

[Science] Chemistry O Level Exam Paper
Preliminary Examination Set [IV]
Secondary Four Express & Five Normal



CANDIDATE NAME:

CLASS:

INDEX NUMBER:

Science(Chemistry)

5076/01

Paper 1 Multiple Choice

5078/01

2024

30 min

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid/tape.

Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A, B, C** or **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

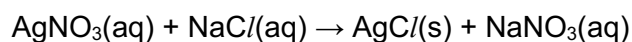
Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

1 Which apparatus should be used to measure a volume of 26.3 cm³ most accurately?

- A beaker
- B pipette
- C measuring cylinder
- D burette

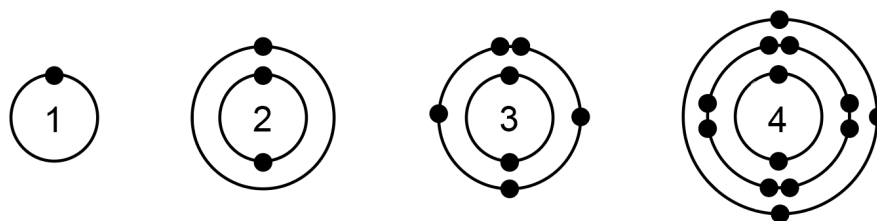
2 The equation represents the reaction between aqueous silver nitrate and aqueous sodium chloride.



Which of the following methods should be used to separate the products?

- A chromatography
- B crystallisation
- C fractional distillation
- D filtration

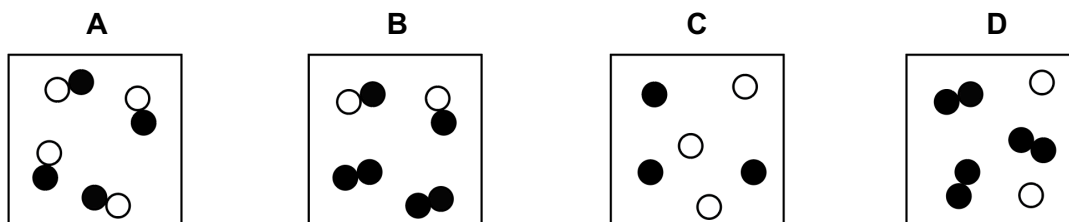
3 The diagrams show the electronic structures of four elements.



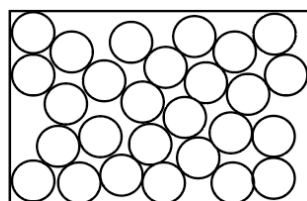
Which elements are metals?

- A 1 and 2
- B 1 and 3
- C 2 and 4
- D 3 and 4

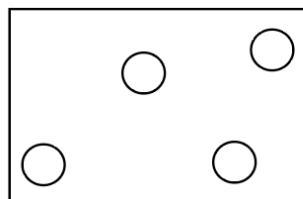
4 Which diagram represents molecules of a compound?



- 5 The diagrams show the particles in a substance at two different temperatures but at the same pressure.



–60 °C



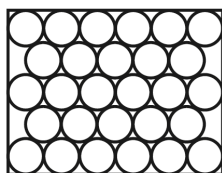
–5 °C

What could be the melting point and boiling point of the substance?

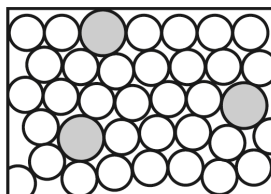
	melting point / °C	boiling point / °C
A	–97	–65
B	–83	–20
C	–66	5
D	–54	–9

- 6 The diagrams show the structure of two substances used to make electrical conductors.

X



Y



Which statement correctly describes X and Y?

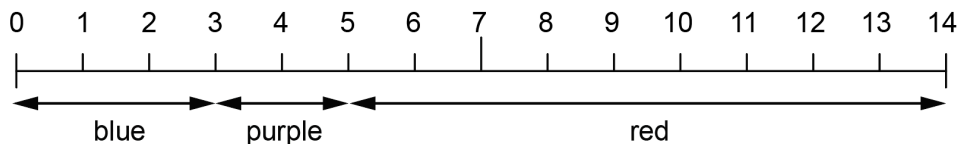
- A** X is a pure metal and Y is a compound.
- B** X is a pure metal and Y is an alloy.
- C** X is a solid and Y is a liquid.
- D** X is harder and stronger than Y.

- 7 Ethene, C_2H_4 , has a higher boiling point than methane, CH_4 . Which statement explains the difference in boiling point?
- A Carbon-carbon double bonds are stronger than carbon-carbon single bonds.
 - B Ethene has more covalent bonds to break.
 - C Ethene does not burn as easily as methane.
 - D The forces of attraction between ethene molecules are stronger than those between methane molecules.

- 8 The average mass of an atom of **X** is 24 times greater than $\frac{1}{12}$ of the mass of a carbon-12 atom.

What is the relative atomic mass of **X**?

- A 2
 - B 12
 - C 24
 - D 48
- 9 The colours of an indicator, Congo Red, in solutions of different pH are shown below.

