Candidate forename		Candidate surname	

Centre number						Candidate number				

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
GENERAL CERTIFICATE OF SECONDARY EDUCATION

A322/02

TWENTY FIRST CENTURY SCIENCE
CHEMISTRY A

Unit 2: Modules C4 C5 C6 (Higher Tier)

WEDNESDAY 19 JANUARY 2011: Morning
DURATION: 40 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the question paper.
A calculator may be used for this paper.

OCR SUPPLIED MATERIALS:

None

OTHER MATERIALS REQUIRED:

Pencil
Ruler (cm/mm)

READ INSTRUCTIONS OVERLEAF

DC (SM/CGW) 11MEP01077 39776/1

INSTRUCTIONS TO CANDIDATES

- **Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.**
- **Use black ink. Pencil may be used for graphs and diagrams only.**
- **Read each question carefully. Make sure you know what you have to do before starting your answer.**
- **Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).**
- **Answer ALL the questions.**

INFORMATION FOR CANDIDATES

- **The number of marks is given in brackets [ ] at the end of each question or part question.**
- **The total number of marks for this paper is 42.**
- **The Periodic Table is provided.**

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TURN OVER FOR QUESTION 1

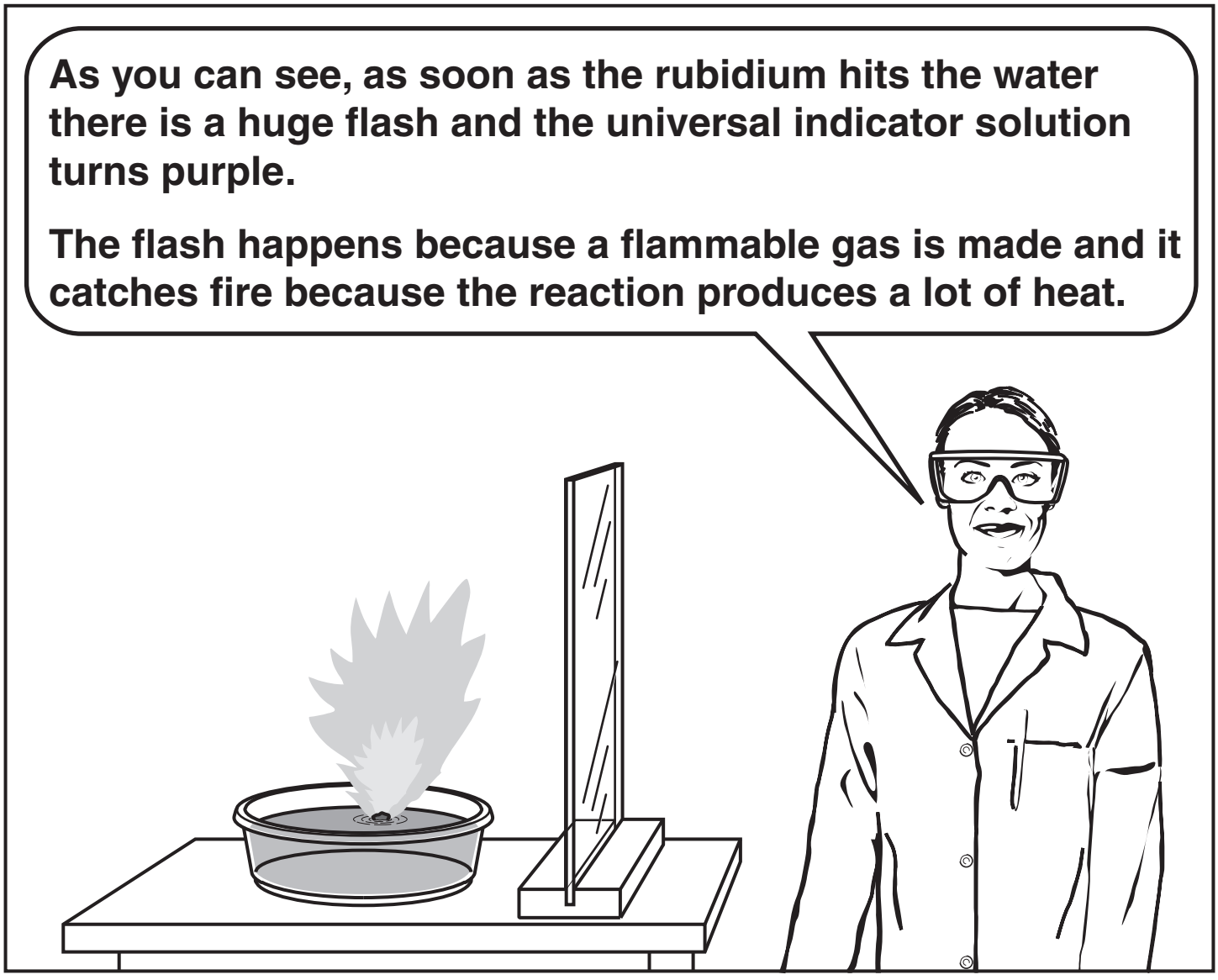
Answer ALL the questions.

