

Instructions

- ## Information

- ## Advice

- Turn over ►

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Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

- 1 A student investigates the reaction that occurs when zinc carbonate is heated.

Figure 1 shows the apparatus the student uses.

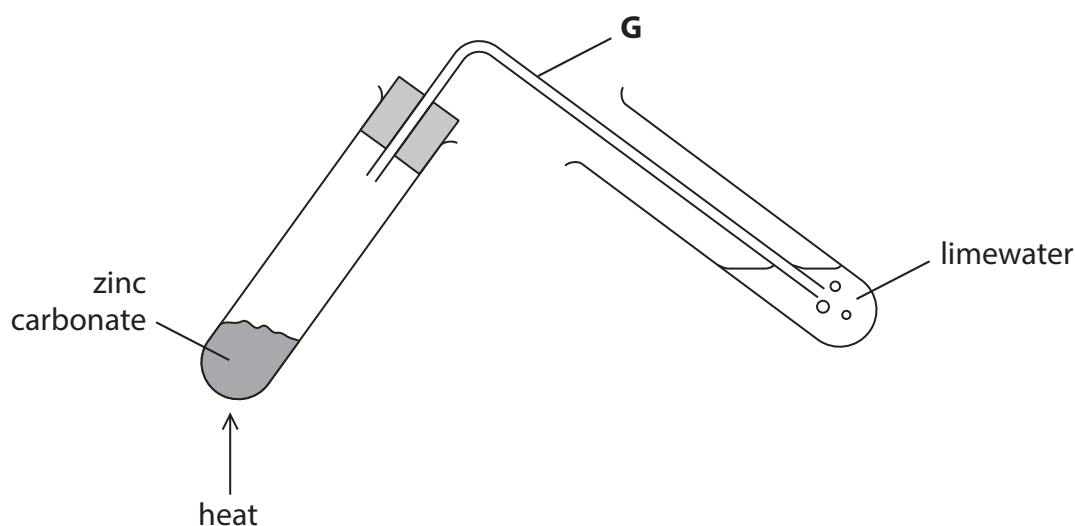


Figure 1

- (a) What is the name of the piece of apparatus labelled **G** in Figure 1?

(1)

- ☐ **A** testing tube
☐ **B** heating tube
☐ **C** delivery tube
☐ **D** boiling tube

- (b) State what apparatus should be used to heat the zinc carbonate in Figure 1.

(1)

.....



(c) The word equation for the reaction that occurs when zinc carbonate is heated is



The carbon dioxide bubbles through the limewater.

State what is seen when carbon dioxide bubbles through the limewater.

(1)

(d) Another student investigates the change in mass that takes place when zinc carbonate is heated.

(i) Figure 2 shows the results the student records at the start of the investigation.

mass of empty test tube	14.62 g
mass of test tube + zinc carbonate	17.83 g

Figure 2

Using the results in Figure 2, calculate the mass of zinc carbonate in the test tube.

(1)

mass of zinc carbonate = g

(ii) The student then

- heats the test tube containing the zinc carbonate for five minutes
- places the hot test tube on a bench mat to cool
- finds the mass of the test tube and contents.

Describe what the student should do next to make sure that all the zinc carbonate has reacted completely.

(2)

(Total for Question 1 = 6 marks)



2 Chemical cells and fuel cells produce a voltage.

- (a) A student sets up a chemical cell by placing two different metal electrodes, magnesium and iron, into a salt solution.

Figure 3 shows an incomplete diagram of the chemical cell used by the student.

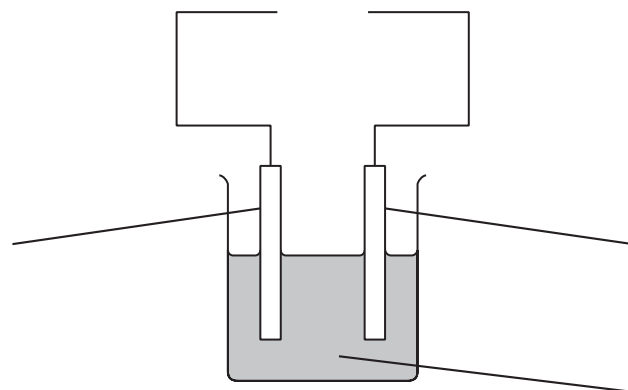


Figure 3

- (i) Complete Figure 3 by adding a suitable piece of apparatus to show that a voltage is produced.

