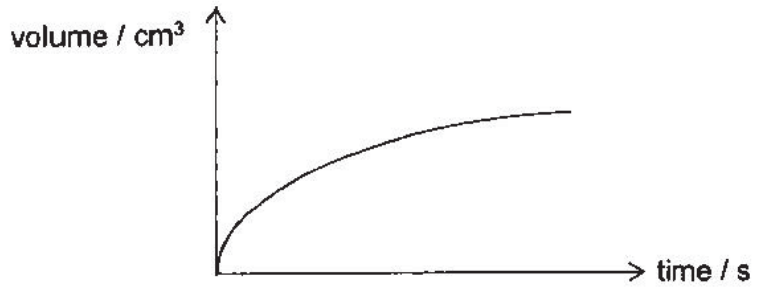
1 A student measured the rate of reaction between calcium carbonate and dilute hydrochloric acid. A graph showing the volume of gas produced against time is shown.



Which apparatus was used to measure the variables shown on the graph?

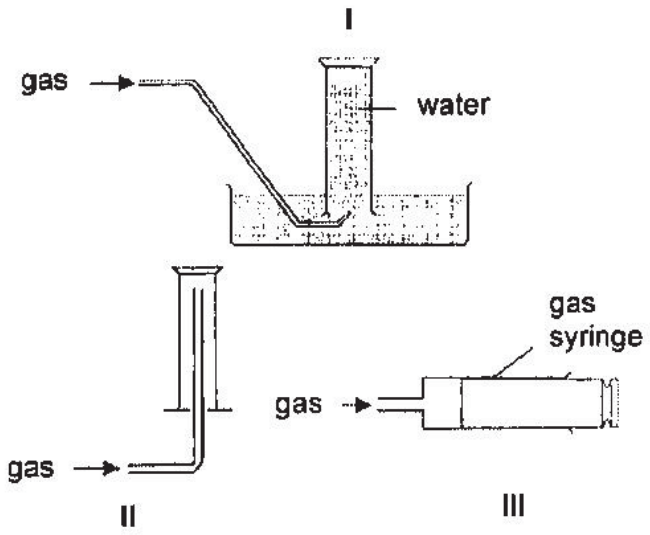
A burette and pipette

B electronic balance and gas syringe

C gas syringe and stop watch

D pipette and stop watch

2 Ethene can be prepared by heating ethanol with excess concentrated sulfuric acid. Ethene is an insoluble gas that has a lower density than air.



Which set-ups can be used to collect the ethene produced?

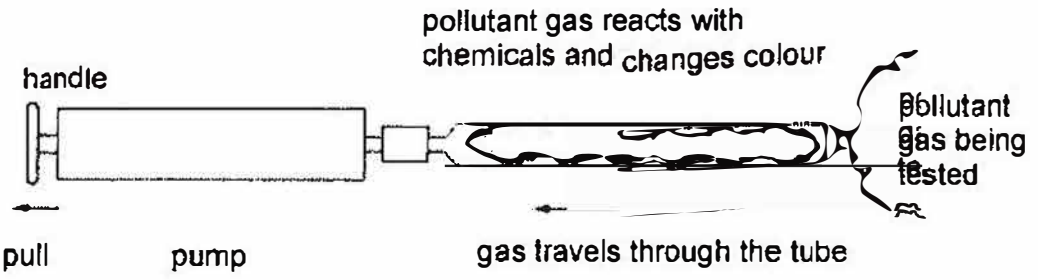
A I and II only

B II and III only

C I and III only

D All of the above

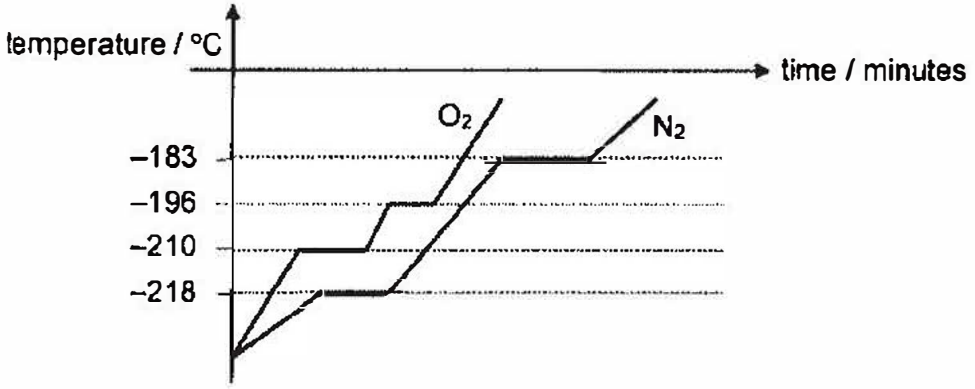
3 A special syringe is used to determine how long a gaseous pollutant takes to diffuse out of car exhausts.



Which pollutant gas would cause a colour change most rapidly?

A CO
B SO_2
C NO_2
D CH_4

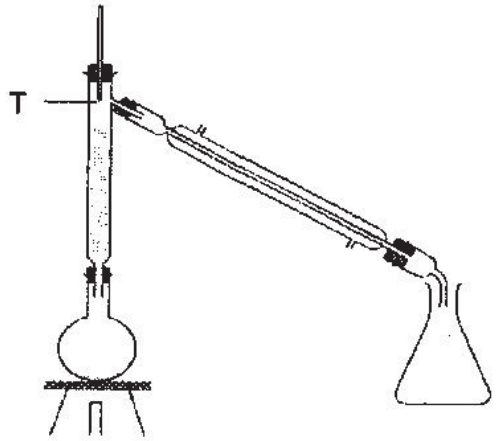
4 The graphs (not drawn to scale) show the heating curves of oxygen and nitrogen over a period of time.



At what temperature will there be two different phases (states) of matter co-existing at the same time, in a mixture of oxygen and nitrogen under room conditions?

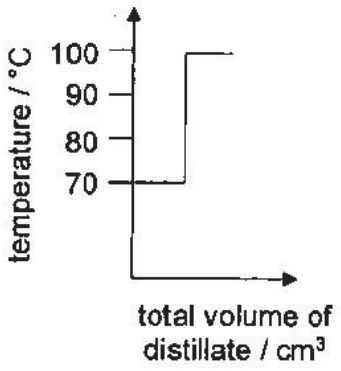
A – 180 °C
B – 210 °C
C – 200 °C
D – 220 °C

5 The diagram shows the apparatus used to separate hexane, boiling point of 70°C, and heptane, boiling point of 98°C.

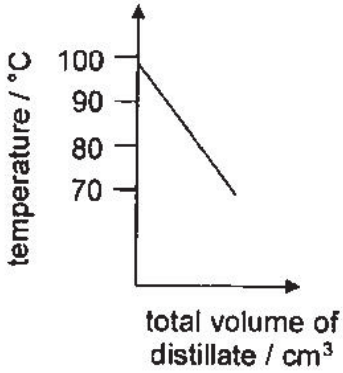


Which graph would be obtained if the temperature at point T was plotted against the total volume of distillate collected?

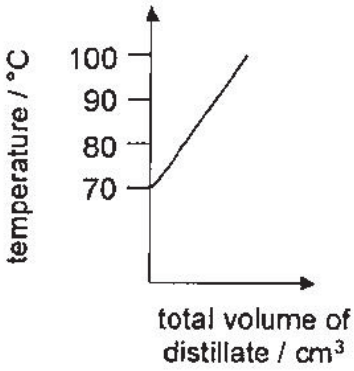
A



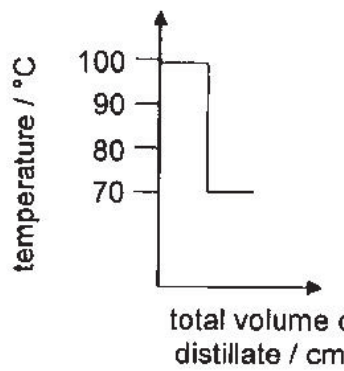
B



C



D

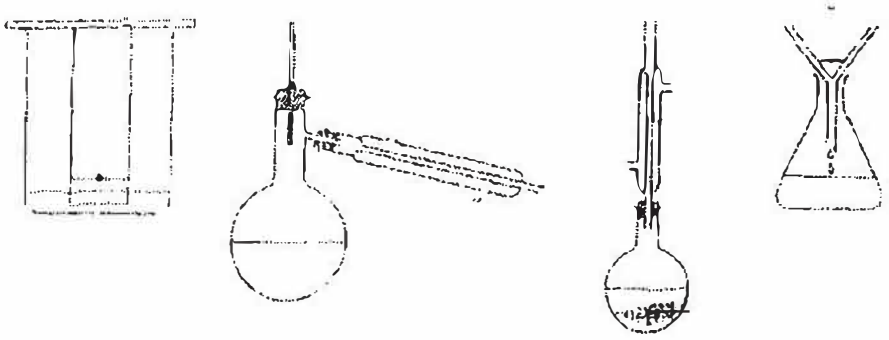


6 Compound P has the following properties:

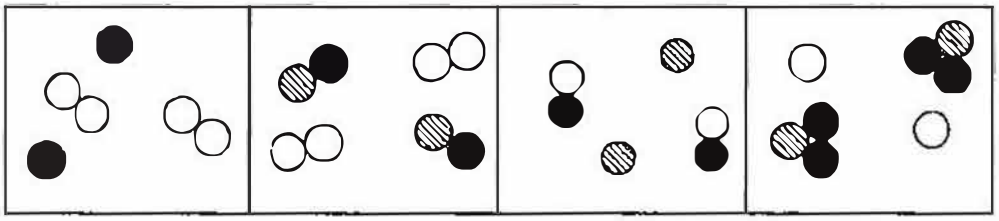
melting point	:	85 °C
boiling point	:	130 °C
solubility in water	:	high

Which apparatus can be used to separate pure P from a mixture of P and water at room temperature?