1 Gemma makes science films for schools.

She is making a film about the reactions of Group 1 elements with water.

(a) She adds universal indicator solution to a bowl of water.

The film shows what happens when she drops a small piece of rubidium into the water.



(i) What is the name and formula of the gas that is made in the reaction?

name _____

formula _____

[2]

(ii) One of the chemicals made in the reaction causes the universal indicator solution to turn purple.

What is the name of this chemical?

Put a tick (✓) in the box next to the correct answer.

rubidium oxide ☐

sodium hydroxide ☐

rubidium hydride ☐

rubidium hydroxide ☐

[1]

(b) Gemma makes another film. This time she adds caesium to the water instead of rubidium.

When the caesium hits the water, there is an explosion and the glass bowl breaks.

Why is this reaction more violent than the reaction using rubidium?

Put ticks (✓) in the boxes next to the TWO correct answers.

The reaction takes in a larger amount of heat from the air.	☐
Elements further down the group are more reactive.	☐
The reaction releases more energy.	☐
Caesium loses more electrons than rubidium.	☐
A more reactive gas is made.	☐

[2]

(c) Gemma then adds a small piece of potassium to a bowl of water that contains universal indicator solution.

(i) Describe what she will see.

Your answer should include

- **how the reaction is similar to the reaction of the other Group 1 elements**
- **any differences between the reaction of potassium and the other Group 1 elements.**

_____

_____

_____

_____ **[3]**

(ii) Gemma used a safety screen when she was carrying out these experiments.

Explain why this was necessary.

_____

_____

_____ **[2]**

[Total: 10]

2 Scientists study the light given off by the Sun.

Light from the Sun can be split to show a spectrum.

Scientists use the lines on the spectrum to identify elements in the Sun.

(a) How do these lines help scientists identify elements?

Put ticks (✓) in the boxes next to the TWO correct statements.

The position of each line shows the amount of each element.	☐
Every line stands for a different element.	☐
Each element has a different pattern of lines.	☐
The lines can be compared to lines from known elements.	☐
The position of each line depends on the reactivity of the element.	☐

[2]

(b) One of the elements present in the Sun is lithium.

The Sun is so hot that lithium atoms (Li) form lithium ions (Li^+).

Which of the statements about lithium ions are true and which are false?

Put one tick (✓) in each row to show whether the statement is TRUE or FALSE.

	TRUE	FALSE
Lithium atoms gain a proton when they form lithium ions.		
Lithium ions have a greater mass than lithium atoms.		
Lithium ions have fewer electrons than lithium atoms.		
Lithium atoms lose neutrons when they form lithium ions.		

[2]