(1)

- (ii) Use words from the box to complete labelling of Figure 3.

electrolyte	magnesium	salt solution
carbon rod	distilled water	iron

(2)

- (iii) Describe what happens to the cell's voltage over a long period of time.

(2)

.....

.....

.....

.....

- (b) One type of fuel cell is the hydrogen-oxygen fuel cell.

Hydrogen-oxygen fuel cells produce water only.

Write the word equation for the reaction.

(2)

..... + →

(Total for Question 2 = 7 marks)



3 (a) Figure 4 shows the changes of state between ice, water and steam.

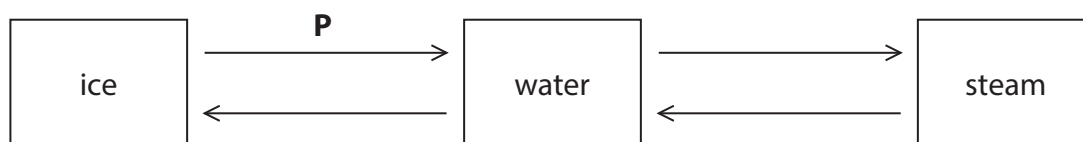


Figure 4

(i) What is the name of the change of state labelled **P** in Figure 4?

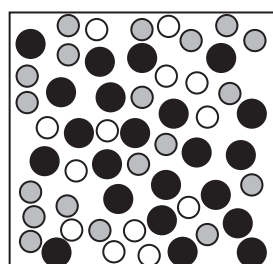
(1)

- ☐ **A** evaporating
- ☐ **B** freezing
- ☐ **C** melting
- ☐ **D** subliming

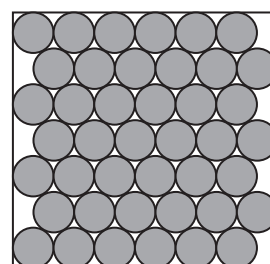
(ii) Which of the following shows the arrangement of particles in ice?

(1)

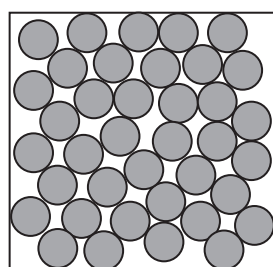
☐ **A**



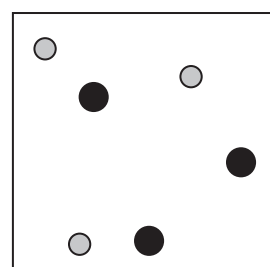
☐ **B**



☐ **C**



☐ **D**



- (b) Figure 5 shows the apparatus that can be used to separate a mixture of ethanol and water by fractional distillation.

