Name:	Index Number:	Class:

HUA YI SECONDARY SCHOOL

Mid Year Examination 2018

4E **4E**

CHEMISTRY **6092/1**

Paper 1 9 May 2018

1 hour

Candidates answer on the Multiple Choice Answer Sheet provided.
Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you have done.
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

A copy of the Periodic Table is printed on page 15.

For Examiner's Use	
Paper 1	

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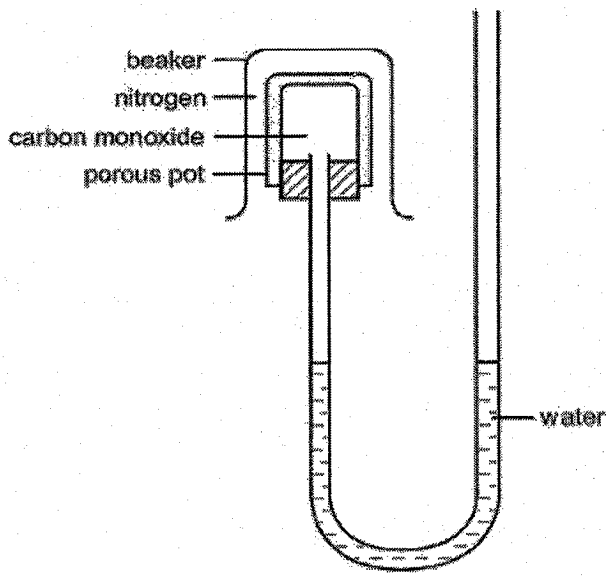
[Turn Over

Setter: Ms Tok Peilin

1 When iodine crystals were heated in a test tube, the iodine sublimed. How did the movement of the iodine particles change?

A particles slide over one another → particles move freely
B particles slide over one another → particles vibrate about fixed positions
C particles vibrate about fixed positions → particles move freely
D particles vibrate about fixed positions → particles slide over one another

2 A beaker of nitrogen is inverted over a porous pot containing carbon monoxide as shown.



The water level does **not** change.

Which statement is correct?

A Both gases are diatomic.
B Nitrogen is an unreactive gas.
C The gas particles are too large to pass through the porous pot.
D The two gases have the same relative molecular mass.

3 In which of the following do both gases change the colour of damp red litmus paper?

A ammonia and chlorine
B ammonia and sulfur dioxide
C carbon dioxide and chlorine
D carbon dioxide and sulfur dioxide

4 A solid can be purified by crystallisation from its aqueous solution.

Which of the following properties does the solid have?

A It dissolves in cold water, but not in hot water.
B It is equally soluble in hot and cold water.
C It is more soluble in hot water than in cold water.
D It is very soluble in cold water.

5 The table shows some information about the solubilities of three solids.

solid	solubility in water	solubility in propanol
P	insoluble	soluble
Q	soluble	insoluble
R	insoluble	insoluble

The following operations could be carried out to obtain pure P from a mixture of P, Q and R.

1 evaporate filtrate to dryness
2 add propanol
3 filter
4 add water
5 collect residue

In what order should the operations be carried out?

A 2, 3, 4, 5, 1
B 2, 3, 5 only
C 4, 1, 2, 3 only
D 2, 3, 1 only

6 An element E forms a negative ion, E^{2-}, with the electronic structure 2,8,8.
What is the proton number of E?

A 16
B 17
C 18
D 20

7 Which statements correctly describes the properties of mixtures of iron and sulfur, and the compound iron(II) sulfide, FeS?

	mixtures of iron and sulfur	compound iron(II) sulfide
1	iron and sulfur mix without chemically reacting	iron and sulfur combine in a chemical reaction to form iron(II) sulfide
2	the ratio of iron to sulfur in mixture can vary	the ratio of iron to sulfur in iron(II) sulfide is always the same
3	the mixtures do not have the properties of iron or sulfur	iron(II) sulfide has the properties of iron and sulfur

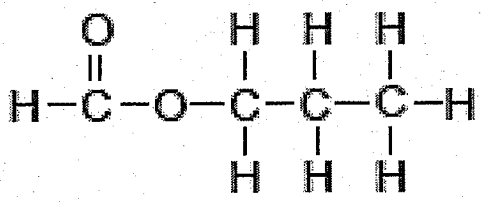
A 1 only
B 1 and 2
C 2 and 3
D 3 only

8 Deuterium (chemical symbol D) is an isotope of hydrogen. An atom of deuterium contains one neutron.

Which of the following statements is **not** true?

A An atom of deuterium is heavier than an atom of hydrogen.
B An atom of deuterium has a relative atomic mass of 1.
C An atom of deuterium has one valence electron.
D The formula of the compound formed between deuterium and oxygen is D_2O.

9 The diagram shows the structural formula of propyl methanoate.



What is the total number of electrons that are **not** involved in chemical bonding in the molecule?

A 8
B 14
C 20
D 28

10 The table shows four elements W, X, Y and Z with their atomic numbers.

element	W	X	Y	Z
atomic number	6	8	11	17

What are the likely formulae of ionic compound and covalent compound formed from the four elements?

	formula of ionic compound	formula of covalent compound
A	W X	YZ
B	Y_2X	WX_2
C	YW	WZ_4
D	YZ	ZX

11 Which particles are responsible for the conduction of electricity through metals?

A electrons only
B electrons and positive ions
C negative ions only
D negative ions and positive ions

12 The table shows some of the physical properties of P, Q, R and S.

substance	melting point / °C	boiling point / °C	electrical conductivity		solubility in water
			solid	liquid	
P	122	550	poor	poor	insoluble
Q	690	1790	poor	good	soluble
R	1510	2489	poor	poor	insoluble
S	1453	2730	good	good	insoluble

Which of the following statements about the four substances is correct?