A B C D



7 Which diagram best represents a mixture of neon and hydrogen bromide?



A B C D

8 Fullerene was discovered in 1985. It is a perfect sphere with the chemical formula C_{60}. From this information, what can be deduced about the structure of fullerene?

A It contains only one element.

B It is a compound of 60 elements.

C It is a mixture of 60 atoms.

D It is a mixture of 60 elements.

9 An element **X** has two isotopes of 16 and 18. Its relative atomic mass is 16.4. Which statement correctly states the proportion of isotope-16 in the sample?

A 20 %
B 60 %
C 40 %
D 80 %

10 An isotope of element **Y** has 19 protons and 20 neutrons in its nucleus. Which is the symbol for the ion of **Y**?

A $^{20}_{19}Y^{+}$
B $^{39}_{19}Y^{+}$
C $^{20}_{19}Y^{-}$
D $^{39}_{19}Y^{-}$

11 The table below gives some information about particles **S** and **T**.

particle	number of protons	number of neutrons	electronic configuration
S	9	10	2,8
T	16	18	2,8,8

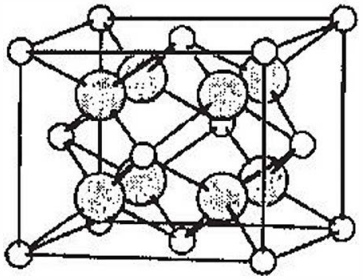
What are particles **S** and **T**?

A atoms of metals
B ions of metals
C atoms of noble gases
D ions of non-metals

12 Elements **X**, **Y** and **Z** have consecutive, increasing proton numbers. If element **X** is a noble gas, what is the symbol for the ion of element **Z** in its compounds?

A Z^{+}
B Z^{3+}
C Z^{2+}
D Z^{2-}

13 The diagram shows the structure of an ionic compound.



What is a possible formula for this compound?

A CaF_2 B SO_2

C KF D MgO

14 The table below shows some of the physical properties of some unknown substances **V**, **W**, **X** and **Y**.

substance	melting point/°C	boiling point/°C	electrical conductivity		solubility in water
			solid state	liquid state	
V	122	150	poor	poor	insoluble
W	690	1790	poor	good	soluble
X	1510	2489	poor	poor	insoluble
Y	1453	2730	good	good	insoluble

Which statement about the four substances is correct?

A Substance **V** has a simple molecular structure and it has weak intermolecular forces of attraction between its molecules.

B Substance **W** can conduct electricity because it has free mobile electrons.

C Substances **X** and **Y** are macromolecules.

D Substance **Y** has a giant molecular structure and it has strong covalent bonds between its atoms.

15 Which fertilizer has the highest percentage composition of nitrogen in a formula unit?

A NH_4NO_3 B $NaNO_3$

C $(NH_4)_3PO_4$ D $(NH_4)_2SO_4$

16 Potassium permanganate(VII) decomposes when gently heated according to the equation:

$$2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$$

When 1.65 g of a sample of impure potassium permanganate(VII) crystals is heated until no more gas evolves, the volume of oxygen gas collected under room temperature and pressure is 120 cm^3. What is the percentage purity of the crystals of potassium permanganate(VII)?

A 20 % **B** 24 % **C** 48 % **D** 96 %

17 Chlorine gas is a severe irritant to the eyes and respiratory system. The maximum safe toleration level of chlorine gas is 0.005 mg/dm^3. How many molecules of chlorine gas are present in 1 dm^3 of air at this toleration level?

A $\frac{0.005}{6\times10^{23}}\times71$

B $\frac{0.005}{1000}\times\frac{1}{71}\times6\times10^{23}$

C $\frac{0.005}{71}\times6\times10^{23}$

D $\frac{0.005}{1000}\times71\times6\times10^{23}$

18 When 0.002 mol of a metal V was reacted with an excess dilute acid, 48 cm^3 of hydrogen gas given off was measured at room temperature and pressure. Which is a correct equation for the reaction?

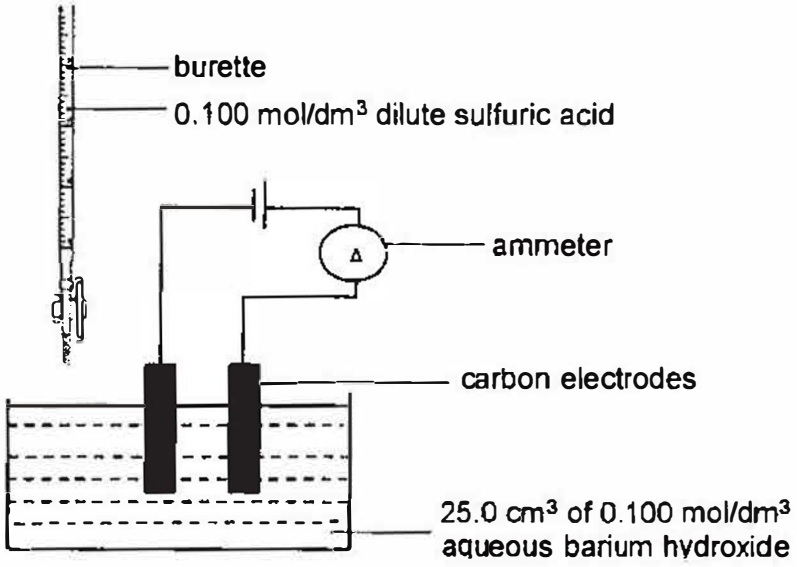
A $2V(s) + 6H^+(aq) \rightarrow 2V^{3+}(aq) + 3H_2(g)$

B $2V(s) + 2H^+(aq) \rightarrow 2V^{3+}(aq) + H_2(g)$

C $V(s) + 2H^+(aq) \rightarrow 2V^{2+}(aq) + 2H(g)$

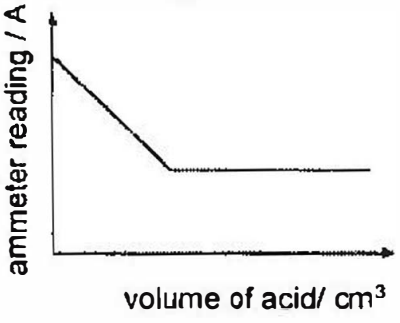
D $V(s) + 2H^+(aq) \rightarrow V^{2+}(aq) + H_2(g)$

19 In an experiment, an excess of 0.100 mol/dm^3 dilute sulfuric acid was added to 25.0 cm^3 of 0.100 mol/dm^3 aqueous barium hydroxide.

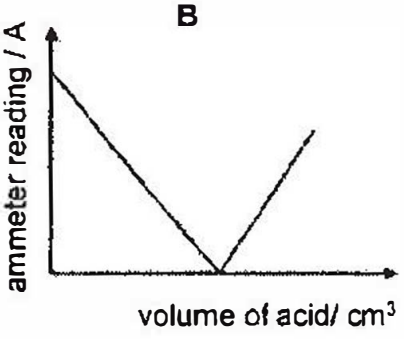


The acid was added from the burette in portions of 5.0 cm^3 until 40.0 cm^3 of the acid was added. After each addition, the solution was stirred and the ammeter reading was noted. Which graph correctly represents the relationship between the ammeter reading and the volume of acid added?

A



B



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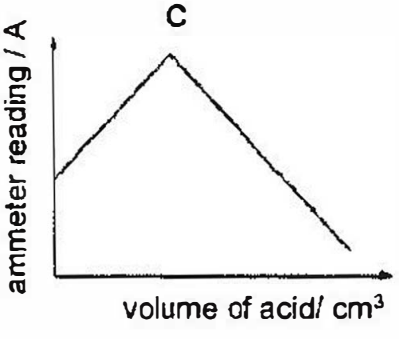
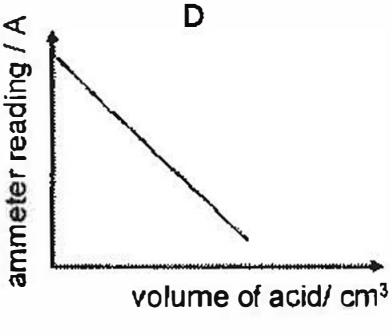


