Accredited

OCR
Oxford Cambridge and RSA

GCSE (9–1) Chemistry A (Gateway Science)

J248/04 Paper 4 (Higher Tier)

Sample Question Paper

H

Date – Morning/Afternoon

Time allowed: 1 hour 45 minutes

You must have:
- the Data Sheet

You may use:
- a scientific or graphical calculator
- a ruler

First name	
Last name	
Centre number	
Candidate number	

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document consists of **32** pages. Any blank pages are indicated.

SECTION A

Answer **all** the questions.

You should spend a maximum of 30 minutes on this section.

1 Which statement is correct for a Group 1 element?

A It dissolves in water to form a bleach.

B It is a non-metal.

C It is an inert gas.

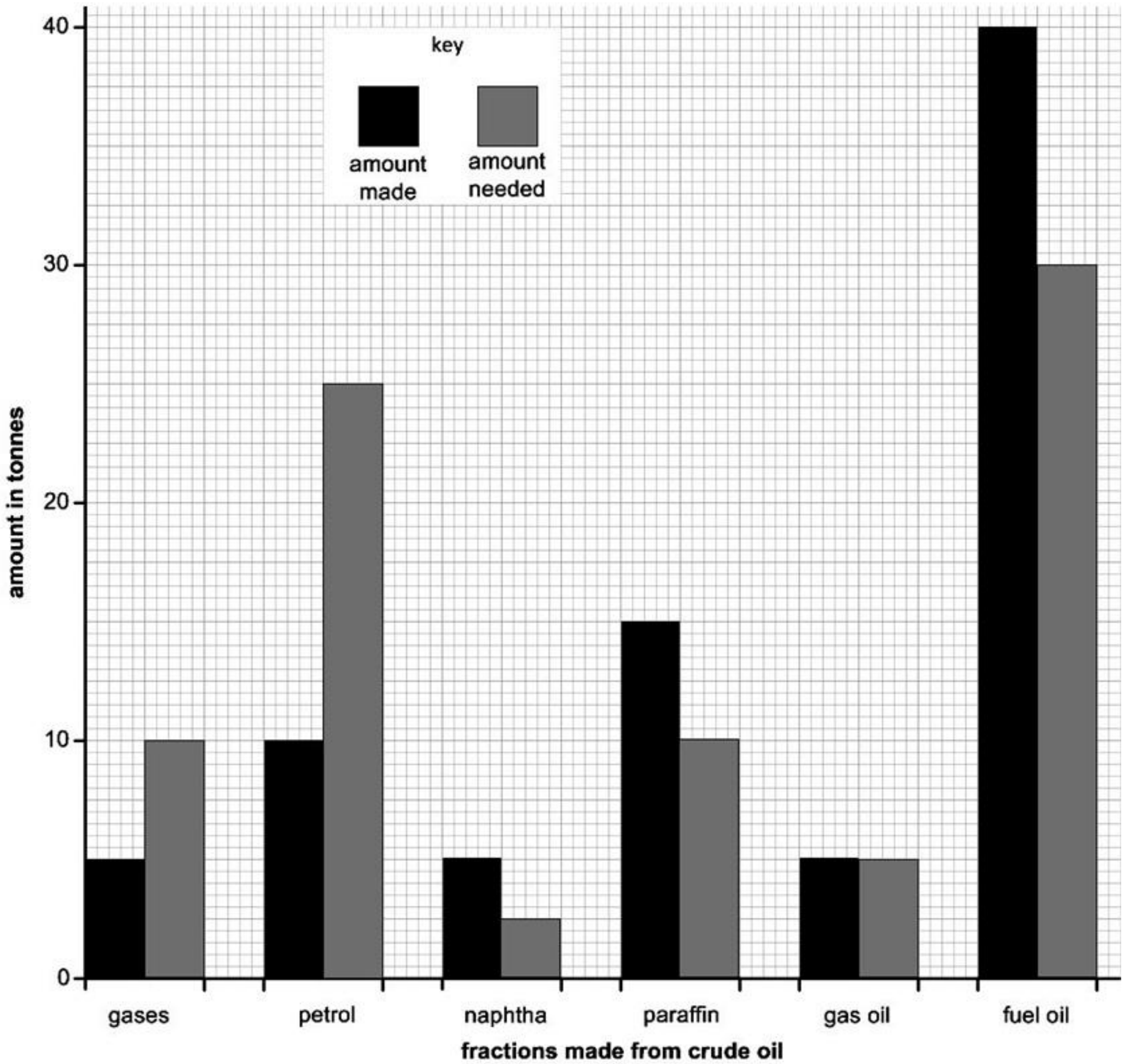
D It reacts with water to form hydrogen.

Your answer ☐

[1]

2 The bar chart shows the amount of some of the fractions made from 100 tonnes of crude oil by fractional distillation.

It also shows the amount of each fraction needed for everyday uses.



Cracking converts large molecules into smaller more useful molecules to make the supply match the demand.

Which fractions are most likely to be cracked to make the supply match the demand?

A gas oil and fuel oil

B gas oil and petrol

C naphtha, paraffin and fuel oil

D petrol and gases

Your answer ☐

[1]

3 Urea is a fertiliser.

The formula for urea is:

$$(NH_2)_2CO$$

A student makes 1 mole of urea from 2 moles of ammonia.

What is the mass of urea that the student makes?