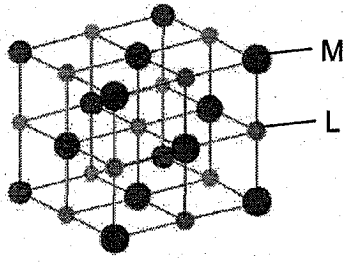
A P is a simple molecular compound held by weak covalent bonds.
B Q is an ionic compound with mobile electrons in the liquid state.
C R is a macromolecule held by strong electrostatic forces of attraction between ions.
D S has a giant lattice structure with mobile electrons.

13 The melting points of magnesium oxide and calcium oxide are given below.

metal oxide	melting point/ °C
magnesium oxide	2852
calcium oxide	2572

A The charge of the calcium ion is higher than that of the magnesium ion.
B The charge of the magnesium ion is higher than that of the calcium ion.
C The radius of the calcium ion is smaller than that of the magnesium ion.
D The radius of the magnesium ion is smaller than that of the calcium ion.

14 Element L and M form a compound which has a structure shown below.



Based on the structure shown above, deduce the chemical formula of the compound formed between element L and M.

A LM
B L_2M
C LM_2
D $L_{14}M_{13}$

15 When sugar, $C_{12}H_{22}O_{11}$, (M_r = 342) is fermented using yeast, the following reaction takes place.

$$C_{12}H_{22}O_{11}(s) + H_2O(l) \rightarrow 4C_2H_5OH(aq) + 4CO_2(g)$$

1kg of sugar is completely fermented.

Which expression shows the volume of carbon dioxide produced?

A $\frac{342 \times 4 \times 24}{1000}$ dm^3

B $\frac{1000 \times 24}{342 \times 4}$ dm^3

C $\frac{342 \times 24}{1000 \times 4}$ dm^3

D $\frac{1000 \times 4 \times 24}{342}$ dm^3

16 A sample of nitrogen gas contains the same number of atoms as found in 4.00 g of methane gas.

What is the mass of the sample of nitrogen gas?

A 7.00 g
B 14.0 g
C 17.5 g
D 35.0 g

17 In an experiment carried out at room conditions, 1.0 dm^3 of carbon dioxide was collected when an excess of dilute hydrochloric acid was added to 5.0 g of calcium carbonate.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

What is the percentage yield of carbon dioxide gas?

A 4.16%
B 12.0%
C 41.6%
D 83.3%

18 What is the total volume of gas, measured at room temperature and pressure, that remains if 20 cm^3 of sulfur dioxide reacts with 20 cm^3 of oxygen to form sulfur trioxide?

$$2SO_2\,(g) + O_2\,(g) \rightarrow 2SO_3\,(g)$$

A 10 cm^3
B 20 cm^3
C 30 cm^3
D 60 cm^3

19 An excess sample of an alloy, containing two metals, was dissolved in dilute sulfuric acid. Aqueous sodium hydroxide was then added to the solution. A precipitate was formed. An excess of the alkali caused the mass of the precipitate to decrease leaving a dirty green solid and a colourless solution.

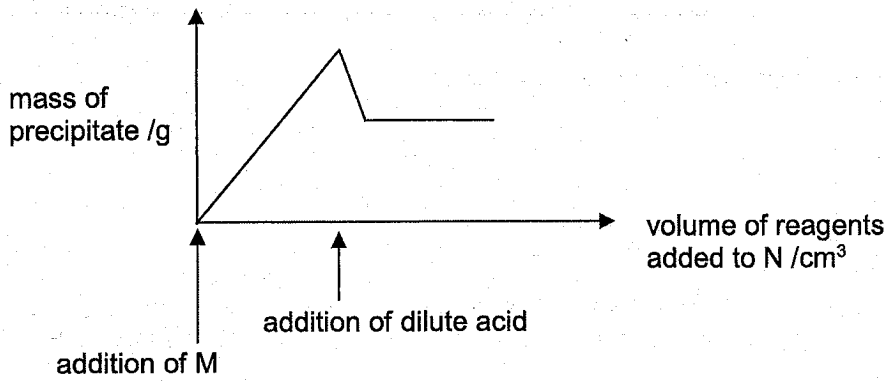
What were the two metals present in the alloy?

A calcium and zinc
B copper and iron
C copper and lead
D iron and zinc

20 Which equation shows the most suitable reaction for the production of lead(II) sulfate in the school laboratory with good yield?

A $Pb + H_2SO_4 \rightarrow PbSO_4$
B $Pb(OH)_2 + H_2SO_4 \rightarrow PbSO_4 + 2H_2O$
C $Pb(NO_3)_2 + H_2SO_4 \rightarrow PbSO_4 + 2HNO_3$
D $PbCO_3 + H_2SO_4 \rightarrow PbSO_4 + CO_2 + H_2O$

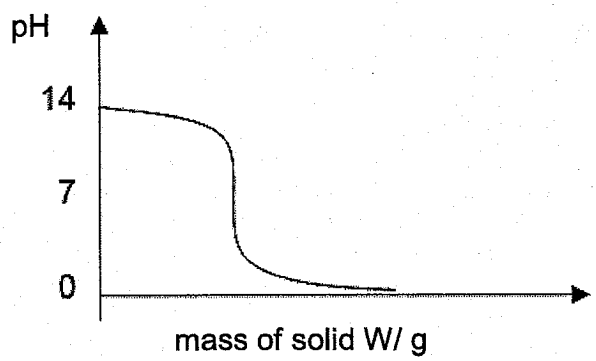
21 In a qualitative analysis, reagent M is gradually added to a salt solution N followed by the addition of a dilute acid. The graph below shows how the mass of the precipitate formed changes with the reagents added.



