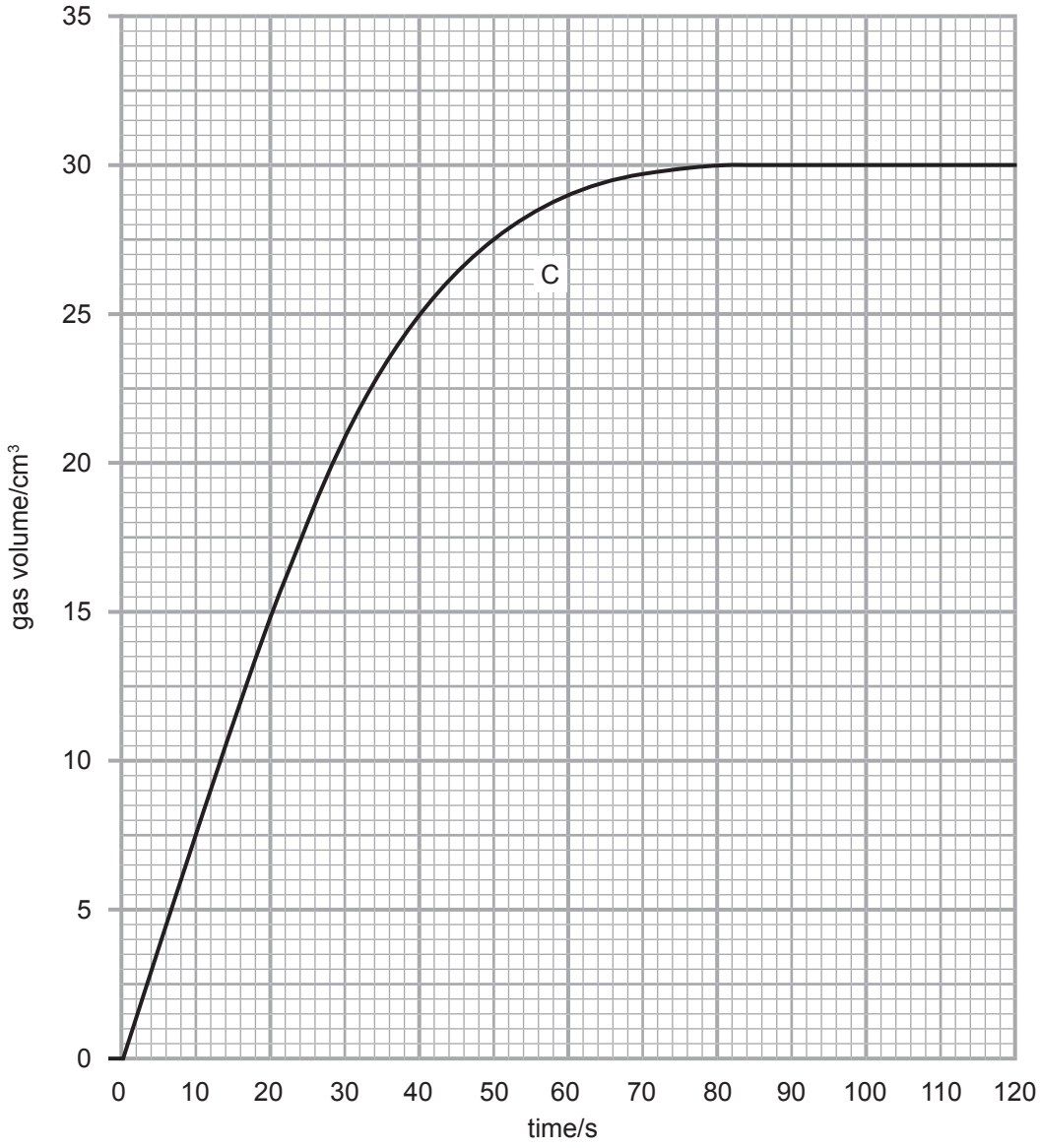
(iv) Which one of the substances (**A**, **B** or **C**) would decolourise bromine water?