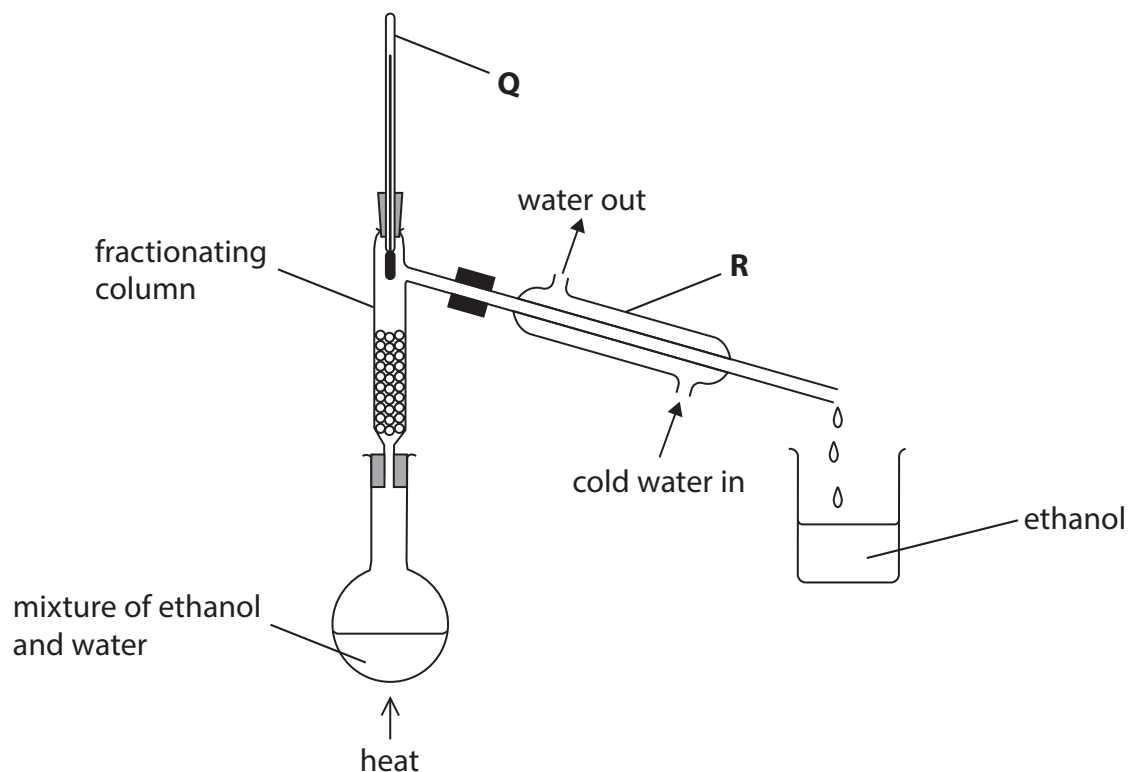


Figure 5

- (i) Name the piece of apparatus labelled **R** in Figure 5.

(1)

- (ii) Explain the purpose of the piece of apparatus labelled **Q** in Figure 5.

(2)



- (c) A student investigates the food dyes used to make the colours **W**, **X**, **Y** and **Z** in four different sweets.

Figure 6 shows the chromatogram produced.

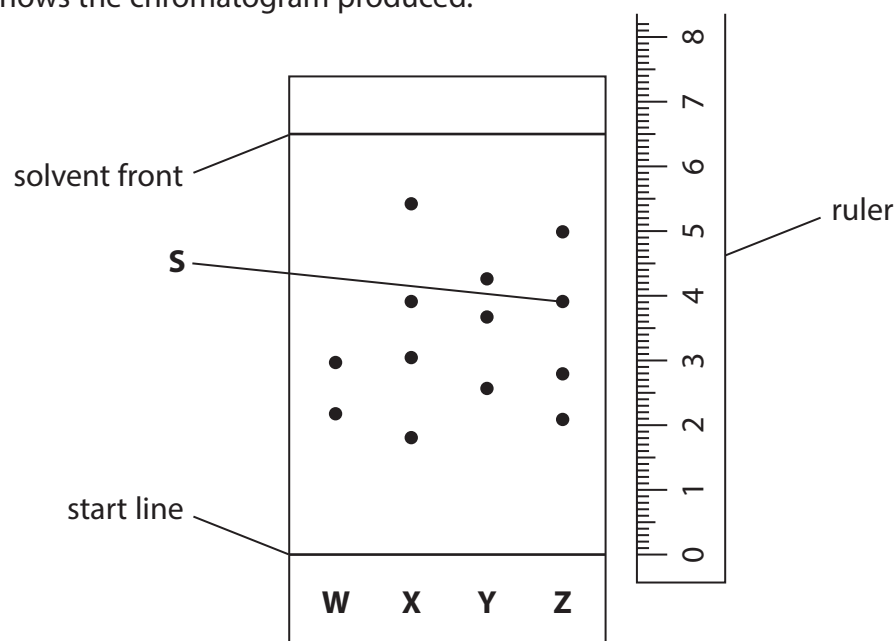


Figure 6

The solvent front shows how far the solvent moves during the investigation.

- (i) Using the information in Figure 6, state which colour is made of only two food dyes.

(1)

- (ii) The R_f value of a spot on the chromatogram can be calculated using the equation

$$R_f = \frac{\text{distance moved by the food dye}}{\text{distance moved by solvent front}}$$

Using the information in Figure 6, calculate the R_f value of the food dye labelled **S**.