Which of the following set of anions would produce the given results?

	reagents (M and acid) added	anion(s) in N
A	add silver nitrate, followed by dilute nitric acid	Cl^-, CO_3^{2-}
B	add silver nitrate, followed by dilute nitric acid	I^-
C	add aqueous barium nitrate, followed by dilute hydrochloric acid	Cl^-, CO_3^{2-}
D	add aqueous barium nitrate, followed by dilute hydrochloric acid	CO_3^{2-}

22 Solid W is gradually added to solution X. The changes in pH are shown on the graph.



What are W and X?

	solution X	solid W
A	nitric acid	insoluble metal oxide
B	hydrochloric acid	soluble metal oxide
C	aqueous ammonia	soluble non-metal oxide
D	sodium hydroxide	soluble non-metal oxide

23 In which of the reactions is the underlined substance acting as a reducing agent?

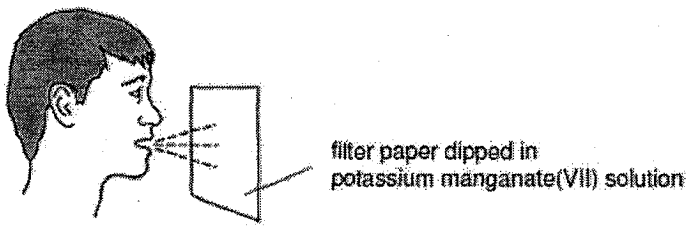
A $\underline{Cl_2} + 2FeCl_2 \rightarrow 2FeCl_3$
B $2HCl + \underline{MgO} \rightarrow MgCl_2 + H_2O$
C $H_2 + \underline{CuO} \rightarrow Cu + H_2O$
D $ZnO + \underline{CO} \rightarrow Zn + CO_2$

24 Disproportionation is a reaction in which the same element is both oxidised and reduced.

Which reaction is an example of disproportionation?

A $Cl_2 + H_2O \rightarrow HClO + HCl$
B $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$
C $Cu + 2H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2$
D $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$

25 Acidified potassium manganate(VII) can be used to detect the presence of ethanol vapour in the breath of a person who has consumed alcohol.



A colour change of the filter paper is observed.

Which of the following conclusion about ethanol is observed?

A It is a reducing agent because it reduces the oxidation state of the manganese.
B It is an alkali because the final colour is purple.
C It is an oxidising agent because the manganese atoms gain oxygen atoms.
D It is neutralised by acidified potassium manganate(VII) solution.

26 Which of the following substances could be used to reduce atmospheric pollution caused by flue gases?

A ammonium carbonate and ammonium sulfate
B ammonium sulfate and calcium carbonate
C calcium carbonate and calcium oxide
D calcium oxide and ammonium sulfate

27 The equation for a particular reaction is shown below.

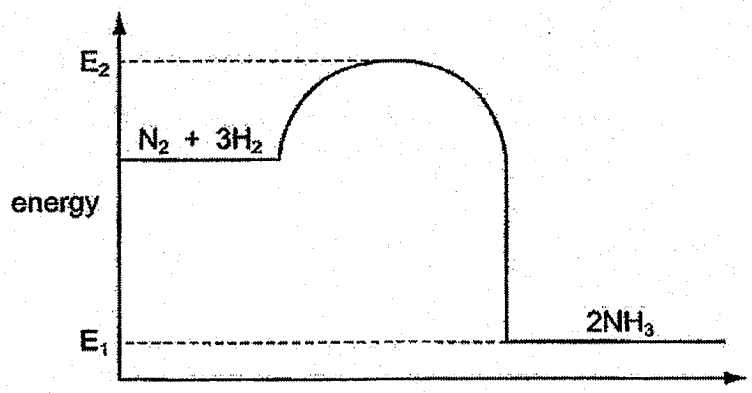
$$2AgI + light \rightarrow 2Ag + I_2$$

Why is this an endothermic reaction?

A Energy is required to vaporise iodine.
B It involves the formation of covalent I – I bonds.
C It involves the transfer of electrons from iodide ions to silver ions.
D Light energy is absorbed when the reaction takes place.

28 The energy profile diagram is that for the Haber process.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$ $\Delta H = -92\,kJ$



What does the energy change $E_2 - E_1$ represent?

A activation energy of the forward reaction
B activation energy of the reverse reaction
C enthalpy change of the forward reaction
D enthalpy change of the reverse reaction

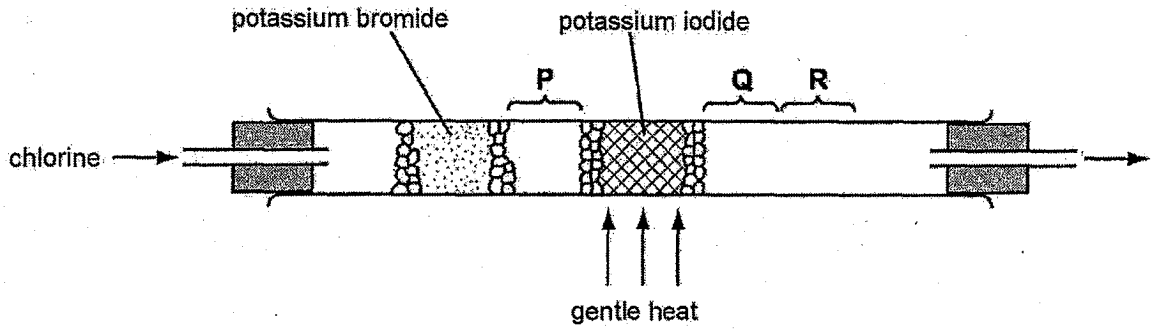
29 Caesium is an element in the same group of the Periodic Table as lithium, sodium and potassium.

Which statements about caesium are likely to be **false**?

I It reacts explosively with cold water.
II It forms a soluble carbonate salt.
III It forms a carbonate with a formula of $CsCO_3$.
IV It can be extracted via electrolysis of concentrated aqueous CsCl.