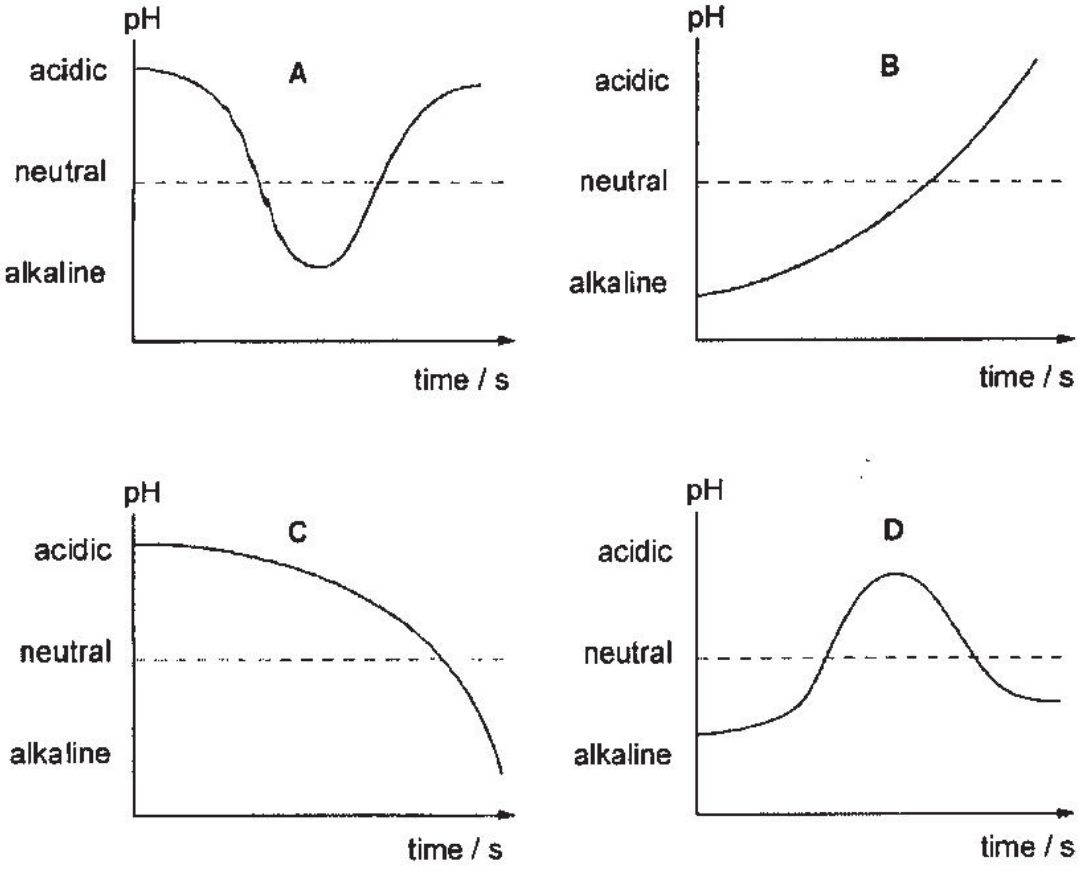
D



20 Element R reacts with oxygen to form a gas, T. T changes the colour of damp litmus paper from blue to red. T is used to kill bacteria in the preservation of dried fruit. Identify R.

A carbon
B nitrogen
C chlorine
D sulfur

21 The mouth contains saliva which is a weak alkali. When sweets containing sugar are eaten, bacteria in the mouth change the sugar into acids. Which graph best shows how the acidity in the mouth changes during and after the eating of sweets?



22 Solid **Z** was dissolved in dilute sulfuric acid to give a colourless solution and a gas that combusts with a blue flame. When aqueous ammonia solution was added to the colourless solution, a white precipitate was obtained, which dissolved in excess aqueous ammonia. The same colourless solution gave a white precipitate with barium nitrate solution. What is the identity of solid **Z**?

A calcium metal
B zinc metal
C calcium sulfate
D zinc sulfate

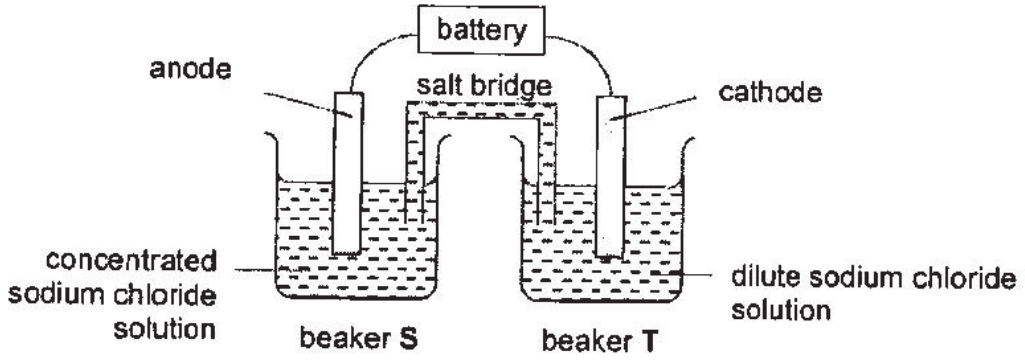
23 Disproportionation is a reaction in which the same element is both oxidised and reduced. Which reaction is an example of disproportionation?

A $3\ Cu + 8\ HNO_3 \rightarrow 3\ Cu(NO_3)_2 + 2NO + 4\ H_2O$
B $Cl_2 + 2\ NaOH \rightarrow NaCl + NaOCl + H_2O$
C $Fe_2(SO_4)_3 + 2\ KI \rightarrow 2\ FeSO_4 + K_2SO_4 + I_2$
D $2\ Pb(NO_3)_2 \rightarrow 2\ PbO + 4\ NO_2 + O_2$

24 A solid deposit of element **X** is formed at the cathode when an aqueous solution containing ions of **X** is electrolyzed. Which statement about element **X** is true?

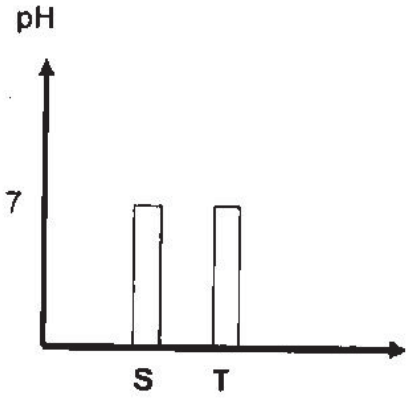
A Ions of **X** gain electrons at the cathode.
B Ions of **X** lose electrons at the cathode.
C **X** is above hydrogen in the reactivity series.
D **X** forms negative ions.

25 The following apparatus was set up as shown.

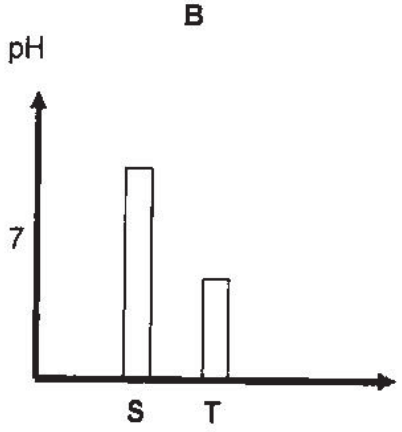


If platinum electrodes were used, which diagram shows the pH of the solution in each beaker at the end of the experiment?

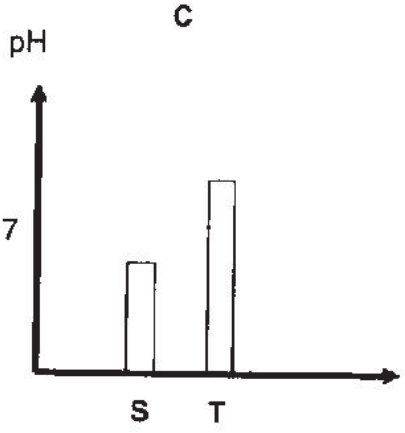
A



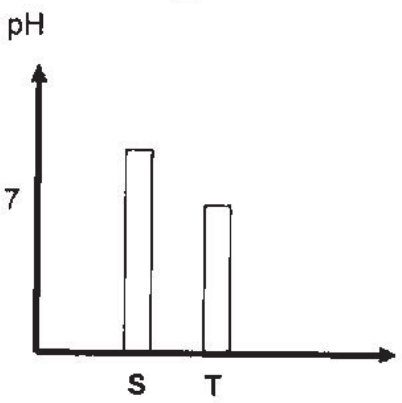
B



C



D

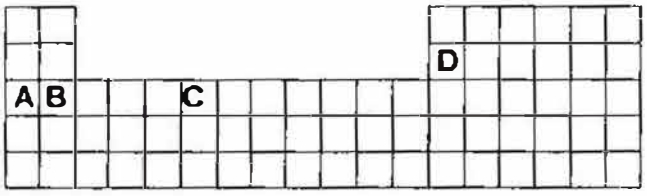


26 Elements **X** and **Y** are in Group VII of the Periodic Table. **X** is a liquid at room temperature. **Y** is a solid at room temperature. Which statement(s) is / are correct?

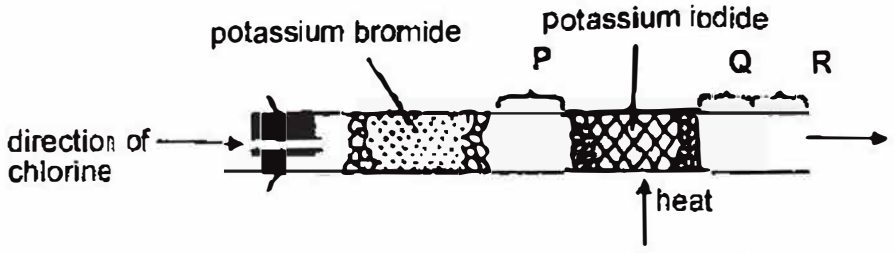
I Atoms of **Y** have more protons than atoms of **X**.
II Molecules of **Y** have more atoms than molecules of **X**.
III **Y** displaces **X** from aqueous solution of X^- ions.

A I only
B III only
C II only
D All of the above

27 The positions of four elements are shown on the outline of part of the Periodic Table. Element T has a high melting point and is a good electrical conductor. It forms chlorides TCl_2 and TCl_3. Which element is **T**?



28 Using the apparatus shown, chlorine gas was passed through the tube containing solid potassium bromide and potassium iodide. After a short time, coloured substances were seen at **P**, **Q** and **R**.



	at P	at Q	at R
A	green gas	violet vapour	black solid
B	green gas	red-brown vapour	violet vapour
C	red-brown vapour	violet vapour	black solid
D	violet vapour	red-brown vapour	red-brown vapour

29 A hand warmer bag purchased by skiers consists of powdered iron, water, salt and sawdust. When the bag is shaken, it becomes hot because the following reaction occurs:

$$4Fe\,(s) + 3O_2\,(g) \rightarrow 2Fe_2O_3\,(s) \qquad \Delta H = -823\ kJ/mol$$

Which statement is not true about the reaction above?