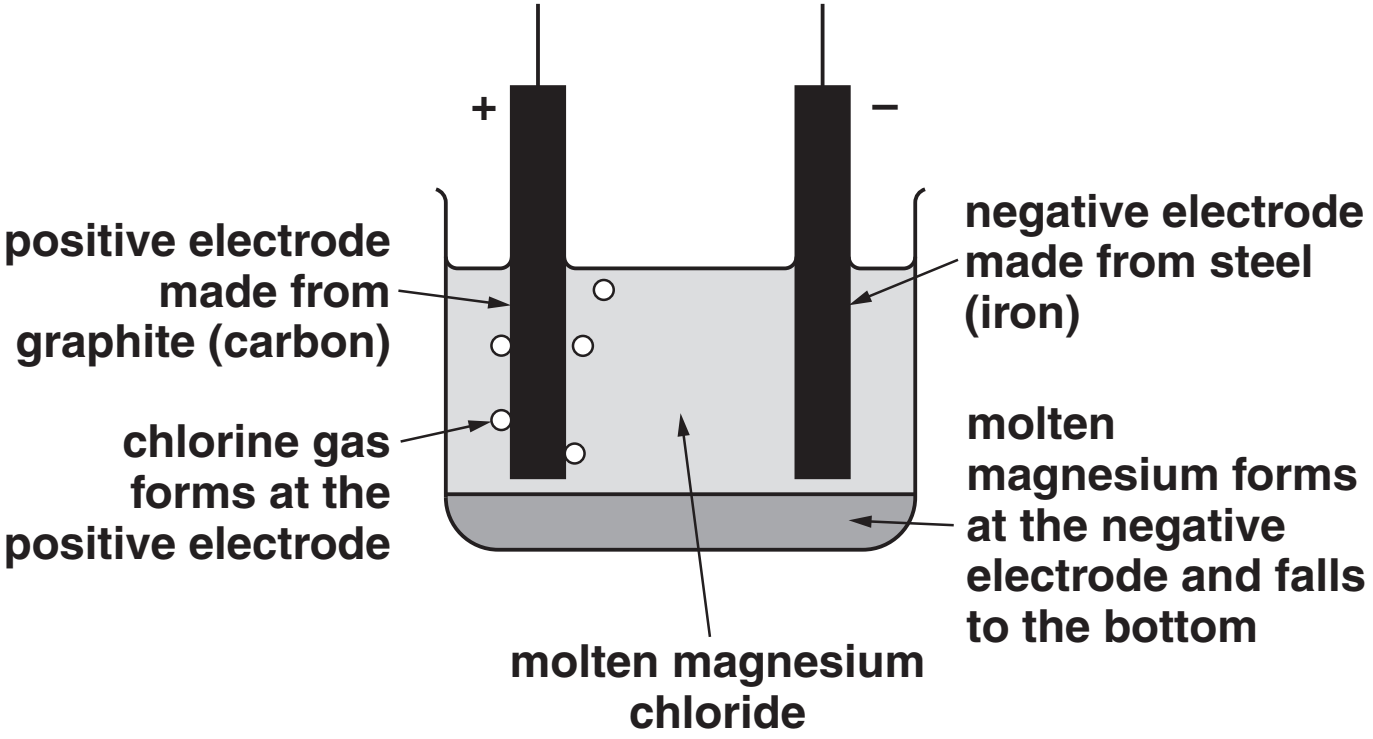
[Total: 4]

3 Read this information about the extraction of magnesium metal.

Magnesium metal is used to make alloys for aircraft.

It is extracted from molten magnesium chloride at 700 °C by electrolysis.

The diagram shows the key features of this process.



(a) During electrolysis at 700 °C, molten magnesium chloride forms molten magnesium and chlorine gas.

Complete the equation for this process, including state symbols.

$MgCl_2$ (_____) → Mg (_____) + _____ (_____)

[2]

(b) Which of the statements about the process are true?

Put ticks (✓) in the boxes next to the TWO correct statements.

The magnesium ions gain electrons.	☐
Pairs of magnesium atoms join to make magnesium molecules.	☐
The magnesium ions give electrons to the electrode.	☐
Two elements react to make a compound.	☐
A non-metal is made.	☐

[2]

(c) The relative formula mass of magnesium chloride ($MgCl_2$) is 95.

relative atomic mass of chlorine, Cl	**= 35.5**
relative atomic mass of magnesium, Mg	**= 24**

(i) What mass of chlorine could be extracted from 190 g of magnesium chloride?

Put a (ring) around the correct answer.

2 g 17 g 35.5 g 71 g 142 g 190 g

[1]

(ii) What mass of magnesium could be extracted from 47.5 tonnes of magnesium chloride?

Put a (ring) around the correct answer.

1 tonne

6 tonnes

12 tonnes

23.75 tonnes

24 tonnes

[1]

(d) During electrolysis, the molten magnesium chloride and the steel electrode both conduct electricity.