A I and II
B I and III
C II and III
D III and IV

30 Using the apparatus shown, chlorine is passed through the tube. After a short time, coloured substances are seen at **P**, **Q** and **R**.



What are these coloured substances?

	P	Q	R
A	reddish-brown vapour	violet vapour	black solid
B	reddish-brown vapour	reddish-brown vapour	reddish-brown vapour
C	green gas	violet vapour	black solid
D	green gas	reddish-brown vapour	reddish-brown liquid

31 The table below gives some information about element Y.

density / g/cm^3	6.2
melting point / °C	1280
formulae of oxides	YO (white) Y_2O_3 (brown)
chemical properties	reacts readily with O_2 or Cl_2

Which of the following statements about element Y is likely to be correct?

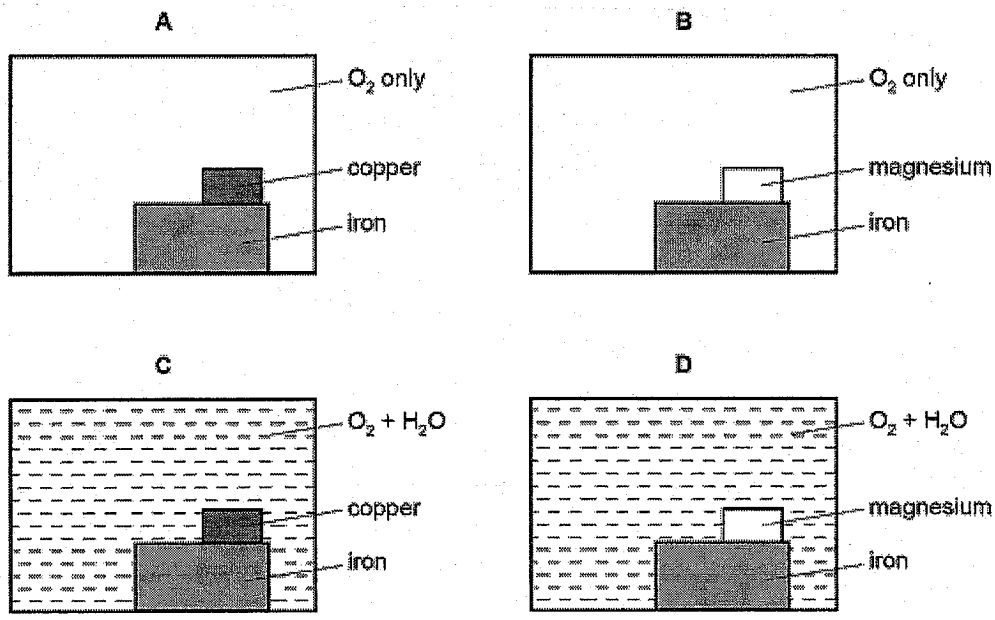
A It is a metal in Group III.
B It is a transition metal.
C It is an alkali metal.
D It forms oxides that are amphoteric in nature.

32 A new element, Hb, placed in Group VII of the Periodic Table, has a higher relative atomic mass than astatine.

Which statement about element Hb is **not** correct?

A Hb atom gains electrons less readily than a chlorine atom.
B Hb displaces astatine out from aqueous potassium astatide.
C Hb has a higher boiling point than bromine.
D Hb is a less powerful oxidizing agent than iodine.

33 Which diagram correctly shows the conditions necessary for rusting of iron and also the metal that can be used to prevent rusting by sacrificial protection?

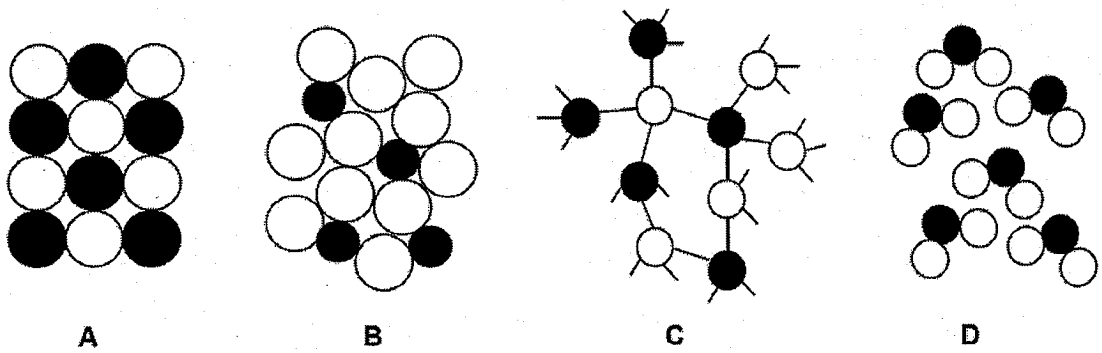


34 Scrap iron is often recycled.

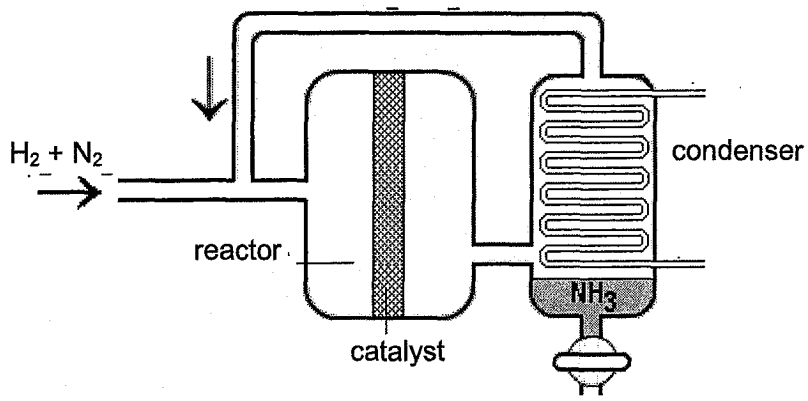
Which reason for recycling is **not** correct?