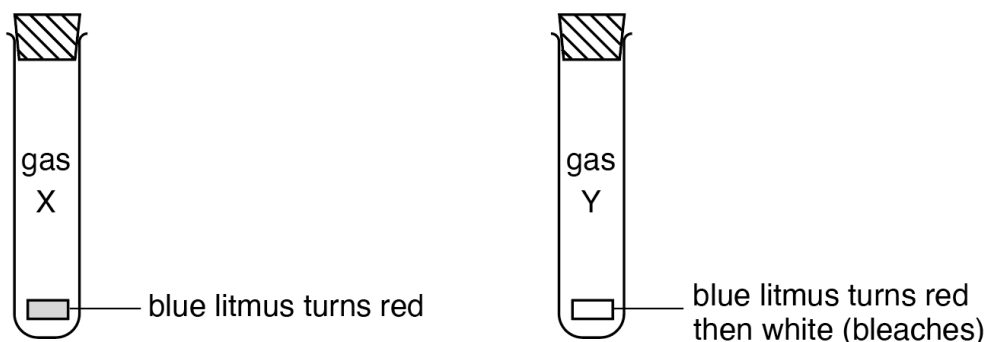


colour of Congo Red indicator at different pH

Which pair of solutions could be distinguished by this indicator?

- A aqueous sodium chloride and aqueous ammonia
- B aqueous sodium chloride and dilute hydrochloric acid
- C aqueous ammonia and aqueous sodium hydroxide
- D dilute sulfuric acid and dilute nitric acid

- 10 The diagram shows what happens when damp blue litmus paper is placed into two different gases, X and Y.



What are gases X and Y?

	X	Y
A	chlorine	hydrogen chloride
B	hydrogen	chlorine
C	chlorine	hydrogen
D	hydrogen chloride	chlorine

- 11 Aqueous potassium iodide and acidified potassium manganate(VII) were added separately to a colourless solution.

The following colour changes were observed.

	aqueous potassium iodide	acidified potassium manganate(VII)
observation	colourless to brown	no change

What could the colourless solution contain?

	oxidising agent	reducing agent
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

12 Which statement about the properties of chlorine, bromine and iodine is correct?

- A Iodine displaces bromine from a solution of bromide ions.
- B Chlorine, bromine and iodine exist as monoatomic molecules.
- C Chlorine displaces iodine from a solution of iodide ions.
- D Bromine is a solid, chlorine is a liquid and iodine is a gas at room temperature.

13 Which statement about the rusting of iron is correct?

- A Iron becomes lighter when it rusts.
- B Iron is reduced when it rusts.
- C Rusting is a reaction involving iron, oxygen and water.
- D Rusting is a reaction involving iron and water only.

14 Dissolving ammonium chloride in water is an endothermic process.

Which row shows the direction of heat flow and the change in temperature when ammonium chloride dissolves in water?

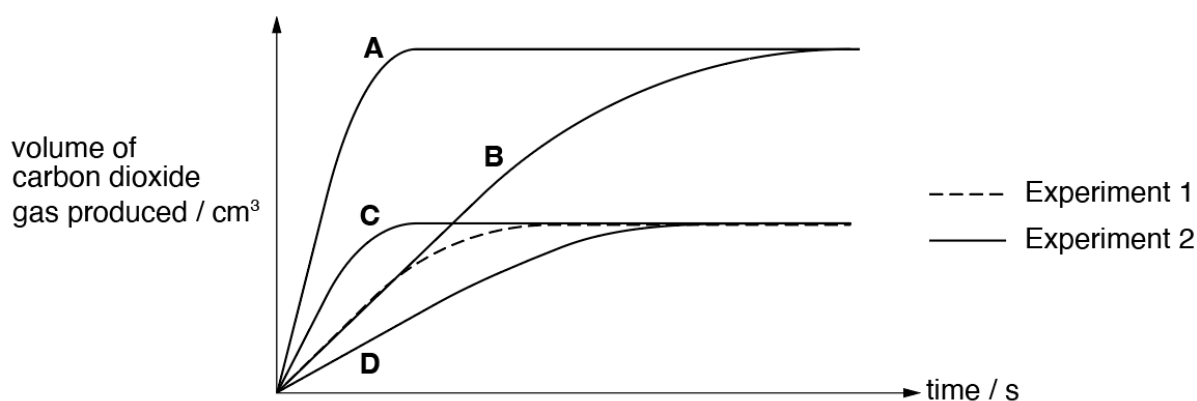
	temperature change	direction of heat flow
A	fall	from surroundings
B	fall	to surroundings
C	rise	from surroundings
D	rise	to surroundings

15 In Experiment 1, excess calcium carbonate was reacted with 10 cm³ of 0.5 mol/dm³ hydrochloric acid.

In Experiment 2, excess calcium carbonate was reacted with 10 cm³ of 1.0 mol/dm³ hydrochloric acid.

In both experiments, the volume of carbon dioxide gas produced was measured over time.

Which graph shows how the volume of carbon dioxide gas produced in Experiment 2 changes with time?