A The energy change involved in bond-forming is more than that in bond-breaking.

B The energy level of products is lower than that of the reactants.

C The energy level of reactants is lower than that of the products.

D The temperature of the reaction mixture increases.

30 If a strip of magnesium is dropped into excess hydrochloric acid, an exothermic reaction occurs. Why does the rate of this reaction increase during the first few seconds?

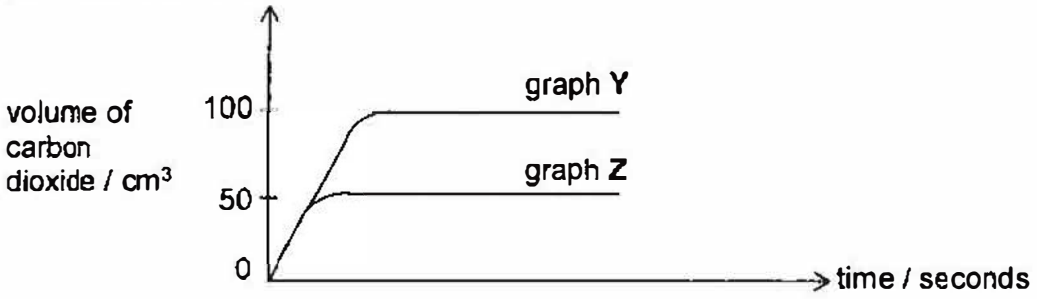
A The mass of magnesium is decreasing.

B The magnesium is acting as a catalyst.

C The solution is becoming hotter.

D The surface area of the magnesium is increasing.

31 Some crystals of sodium carbonate were added to excess sulfuric acid at room temperature. The volume of carbon dioxide produced was measured over a period of time. The results are shown in graph **Y**. The experiment was repeated and graph **Z** was obtained.



Which one change was used to obtain the results shown in graph **Z**?

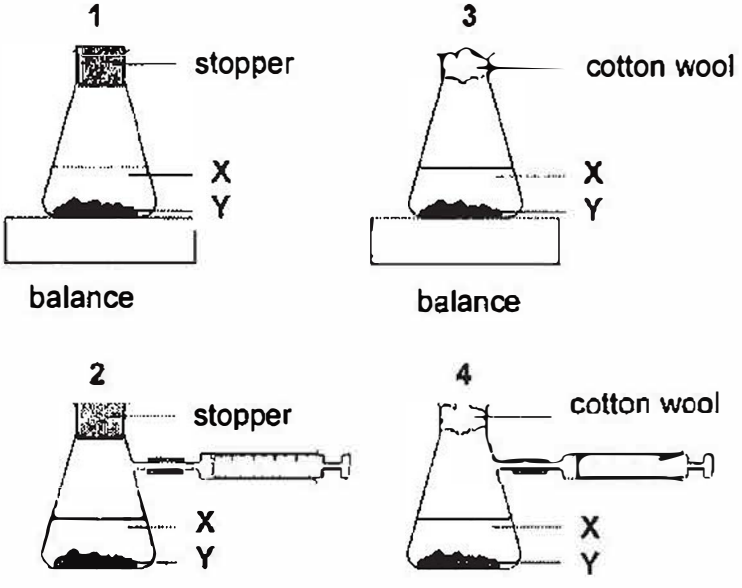
A A lower temperature was used.

B Acid of half the original concentration was used.

C Half the mass of sodium carbonate was used.

D Larger crystals of sodium carbonate were used.

32 A liquid **X** reacts with solid **Y** to form a gas. Which two diagrams show suitable methods for investigating the speed of the reaction?



A 1 and 3

B 2 and 3

C 1 and 4

D 2 and 4

33 Ammonia is produced by Haber process. Which statement is **not** correct?

A A catalyst of iron is used.

B Each hydrogen molecule reacts with three nitrogen molecules to form two molecules of ammonia.

C Hydrogen for the process can be obtained by cracking of oil.

D The reaction is reversible.

34 Which statement about the properties of ammonia is correct?

A It decomposes on heating at high temperature to form nitrogen gas and hydrogen gas.

B It dissolves in water to form an acidic solution.

C It is formed by heating ammonium salts with sulfuric acid.

D It reacts with alkalis to form salts.

35 A steel works and a chemical works are built near to a city. The limestone buildings in the city begin to crumble. Which gas is most likely to cause this damage?

A carbon monoxide

B nitrogen

C oxygen

D sulfur dioxide

36 For which property of the alkanes does the numerical value decrease as the number of carbon atoms in the homologous series of alkane molecules increases?

A density

B flammability

C number of isomers

D viscosity

37 The table shows the boiling points of four fractions, **P**, **Q**, **R** and **S**, obtained when crude oil is distilled.

fraction	P	Q	R	S
boiling range / °C	35 - 75	80 - 145	150 - 250	greater than 250

How is fraction **P** different from fraction **S**?

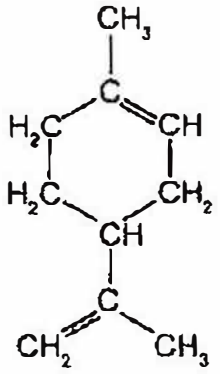
A Fraction **P** is more viscous than fraction **S**.

B Fraction **P** is in less demand than fraction **S**.

C Fraction **P** is more flammable than fraction **S**.

D Fraction **P** contains molecules of larger molecular masses than fraction **S**.

38 Liquid limonene can be extracted from oranges. Its structure is shown below.



Which statement about limonene is **not** correct?

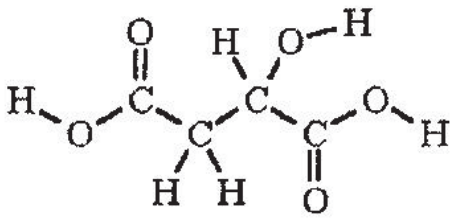
A It can be oxidised into a carboxylic acid directly in the presence of bacteria in the air.

B It is an unsaturated hydrocarbon with alkene functional group.

C It undergoes hydrogenation in the presence of nickel catalyst to form limonane.

D When it undergoes cracking, the following reaction is possible:
limonene → $C_6H_8 + C_3H_6 + CH_4$

39 Malic acid is found in unripe fruit. It was first isolated from an apple in 1785. The structural formula of malic acid is shown below.



How many moles of sodium hydroxide are needed to react completely with 1 mol of malic acid?

A 1 **B** 3

C 2 **D** 4

40 Alcohol **G** and acid **H** can react to form an ester, $C_6H_{12}O_2$. Alcohol **G** can be oxidized to acid **H** by acidified potassium dichromate(VI). What is the formula of the ester formed?

A $HCOOC_5H_{11}$

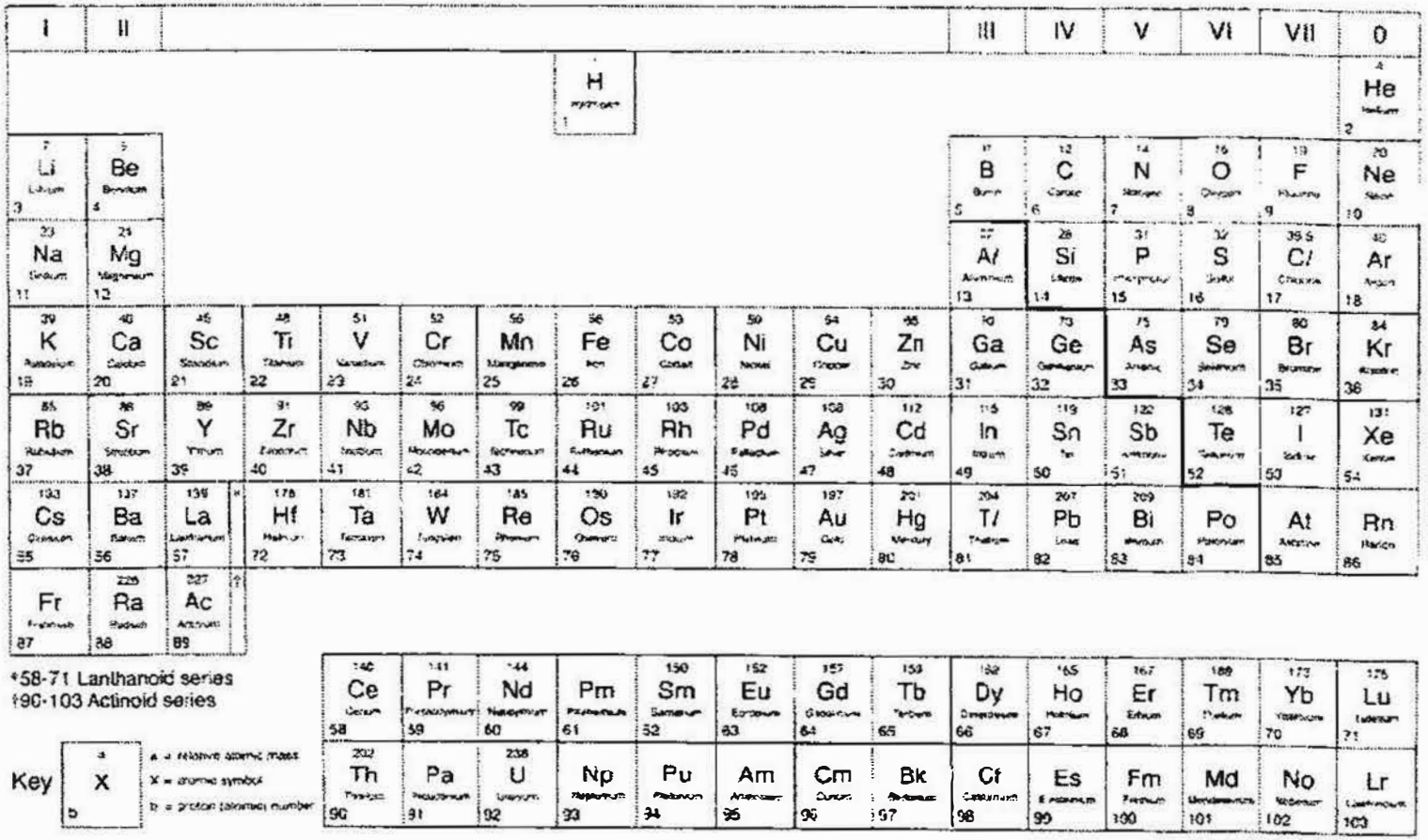
B $CH_3COOC_4H_9$

C $C_2H_5COOC_3H_7$

D $C_3H_7COOC_2H_5$

- END OF PAPER -

The Periodic Table of Elements



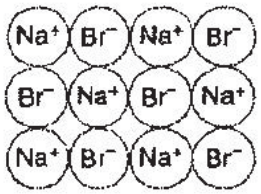
The volume of one mole of any gas is 24 dm³ at room temperature and pressure.