A It reduces the amount of pollution at the site of the ore extraction.
B It reduces the amount of waste taken to landfill sites.
C It reduces the need to collect the scrap iron.
D It saves natural resources.

35 Which diagram below shows the structure of an alloy?



36 Ammonia is produced by Haber process as shown in the diagram.



Which one of the following processes separates ammonia from the reaction mixture?

A cooling the gaseous mixture
B distillation of the gaseous mixture
C filtering out the other two gases
D passing the gaseous mixture through fused calcium oxide

37 Which solution(s) would produce hydrogen gas at the cathode upon electrolysis?

1 dilute nitric acid
2 aqueous potassium hydroxide
3 aqueous sodium chloride

A 1 only
B 1 and 2
C 2 and 3
D all of the above

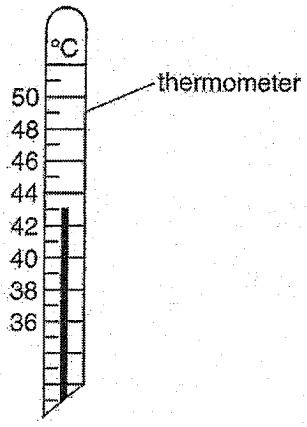
38 The table shows the energy released by complete combustion of some compounds used as fuels.

compound	M_r	ΔH (kJ/mol)
methane	16	-880
ethanol	46	-1380
propane	44	-2200
heptane	100	-4800

Which fuel produces the least energy when 1 g of the compound is completely burned?

A methane
B ethanol
C propane
D heptane

39 A thermometer is placed in warm water and the temperature is measured as shown.



When a solid is dissolved in the water, an exothermic change takes place. The temperature changes by 5°C.

What is the final temperature?

A 38.0 °C
B 38.5 °C
C 48.0 °C
D 48.5 °C

40 In which reaction is the pressure **not** likely to affect the rate of reaction?

A $3H_2\ (g) + N_2\ (g) \rightarrow 2NH_3\ (g)$
B $CuO\ (s) + H_2\ (g) \rightarrow Cu\ (s) + H_2O\ (l)$
C $Fe_2O_3\ (s) + 3CO\ (g) \rightarrow 2Fe\ (s) + 3CO_2\ (g)$
D $H_2SO_4\ (aq) + 2NaOH\ (aq) \rightarrow Na_2SO_4\ (aq) + 2H_2O\ (l)$

End of Paper

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										2 He helium 4
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 –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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 –

Name	Index Number	Class

HUA YI SECONDARY SCHOOL

Mid Year Examination 2018

4E **4E**

CHEMISTRY **6092/2**

Paper 2 7 May 2018

1 hr 45 min

Candidates answer on the Question Paper.
Additional Materials: NIL

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 21.

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

For Examiner's Use	
Section A	
Section B	
Total	

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Setter: Ms Tok Peilin

2

Section A

Answer **all** the questions in this section in the spaces provided.
The total mark for this section is **50**.

A1 The following compounds are used in manufacturing chemicals for agriculture.

A	K_3PO_4
B	H_2SO_4
C	NH_3
D	$Ca(OH)_2$
E	NH_4NO_3

Use the letters **A**, **B**, **C**, **D** and **E** to answer the following questions.

(a) Which solid compound is added to increase the pH of soil?

..... [1]

(b) Two raw materials are used to make a compound.

- One of the raw materials is made by cracking petroleum.
- The other raw material is obtained by fractional distillation of air.

Which compound is manufactured from these two raw materials?

..... [1]

(c) Which **two** compounds can be reacted together to form an ammonium salt?

.....and..... [1]

(d) NPK fertilisers are solid fertilisers that contain compounds of nitrogen, phosphorus and potassium.

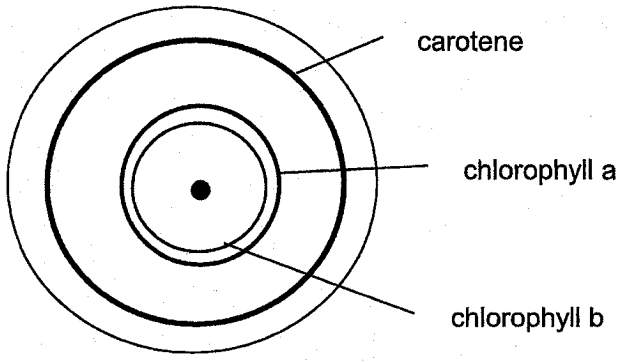
Which **two** compounds could be mixed to produce an NPK fertiliser?

.....and..... [1]

[Total: 4]

3

A2 Spinach is an edible plant that has a deep green colour. The following chromatogram is obtained when water-acetone mixture is added to a drop of spinach extract in the centre of a piece of filter paper.

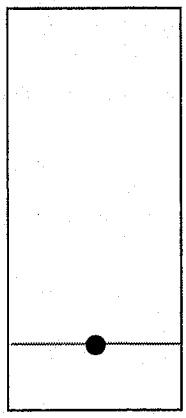


(a) State the property which allows the components of the spinach extract to be separated using chromatography.

.....

..... [1]

(b) The experiment was repeated using a typical chromatography paper as shown below.



Draw and label the expected positions of the components of spinach extract on the chromatogram. [2]

(c) State one experimental procedure that should be followed to obtain a good **separation** of the components.

.....

..... [1]

(d) Suggest why a water-acetone mixture is used as the solvent, instead of just a pure water or pure acetone solvent.

.....

..... [1]

[Total: 5]

A3 One of the ways to reduce air pollution is to curb the number of vehicles on the road.