A 43.0 g

B 44.0 g

C 58.0 g

D 60.0 g

Your answer ☐

[1]

4 A student is testing sodium carbonate solution.

She adds barium chloride solution followed by excess dilute hydrochloric acid.

Which of these observations would **not** be seen?

A colourless solution at the end

B gas bubbles when the dilute acid is added

C white precipitate formed when the dilute acid is added

D white precipitate formed when the barium chloride solution is added

Your answer ☐

[1]

5 A student is making a fertiliser called potassium nitrate, KNO_3.

Look at the equation for the reaction she uses.

$$KOH + HNO_3 \rightarrow KNO_3 + H_2O$$

The relative formula masses, M_r, of each compound are shown in the table.

Compound	**Formula**	**Relative formula mass**
potassium hydroxide	KOH	56.1
nitric acid	HNO_3	63.0
potassium nitrate	KNO_3	101.1
water	H_2O	18.0

What is the atom economy for the reaction to make potassium nitrate?

Assume that water is a waste product.

A 15.1%

B 47.1%

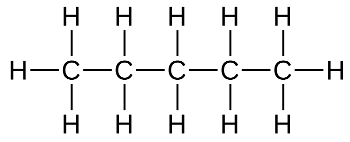
C 52.9%

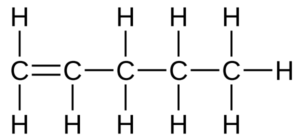
D 84.9%

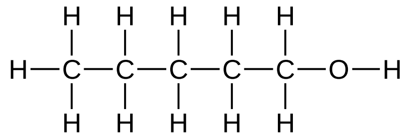
Your answer ☐

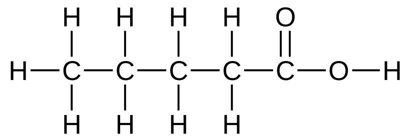
[1]

6 Which displayed formula includes the functional group of an alcohol?

A 

B 

C 

D 

Your answer ☐

[1]

7 Zinc nitrate thermally decomposes to give two gases.

$$2Zn(NO_3)_2(s) \rightarrow 2ZnO(s) + 4NO_2(g) + O_2(g)$$

A student heats 1.89 g of zinc nitrate until there is no further reaction.

What is the total volume of gas, measured at room temperature and pressure, made in this reaction?

Assume that one mole of gas occupies a volume of 24 dm^3 at room temperature and pressure.

The molar mass of zinc nitrate is 189 g/mol.

A 0.12 dm^3

B 0.48 dm^3

C 0.60 dm^3

D 1.20 dm^3

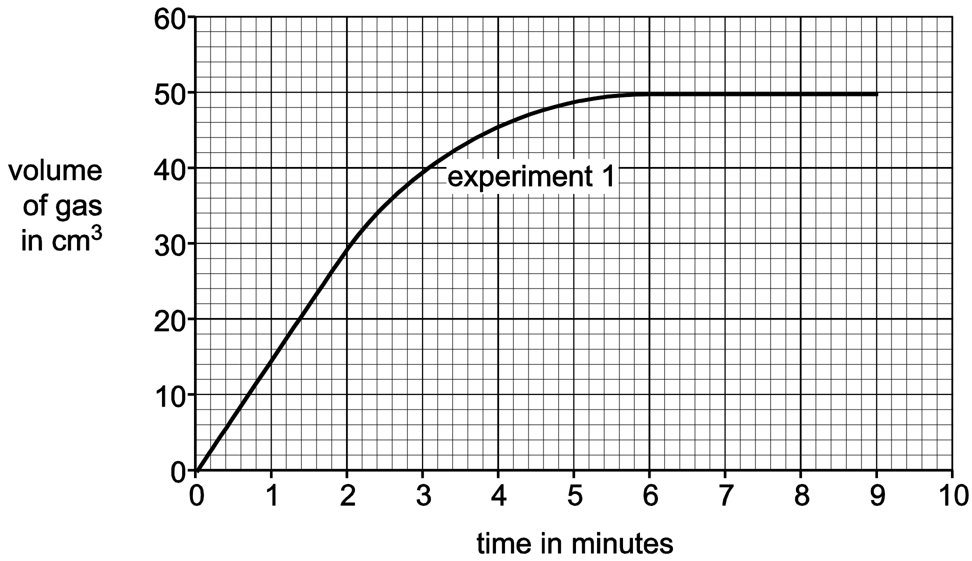
Your answer ☐

[1]

8 A student investigates the reaction between calcium carbonate and hydrochloric acid.

He measures the volume of gas made every minute.

Look at the graph. It shows his results for the experiment.



What is the rate of reaction between 0 and 2 minutes in cm^3/minute?

A 7.5 cm^3/min

B 15 cm^3/min

C 30 cm^3/min

D 60 cm^3/min

Your answer ☐

[1]

9 A student investigates the reaction between 1.0 g of calcium carbonate and 20 cm^3 of 1.0 mol/dm^3 hydrochloric acid at 25ºC.

The student does two experiments. He uses different sized pieces of calcium carbonate for each experiment.

The rate of reaction is greater in the first experiment.

Which is the best explanation for this?

A Small pieces of calcium carbonate have a larger surface area resulting in less frequent collisions.

B Large pieces of calcium carbonate have a larger surface area resulting in less frequent collisions.

C Large pieces of calcium carbonate have a smaller surface area resulting in more frequent collisions.

D Small pieces of calcium carbonate have a larger surface area resulting in more frequent collisions.