Section A

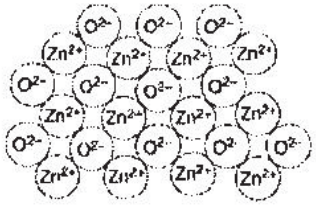
Answer **all** the questions in this section in the spaces provided.

The total marks for this section is 50.

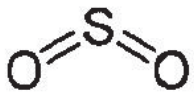
1 The diagram shows the structures of various compounds.



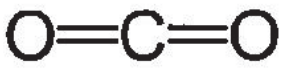
A



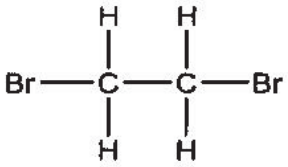
B



C



D



E

Using the letters **A** to **E**, choose the compound that is best described in the statements below. Each compound may be used once, more than once or not at all.

(a) A compound that is most likely to contribute to acid rain.

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

(b) A compound that is an amphoteric oxide.

..... [1]

(c) A compound that is a product of a substitution reaction of an alkane.

..... [1]

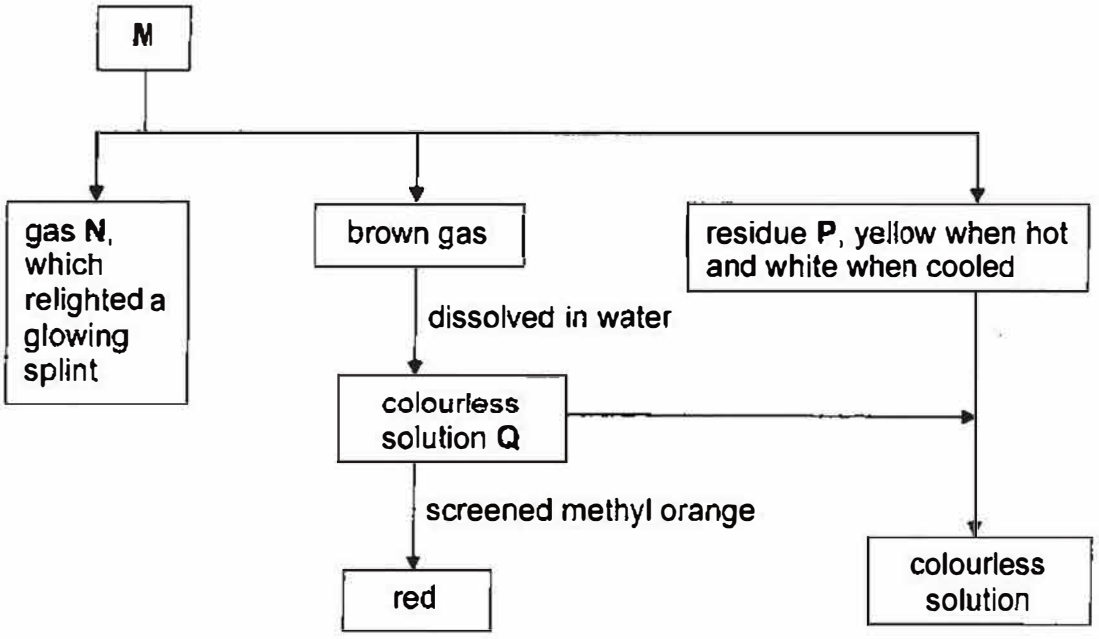
(d) A compound, in molten state, that releases a reddish-brown gas at the anode when electrolysed.

..... [1]

(e) A compound that is produced in catalytic converters of cars.

..... [1]

2 The flow diagram below shows the decomposition of compound **M**.



Identify and name the following unknown substances.

(a) (i) compound **M** : ..... [1]

(ii) gas **N** : ..... [1]

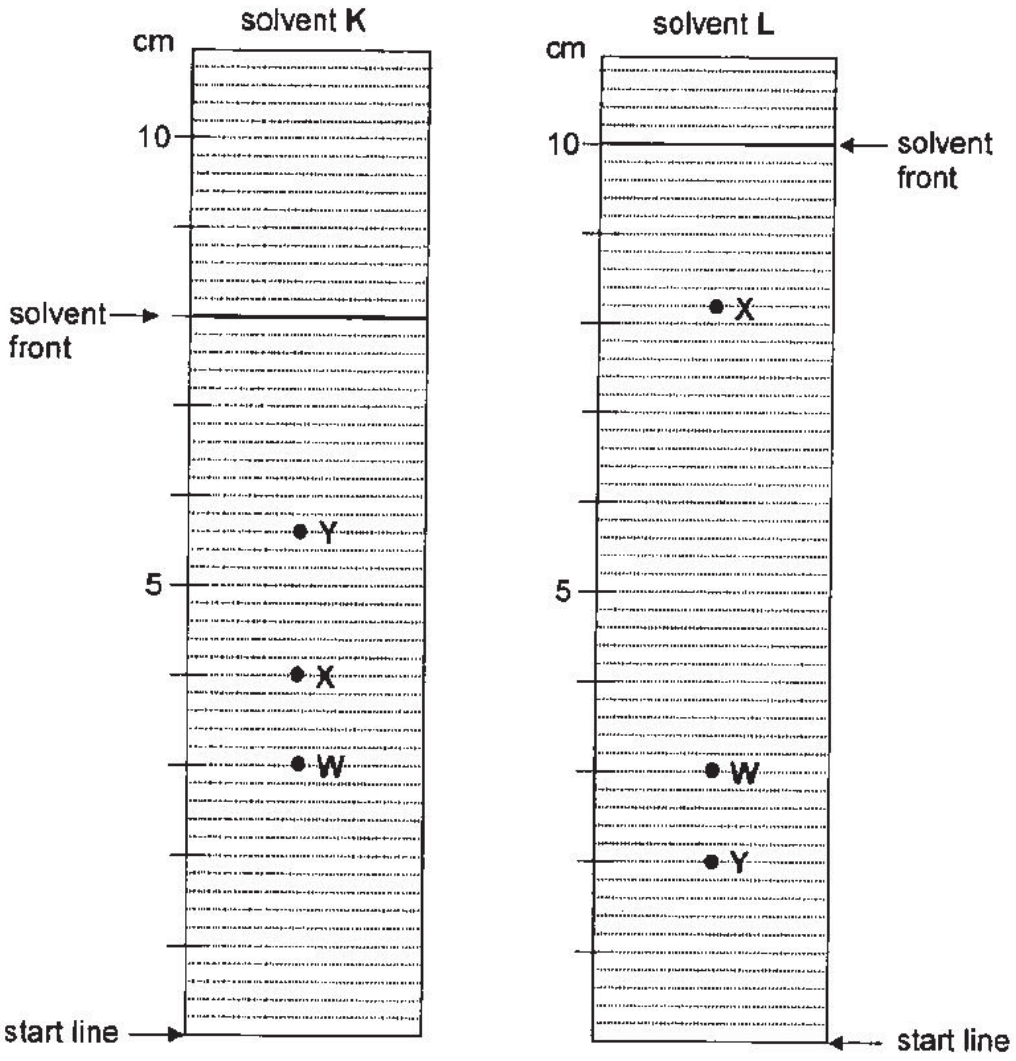
(iii) residue **P** : ..... [1]

(iv) solution **Q** : ..... [1]

(b) State the type of reaction that occurs between residue **P** and colourless solution **Q**.

..... [1]

3 Chromatography is an important tool for chemical investigation. A mixture of amino acids was separated by paper chromatography using two different solvents; **K** and **L**. After treating with a locating agent, the results are shown below. The positions of the amino acids on the two chromatograms are labelled **W**, **X** and **Y**.



(a) Suggest a reason why a locating agent was used.

.....

..... [1]

(b) Calculate the R_f value of each amino acid in each solvent and write them in the table. Your answers must be given to **2 significant figures**.

amino acid 'spot' on chromatogram	R_f value in solvent K	R_f value in solvent L
W		
X		
Y		

[2]

(c) The R_f values of a number of amino acids in the two solvents are listed below.

amino acid	R_f value in solvent K	R_f value in solvent L
glutamic acid	0.38	0.30
glysine	0.50	0.26
tyrosine	0.66	0.45
arginine	0.70	0.20
alanine	0.72	0.38

For each of the amino acids in the mixture, use the table above and the chromatography results to either name the amino acid or state that it is not in the list given.

W : .....

X : .....

Y : .....