(a) Name **two** air pollutants produced by motor vehicles.

..... [2]

(b) Catalytic converters are fitted in cars to reduce the amount of air pollutants emitted by motor vehicles. In the catalytic converter, nitrogen monoxide and carbon monoxide react together to form harmless products.

(i) Write a chemical equation to show how air pollutants are removed by catalytic converters.

..... [1]

(ii) Explain why catalytic converters do **not** solve all the environmental problems caused by motor vehicles.

.....

.....

..... [2]

[Total: 5]

A4 The reaction below is an example of a redox reaction.

$$\text{.....}I^-(aq) + \text{.....}H^+(aq) + \text{.....}H_2O_2(aq) \rightarrow \text{.....}I_2(aq) + \text{.....}H_2O(l)$$

(a) Balance the equation by inserting numbers (if necessary) on the dotted lines provided. [1]

(b) Identify the oxidising agent in this reaction. Explain your answer using oxidation states.

.....

.....

..... [2]

5

(c) What colour change will be seen when this reaction is carried out?

.....

..... [1]

[Total: 4]

A5 The table shows some data about the different components of air.

components	melting point / °C	boiling point / °C
argon	– 189	– 186
carbon dioxide	– 78	– 78
krypton	– 157	– 153
neon	– 249	– 246
nitrogen	– 210	– 196
oxygen	– 219	– 183
water vapour	0	100

(a) State the percentage by volume of nitrogen and oxygen in air.

nitrogen..... oxygen..... [2]

(b) Air is a source of nitrogen, oxygen and the noble gases. These are obtained by the fractional distillation of liquid air. Before air is liquefied, carbon dioxide and water are removed.

(i) Suggest why air is dried before it is liquefied.

.....

..... [1]

(ii) At – 200 °C, liquid air is fractionally distilled by allowing it to warm up gradually. List the order of the fractions (elements) obtained, starting from the first fraction

.....

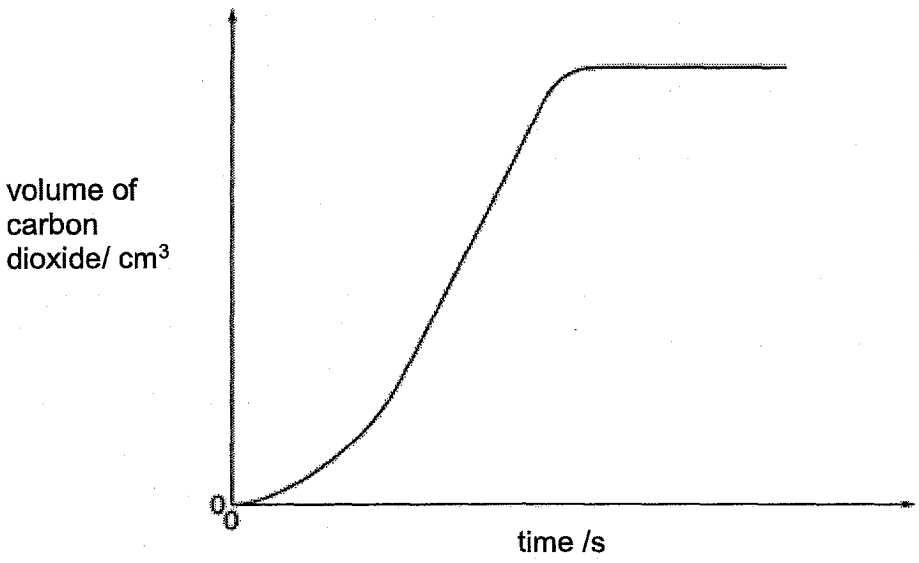
..... [1]

[Total: 4]

6

A6 In **Experiment I**, a sample of magnesium carbonate is heated in a test-tube using a hot plate at 300 °C. The total volume of carbon dioxide formed is measured every 10 seconds.

The graph shows his results.



(a) Suggest why there is **no significant** increase in the volume of carbon dioxide when magnesium carbonate is first heated.

.....

..... [1]

(b) In **Experiment II**, the same mass of magnesium carbonate is heated in a test-tube using a hot plate at a **higher temperature** of 500 °C.

Sketch a curve on the graph above to show the results for this experiment.

Explain your answer.

.....

.....

.....

..... [3]

7

(c) Ron wishes to investigate how the thermal stability of metal carbonates is related to the position of their metal in the reactivity series.

To ensure a fair experiment, he repeated **Experiment I** using different metal carbonates, while keeping all other variables constant.

The table below shows the results of the experiment after the first 60 seconds.

metal carbonate	total volume of gas collected/ cm^3
$\mathbf{X}_2CO_3$	0
$\mathbf{Y}CO_3$	0
$CaCO_3$	2
$FeCO_3$	7
$ZnCO_3$	5

(i) Write a balanced equation, with state symbols, for the thermal decomposition of $FeCO_3$.

..... [2]

(ii) Explain why $\mathbf{X}_2CO_3$ and $\mathbf{Y}CO_3$ do **not** decompose.

.....

.....

..... [2]

(iii) A solution containing 0.002 mol of sulfuric acid is titrated with a solution containing 9.2 g/dm^3 of $\mathbf{X}_2CO_3$. The volume of $\mathbf{X}_2CO_3$ solution needed to exactly neutralise the acid is 23.2 cm^3.

1 mole of sulfuric acid reacts with 1 mole of $\mathbf{X}_2CO_3$.

Calculate the relative atomic mass, *A*r, of **X** and suggest its identity.

A_r of **X** = ...

identity of **X** ..... [3]

[Total:11]

8

A7 The reaction between magnesium and steam is an exothermic reaction.