(i) Molten magnesium chloride conducts electricity because it is an ionic compound.

Explain how an ionic compound conducts electricity.

_____

_____ **[2]**

(ii) Steel conducts electricity because it contains mainly iron, which is a metal.

Explain how a metal conducts electricity.

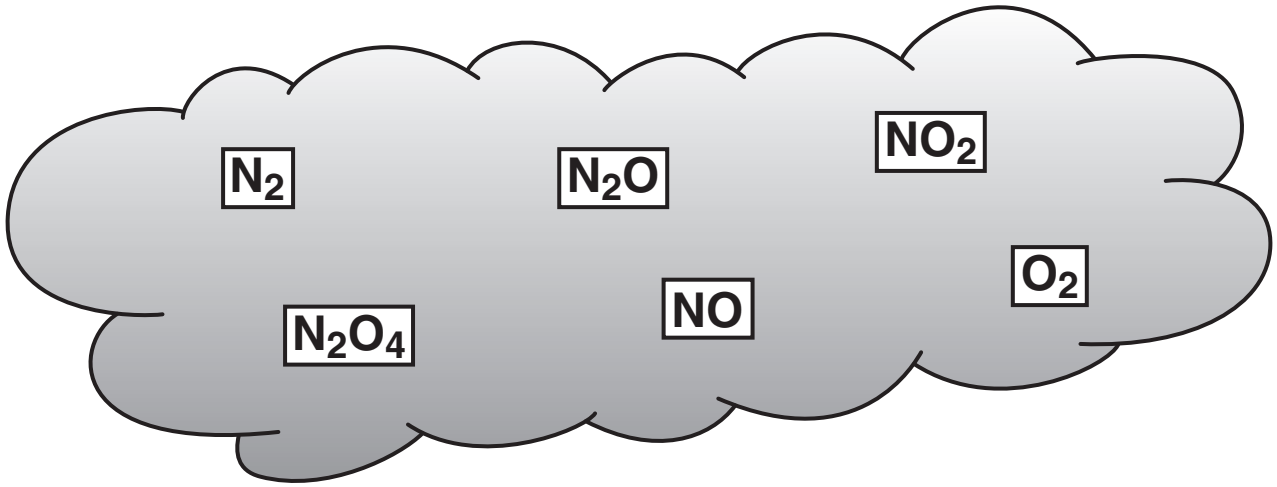
_____

_____ **[2]**

[Total: 10]

4 Some gases in air contain nitrogen and oxygen atoms.

The formulae of these gases are shown in the boxes.



(a) Which of the statements about these gases are true and which are false?

Put one tick (✓) in each row to show whether the statement is TRUE or FALSE.

	TRUE	FALSE
Some of these gases have a giant structure.		
Molecules of these gases contain covalent bonds.		
These gases conduct electricity.		
These gases only contain atoms of non-metallic elements.		

[2]

(b) Put a (ring) around the correct word to complete each of the following sentences.

The melting points of these gases are

ABOVE / BELOW room temperature.

Their boiling points are ABOVE / BELOW

room temperature.

Gases in the air have MOLECULAR / IONIC

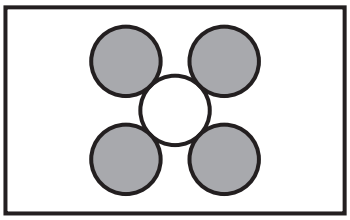
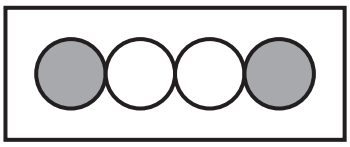
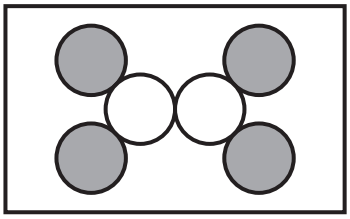
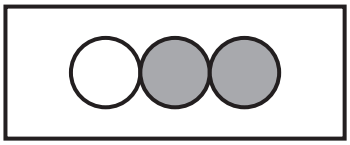
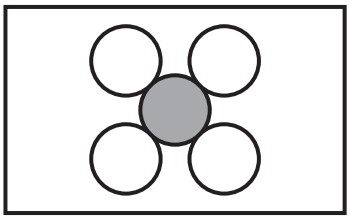
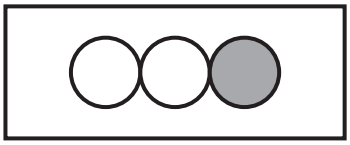
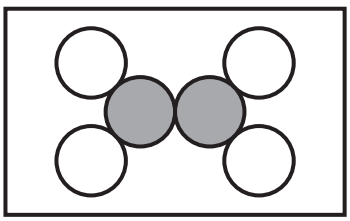
structures.