Your answer ☐

[1]

10 These statements explain how scientists think our modern-day atmosphere was formed.

1 Plants evolved and used carbon dioxide during photosynthesis to make oxygen.

2 As the Earth cooled down water fell as rain resulting in the formation of the oceans.

3 The atmosphere today consists of nitrogen, oxygen and a small amount of carbon dioxide.

4 Volcanoes gave out ammonia and carbon dioxide as well as methane and water vapour.

5 Ammonia was changed by bacteria in the soil into nitrogen gas.

What is the correct order that these events happened?

A 4, 2, 5, 1, 3

B 2, 4, 5, 3, 1

C 4, 1, 5, 2, 3

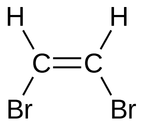
D 1, 4, 2, 5, 3

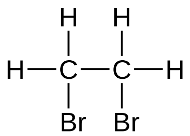
Your answer ☐

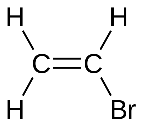
[1]

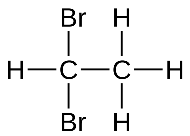
11 A student bubbles ethene gas into bromine water.

Which displayed formula shows the product of this reaction?

A 

B 

C 

D 

Your answer ☐

[1]

12 Which of the following procedures is the most suitable for preparing a 0.100 mol/dm^3 solution of sodium carbonate?

The relative formula mass, M_r, of sodium carbonate is 106.

A Dissolving 10.6 g of sodium carbonate in water to make 1.0 dm^3 of solution.

B Dissolving 10.6 g of sodium carbonate in 0.10 dm^3 of water.

C Dissolving 10.6 g of sodium carbonate in 1.0 dm^3 of water.

D Dissolving 106 g of sodium carbonate in water to make 1.0 dm^3 of solution.

Your answer ☐

[1]

13 A student reacts some metals with different salt solutions and records her results.

She places a tick (✓) in her results table if she sees a chemical change and a cross (x) if there is no reaction.

Some of the boxes are blanked out.

	Magnesium chloride	**Silver nitrate**	**Copper(II) sulfate**	**Iron(II) sulfate**
Magnesium		✓	✓	✓
Silver	x		x	x
Copper	x	✓		x
Iron	x	✓	✓	

Which metal has the **least** tendency to form a positive ion?

A copper

B iron

C magnesium

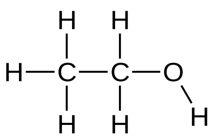
D silver

Your answer

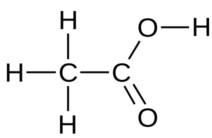
[1]

14 A student heats compound **X** with acidified potassium manganate(VII) solution.

The product of the reaction is compound **Y**.



X



Y

What is the colour change seen during this reaction?

A colourless to orange

B colourless to purple

C orange to colourless

D purple to colourless

Your answer

[1]

15 A condensation polymer is made from two monomers.

One of the monomers has two –OH groups in its molecules.

The other monomer has two –COOH groups in its molecule.

Which one of the following is the polymer?

A polyamide

B poly(chloroethene)

C polyester

D DNA

Your answer

[1]

SECTION B

Answer **all** the questions.

16 Zinc and dilute sulfuric acid react to make hydrogen.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

Inga measures the rate of this reaction by measuring the **loss in mass** of the reaction mixture.

She finds that the change in mass is very small and difficult to measure.

(a) Draw a labelled diagram to show a **better way** of measuring the rate of this reaction.

[3]

(b) The reaction between zinc and dilute sulfuric acid is slow.

Inga decides to try and find a catalyst for this reaction.

She tests four possible substances.

Each time she adds 0.5 g of the substance to 1.0 g of zinc and 25 cm^3 of dilute sulfuric acid.

Look at her table of results.

Substance	Colour of substance at start	Colour of substance at end	Relative rate of reaction
no substance			1
calcium sulfate powder	white	white	1
copper powder	pink	pink	10
copper(II) sulfate powder	blue	pink	30
manganese(IV) oxide powder	black	black	1

(i) It is important to do the reaction with **only** zinc and dilute sulfuric acid.

Explain why.

……………………………………………………………………………………………………

……………………………………………………………………………………………... **[1]**

(ii) It is important to do all of the reactions with the same concentration of acid.

Explain why.

……………………………………………………………………………………………………

……………………………………………………………………………………………... **[1]**

(iii) Which of the substances could be a catalyst for the reaction between zinc and dilute sulfuric acid?

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Explain your answer.

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……………………………………………………………………………………………... **[2]**

(iv) There is not enough evidence to confirm which substance is a catalyst.

Suggest an extra piece of experimental evidence that could be collected to confirm which substance is a catalyst.

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……………………………………………………………………………………………... **[1]**

(v) Inga does the experiment with copper, zinc and dilute sulfuric acid again.

This time she uses a lump of copper rather than copper powder.

Predict, with reasons, the relative rate of reaction.

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………………………………………………………………………………………………... **[2]**

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PLEASE TURN OVER FOR THE NEXT QUESTION

17 The Group 7 elements are known as the halogens.

The halogens have similar chemical properties.

Their physical properties vary with increasing atomic number.

(a) Look at the table of information about the halogens.

Halogen	Atomic symbol	Atomic number	Molecular formula	Atomic radius in pm	Reaction of halogen with sodium iodide solution
fluorine	F	9	F_2	64	Makes iodine and sodium fluoride
chlorine	Cl	17	Cl_2	99	Makes iodine and sodium chloride
bromine	Br	35	Br_2	114	………………………….... ………………………….. …………………………..
iodine	I	53	I_2	133	No reaction
astatine	At	85	…………..	……………....	No reaction

(i) Predict the molecular formula and atomic radius of astatine.