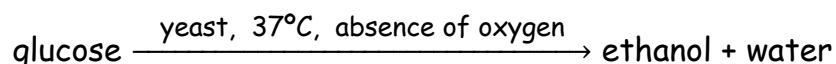
- 16 Which statement about the fractional distillation of crude oil is correct?
- A The hydrocarbons are separated according to their melting points.
 - B The hydrocarbons collected in each fraction have similar boiling points.
 - C The fractions with higher boiling points are collected higher up the fractionating column.
 - D The fractions with molecules containing a smaller number of carbon atoms are collected lower down the fractionating column.

- 17 Ethane is allowed to react with chlorine in the presence of ultraviolet light.

Which equation represents this reaction?

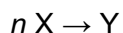
- A $\text{C}_2\text{H}_4 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_4\text{Cl}_2$
- B $\text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_6\text{Cl}_2$
- C $\text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_4\text{Cl}_2 + \text{H}_2$
- D $\text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{HCl}$

- 18 Ethanol can be formed from glucose by fermentation.
A student wrote the following word equation.



Why is the student's equation incorrect?

- A Water should be a reactant, not a product.
 - B Oxygen is needed for yeast to carry out respiration.
 - C The reaction produces carbon dioxide instead of water.
 - D The fermentation reaction should be carried out by bacteria, not yeast.
- 19 Many molecules of X combine to form a single molecule Y as shown in the equation.

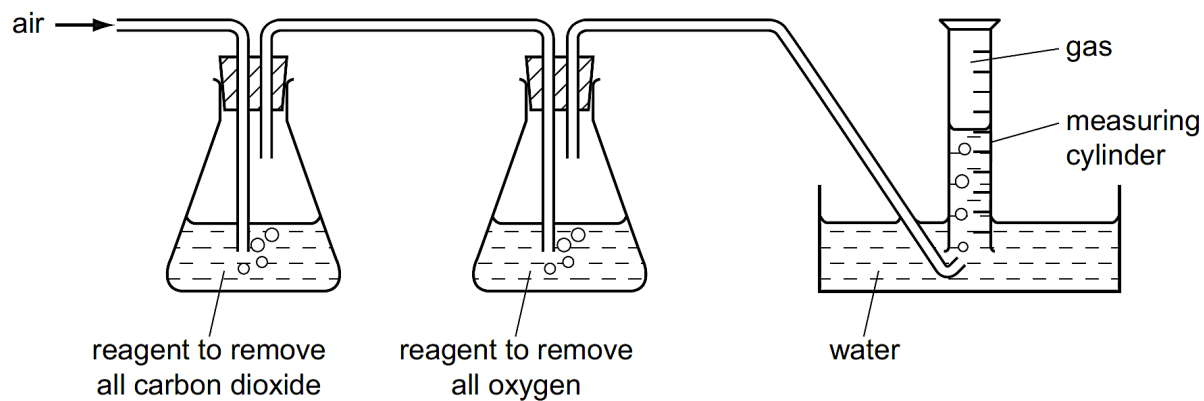


(n is a very large number)

Which terms best describe X and Y in this reaction?

	X	Y
A	fraction	monomer
B	monomer	fraction
C	monomer	polymer
D	polymer	fraction

20 A 100 cm³ sample of air is passed into the apparatus as shown.



What is the volume and the composition of the gas collected in the measuring cylinder?

	volume / cm ³	composition
A	21	pure nitrogen
B	21	nitrogen and other gases
C	79	pure nitrogen
D	79	nitrogen and other gases

Data Sheet

Colours of Some Common Metal Hydroxides

aluminium hydroxide	white
calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
zinc hydroxide	white

Group

57	La	lanthanum	139	58	Ce	cerium	140	59	Pr	praseodymium	141	60	Nd	neodymium	144	61	Pm	promethium	—	62	Sm	samarium	150	63	Eu	europlum	152	64	Gd	gadolinium	157	65	Tb	terbium	159	66	Dy	dysprosium	163	67	Ho	holmium	165	68	Er	erbium	167	69	Tm	thulium	169	70	Yb	ytterbium	173	71	Lu	lutetium	175
89	Ac	actinium	227	90	Th	thorium	232	91	Pa	protactinium	231	92	U	uranium	238	93	Np	neptunium	—	94	Pu	plutonium	—	95	Am	americium	—	96	Cm	curium	—	97	Bk	berkelium	—	98	Cf	californium	—	99	Es	einsteinium	—	100	Fm	fermium	—	101	Md	mendelevium	—	102	No	nobelium	—	103	Lr	lawrencium	—

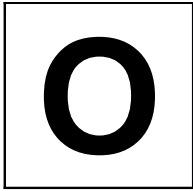
The Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$