They have STRONG / WEAK forces

between their molecules. [2]

(c) Look at this diagram of a molecule of NO_2.

Draw straight lines to join each FORMULA to the correct DIAGRAM. [2]

FORMULA	DIAGRAM
	
	
N_2O_4	
	
N_2O	
	
	

[Total: 6]

5 Joe carries out an investigation to find the acid content of vinegar.

He takes samples of vinegar from different places.

Some of the samples contain a brown food colouring.

(a) Joe uses a pH probe to measure the pH of each vinegar.

Why is a pH probe the BEST way of measuring the pH of these vinegar samples?

Put a tick (✓) in the box next to the correct answer.

Using a pH probe is the only method that gives numbered pH values. ☐

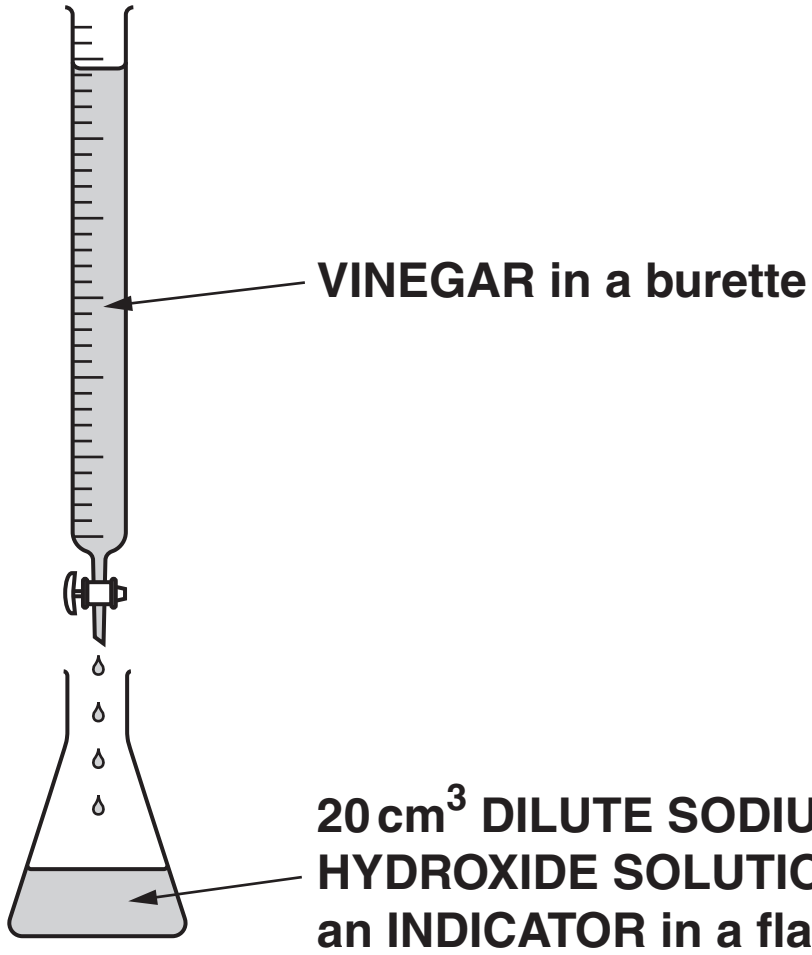
pH probes are always more accurate than other methods. ☐

pH probes do not rely on colour to measure pH. ☐

Food acids do not give results with other indicators. ☐

[1]

(b) Joe sets up a titration experiment to find the concentration of acid in a colourless sample of vinegar.



Joe does the titration. He records the volume of vinegar needed to neutralise the dilute sodium hydroxide solution.