Put your answers in the table. **[2]**

(ii) Predict the reaction of bromine with sodium iodide solution.

Put your answer in the table. **[1]**

(iii) Explain your answer to **(ii)** in terms of the reactivity of the halogens.

……………………………………………………………………………………………………

…………………………………………………………………………………………….... **[1]**

(b) All halogens react with alkali metals to make a salt.

(i) All halogens have similar chemical reactions.

Explain why in terms of electronic structure.

....

.... **[1]**

(ii) Sodium reacts with bromine to make sodium bromide, NaBr.

Construct the **balanced symbol** equation for this reaction.

.... **[2]**

(iii) What is the formula of the product of the reaction between astatine and potassium?

.... **[1]**

18 Chemical tests are used to identify gases, anions and cations.

Leila has an unknown solution.

She thinks that the solution contains copper(II) ions and bromide ions.

Describe the chemical tests she does to confirm the presence of these two ions in the solution.

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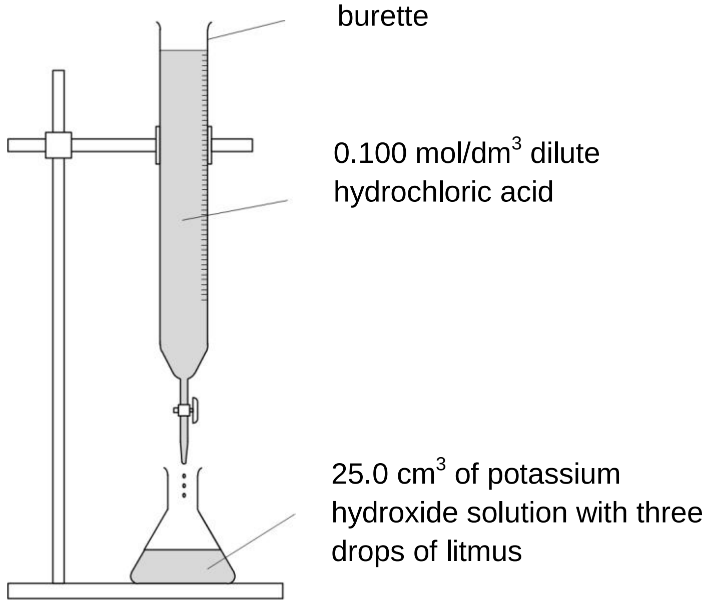
.... **[4]**

19 Sarah does three titrations with dilute hydrochloric acid and potassium hydroxide solution.

Hydrochloric acid neutralises the alkali potassium hydroxide.

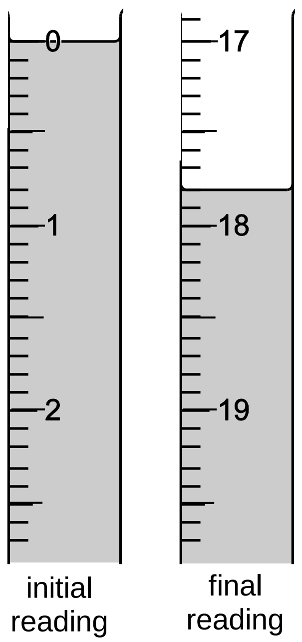
$$HCl(aq) + KOH(aq) \rightarrow KCl(aq) + H_2O(l)$$

Look at the apparatus she uses.



Look at the diagrams. They show parts of the burette during the first titration.

First titration



Here is Sarah's results table:

Titration number	1	2	3
final reading (cm^3)		37.5	32.1
initial reading (cm^3)		20.4	15.0
titre (volume of acid added) (cm^3)		17.1	17.1

(a) Use the diagrams and table to help you calculate the mean titre.

Explain your answer.

………

………

Mean titre = …………….. cm^3 **[2]**

(b) Sarah uses 25.0 cm^3 of potassium hydroxide solution, KOH.

She also uses hydrochloric acid with a concentration of 0.100 mol/dm^3.

Calculate the concentration, in mol/dm^3, of the KOH(aq).

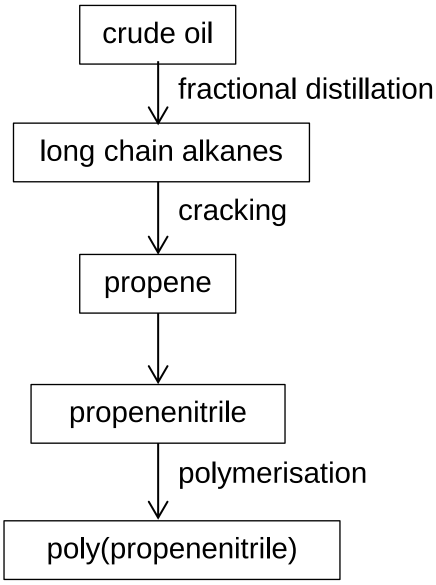
Concentration of KOH(aq) = ………………….. mol/dm^3 **[2]**

(c) Use your answer to **(b)** to calculate the concentration of the KOH(aq) in g/dm^3.

Concentration of KOH(aq) = ………………….. g/dm^3 **[2]**

20 Poly(propenenitrile) is an addition polymer.

Look at the flow chart. It shows how poly(propenenitrile) is made from crude oil.