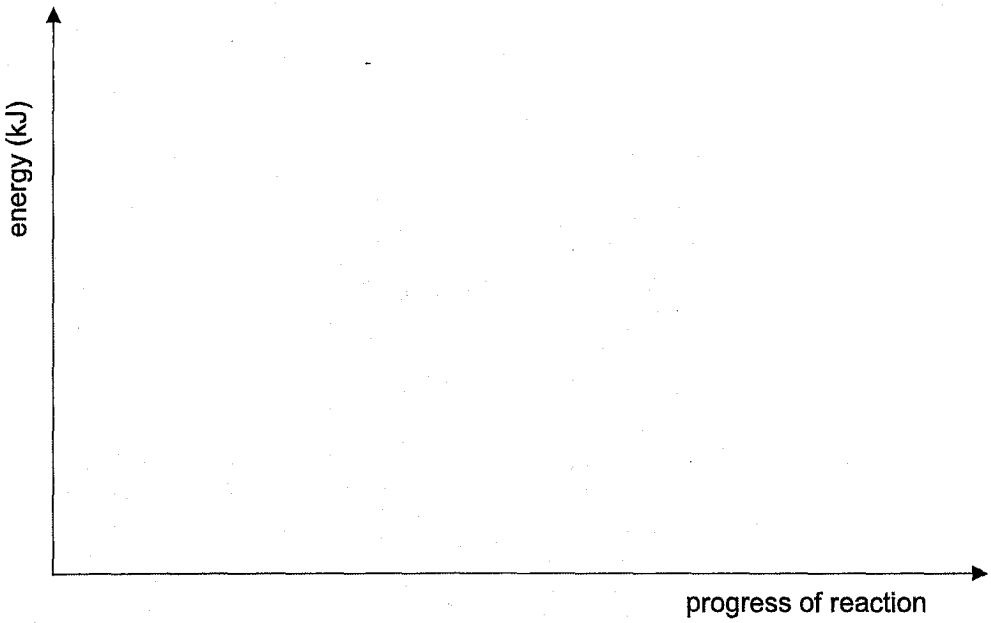
(a) Write a balanced equation, with state symbols, to represent the reaction between magnesium and steam.

..... [2]

(b) The energy output of the reaction between magnesium and steam can be shown using an energy profile diagram.

Draw an energy profile diagram for the reaction.

Your diagram should include names of the reactants and products, labels for the reaction enthalpy change and activation energy.



[3]

(c) Explain, using ideas about bond breaking and bond making, why the overall reaction is exothermic.

.....

.....

..... [2]

[Total: 7]

9

A8 Molten lead(II) bromide was electrolysed using carbon electrodes.

(a) **(i)** Write the ionic equation for the reaction at the cathode.

..... [1]

(ii) Write the ionic equation for the reaction at the anode.

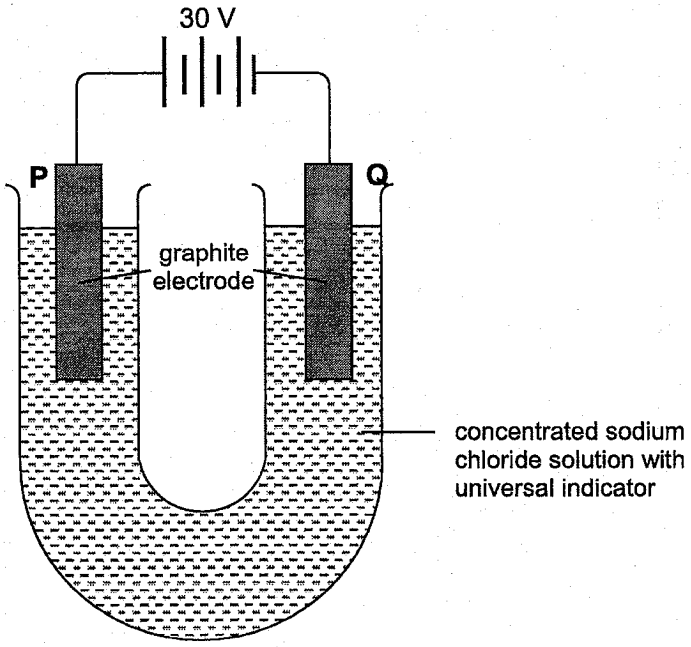
..... [1]

(iii) State the observation at the cathode during the electrolysis.

.....

..... [1]

(b) The setup shows the electrolysis of concentrated sodium chloride solution.



(i) Describe the observations at the electrodes of **P** and **Q**.

Electrode **P**: .....

.....

.....

Electrode **Q**: .....

.....

..... [4]

10

(ii) How does the pH of the electrolyte change as the electrolysis proceeds? Explain your answer.

.....

.....

..... [2]

(iii) Suggest why iron is **not** suitable to be used as an electrode for this experiment.

.....

..... [1]