_____ [1]

[Turn over

3 0.03 g of magnesium ribbon reacted with **excess** dilute hydrochloric acid at room temperature. The volume of gas produced was recorded every 20 seconds.

(a) The results obtained in the experiment, using 0.03 g of magnesium ribbon and **excess** dilute hydrochloric acid, are shown as line C on the graph below.



(i) Use the graph to determine the time taken for the reaction to finish.

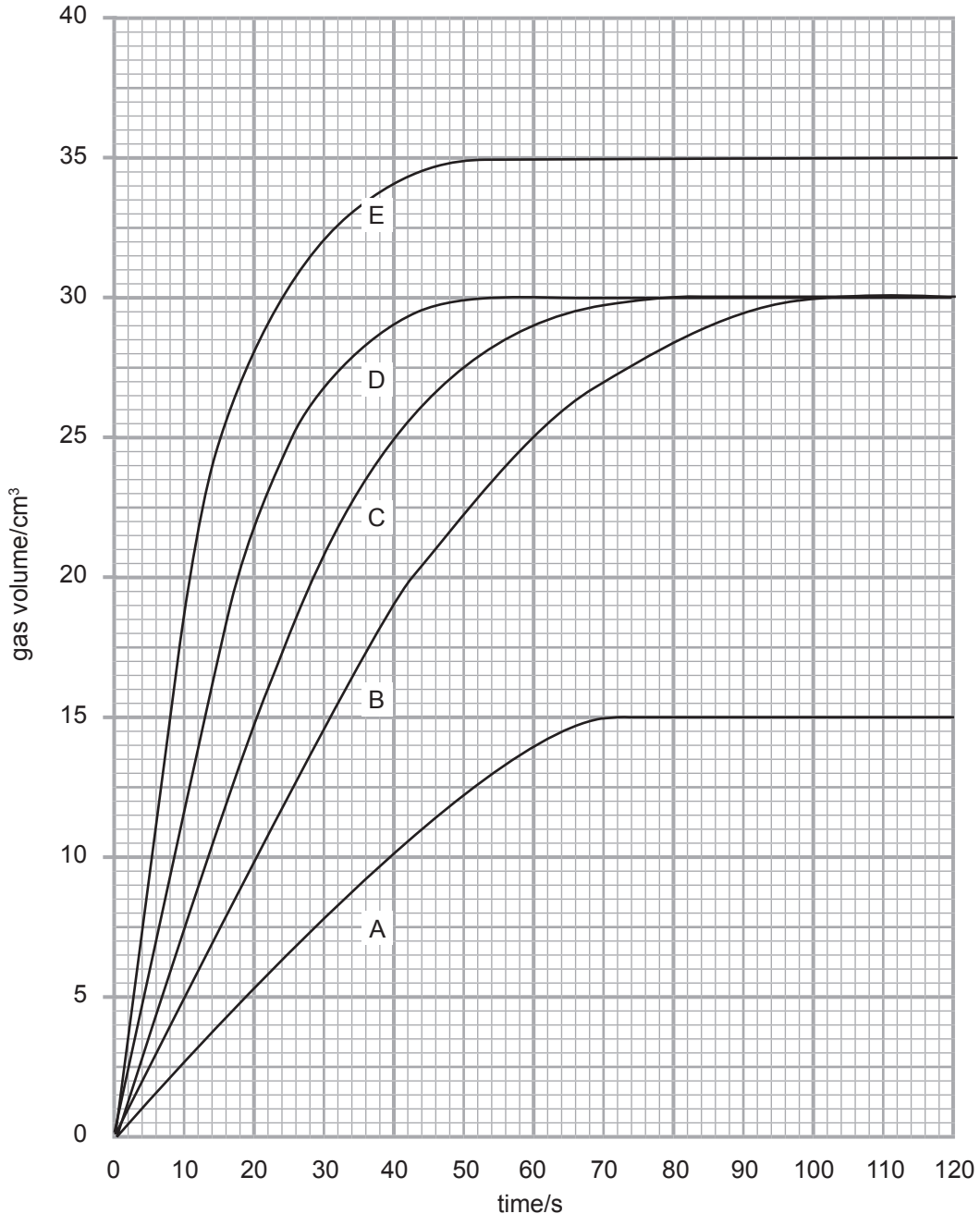
time taken _____ s [1]

(ii) Calculate the rate of this reaction.

rate = _____ s^{-1} [2]

[Turn over

(b) The experiment was repeated using different conditions and the results obtained plotted as lines A, B, D and E on the graph below. Line C shows the original experiment with 0.03 g of magnesium ribbon and **excess** dilute hydrochloric acid at room temperature.