(a) Crude oil is a complex mixture of hydrocarbons.

Fractional distillation separates this mixture.

Explain, in terms of intermolecular forces, fractional distillation.

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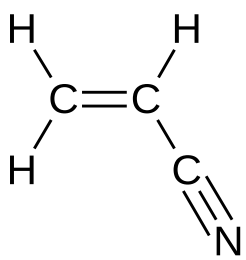
.... **[2]**

(b) Look at the displayed formula for propenenitrile.



Propenenitrile is an unsaturated compound.

How you can tell from the displayed formula?

....

.... **[1]**

21 The reversible reaction between carbon dioxide and hydrogen makes methane and water.

carbon dioxide + hydrogen ⇌ methane + water

(a) In a sealed container this reversible reaction forms a **dynamic equilibrium**.

What is meant by the term dynamic equilibrium?

Refer to both concentration and rate of reaction in your answer.

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.... **[2]**

(b) Kayvan investigates this reaction.

He predicts that 11.0 g of carbon dioxide should make 4.0 g of methane.

In an experiment, he finds that 11.0 g of carbon dioxide makes 2.2 g of methane.

Calculate the percentage yield of methane.

....

....

....

Percentage yield = ...% **[2]**

(c)* Kayvan investigates the effect of changing the pressure and changing the temperature on this reaction.

carbon dioxide + hydrogen ⇌ methane + water

$$CO_2(g) + 4H_2(g) \rightleftharpoons CH_4(g) + 2H_2O(l)$$

The table shows the percentage yield of methane in the equilibrium mixture under different conditions.

		Pressure in atmospheres			
		100	**200**	**300**	**400**
Temperature in °C	**300**	35%	52%	65%	80%
	600	30%	46%	58%	74%
	900	23%	37%	47%	62%
	1200	14%	25%	36%	48%

Kayvan predicts that the reaction between carbon dioxide and hydrogen is endothermic and involves a reduction in the volume of gases.

Describe and explain whether Kayvan's predictions are supported by the reaction and results in the table.

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.... **[6]**

22 Ammonium sulfate, $(NH_4)_2SO_4$, is a fertiliser.

Ammonium sulfate can be manufactured from ammonia and sulfuric acid.

(a) The Haber Process is used to manufacture ammonia. Scientists think that the Haber Process is one of the most important chemical reactions.

Explain the importance of the Haber Process in agriculture.

....

....

.... **[2]**

(b) The Contact Process is used to manufacture sulfuric acid.

The Contact Process involves the reaction between sulfur dioxide and oxygen.

The conditions used are 450°C and about 10 atmospheres pressure.

(i) If the temperature is increased to 500°C the rate of reaction changes.

Describe and explain this change in rate of reaction.

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....

.... **[2]**

(ii) If the pressure is reduced to 5 atmospheres the rate of reaction changes.

Describe and explain this change in rate of reaction.

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....

....

.... **[2]**

(c) Ammonium sulfate is a salt.

It is made using the reaction between the alkali ammonia and sulfuric acid.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

(i) Describe how a sample of solid ammonium sulfate is prepared in a laboratory.

Explain why this method is not suitable to be used industrially.

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……………………………………………………………………………………………….. **[4]**

(ii) Predict the maximum mass of ammonium sulfate that can be made from 51 tonnes of ammonia.

Maximum mass = ……………….. tonnes **[2]**

23 Carbon dioxide is one of several greenhouse gases.

It is made by the combustion of fossil fuels such as coal, gas and oil.

Look at the table. It shows the amount of carbon dioxide produced in a large city in the years 2010 and 2016.

Between the years 2010 and 2016 the percentage increase of atmospheric carbon dioxide has been about 2.5%. During the same time, the increase in mean global temperature has been only 0.05°C.

Source of carbon dioxide	**Carbon dioxide produced (tonnes)**		**Percentage increase (%)**
	in 2010	**in 2016**	
Homes	500 000	600 000	20
Factories and industry	500 000	750 000	50
Transport	1 000 000	1 000 000	0
Electricity generation	750 000	900 000	…………….

(a) Look at the row for electricity generation.

Calculate the percentage increase of carbon dioxide produced.

Percentage increase = ……………. % **[2]**

(b) Some scientists think there is a link between the amount of fossil fuels burnt and climate change.

The data in the table does **not** support this view.

Suggest reasons why.

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…………………………………………………………………………………………………….......... **[2]**

24 Kasia investigates the corrosion of different metals.

She places a small strip of each metal in different samples of air.

She leaves the metals for one week before collecting her results.

Look at her table of results.

Metal	**Original appearance of metal**	**Appearance of metal after one week in**			
		moist acidic air	**moist alkaline air**	**dry air**	**moist air**
aluminium	shiny silver	dull silver	dull silver	shiny silver	shiny silver
copper	shiny red-orange	dull red-orange	green red-orange	shiny red-orange	dull red-orange
iron	shiny silver	brown coating	brown coating	shiny silver	brown coating
magnesium	shiny silver	whitish coating	dull silver	shiny silver	dull silver
zinc	shiny silver	dark coating	dark coating	shiny silver	dull silver

(a) Suggest, with a reason, one change to the experimental procedure that would improve the quality of the results.

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.... **[1]**

(b) Explain the conclusions that can be made from Kasia's results.

....

....

....

.... **[3]**

25 Aluminium is extracted from its ore using electrolysis.

Copper is extracted from its ore by heating with carbon.