Data Sheet

Colours of Some Common Metal Hydroxides

calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white

Group																			
I	II							III	IV	V	VI	VII	0						
		Key atomic number atomic symbol name relative atomic mass								1Hhydrogen1					2Hehelium4				
3Li7lithium	4Be9beryllium													5Bboron11	6Ccarbon12	7Nnitrogen14	8Ooxygen16	9Ffluorine19	10Ne20neon
11Na23sodium	12Mg24magnesium													13Aluminum27	14Si28silicon	15Pphosphorus31	16Ssulfur32	17Clchlorine35.5	18Arargon40
19K39potassium	20Ca40calcium	21Scscandium	22Titi-48titanium	23Vvanadium51	24Crchromium52	25Mnmanganese55	26Feiron56	27Cocobalt59	28Ninickel59	29Cucopper64	30Znzinc65	31Gagallium70	32Gegermanium73	33Asarsenic75	34Seselenium79	35Brbromine80	36Krkrpton84		
37Rb85rubidium	38Sr88strontium	39Yyttrium89	40Zr91zirconium	41Nbniobium93	42Momolybdenum96	43Tctechnetium—	44Ruruthenium101	45Rh103rhodium	46Pd106palladium	47Ag108silver	48Cd112cadmium	49Inindium115	50Sn119tin	51Sbsb122antimony	52Tetellurium128	53Iiodine127	54Xexenon131		
55Cs133caesium	56Ba137barium	57–71lanthanoids		72Hf178hafnium	73Ta181tantalum	74Wtungsten184	75Re186rhenium	76Os190osmium	77Ir192iridium	78Pt195platinum	79Au197gold	80Hg201mercury	81Tl204thallium	82Pb207lead	83Bi209bismuth	84Po—polonium	85Atastatine—	86Rnradon—	
87Fr—francium	88Ra—radium	89–103actinoids		104Rf—rutherfordium	105Dbdubnium—	106Sgseaborgium—	107Bhb bohrium—	108Hshassium—	109Mt—meitnerium	110Ds—darmstadtium	111Rgroentgenium—	112Cncopernicium—		114Fl—flerovium		116Lv—livermorium			
lanthanoids																			
57La139lanthanum		58Ce140cerium	59Pr141praseodymium	60Nd144neodymium	61Pmpromethium—	62Sm150samarium	63Eu152europium	64Gdgadolinium157	65Tb159terbium	66Dy163dysprosium	67Ho165holmium	68Er167erbium	69Tm169thulium	70Yb173ytterbium	71Lu175lutetium				
actinoids																			
89Ac—actinium		90Th232thorium	91Pa231protactinium	92U238uranium	93Np—neptunium	94Pu—plutonium	95Am—americium	96Cm—curium	97Bk—berkelium	98Cf—californium	99Es—einsteinium	100Fmfermium—	101Md—mendeleevium	102No—nobelium	103Lrlawrencium—				



[Science] Chemistry O Level Exam
Paper Preliminary Examination Set [IV]
Secondary Four Express & Five Normal



CANDIDATE NAME:

CLASS:

INDEX NUMBER:

Science(Chemistry)

Paper 2 Theory

5076/03

2024

5078/03

1 hour 15 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid/tape.

Section A

Answer **all** questions.

Section B

Answer **all** questions. Question 11 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

Section A	
Section B	
Total	

Section A

Answer **all** the questions in the spaces provided.

- 1 The table contains details of seven different particles.
The letters are **not** the chemical symbols.

	T	U	V	W	X	Y	Z
number of protons	5	6	7	7	11	12	12
number of neutrons	6	8	7	7	12	12	13
number of electrons	5	6	7	10	10	12	12

Use the table to state which of the particles **T, U, V, W, X, Y** and **Z**

- (a) is the element carbon, [1]
- (b) has 5 valence electrons, [1]
- (c) is a negative ion, [1]
- (d) are both isotopes of the same element and [1]

[Total: 4]

- 2 State the observation in each of the following experiments which shows that the sample being analysed is a pure substance.

experiment	observation if sample is a pure substance
perform paper chromatography and analyse the chromatogram	
measure melting point of the sample	

[2]

[Total: 2]

- 3 A student investigates the combustion of natural gas, as shown in Fig. 3.1.

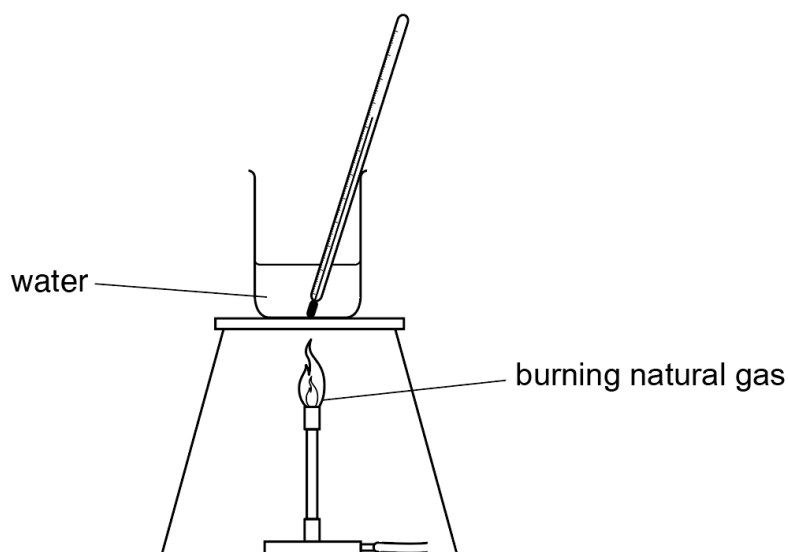


Fig. 3.1

The student measures the temperature of the water as the natural gas burns.

- (a) Natural gas consists of hydrocarbon molecules.