(i) State and explain which line, A, B, D or E, was obtained when 0.03 g of magnesium ribbon were replaced by 0.03 g of magnesium powder.

Line: _____ [1]

Explanation: _____

_____

_____

_____ [2]

(ii) Which line, A, B, D or E, was obtained when 0.03 g of magnesium ribbon reacted with **excess** dilute hydrochloric acid at a temperature below room temperature?

Line: _____ [1]

(iii) State and explain which line, A, B, D or E, was obtained when 0.015 g of magnesium ribbon reacted with **excess** dilute hydrochloric acid at room temperature.

Line: _____ [1]

Explanation: _____

_____

_____

_____ [1]

[Turn over

(iv) State and explain, **in terms of particles**, the effect of increasing the concentration of hydrochloric acid on the rate of the reaction between hydrochloric acid and magnesium.

Effect: _____

_____ [1]

Explanation: _____

_____

_____

_____ [3]

(c) In an experiment to find a suitable catalyst for a reaction, the following results were obtained. All of the reactions were carried out under the same conditions.

Substance under test as a catalyst	Time for the reaction to be completed/s
cobalt chloride	15
cobalt nitrate	12
potassium nitrate	41
sodium chloride	56

(i) Which substance in the table is the best catalyst for this reaction? Explain your answer.

Substance: _____ [1]

Explanation: _____

_____

_____ [1]

(ii) A catalyst provides an alternative reaction pathway of lower activation energy. What is meant by the term activation energy?

_____

_____

_____ [1]

[Turn over

4 **(a)** Many gases, for example sulfur dioxide and nitrogen, can be used as refrigerants.

(i) Complete the table below about the properties of sulfur dioxide and nitrogen.

Property \ Gas	Sulfur dioxide	Nitrogen
Colour		
Acidic, basic or neutral		neutral

[3]

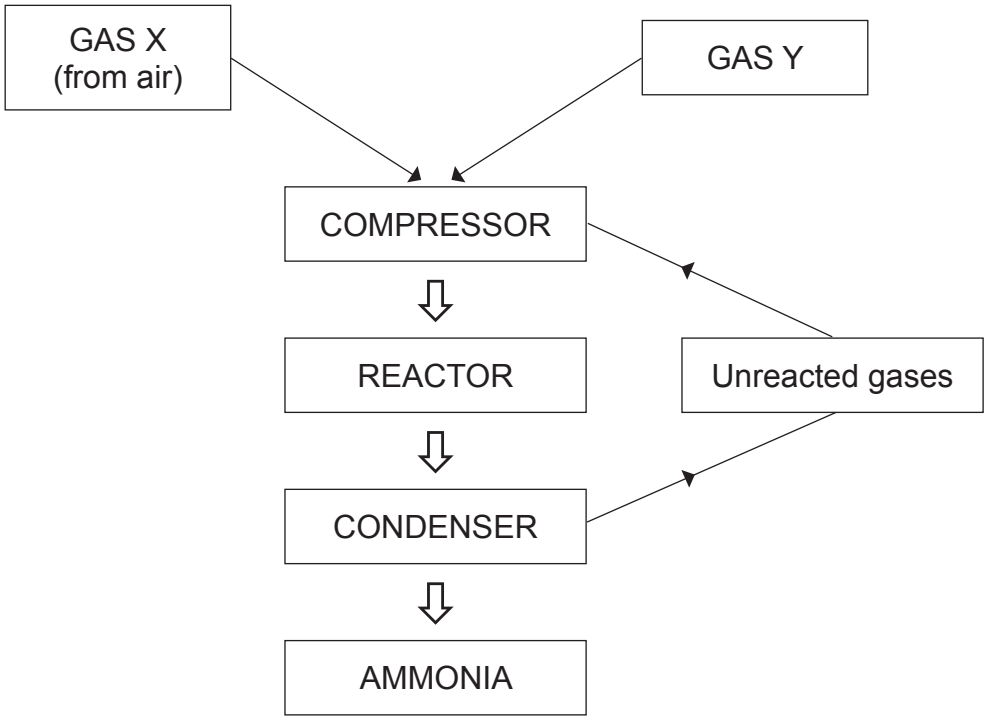
(ii) Nitrogen is used as a refrigerant in the food industry because it is unreactive. Explain why nitrogen is unreactive.