Explain what Joe should do to make sure that his titration result is as ACCURATE as possible.

_____

_____

_____

_____

_____ **[3]**

(c) Joe uses the same dilute sodium hydroxide solution and the same titration method to test four different vinegars.

The acid in vinegar is ethanoic acid, CH_3COOH.

Joe calculates the concentration of ethanoic acid in each vinegar.

The first step in Joe's calculation is to work out the relative formula masses of sodium hydroxide and ethanoic acid.

(i) What is the relative formula mass of sodium hydroxide (NaOH)?

Use the Periodic Table to find the relative atomic masses you need to use in your calculation.

Put a (ring) around the correct answer.

3 23 31 39 40

[1]

(ii) What is the relative formula mass of ethanoic acid, CH_3COOH?

Use the Periodic Table to find the relative atomic masses you need to use in your calculation.

answer = _____ [1]

(d) Joe writes down his titration results.

	CHIP SHOP VINEGAR	SUPER-MARKET VINEGAR	CAFE VINEGAR	CANTEEN VINEGAR
volume of vinegar that reacts with 20 cm^3 dilute sodium hydroxide solution	15 cm^3	21 cm^3	19 cm^3	25 cm^3

What other information does Joe need to work out the concentration of the acid in the vinegar?

Put ticks (✓) in the boxes next to the TWO correct answers.

- **an equation for the reaction** ☐
- **the cost of each bottle of vinegar** ☐
- **the concentration of alkali used** ☐
- **the temperature of the room** ☐
- **the rate of the reaction** ☐

[1]

(e) Joe calculates that exactly 1.0 g of ethanoic acid reacts with 20 cm^3 dilute sodium hydroxide.

He then calculates the concentration of ethanoic acid in each vinegar.

The table shows the results of the titration and some of Joe's calculations.

	CHIP SHOP VINEGAR	SUPER-MARKET VINEGAR	CAFE VINEGAR	CANTEEN VINEGAR
volume of vinegar that reacts with 20 cm^3 dilute sodium hydroxide solution	15 cm^3	21 cm^3	19 cm^3	25 cm^3
concentration of ethanoic acid in vinegar sample	$\frac{1.0}{15} \times 1000$ = 67 g/dm^3	$\frac{1.0}{21} \times 1000$ = 48 g/dm^3	$\frac{1.0}{19} \times 1000$ = 35 g/dm^3	$\frac{1.0}{25} \times 1000$ = 40 g/dm^3

(i) Joe has made a mistake in one of his calculations.

For which vinegar is his calculation INCORRECT?

Put a (ring) around the answer.

CHIP SHOP VINEGAR	SUPER-MARKET VINEGAR	CAFE VINEGAR	CANTEEN VINEGAR

[1]

(ii) Joe does another titration using vinegar from a jar of pickled onions.

His titration value for the pickled onions vinegar is 20 cm^3.

What is the concentration of ethanoic acid in this vinegar?

Put a (ring) around the correct answer.

$0.02\,g/dm^3$

$0.05\,g/dm^3$

$2\,g/dm^3$

$46\,g/dm^3$

$50\,g/dm^3$

[1]

[Total: 9]

6 Old copper coins are often covered with a layer of corrosion.

The corrosion contains copper carbonate.

Sulfuric acid can be used to clean the coin.

(a) Sulfuric acid reacts with copper carbonate to form a salt and two other products.

(i) What is the NAME of the salt that is formed when sulfuric acid reacts with copper carbonate?

_____ **[1]**

(ii) What are the formulae of the two OTHER products of the reaction?

Put a (ring) around each of the TWO correct answers.

CO_2 H_2O H_2SO_4 NaOH O_2

[1]

(b) Eve uses sulfuric acid to remove copper carbonate from old coins.

The rate of reaction increases when she increases the concentration of the acid.

Why does a more concentrated acid react faster?

Put a tick (✓) in the box next to the statement that correctly explains why.

The particles move faster in more concentrated acid.	☐
Particles collide less often in more dilute solution.	☐
The acid particles are closer together in more concentrated acid.	☐
Particles need more space to carry out successful reactions.	☐

[1]

[Total: 3]

END OF QUESTION PAPER

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The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.