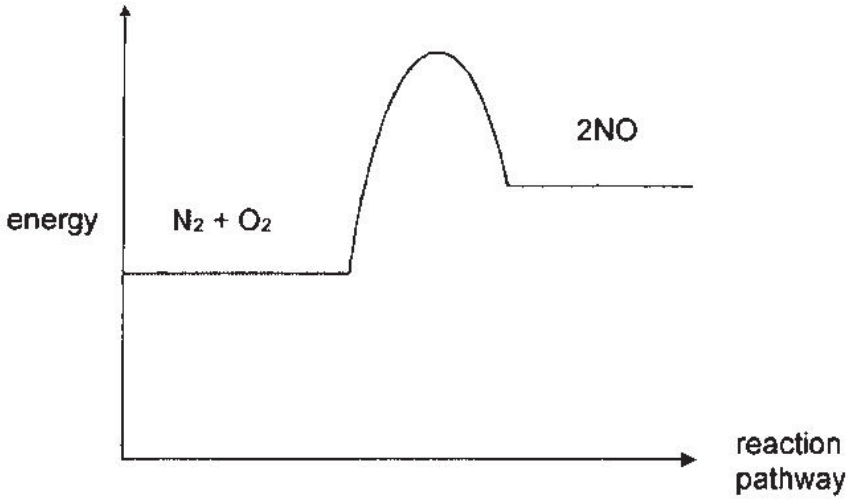
[2]

4 During a thunderstorm, lightning strikes the Eiffel Tower. In lightning, the temperature can reach 30 000 °C. This causes nitrogen and oxygen in the air to react, producing nitrogen monoxide. This reaction has high activation energy and is endothermic.

A chemical equation that represents this endothermic reaction is:

$$N_2 + O_2 \rightarrow 2NO$$

The energy level diagram for this reaction is given below.



(a) Explain how the energy level diagram shows that this reaction is endothermic.

.....

..... [1]

(b) Label activation energy (E_a) and enthalpy change (ΔH) in the diagram above. [2]

(c) The table below shows the bond energies.

bond	bond energy (kJ/mol)
N≡N	945
N–N	145
N=O	630
O=O	498

(i) Use the bond energies in the table to calculate the enthalpy change, ΔH for this reaction.

ΔH = ... kJ/mol [3]

(ii) In terms of bond forming and bond breaking, explain why this reaction is endothermic.

.....

.....

..... [1]

5 Both ethanoic acid and butanoic acid are weak acids that are found in some plants and bacteria.

(a) **(i)** Explain what is meant by *weak acid*.

.....

..... [1]

(ii) Describe a simple chemical test to show that butanoic acid is a weak acid.

.....

.....

..... [2]

(b) Butanoic acid can be converted into an ester by heating it with an alcohol and a few drops of concentrated sulfuric acid. A sample of the ester contains 0.18 g of carbon, 0.03 g of hydrogen and 0.08 g of oxygen. The relative molecular mass of the ester is 116.

(i) Find the empirical formula of this ester.

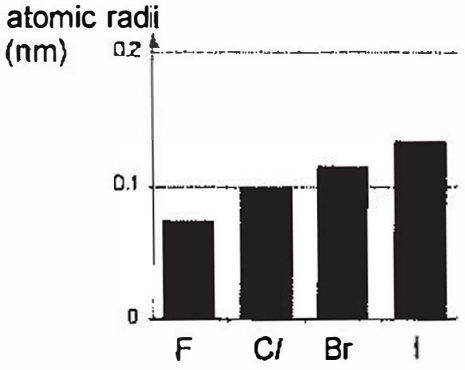
[2]

(ii) Hence, deduce the full structural formula of the ester.

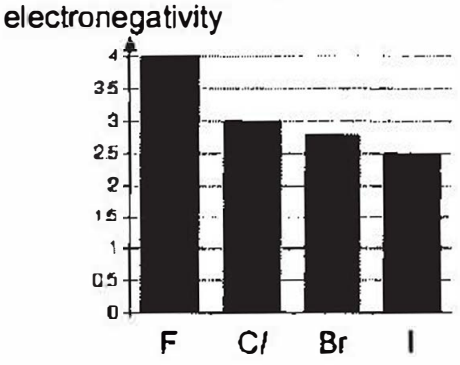
[2]

6 The graphs below show some properties of Group VII elements, the halogens. **Graph 1** shows the atomic radii and **Graph 2** shows the electronegativity of the Group VII elements. Electronegativity is a measure of the tendency of an atom to attract a bonding pair of electrons. It is usually measured on the Pauling scale, on which the most electronegative element is given an electronegativity of 4.0.

Graph 1



Graph 2



(a) Using your knowledge on atomic structure, state and explain the trend seen in **Graph 1**.

.....

.....

..... [2]

(b) Use the information from **Graph 2** to explain the reactivity of the halogens on going down the group.

.....

.....

..... [2]

(c) Write a balanced chemical equation for the reaction when chlorine gas is passed through colourless potassium bromide solution.

..... [1]

(d) Draw a dot and cross diagram to show the bonding in potassium bromide, showing only the valence electrons.

[2]

7 Poly(butene) is a polymer made from crude oil in two stages.

(a) The first stage in making poly(butene) is to break down large hydrocarbon molecules from crude oil into smaller hydrocarbon molecules, as shown below.

$$C_{16}H_{34} \longrightarrow C_8H_{18} + C_4H_8 + 2C_2H_4$$

(i) Name the process where poly(butene) is broken down into smaller hydrocarbon molecules.

..... [1]

(ii) The products contain two types of hydrocarbon with different general formulae. Name one type of hydrocarbon.

..... [1]

(iii) Suggest a reason why air cannot be introduced in this reaction.

..... [1]

(iv) The labels on the bottles of C_4H_8 and C_4H_{10} are missing. Describe, how to distinguish, the two substances.

.....

..... [2]

(b) The second stage is to use butene to produce poly(butene).

(i) Draw the structural formula of a butene molecule.

[1]

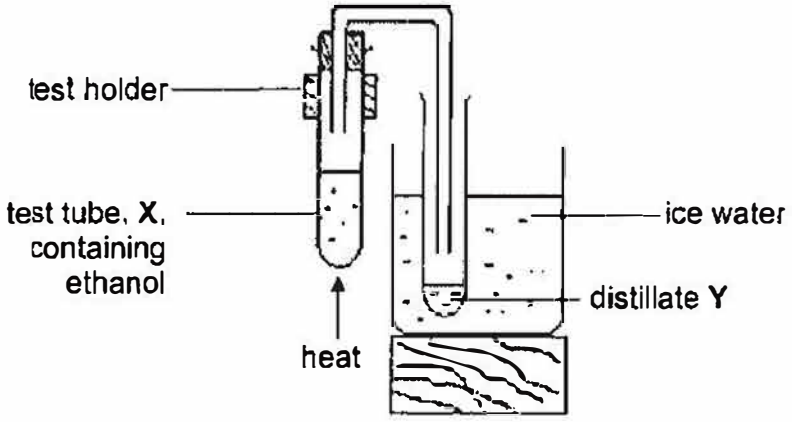
(ii) Describe how molecules of butene form poly(butene).

.....

.....

..... [2]

8 The set up below shows a test tube containing ethanol being heated.



(a) 5 cm^3 of acidified potassium manganate is added to test-tube **X**.

(i) State the colour change observed in test tube **X** when acidified potassium manganate is added.

..... [1]

(ii) Name the type of reaction taking place in test-tube **X** when acidified potassium manganate is added.

..... [1]

(b) Name distillate **Y** and draw its full structural formula.

Name: ..... [1]

Full structural formula:

[1]

(c) State two chemical properties of distillate **Y**.

.....

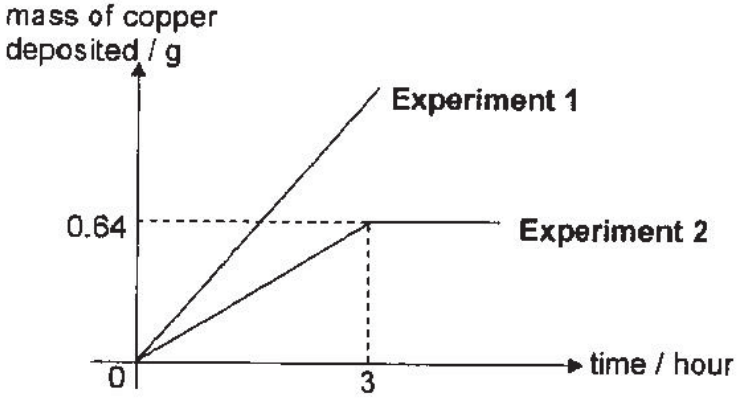
..... [2]

Section B

Answer **all three** questions in this section in the spaces provided.
The last question is in the form of either/or and only one of the alternatives should be attempted.

The total marks for this section is 30.

1 Harry carried out two separate experiments in the laboratory for 3 hours. In each experiment, he electrolysed 2 dm^3 of aqueous copper(II) sulfate containing 0.64 g of copper(II) ions. The two solid electrodes were placed the same distance apart in each experiment. The diagram below shows the results of the two experiments. After 3 hours, there was no more solid deposited in **Experiment 2**.



(a) (i) Two different electrodes, carbon electrode and copper electrode were used in these two experiments. State the electrode used in each experiment.

Experiment 1: .....

Experiment 2: ..... [1]

(ii) Using your answer to (ii), explain the shape of the 2 graphs.

.....

.....

..... [3]

(b) Write a balanced chemical equation, with state symbols, for the reaction happening at the anode and cathode for **Experiment 1**. [2]

Anode: .....

Cathode: .....