(a) Explain why different methods are used to extract aluminium and copper.

....

....

....

.... **[2]**

(b) Molten aluminium oxide contains Al^{3+} and O^{2-} ions.

The electrolysis of molten aluminium oxide makes aluminium and oxygen.

(i) Write the **balanced symbol** equation for the electrode reaction that happens at the cathode.

Use the symbol e^- to represent an electron.

.... **[1]**

(ii) Solid aluminium oxide cannot be electrolysed.

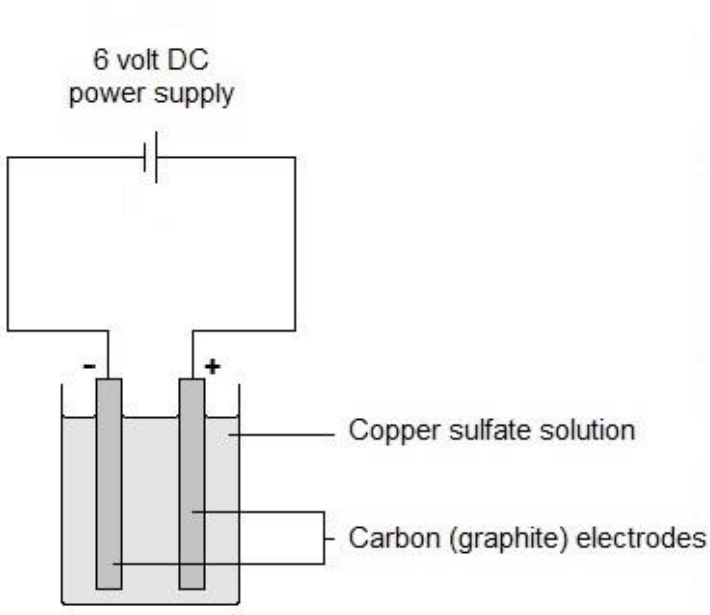
Explain why.

....

.... **[1]**

(c) Copper is also made by electrolysis of copper sulfate solution.

Look at the diagram of the apparatus used in this electrolysis.



Describe what you would **see** at each of the electrodes.

At the anode: ....

At the cathode: ....

[2]

26 Iron rusts when it gets wet.

(a) The word equation for rusting is

iron + water + oxygen → rust (hydrated iron(III) oxide)

Balance the symbol equation for the formation of rust.

$$\ldots\ldots Fe(s) + \ldots\ldots H_2O(l) + \ldots\ldots O_2(g) \rightarrow \ldots\ldots Fe_2O_3.3H_2O(s)$$ **[2]**

(b) A 1.0 kg iron bar is left outside in the rain.

All of the iron turns to rust.

The rust forms at a rate of 60 g per day.

Calculate how long it will take for the iron bar to turn completely to rust.

Give your answer to the nearest day.

…………………………….. days **[6]**

END OF QUESTION PAPER

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…day June 20XX – Morning/Afternoon

GCSE (9–1) Chemistry A (Gateway Science)
J248/04 Paper 4 (Higher Tier)

SAMPLE MARK SCHEME

Duration: 1 hour 45 minutes

MAXIMUM MARK 90

DRAFT

This document consists of 20 pages

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to scoris and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.

5. Work crossed out:
   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)
   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
   - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
   If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance.
Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer. Once the level is located, award the higher or lower mark:

The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.
The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

In summary:

The skills and science content determines the level.
The communication statement determines the mark within a level.

11. Annotations

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

12. **Subject-specific Marking Instructions**

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

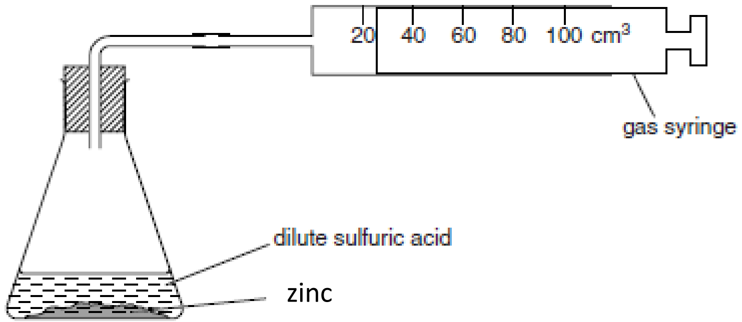
The breakdown of Assessment Objectives for GCSE (9–1) in Chemistry A:

	Assessment Objective
AO1	**Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.**
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	**Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.**
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	**Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.**
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

SECTION A

Question	Answer	Marks	AO element	Guidance
1	D	**1**	**1.1**	
2	C	**1**	**2.1**	
3	D	**1**	**2.1**	
4	C	**1**	**1.2**	
5	D	**1**	**2.1**	
6	C	**1**	**2.1**	
7	C	**1**	**2.1**	
8	B	**1**	**2.2**	
9	D	**1**	**1.2**	
10	A	**1**	**1.1**	
11	B	**1**	**1.1**	
12	A	**1**	**2.2**	
13	D	**1**	**1.2**	
14	D	**1**	**1.2**	
15	C	**1**	**1.1**	