- (i) State what is meant by the term *hydrocarbon*.

..... [1]

- (ii) State the main constituent of natural gas.

..... [1]

- (b) Three processes occur in the set up in Fig. 3.1.
State whether each process is exothermic or endothermic.

process	exothermic or endothermic?
combustion of natural gas	
evaporation of water in the beaker	
condensation of water droplets on the sides of the beaker	

[2]

- (c) The water in the beaker begins to boil when the temperature reaches 100 °C.

Describe how the movement and arrangement of water molecules changes during boiling.

.....

.....

.....

.....

[2]

- (d) One of the products of the combustion of natural gas is carbon dioxide.

Draw the 'dot and cross' diagram for a carbon dioxide molecule.
Only the outer shells of electrons need to be shown.

[2]

[Total: 8]

- 4 Many electricity generating power stations burn fossil fuels. The combustion of these fuels produces waste gases called flue gas.

The flue gas contains oxides of nitrogen and sulfur dioxide, which cause acid rain, and must be removed before they reach the atmosphere.

- (a) State **one** physical property of acids.

..... [1]

- (b) State another source of oxides of nitrogen and explain how they are formed.

.....

..... [2]

- (c) When nitrogen dioxide, NO_2 reacts with water, it forms nitric acid and another acid with the formula, HNO_2 .

State the change in oxidation state of nitrogen when NO_2 is converted to HNO_2 .

..... [1]

- (d) Acid rain can reduce the pH of soil, leaching nutrients and killing plants.

- (i) Describe **one** other environmental problem caused by acid rain.

.....

..... [1]

- (ii) Name the substance that farmers use to neutralise the excess acids in the soil.

.....

[1]

- (iii) Write an ionic equation, with state symbols, to show what is meant by the term *neutralisation*.

.....

[1]

- (e) Farmers also use ammonium sulfate fertilisers to improve the yield of crops.

When dissolved in water, the formula of ammonium sulfate may be written as $(\text{NH}_4)_2\text{SO}_4(\text{aq})$.

At room temperature, the maximum mass of ammonium sulfate that can dissolve per 100 cm^3 of water is 75.9 g to form a saturated solution.

Calculate the concentration of a saturated solution of ammonium sulfate

- (i) in g/dm^3 , and

concentration of ammonium sulfate = g/dm^3 [1]

- (ii) in mol/dm^3 . [relative atomic masses, A_r : N, 14; H, 1; S, 32; O, 16]

concentration of ammonium sulfate = mol/dm^3 [2]

[Total: 10]

5 Fig. 5.1 describes some properties of a metal oxide **M**.

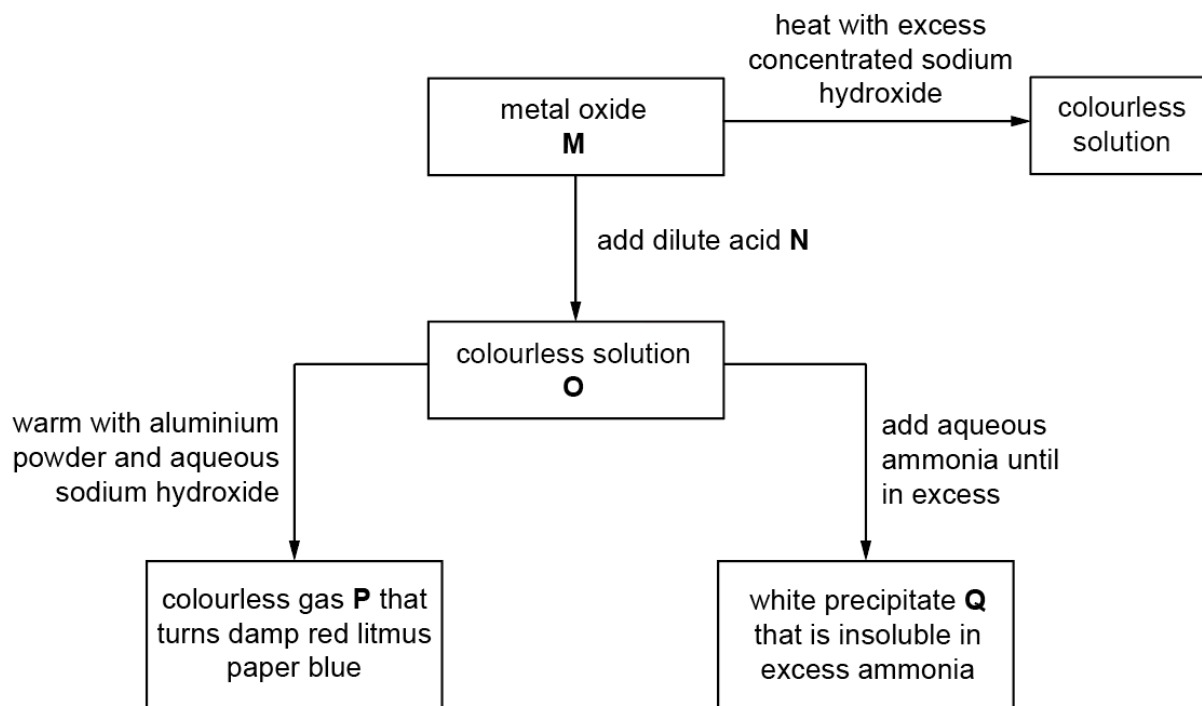


Fig. 5.1

(a) Identify **M**, **N**, **O**, **P** and **Q**.