Give your answer to 2 decimal places.

(3)

R_f value of food dye **S** =

(Total for Question 3 = 9 marks)



P 7 5 5 0 6 R R A 0 7 3 2

4 This question is about metals and their reactions with acids.

(a) Place ticks (✓) in boxes to show which elements in the table are metals.

Use the periodic table to help you answer this question.

(2)

element	(✓)
phosphorus, P	
rubidium, Rb	
rhodium, Rh	
strontium, Sr	
tellurium, Te	

(b) Three equal sized pieces of the metals **E**, **F**, **G** and **H** are put into separate test tubes containing equal volumes of dilute sulfuric acid.

The results in Figure 7 show the test tubes after half a minute.

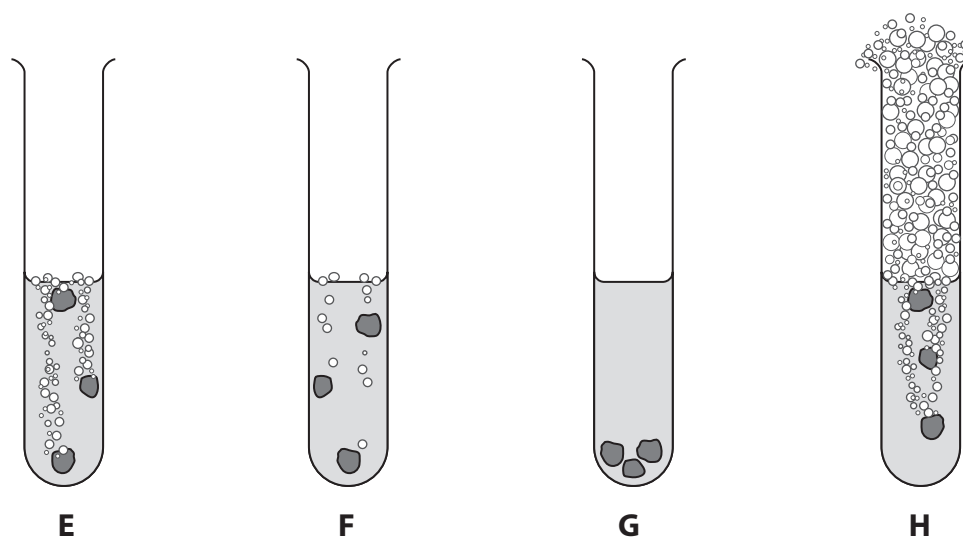


Figure 7



- (i) Arrange the metals **E, F, G** and **H** in order of reactivity.

(2)

metal	
	most reactive
	least reactive

- (ii) The bubbles that form are hydrogen.

Which row of the table shows the test and result that confirm the gas is hydrogen?

(1)

	test	result
☐ A	put a glowing splint into the gas	the splint relights
☐ B	put a lighted splint into the gas	the gas ignites with a squeaky pop
☐ C	test the gas with damp litmus paper	the litmus paper turns pink
☐ D	test the gas with damp litmus paper	the litmus paper turns white

- (c) When zinc reacts with very dilute nitric acid, zinc nitrate is formed.

- (i) The formula of zinc nitrate is $\text{Zn}(\text{NO}_3)_2$

Calculate the relative formula mass of zinc nitrate, $\text{Zn}(\text{NO}_3)_2$

(relative atomic masses: $\text{Zn} = 65$, $\text{N} = 14$, $\text{O} = 16$)

(2)

.....

.....

.....

relative formula mass =



- (ii) A student investigates the reaction between a metal and a dilute acid using the apparatus shown in Figure 8.

Cotton wool is placed in the top of the apparatus as shown, to stop any acid from spraying out.

The total mass of the apparatus is shown at the start of the reaction and after the reaction has ended.