_____

_____

_____ [2]

(b) Ammonia gas is also used as a refrigerant. It is used to freeze water in ice rinks. Ammonia is produced in industry by the Haber process which is illustrated in the diagram below.



(i) Name the gas X used in the Haber process.

_____ [1]

(ii) Name the gas Y used in the Haber process.

_____ [1]

(iii) State the pressure to which the gases are compressed.

_____ [1]

(iv) Write a balanced symbol equation for the reaction which occurs in the reactor.

_____ [3]

[Turn over

(v) Name the catalyst used in the reactor.

_____ [1]

(vi) State the temperature used in the reactor.

_____ [1]

(vii) Explain what happens in the condenser.

_____

_____ [1]

(viii) Suggest why the unreacted gases are recycled.

_____ [1]

(c) Ammonia can be produced by the reaction of ammonium sulfate with sodium hydroxide.

Write a balanced symbol equation for this reaction.

_____ [3]

(d) Water containing dissolved iron(III) ions is unsuitable for use in an ice rink as the ice formed is coloured.

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Describe how you would experimentally prove that a sample of this water contained iron(III) ions.

_____

_____

_____

_____

_____

_____ [3]

[Turn over

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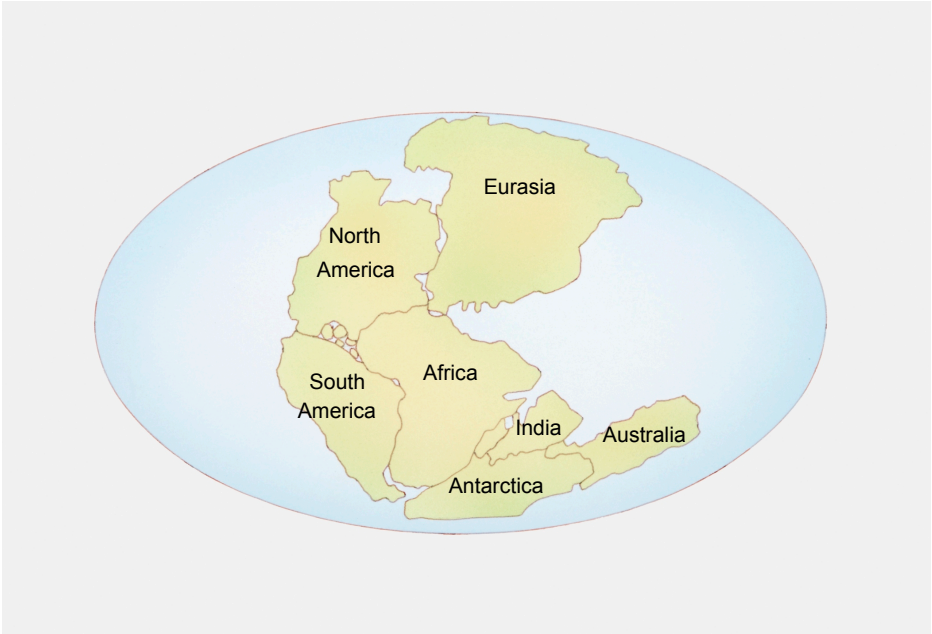
5 **(a)** In 1912 Alfred Wegener proposed the theory that the continents on the Earth could move and were once arranged as shown in the diagram below.