M

N

O

P

Q

[5]

(b) State the information in Fig. 5.1 which suggests that **M** is an amphoteric oxide.

..... [1]

(c) Write an ionic equation, with state symbols, for the formation of white precipitate **Q**.

..... [1]

[Total: 7]

- 6 A student investigates the reactivities of copper, magnesium and two unknown metals, **X** and **Y**, as shown in Fig. 6.1.

Metal **X** and magnesium are added to cold water.

Copper and metal **Y** are added to dilute hydrochloric acid.

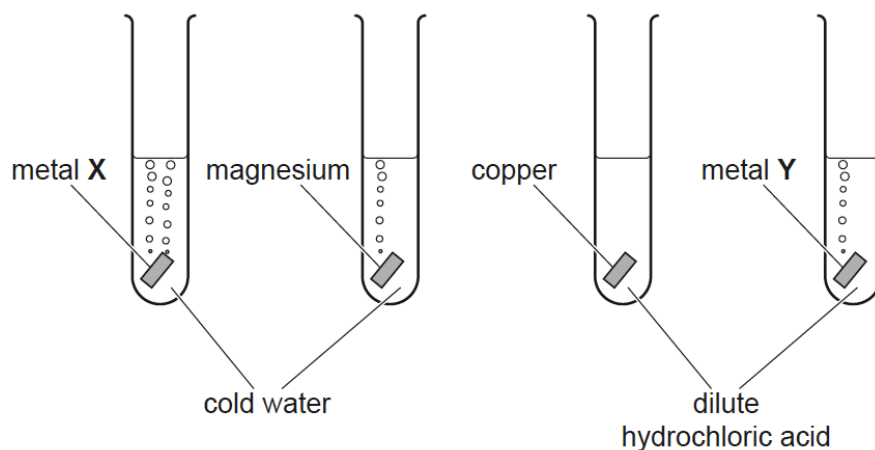


Fig. 6.1

- (a) Deduce the order of reactivity for these four metals.

most reactive
↓
↓
↓
least reactive

[2]

- (b) The student found that the pH of the mixture produced when metal **X** reacted was 12.

State the name or formula of the ion whose concentration has increased and which is responsible for the change in pH.

Explain your answer briefly.

ion

explanation

[2]

(c) Use Fig. 6.1 to explain why metal **X** cannot be potassium.

.....

..... [1]

(d) State the metal in Fig. 6.1 that is the easiest to extract from its ore.

..... [1]

[Total: 6]

7 Fig. 7.1 shows the reactions of an organic molecule **B**.

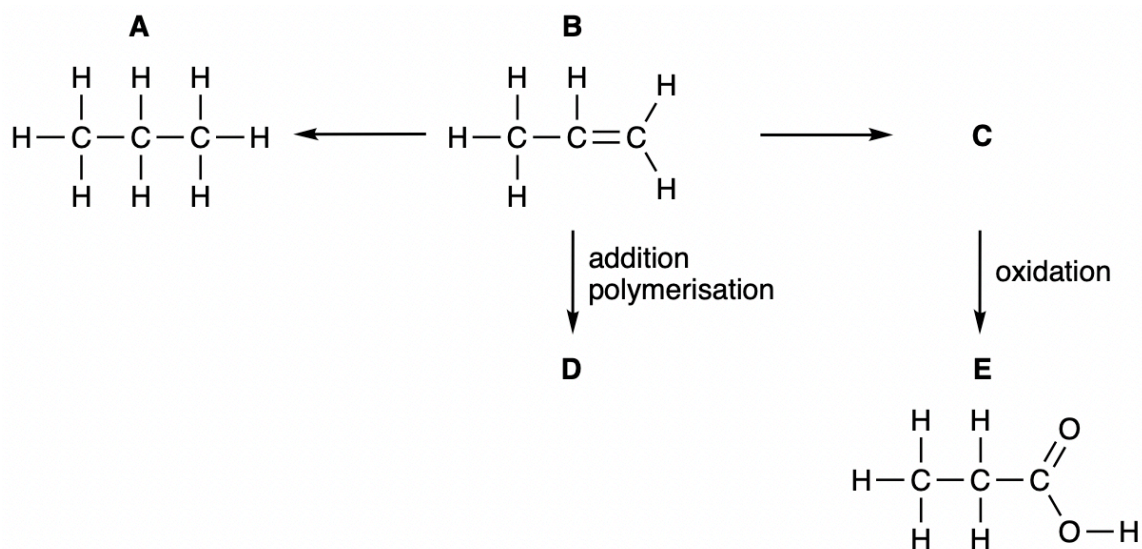


Fig. 7.1

- (a) Describe a chemical test that can be used to distinguish between **A** and **B**.
In each case, describe what you would see.
- test
- observation with **A**
- observation with **B** [2]
- (b) Write a balanced chemical equation for the combustion of **A** in excess air.
- [2]
- (c) **C** belongs to the homologous series of alcohols.
Deduce its name and draw its full structural formula. Show all the bonds in your answer.
- name:
- full structural formula:

[2]

(d) Draw the structure of **D**, showing three repeat units.