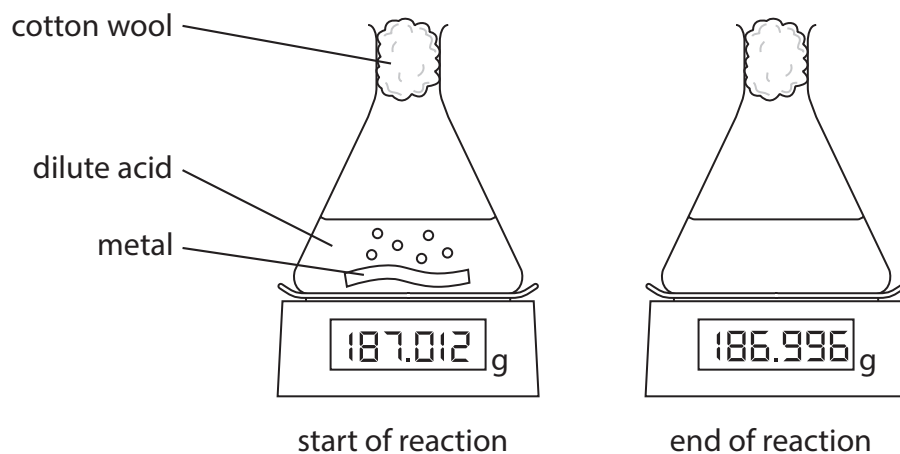


Figure 8

State **two** ways the student would know that the reaction has ended.

(2)