(c) Describe what would be observed when Universal indicator was added to electrolytic cell of **Experiment 2** after three hours. Explain your answer.

.....

.....

..... [2]

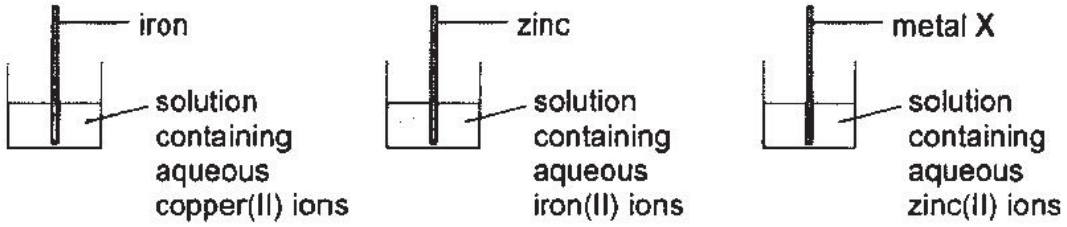
(d) The overall equation for **Experiment 2** is as follows:

$$2Cu^{2+}\,(aq) + 4OH^{-}\,(aq) \rightarrow 2Cu\,(s) + 2H_2O\,(l) + O_2\,(g)$$

Calculate the volume of oxygen gas produced at the end of three hours.

volume of oxygen gas = ... dm^3 [2]

2 A student investigated the reactivity of four metals; iron, copper, zinc and metal **X**. He set up three experiments as shown below.



Experiment 1 **Experiment 2** **Experiment 3**

(a) In **Experiment 1**, the student sees changes happen to both the iron rod and the solution.

(i) Describe the changes that the student sees.

.....

..... [1]

(ii) Explain why these changes occur.

.....

.....

..... [2]

(b) The student observes that a reaction happens in all the three experiments.

(i) Arrange the four metals in **increasing** order of reactivity.

..... [1]

(ii) Explain your reasoning for such an arrangement in **(b)(i)**.

.....

..... [2]

(iii) Suggest an identity for metal **X**.

..... [1]

(c) The student decides to investigate the thermal stability of the carbonates of the four metals. He heats each metal carbonate in a test tube and bubbles the gas produced into limewater.

(i) Describe what he would observe in limewater.

..... [1]

(ii) Describe how he could use the results obtained to place the metal carbonates in order of thermal stability.

.....

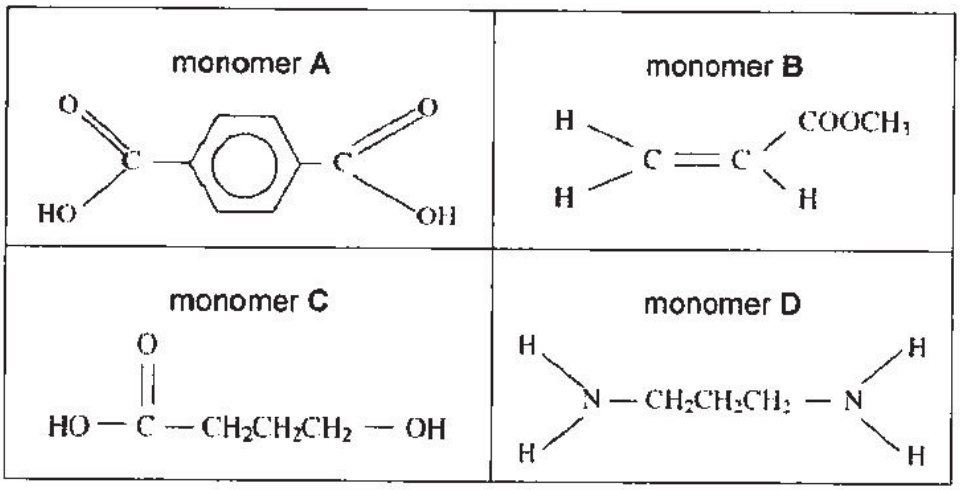
.....

.....

..... [2]

3 Either

The diagrams below show four monomers, **A** to **D**.



(a) Monomer **B** was formed by reacting $CH_2CHCOOH$ with another compound, **X**. State the conditions of the reaction and the name of compound **X**.

Conditions: ..... [1]

Compound **X**: ..... [1]

(b) **(i)** State the monomer that can be used to produce a polymer by itself via condensation polymerisation.

..... [1]

(ii) State the monomer that will undergo polymerisation without a change in percentage composition. Explain your answer.

.....

.....

.....

..... [2]

(c) (i) Using two monomers from above, draw a repeat unit of the polymer formed, which has the same linkages as those found in nylon.

[1]

(ii) Give a reason why the polymer formed in (c)(i) should not be disposed by burning.

.....

..... [1]

(d) A student has three solutions containing monomers **A** to **C** each. Describe chemical tests the student could do to identify the three solutions.

.....

.....

.....

.....

.....

..... [3]

3 Or

In the recent years, the build-up of greenhouse gases has been one of the greatest environmental concerns. The table below compares the effects of some of these greenhouse gases.

gas	heat trapping effectiveness compared to CO_2	overall contribution to increased global warming (%)	percentage abundance of gas / dm^3
carbon dioxide	1	50	0.03
methane	30	18	0.00017
ozone (at ground level)	2000	14	0.000004
CFCs	10000 - 25000	12	0.000004

(a) (i) Draw a dot and cross diagram to show the bonding in $CFCl_3$, showing only the valence electrons.

[2]

(ii) State whether $CFCl_3$ has a high or low boiling point. Explain your answer, referring to the bonding in $CFCl_3$.

.....

.....

..... [2]

(b) Describe the trend between the gases' heat trapping effectiveness and its contribution to global warming.

.....

..... [1]

(c) Though CFCs are thousands of times better at absorbing heat than carbon dioxide, their effect on global warming is low compared to carbon dioxide. Suggest why.

.....

..... [1]

(d) Flue gases containing acidic gases are produced in power stations as oil and coal are burnt to produce electricity. Sulfur dioxide is one such pollutant.

(i) A certain chemical can be lined on the chimneys of power stations to reduce the amount of sulfur dioxide released. Suggest the name of the chemical.

..... [1]

(ii) Write a balanced chemical equation to represent the reaction that takes place in **(d)(i)**.

..... [1]

(iii) 60 dm^3 of sulfur dioxide was released from the chimney. Calculate the mass of the chemical suggested in **(d)(i)** needed to react.

mass of substance = ... g [2]

- END OF PAPER -

ASSUMPTION ENGLISH SCHOOL
Preliminary Examination 2015
Pure Chemistry 5073 – Marking Scheme

PAPER 1: (40 marks)

1	C	11	D	21	D	31	C
2	D	12	C	22	B	32	B
3	D	13	A	23	B	33	B
4	B	14	A	24	A	34	A
5	A	15	A	25	D	35	D
6	B	16	D	26	A	36	B
7	C	17	B	27	C	37	C
8	A	18	D	28	C	38	A
9	D	19	B	29	C	39	C
10	B	20	D	30	C	40	C

PAPER 2
SECTION A: (50 marks)

1	(a)	C		[1]
	(b)	B		[1]
	(c)	E		[1]
	(d)	A		[1]
	(e)	D		[1]
2	(a)	(i)	Zinc nitrate	[1]
		(ii)	Oxygen	[1]
		(iii)	Zinc oxide	[1]
		(iv)	Nitric acid	[1]
	(b)	Neutralization		[1]

3 (a) Amino acids are colourless, thus a locating agent is required to react with the amino acids and make it visible/identify it. **[1]**

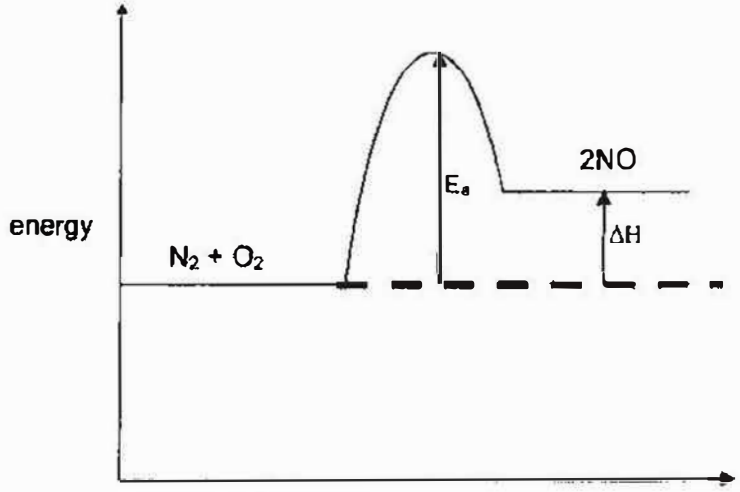
Stating colourless is not sufficient!

(b)

amino acid 'spot' on chromatogram	R_f value in solvent K	R_f value in solvent L
W	0.38	0.30
X	0.50	0.82
Y	0.70	0.20

[2]

All 6 correct – award 2 marks
3/4/5 correct – award 1 mark

	(c)		**W**: Glutamic acid **X**: Not in the list **Y**: Arginine All 3 correct – award 2 marks 2 correct – award 1 mark	[2]
4	(a)		The energy level of the products is higher than that of the reactants, showing that energy is taken in. [Reject if answer is in terms of bond breaking of reactants and bond forming of products]	[1]
	(b)		 Each correct labelling – 1 mark	[2]
	(c)	(i)	Energy taken in for bond breaking = 945 + 498 = +1443 kJ Energy given out for bond forming = 2(-630) = -1260 kJ ΔH reaction = ΔH bond breaking + ΔH bond forming = 1443 – 1260 = +183 kJ Deduct 1 mark overall for following: - $\Delta H_{bond\ forming}$ or $\Delta H_{bond\ breaking}$ without signs - No units	[1] [1] [1]
		(ii)	The **energy absorbed in bond breaking** of N≡N and O=O bonds is greater than the **energy released in bond making** of N=O bonds. **cannot write: needed, used, required (too general)**	[1]

5 (a) (i) A weak acid is a substance that dissociates/ionises partially in water to release hydrogen ions. **[1]**

Do not award mark if hydrogen ions are not in answer.