[2]

[Total: 8]

- 8 Fig. 8.1 shows the apparatus that a student used to study the rate of reaction between dilute hydrochloric acid and calcium carbonate.

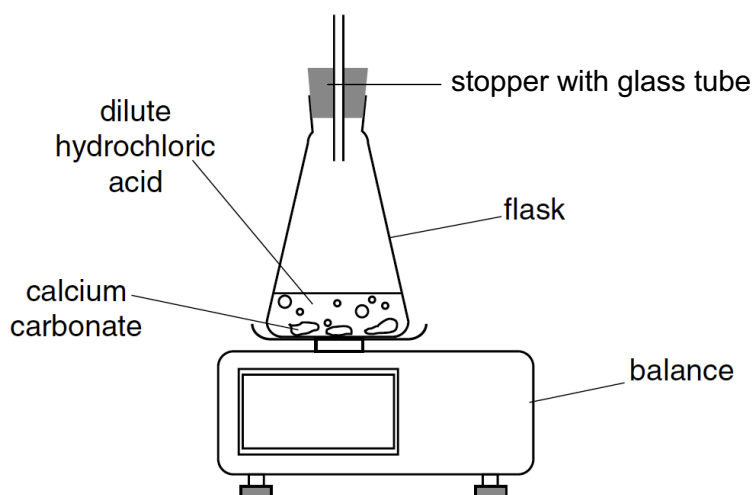


Fig. 8.1

The student studied the rate of reaction at three different temperatures. Table 8.1 and Fig. 8.2 show some data for the three experiments.

Table 8.1

experiment	initial mass of calcium carbonate / g	temperature of hydrochloric acid / °C
A	10.0	15
B	10.0	25
C	10.0	35

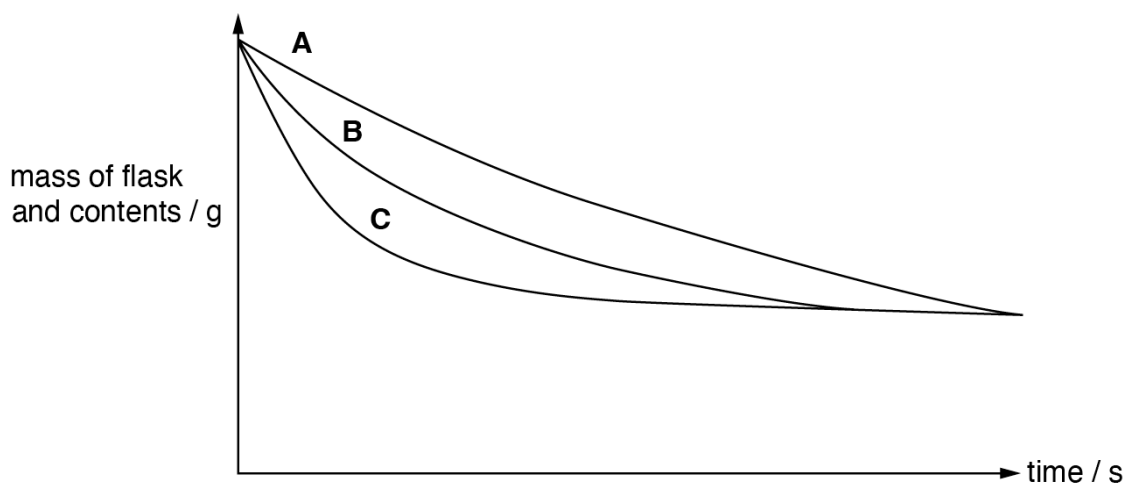


Fig. 8.2

- (a) Explain why the balance reading decreases during the reaction.

.....
.....

[1]

- (b) The conical flask is fitted with a stopper with a glass tube.
Suggest why the mouth of the conical flask should not be left fully open.

.....
.....

[1]

- (c) The student used 10.0 g of calcium carbonate in each experiment.
State **one** other condition that should be kept the same for each experiment.

.....

[1]

- (d) Describe and explain, in terms of the collisions between particles, the difference in the shape of the graph between experiments **A** and **C**.

.....
.....
.....
.....
.....

[3]

- (e) An aqueous solution of calcium chloride is formed in the reaction.

- (i) Draw a 'dot and cross' diagram to show the arrangement of the outer shell electrons in calcium chloride.

[2]

- (ii) Aqueous calcium chloride conducts electricity, but solid calcium chloride does not. Explain this difference.

.....

.....

.....

.....

[2]

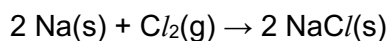
[Total: 10]

Section B

Answer **one** question from this section.

- 9 Sodium, chlorine and argon are found in Period 3 of the Periodic Table.

When hot sodium is held in a gas jar of chlorine, it burns. Sodium chloride forms on the walls of the jar. The chemical equation for the reaction is shown.



The apparatus used is shown in Fig. 9.1.