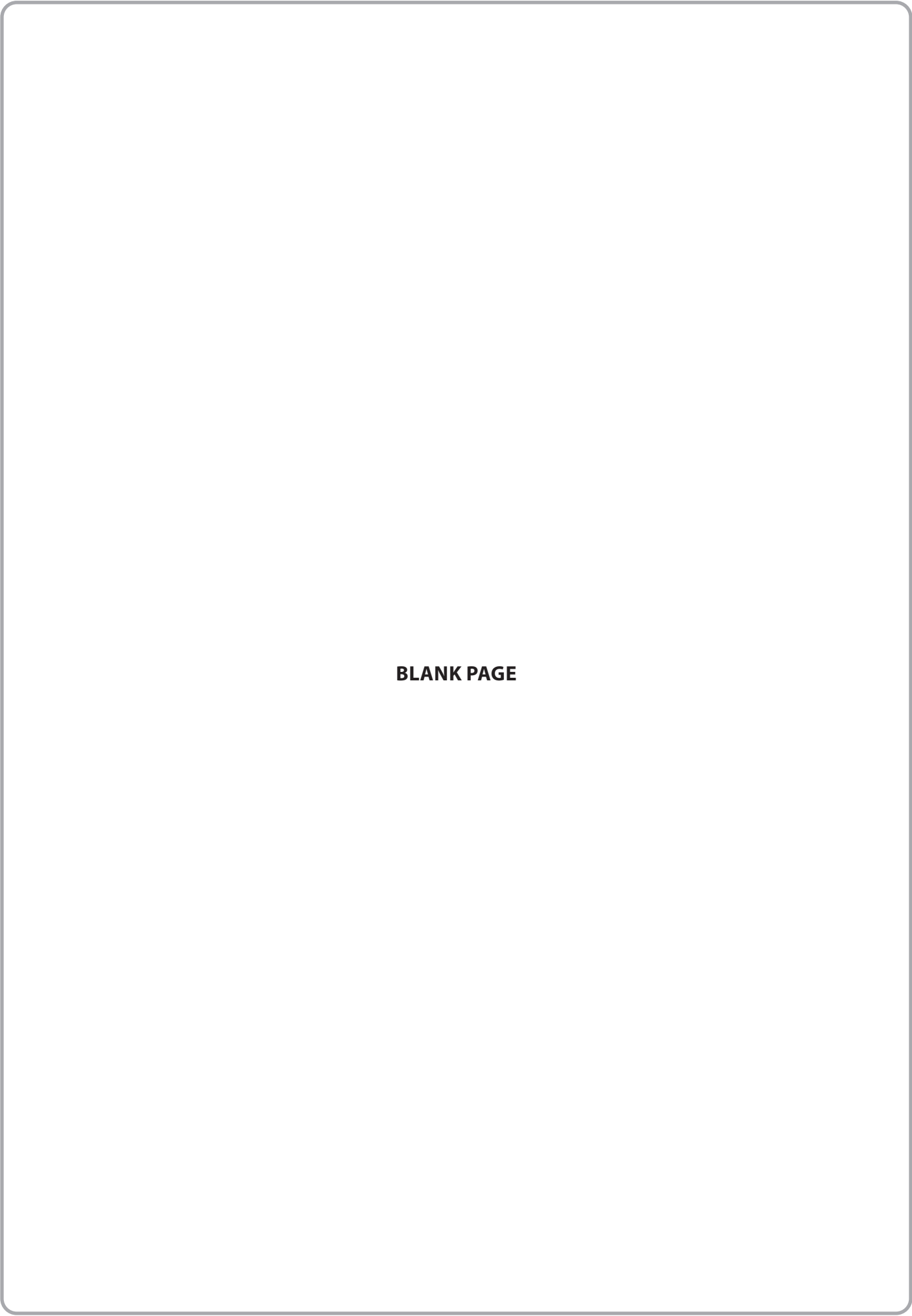
- 1
- 2

(Total for Question 4 = 9 marks)



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P 7 5 5 0 6 R R A 0 1 1 3 2

5 A student makes some ammonium sulfate solution by using a titration.

(a) Which pair of solutions should be used to make the ammonium sulfate solution?

(1)

- ☐ A ammonium solution and concentrated sulfuric acid
- ☐ B ammonia solution and concentrated sulfuric acid
- ☐ C ammonium solution and dilute sulfuric acid
- ☐ D ammonia solution and dilute sulfuric acid

(b) The student uses the following apparatus to make the solution of ammonium sulfate.

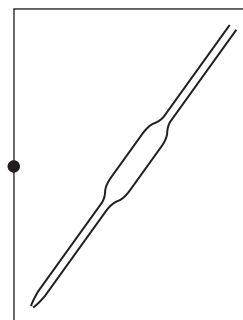
Draw **one** straight line from each apparatus name to the diagram of the apparatus.

(2)

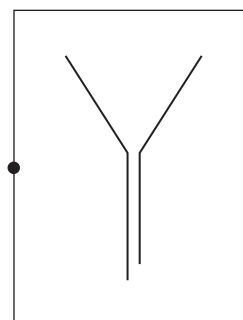
apparatus name

diagram of the apparatus

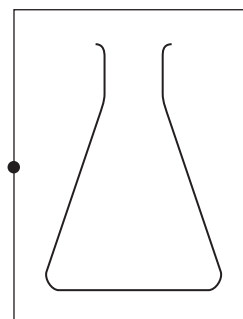
conical flask



filter funnel



pipette



(c) In this titration, the student uses methyl orange as the indicator.

Explain why an indicator is used in a titration.

(2)

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.....

.....

(d) The student carries out a rough titration first.

Figure 9 shows the burette readings at the start and at the end of the titration.

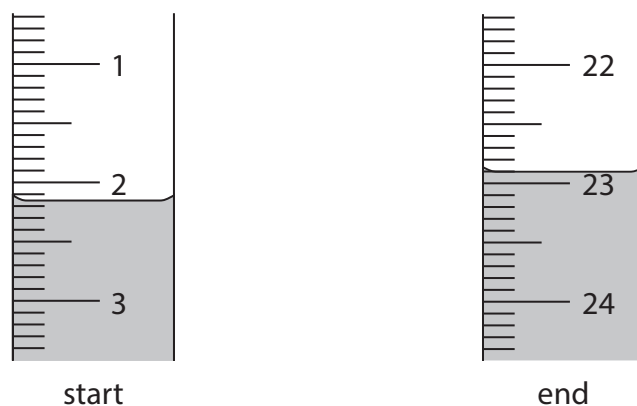


Figure 9

At the start of the titration, the burette reading is 2.15 cm^3 .

Give the reading on the burette at the end of the titration.

(2)

..... cm^3



(e) The student carries out accurate titrations to obtain concordant results.

- (i) Figure 10 shows the volume of solution delivered by the burette in the three accurate titrations.

Circle the volumes the student should use to calculate the mean volume.

	titration 1	titration 2	titration 3
volume in cm ³	20.00	20.10	20.25

Figure 10

(1)

- (ii) Using the volumes that you have circled, calculate the mean volume of solution delivered by the burette.

(1)

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mean volume of solution = cm³

(Total for Question 5 = 9 marks)



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6 Figure 11 shows part of the reactivity series of metals.