Scientists at the time did not accept Wegener's theory, but in the 1960s some new evidence based on the physical properties of iron helped to establish the theory.

(i) What name was given to Wegener's theory that the continents could move?

_____ [1]

(ii) Explain why other scientists at the time did not accept Wegener's theory.

_____

_____ [1]

[Turn over

(b) In the following three reactions, **A**, **B** and **C**, iron is oxidised.

Reaction A: iron + oxygen + water → hydrated iron(III) oxide

Reaction B: iron + copper(II) sulfate → iron(II) sulfate + copper

Reaction C: iron + hydrochloric acid → iron(II) chloride + hydrogen

(i) Write the chemical formula for iron(II) chloride.

_____ [1]

(ii) What is the common name for hydrated iron(III) oxide?

_____ [1]

(iii) Explain why iron is oxidised in **Reaction A**.

_____

_____

_____

_____ [2]

(iv) Describe how you would test for the presence of the hydrogen gas produced in **Reaction C**.

_____

_____ [2]

(v) Write a balanced symbol equation for **Reaction B**.

_____ [2]

(vi) **Reaction B** is described as a redox reaction. Explain, in terms of electrons, why Reaction **B** is described as a redox reaction.

Your answer should include half equations.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

[6]

[Turn over

6 Iron is below aluminium in the reactivity series. Iron is extracted from its ore in a Blast Furnace. Aluminium is extracted from its ore by electrolysis.

(a) Name the ore from which iron metal is extracted.

_____ [1]

(b) The extraction of iron in the blast furnace involves three main stages.

Stage 1: the production of the reducing agent

Stage 2: reduction of iron ore

Stage 3: removal of acidic impurities

(i) Describe in words the production of the reducing agent in **Stage 1**.

_____

_____

_____

_____

_____

_____

_____ [3]

(ii) Write a balanced symbol equation for the reduction of the iron ore in **Stage 2**.

_____ [3]

(iii) Describe how the acidic impurities are removed.

Your answer should include balanced symbol equations.

[6]

(c) Name the ore of aluminium from which it is extracted.

[1]

(d) What is meant by the term electrolysis?

[2]

(e) Write a half equation for the reaction which occurs at the cathode during the extraction of aluminium.

[3]

[Turn over

7 Vinegar contains ethanoic acid which is a weak organic acid.

(a) A student was asked to determine the concentration of ethanoic acid in a bottle of vinegar. The following procedure was used:

- 25.0 cm^3 of vinegar solution were measured out and placed in a clean, dry conical flask.
- A few drops of phenolphthalein indicator were added to the conical flask.
- A burette was filled with 0.2 mol/dm^3 sodium hydroxide solution.
- The sodium hydroxide solution was added to the conical flask until the indicator changed colour.

(i) Name a suitable piece of apparatus to accurately measure out 25.0 cm^3 of vinegar solution.

_____ [1]

(ii) Describe in detail how you would prepare and fill the burette for use in this titration.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

(iii) State the colour change observed at the end-point.

From _____ to _____ [2]

(b) 26.5 cm^3 of sodium hydroxide solution were required to completely react with the vinegar solution in the conical flask.

(i) Calculate the number of moles of sodium hydroxide used in the titration.

_____ [1]

The balanced symbol equation for the reaction is:

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

(ii) Calculate the number of moles of ethanoic acid present in 25.0 cm^3 of the vinegar solution.

_____ [1]

(iii) Calculate the concentration of the ethanoic acid solution in mol/dm^3.

_____ mol/dm^3 [1]

(iv) Calculate the concentration of the ethanoic acid solution in g/dm^3.

_____ g/dm^3 [2]

[Turn over

(c) A solution of ethanoic acid was prepared by dissolving 12 g of ethanoic acid in 50 cm^3 of deionized water. Calculate the concentration of ethanoic acid in mol/dm^3.

_____ mol/dm^3 [3]

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For Examiner's use only	
Question Number	**Marks**
1	
2	
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Total Marks	

Examiner Number