SECTION B

Question			Answer	Marks	AO element	Guidance
16	(a)		Suitable container for the reactants e.g. flask, boiling tube or test tube (1) Use of a gas syringe / upturned burette with water in trough of water / upturned measuring cylinder with water in trough of water (1) The method actually works (1)	3	3.3b	
	(b)	(i)	To allow a comparison between with and without the added substance (1)	1	2.2	
		(ii)	Idea that the rate of reaction will change if concentration is changed (1)	1	2.2	It is a fair test is not sufficient **ALLOW** if concentration is increased the rate of reaction is increased **ALLOW** to ensure there are the same number of acid particles present / same number of acid particles per unit volume
		(iii)	Copper Because the reaction is faster (1) There is no change in appearance (1)	2	3.2b	**No** marks for copper on its own If substance other than copper given then 0 marks for the question
		(iv)	Measure mass of catalyst before and after (1)	1	3.3b	
		(v)	(Relative rate) between above 1 and below 10 because of smaller surface area / less exposed particles / less collisions (2)	2	2.2	**No** marks for the prediction on its own **No** marks for whole question if prediction incorrect

Question			Answer	Marks	AO element	Guidance
17	**(a)**	**(i)**	Molecular formula: At_2 (1) Atomic radius: 148 – 168 (1)	**2**	**2.1**	**DO NOT ALLOW** AT_2 / At2 **ALLOW** any range of numbers provided it is completely within the range given for the answer
		(ii)	Makes iod<u>ine</u> and sodium brom<u>ide</u> (1)	**1**	**2.1**	
		(iii)	Brom<u>ine</u> is more reactive than iod<u>ine</u> (1)	**1**	**2.1**	**ALLOW** ORA
	(b)	**(i)**	Same number of electrons in outer shell / all have 7 electrons in outer shell (1)	**1**	**1.1**	**ALLOW** outer electrons or valence electrons rather than electrons in the outer shell **ALLOW** valence shell rather than outer shell **DO NOT ALLOW** the wrong number of electrons in the outer shell
		(ii)	$2Na + Br_2 \rightarrow 2NaBr$ Correct formulae of reactants and products (1) Balancing – depend on correct formulae (1)	**2**	**2.1**	**ALLOW** any correct multiple of the equation including fractions **ALLOW** = or ⇌ instead of → **DO NOT ALLOW** and or & instead of + **ALLOW** one mark for correct balanced equation with minor errors of case and subscript e.g. 2NA + Br2 → 2NaBr
		(iii)	KAt (1)	**1**	**2.1**	

Question			Answer	Marks	AO element	Guidance
18			Copper(II) ions – add aqueous sodium hydroxide (1) Gives a blue precipitate (1) Bromide ion – add aqueous silver nitrate followed by dilute nitric acid (1) Gives a cream precipitate (1)	4	1.2	**ALLOW** any soluble metal hydroxide / aqueous ammonia **ALLOW** blue solid / blue solid that redissolves into dark blue solution if ammonia is used
19	(a)		Mean titre = 17.1 (1) Because titration 1 is a rough estimate / titration 1 is an outlier / titrations 2 and 3 are identical (1)	2	3.1b 3.2b	**IGNORE** anything in the titration table
	(b)		Moles of acid = 0.00171 (1) Concentration of KOH = 0.0684 (1)	2	2.1	**ALLOW ECF** from incorrect titre / 0.100 × titre × 10^{-3} **ALLOW ECF** from incorrect moles providing answer is to 3 sig figs / moles÷volume
	(c)		M_r of KOH = 56.1 (1) Concentration of KOH = 3.84 (1)	2	2.1	**ALLOW** correct answer without working **ALLOW** 3.837 **ALLOW ECF** from incorrect M_r and/or incorrect concentration from (b) / M_r × conc

Question			Answer	Marks	AO element	Guidance
20	**(a)**		Fractions have different boiling points (1) Idea that larger molecules have stronger intermolecular forces (1)	**2**	**1.1**	Answer must be **comparative** **ALLOW ORA**
	(b)		Has a carbon-carbon double bond (1)	**1**	**1.1**	**ALLOW** has C=C **ALLOW** answer indicated on the displayed formula Has a double bond is not sufficient

Question			Answer	Marks	AO element	Guidance
21	**(a)**		Rate of forward reaction equals the rate of the backward reaction (1) Concentration of reactants and products do not change (1)	**2**	**1.1**	**ALLOW** concentration of reactant and product do not change **DO NOT ALLOW** concentration of reactant and products are the same
	(b)		Percentage yield = (actual yield ÷ predicted yield) × 100 / (2.2 ÷ 4.0) × 100 (1) 55 (1)	**2**	**2.1**	**ALLOW** full marks for answer with no working out

Question			Answer	Marks	AO element	Guidance
	(c)*		*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** **Describes and explains the effect of changing the temperature and pressure on the position of equilibrium in both theoretical terms and from the table and explains that one prediction is supported and the other prediction is not** *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** **Describes and explains the effect of changing the temperature and pressure on the position of equilibrium in both theoretical terms and from the table** *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** **Describes the effect of changing the temperature and pressure on the position of equilibrium in theoretical terms or describes the effect of changing the temperature and pressure on the position of equilibrium from the table** *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** *No response or no response worthy of credit.*	6	2 x 1.1 2 x 3.1a 2 x 3.2b	**AO1.1: Knowledge of temperature and pressure on percentage yield** • As temperature increases the position of equilibrium shifts to the left in an exothermic reaction. • As pressure increases the position of equilibrium shifts to the side with the least number of moles of gas. • Decreasing the temperature of a system in dynamic equilibrium favours the exothermic reaction. **AO3.1a: Analyse information in the table to interpret equilibrium position** • As temperature increases the percentage yield decreases. • As temperature increases position of equilibrium moves to the left. • As the pressure increases the percentage yield increases. • As the pressure increases position of equilibrium moves to the right. **AO3.2a: Analyse information in the table/equation to make judgements/predictions** • The prediction is not supported since reaction must be exothermic rather than endothermic because position of equilibrium moves to the left as temperature increases. • The prediction is supported in terms of the moles of gas as pressure increases the position of equilibrium moves to the right. • The prediction is supported because as the pressure increases the percentage yield increases.