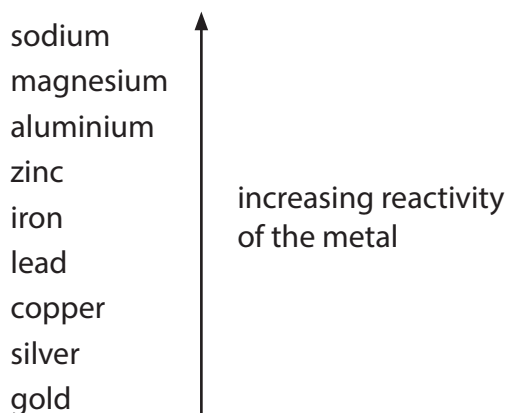


Figure 11

(a) The method used to extract a metal from its ore is related to the metal's position in the reactivity series.

(i) Which metal is found in the Earth's crust as an uncombined element?

(1)

- ☐ A aluminium
- ☐ B gold
- ☐ C lead
- ☐ D sodium

(ii) Name **one** metal in Figure 11 that is normally extracted by electrolysis.

(1)

(b) 25 000 kg of an ore of iron was found to contain 10 050 kg of iron.

Calculate the percentage of iron in this ore of iron.

$$\text{percentage of metal} = \frac{\text{mass of metal}}{\text{mass of metal ore}} \times 100$$

(2)

percentage of iron in ore =



(c) When copper oxide is heated with carbon, the products are copper and carbon dioxide.

(i) Write the word equation for this reaction.

(1)

(ii) In this reaction, copper oxide loses oxygen.

State the type of reaction when copper oxide loses oxygen.

(1)

(iii) In one reaction, 159.0 g of copper oxide was heated with excess carbon to produce 127.0 g of copper.

Use this information to calculate the mass of copper formed, in g, when 238.5 g of copper oxide is reacted with excess carbon.

(2)

mass of copper = g

(iv) State why this reaction with copper oxide uses excess carbon.

(1)

(d) A solution of zinc sulfate was made by dissolving 23.8 g of the compound in water and was made up to a total volume of 250 cm³ with water.

Calculate the concentration of this solution in g dm⁻³.

$$\text{concentration (g dm}^{-3}\text{)} = \frac{\text{mass of solid (g)}}{\text{volume of solution (dm}^3\text{)}}$$

Give your answer to 2 significant figures.

(3)

concentration = g dm⁻³

(Total for Question 6 = 12 marks)





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7 This question is about the transition metals iron and copper.

(a) When iron rods are left out in the rain for a few weeks, the rods corrode and become covered in a brown solid.

(i) State the name of this brown solid.

(1)

(ii) Place ticks (✓) in boxes to show which **two** substances in the air react with iron to form the brown solid.

(2)

substance	(✓)
neon	
carbon dioxide	
nitrogen	
oxygen	
water vapour	

(iii) State **one** way to prevent the corrosion of iron rods that will be used outside.

(1)

(iv) In an experiment, 5 iron rods were left outside in the rain for a few weeks.

The mass of the iron rods was found before they were left outside and again after a few weeks.

Figure 12 shows the recorded masses.

mass of 5 iron rods before being left outside	3.75 g
mass of 5 iron rods after being outside for a few weeks	4.53 g

Figure 12

Use this information to calculate the mean increase in mass of **one** iron rod.

(2)

mean increase in mass of one iron rod = g



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(1)

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- (6)

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(Total for Question 7 = 13 marks)





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8 (a) Atoms of neon are made up of subatomic particles.

- (i) Figure 14 shows some information about the subatomic particles in neon atoms.

Complete Figure 14 with the missing information.

(3)

subatomic particle	relative charge	relative mass
proton		1
neutron	0	
electron		negligible

Figure 14

- (ii) All atoms of neon have an atomic number of 10.

Describe what information about the number of subatomic particles can be obtained from the atomic number of neon.

(2)

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.....

- (iii) Explain why atoms of neon are electrically neutral.

(2)

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.....



*(b) The structure of the periodic table and the position of the elements in the periodic table are linked to the electronic configuration of the elements.