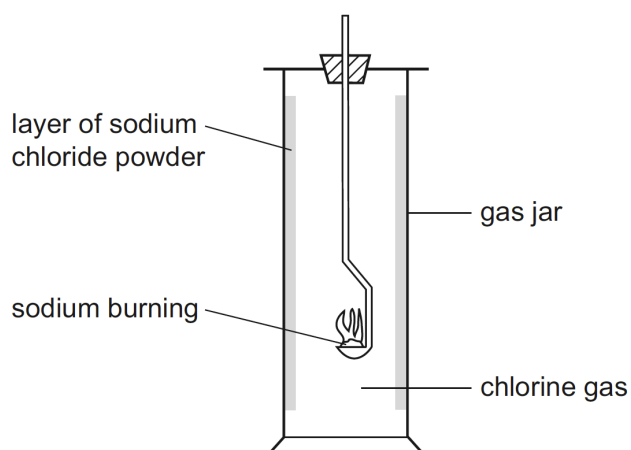


Fig. 9.1

- (a) On moving across Period 3 from sodium to chlorine, the character of the elements changes. Describe and explain the change.

.....

.....

.....

.....

[3]

- (b) Explain why argon does not react with sodium.
Use ideas about electrons in your answer.

.....

.....

[1]

- (c) The reaction between sodium and chlorine is an example of redox.

Explain, in terms of electrons, why the reaction involves both reduction and oxidation.

oxidation

reduction [2]

- (d) In the experiment, 1.84 g of hot sodium was lowered into a jar containing 1.2 dm³ of chlorine gas at room temperature and pressure.
[relative atomic masses, A_r : Na, 23; Cl, 35.5]

- (i) Calculate the number of moles of chlorine gas in 1.2 dm³.

number of moles of chlorine gas = mol [1]

- (ii) Calculate the number of moles of sodium in 1.84 g.

number of moles of sodium = mol [1]

- (iii) Identify the limiting reactant.
Hence, determine the maximum mass of sodium chloride that can be produced.

mass of sodium chloride = g [2]

[Total: 10]

- 10 The increasing use of fossil fuels has raised concerns about their environmental impact.

Biofuels are being explored as more sustainable alternatives. However, an understanding of the carbon cycle is essential when evaluating these options.

- (a) Ethanol for use as fuel for vehicles can be produced industrially from ethene or by the fermentation of glucose.

Fig. 10.1 shows the key stages involved in the two processes.

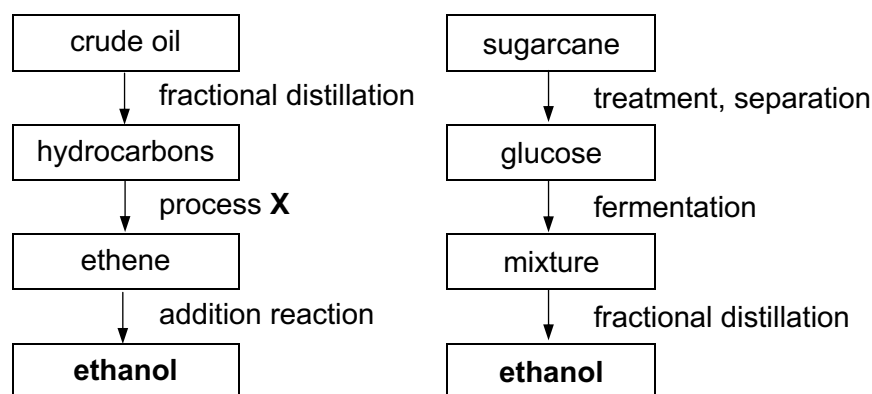


Fig. 10.1

- (i) Name process X.

..... [1]

- (ii) Explain why ethanol made from ethene is a non-renewable fuel but that made from glucose is a renewable fuel.

.....
.....
.....
..... [2]

- (iii) Some people think that ethanol is a 'carbon neutral' fuel. This means that their use does not lead to an overall increase in the amount of carbon in the atmosphere.

Explain why people would think like this and explain how Fig. 10.1 shows that this is incorrect.

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..... [2]

- (b) (i) Describe how photosynthesis and respiration in the carbon cycle regulate the amount of carbon dioxide in the atmosphere.

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..... [2]

- (ii) Carbon dioxide is a greenhouse gas which contributes to global warming. What do you understand by the term *greenhouse gas*?

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..... [1]

- (iii) The percentage by volume of carbon dioxide in the atmosphere is slowly increasing.

Describe **two** possible consequences of an increase in global warming.

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..... [2]

[Total: 10]

Data Sheet

Colours of Some Common Metal Hydroxides

aluminium hydroxide	white
calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
zinc hydroxide	white

The Periodic Table of Elements

Group																									
1	2	Key												13	14	15	16	17	18						
		proton (atomic) number atomic symbol name relative atomic mass												1 H hydrogen 1											
3 Li lithium 7	4 Be beryllium 9													5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20						
11 Na sodium 23	12 Mg magnesium 24													13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40						
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84								
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131								
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids		72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —							
87 Fr francium —	88 Ra radium —	89–103 actinoids		104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganeson —							
lanthanoids		57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175									
actinoids		89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —									

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).The Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$