Question			Answer	Marks	AO element	Guidance
22	(a)		Endless supply of starting materials / no need to use solid raw materials to make fertilisers (1) Ammonia used to make fertilisers which increase crop yield (1)	2	1.1	**ALLOW** Haber Process used to convert atmospheric nitrogen into ammonia / Haber process involves the chemical fixation of ammonia (1)
	(b)	(i)	Rate increases More particles have energy above that of activation energy (1) More successful collisions (per second) (1)	2	1.1	**No** mark for rate increases but must be there to award two marks. Rate decreases give 0 marks for the question
		(ii)	Rate decreases Less particles per unit volume (1) Fewer collisions per second / decreased collision frequency (1)	2	1.1	**No** mark for rate decreases but must be there to award two marks. Rate increases give 0 marks for the question **ALLOW** less crowded particles **ALLOW** collisions less often

Question			Answer	Marks	AO element	Guidance
	(c)	**(i)**	Titrate ammonia against sulfuric acid to obtain volumes needed for complete neutralisation (1) Add these volumes without the use of indicator (1) Slow evaporation of reaction mixture / heat reaction mixture over a steam bath (1) Burette and other chemical apparatus not suitable for using large quantities / very difficult to use a steam bath in the large scale (1)	**4**	**1.2** **1.2** **1.2** **2.1**	**ALLOW** heat neutral mixture with carbon or charcoal and then filter off carbon **ALLOW** Slow evaporation of filtrate / heat filtrate over a steam bath if method involving carbon is used
		(ii)	34 (g or tonnes) of ammonia makes 132 (g or tonnes) of ammonium sulfate / 17 (g or tonnes) of ammonia makes 66 (g or tonnes) of ammonium sulfate (1) So 51 tonnes makes 198 tonnes of ammonium sulfate (1)	**2**	**2.1**	**ALLOW** one mark for correct calculation of M_r for ammonia **AND** ammonium sulfate **IGNORE** units for the first marking point **ALLOW** one mark for 2 moles of ammonia makes 1 mole of ammonium sulfate

Question			Answer	Marks	AO element	Guidance
23	**(a)**		(900 000 ÷ 750 000) × 100 (1) 20 (1)	**2**	**2.1**	
	(b)		**ANY TWO FROM** Idea that insufficient data since none of the data refers to climate change or global temperature (1) Idea that the data itself is limited since it is for one city and not a global figure (1) % increase of carbon dioxide in the air is much less than increase in carbon dioxide emissions (1) Idea that the significant % increase of carbon dioxide emitted has had very little effect on the mean global temperature (1)	**2**	**3.1a**	**No** mark for no on its own

Question			Answer	Marks	AO element	Guidance
24	(a)		Leave for a longer period of time so that the results are more differentiated / keep at the same temperature because rate of reaction changes with temperature (1)	1	3.3b	**IGNORE** references to same mass of metals **ALLOW** same surface area of metal strip because surface area affects rate of reaction
	(b)		**ANY THREE FROM** Water is needed for corrosion (of most metals) since no corrosion in dry air but there is corrosion in moist air (1) Most metals corrode faster in moist alkaline air since more corrosion than in moist air (1) Most metals corrode faster in moist acidic air since more corrosion than in moist air (1) The rate of corrosion is not related to the reactivity series with reference to either copper or aluminium (1)	3	3.2b	

Question			Answer	Marks	AO element	Guidance
25	(a)		Aluminium is above carbon in the reactivity series so cannot be obtained by reaction of oxide with carbon (1) Copper is below carbon in the reactivity series (1)	2	1.1	
	(b)	(i)	Al^{3+} + $3e^-$ → Al (1)	1	1.1	**ALLOW** any correct multiple **ALLOW** = instead of → **DO NOT ALLOW** & or and instead of +
		(ii)	Ions cannot move (1)	1	1.1	**IGNORE** electrons cannot move
	(c)		Anode: bubbles/effervescence (1) Cathode: Brown/salmon pink deposit/layer/coating (1)	2	1.2	Both correct descriptions but at wrong electrodes

Question			Answer	Marks	AO element	Guidance
26	(a)		…**4**…Fe(s) + …**6**…H_2O(l) +…**3**…O_2(g) → **…2…$Fe_2O_3.3H_2O$(s)**	**2**	**2.1**	
	(b)		Moles of iron = 1000.0 / 55.8 = 17.92 mol (1) Mole ratio (rust / iron) = 2/4 (1) Moles of rust = 17.92 x 2/4 = 8.96 mol (1) Mass of rust = 8.96 x 213.6 = 1914 g (1) Days to rust = 1914 / 60 days (1) = 32 days (1)	**6**	**5 x 2.1** **1.2**	% of iron in rust = ((2 x 55.8) / 213.6) x 100 = 52.25% For a 1.0 kg Fe bar, total mass of rust produced = (1.0 (kg) / 52.25%) x 100% = 1.914 kg = 1914 g