Figure 15 shows the structure of the periodic table and the first 12 elements with their atomic numbers.

group

1	2											3	4	5	6	7	0
																	He 2
Li 3	Be 4											B 5	C 6	N 7	O 8	F 9	Ne 10
Na 11	Mg 12											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

Figure 15

Use the first 12 elements shown in Figure 15 to explain

- how the structure of the periodic table is linked to the electronic configuration of the atoms of the elements
- how the arrangement of the elements is linked to their electronic configuration.

(6)



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(Total for Question 8 = 13 marks)



9 Silver nitrate and potassium chloride are ionic compounds that are soluble in water.

(a) When potassium chloride solution is added to a solution of silver nitrate, a white precipitate forms.

(i) Complete the equation for this reaction, including the missing state symbol.

(2)



(ii) Give the name of the white precipitate that forms.

(1)

(iii) State and explain how the white precipitate can be separated from the reaction mixture.

(3)

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(b) Silver nitrate solution conducts electricity.
Solid silver also conducts electricity.

Describe how silver nitrate solution conducts electricity and how solid silver conducts electricity.

(3)

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- (c) A bottle containing an unknown solution is labelled with the two hazard symbols shown in Figure 16.

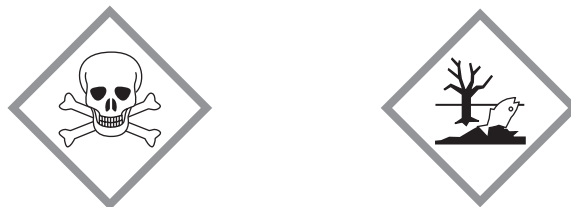


Figure 16

- (i) What are the meanings of these two symbols?

(1)

- ☐ **A** flammable and toxic
- ☐ **B** harmful and dangerous to the environment
- ☐ **C** toxic and dangerous to the environment
- ☐ **D** toxic and harmful

- (ii) State a safety step that should be taken when using the unknown solution.

(1)

(Total for Question 9 = 11 marks)



10 Phosphoric acid is important in the production of fertilisers.

- (a) (i) A few drops of litmus solution are added to a sample of dilute phosphoric acid.

What is the colour of the mixture formed?

(1)

- ☐ **A** colourless
- ☐ **B** green
- ☐ **C** purple
- ☐ **D** red

- (ii) State why litmus cannot be used to measure pH.

(1)

.....

.....

- (b) Phosphoric acid can react to form phosphate salts which are used in fertilisers.

Give **two** reasons why farmers use fertilisers on their fields.

(2)

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2

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(c) An experiment was carried out to produce phosphoric acid.

(i) The actual yield for the experiment was 18.62 g.

The theoretical yield for the experiment is 24.50 g.

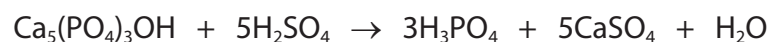
$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

Calculate the percentage yield of this experiment.

(2)

percentage yield =

(ii) The equation for a reaction to make phosphoric acid, H_3PO_4 , is



Calculate the atom economy for the production of phosphoric acid in this reaction.

$$\text{atom economy (\%)} = \frac{\text{total formula mass of desired product}}{\text{total formula mass of all reactants or products}} \times 100$$

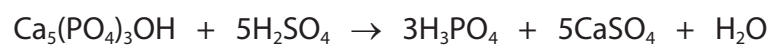
(relative formula masses: $\text{Ca}_5(\text{PO}_4)_3\text{OH} = 502$, $\text{H}_2\text{SO}_4 = 98$, $\text{H}_3\text{PO}_4 = 98$, $\text{CaSO}_4 = 136$, $\text{H}_2\text{O} = 18$)

(3)

atom economy = %



(iii) The equation for a reaction to produce phosphoric acid is



Explain how the atom economy of the reaction can be increased.

(2)

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(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS

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Monday 19 May 2025

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reference

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Chemistry

PAPER 1

Foundation Tier

Periodic Table Insert

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The periodic table of the elements

1	2	Key										3	4	5	6	7	0	
		relative atomic mass atomic symbol name atomic (proton) number																
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	

1 H hydrogen 1

relative atomic mass
atomic symbol
name
atomic (proton) number

* The elements with atomic numbers from 58 to 71 are omitted from this part of the periodic table.

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