No such thing as dissociate incompletely!!

(ii) Compare rate of effervescence for metal dissolving in butanoic acid and any named strong acid and indicating observation for butanoic acid.

When a strip of zinc metal (can be any reactive metal) is dissolved in butanoic acid, the rate of effervescence / volume of effervescence produced would be less than that of a strip of zinc metal in hydrochloric acid. **[1]**

Deduct **1** mark if bubbles are used. **Strict use of effervescence only.** **[1]**

Simple chemical test!!!
Universal Indicator is not chemical test!

(b) (i)

	C	H	O
mass /g	0.18	0.03	0.08
mr	12	1	16
no. of moles	$\frac{0.18}{12} = 0.015$	$\frac{0.03}{1} = 0.03$	$\frac{0.08}{16} = 0.005$
simplest ratio	$\frac{0.015}{0.005} = 3$	$\frac{0.03}{0.005} = 6$	$\frac{0.005}{0.005} = 1$

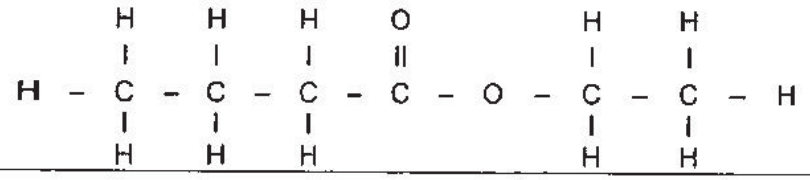
[1]

empiricial formula: C_3H_6O **[1]**

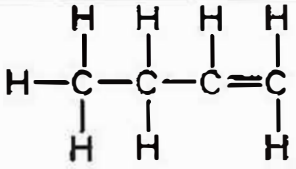
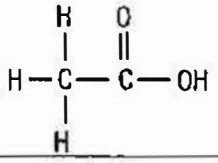
(ii) Let the molecular formula of the ester be $(C_3H_6O)_n$

Mr = 3n(12) + 6n(1) + 16n
116 = 36n + 6n + 16n = 58n
n = 2

Molecular formula = $C_6H_{12}O_2$ **[1]**



[1]

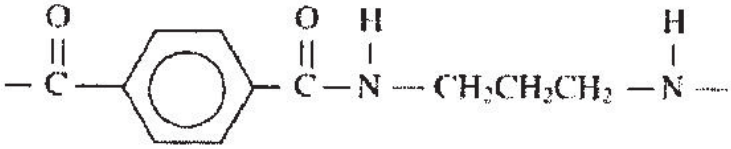
6	(a)		The atomic radii <u>increase</u> down the group. As the number of electrons increases, <u>more electron shells</u> are required to 'house' the electrons, thus creating a bigger atom.	[1] [1]
	(b)		As seen in Graph 2, the electronegativity <u>decreases</u> on going down the group. <u>The ability of attraction of another electron from other atom decreases on going down the group</u>. Hence, the decrease in electronegativity leads to the <u>decrease in reactivity down the group</u>. **Trend and reason must tally!** **No mark for just stating electronegativity decreases. READ question. It is about reactivity!!**	[1] [1]
	(c)		$Cl_2 + 2\ KBr \rightarrow 2\ KCl + Br_2$ (state symbols not required)	[1]
	(d)		correct number of electrons in cation K^+ correct number of electrons in bromide Br^-	[1] [1]
7	(a)	(i)	Cracking	[1]
		(ii)	Alkanes **<u>OR</u>** Alkenes	[1]
		(iii)	The hydrocarbons would undergo combustion with oxygen.	[1]
		(iv)	Add aqueous bromine/bromine solution/bromine water to separate test tubes containing butane and butene. The test tube with butene will decolourise aqueous reddish brown bromine.	[1] [1]
	(b)	(i)	 Accept alternate structures (2nd C = 3rd C)	[1]
		(ii)	Under a <u>high pressure</u> and <u>high temperature</u> in the presence of a catalyst, the <u>carbon carbon double bond</u> in butane is <u>broken</u> to form poly(butene).	[1] [1]
8	(a)	(i)	Purple to colourless	[1]
		(ii)	Oxidation	[1]
	(b)		Name: Ethanoic acid Structural formula: 	[1] [1]

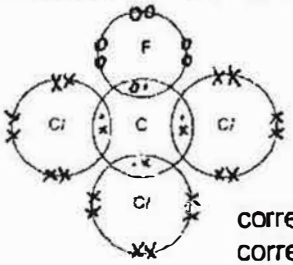
	(c)	It can react with metal to form salt and hydrogen gas. It can react with metal carbonates to form salt, carbon dioxide gas and water. It can react with base to form salt and water. It can react with alcohol to produce sweet smelling liquid (ester). Any two answers	[2]

SECTION B: (30 marks)

1.	**(a)**	**(i)**	Experiment 1: copper Experiment 2: carbon Both must be correct to be awarded 1 mark.	**[1]**
		(ii)	Experiment 1 uses copper anode, reaction continues and copper(II) ions are reduced at the cathode as long as the anode is not used up. Experiment 2 uses an inert electrode, the copper(II) ions from the electrolyte is oxdised to form copper at the cathode. When all the copper ions in the electrolyte are discharged, the reaction stops. This explains why reaction stops when about 0.6g of copper is deposited.	**[1]** **[1]** **[1]**
	(b)		Anode: $Cu\ (s) \rightarrow Cu^{2+}\ (aq) + 2e$ Cathode: $Cu^{2+}\ (aq) + 2e \rightarrow Cu\ (s)$ State symbols must be given.	**[1]** **[1]**
	(c)		The resulting solution would turn the indicator red. The resulting solution contains H^+ (hydrogen ions) that causes it to be acidic and turn U.I. red.	**[1]** **[1]**
	(d)		No. of moles of oxygen = (0.64 ÷ 64) ÷ 2 = 0.005 Volume of oxygen = 0.005 × 24 =0.12 dm^3	**[1]** **[1]**

2.	**(a)**	**(i)**	Blue solution turns green. A pink solid is deposited on the rod.	**[1]**
		(ii)	The more reactive iron metal displaces the less reactive copper ions from the solution. The solution turns green due to iron(II) ions. A pink solid is formed due to copper metal.	**[1]** **[1]**
	(b)	**(i)**	Copper , Iron, Zinc, X	**[1]**
		(ii)	Experiment 2 shows that zinc is more reactive than iron. Experiment 3 shows that X is more reactive than zinc. Thus the reactivity is such: Copper, Iron, Zinc, X.	**[1]** **[1]**
		(iii)	K/Na/Ca/Mg/Al Name or formula can be accepted.	**[1]**
	(c)	**(i)**	A white precipitate will be formed.	**[1]**
		(ii)	The more reactive a metal, the more difficult it is to decompose its carbonate by heat. Hence the test tube that forms the least volume of gas in a given time contains the metal carbonate of the most reactive metal. OR Hence the test tube that takes the longest time for bubbles to stop forming contains the metal carbonate of the most reactive metal.	**[1]** **[1]**

3E	(a)	Conditions: Warm / Heat with concentrated sulfuric acid Compound **X**: methanol (no formula to be accepted)		[1] [1]
	(b)	(i)	Monomer **C**.	[1]
		(ii)	Monomer **B** contains carbon-carbon double bonds (C = C) bonds needed to undergo addition reaction to form polymers without losing small molecules in the polymerisation process.	[1] [1]
	(c)	(i)		[1]
		(ii)	Burning of the polymer results in nitrogen dioxide that causes acid rain Production harmful air pollutants to the environment. Any logical reason related to environmental issues. **Don't write harmful. Give identity of gas and its effect.**	[1]
	(d)	Heat the three solutions with acidified potassium dichromate(VI). If orange potassium dichromate(VI) turns green, the solution contains monomer **C**. Add aqueous bromine to the remaining two solutions. If reddish brown aqueous bromine decolourises rapidly, the solution contains monomer **B**. Add magnesium / sodium carbonate to the remaining solution. If effervescence is observed, the solution contains monomers **A**.		[1] [1] [1]

3 Or	(a)	(i)	 correct number of bonding electrons – 1mark correct number of non-bonding electrons – 1 mark	[2]
		(ii)	It will have a low boiling point. Little amount of energy is required to overcome the weak intermolecular forces of attraction/van der waals' forces between the molecules.	[1] [1]
	(b)	The gas with the smallest heat trapping effectiveness has the greatest contribution towards global warming.		[1]
	(c)	CFCs are present in the atmosphere at low percentages.		[1]
	(d)	(i)	calcium carbonate /limestone **OR** calcium oxide/lime	[1]
		(ii)	$SO_2 + CaCO_3 \rightarrow CaSO_3 + CO_2$ **OR** $SO_2 + CaO \rightarrow CaSO_3$	[1]
		(iii)	No. of moles of $SO_2 = 60 \div 24$ $= 2.5$ No. of moles of $CaCO_3 = 2.5$ Mass of $CaCO_3$ needed $= 2.5 \times (40 + 12 + 3 \times 16)$ $= 250g$ **OR** No. of moles of $CaO = 2.5$ Mass of CaO needed $= 2.5 \times (40 + 16)$ $= 140g$	[1] [1] **OR** [1]