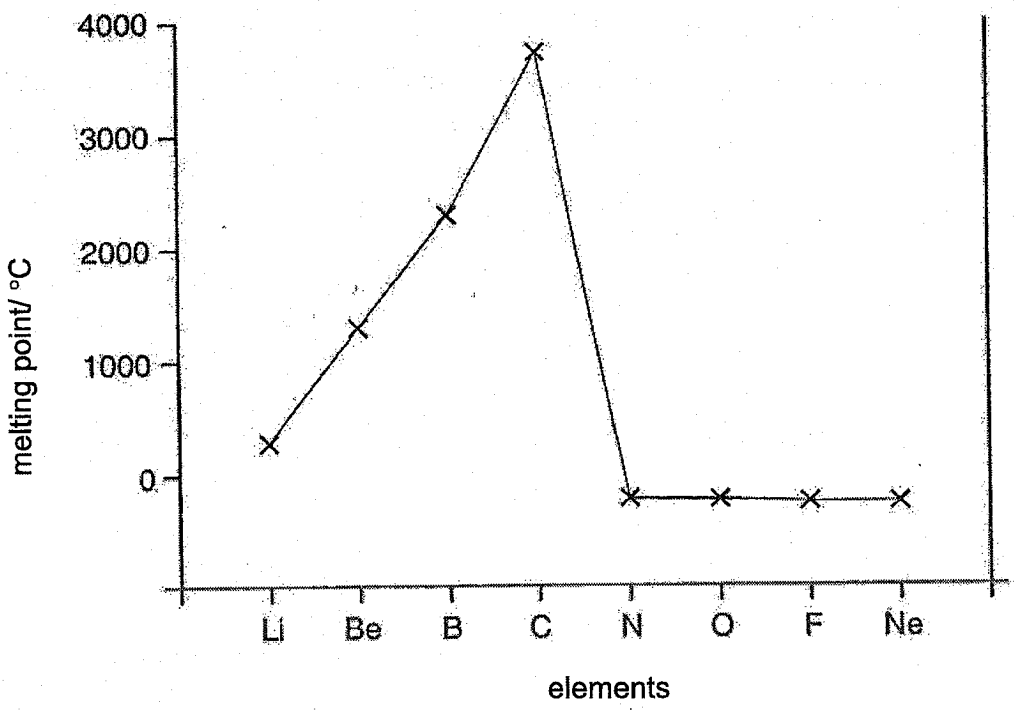
[Total:10]

Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B9 This information is about the elements in **Period 2** of the Periodic Table.



element	electrical conductivity (at room temperature and pressure)
Li	good
Be	good
B	poor
C	good
N	does not conduct
O	does not conduct
F	does not conduct
Ne	does not conduct

12

(a) **(i)** Use the information to describe the trends in melting point and electrical conductivity across Period 2.

.....

.....

..... [2]

(ii) How does the data show that the first four elements in Period 2 are solids at room temperature and pressure?

.....

..... [1]

(b) **(i)** Does the electrical conductivity of carbon fit the general pattern across the period? Justify your answer.

.....

.....

.....

..... [2]

(ii) There are two forms of carbon: diamond and graphite.

Which form of carbon does the data refer to?
Explain your answer with reference to the structure of the substance you have chosen.

.....

.....

.....

..... [2]

13

(c) Draw a sketch graph to show how atomic number changes across the period.

[1]

(d) An element in **Period 3** has the following properties.

melting point/ °C	98
conductivity	good

Use the information given in the question to suggest the element that this data is most likely to refer to.

Explain your answer.

.....

.....

..... [2]

[Total: 10]

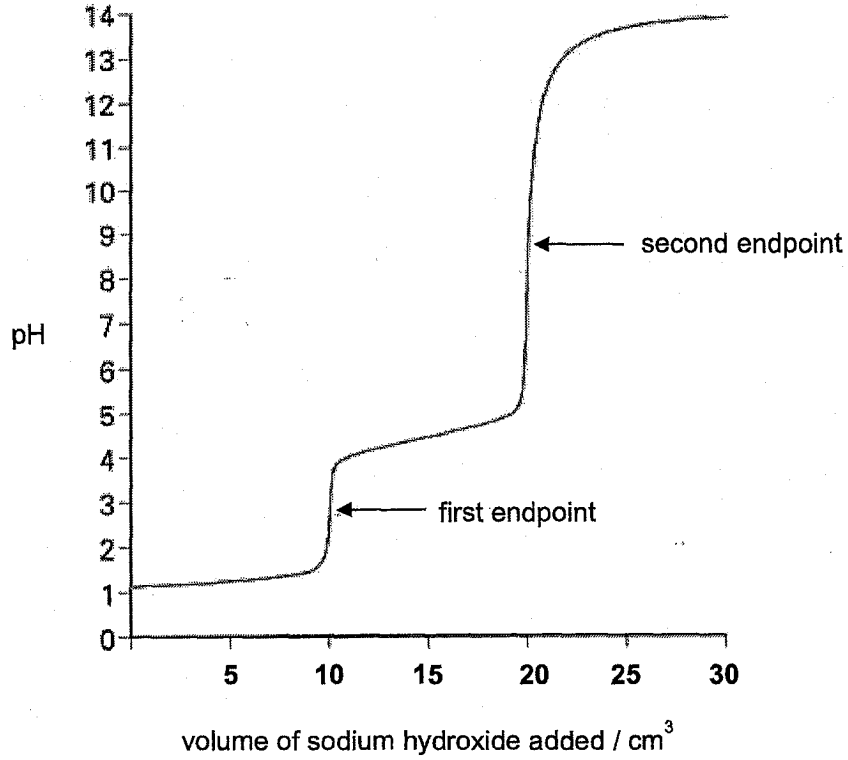
14

B10 Different experiments were set up to investigate the reactions of sulfuric acid.

25.0 cm^3 of 0.10 mol/dm^3 sulfuric acid was transferred to a conical flask and sodium hydroxide was added from a burette.

After each addition of sodium hydroxide, the pH of the solution was recorded using a pH probe attached to a data logger.

The display from the data logger shows the results below. The pH curve has two endpoints, which resulted because H_2SO_4 undergoes two stages of ionisation in water to produce hydrogen sulfate ions, and sulfate ions respectively.



(a) (i) Sulfuric acid ionises in water in two stages. In stage I, it ionises to produce HSO_4^- ions.

$$H_2SO_4\,(aq) \rightarrow HSO_4^-\,(aq) + H^+\,(aq)$$

Write an equation to show the second stage of ionisation of HSO_4^- in water.

..... [1]

(ii) State the chemical formula and name of the salt formed at the first endpoint.

chemical formula .....

chemical name ..... [2]

15

(iii) H_2SO_4 is completely neutralised when the second endpoint is reached.

Use the information from the pH curve to calculate the concentration of sodium hydroxide used in the experiment.

[3]

(b) Describe how you would show that iron(II) sulfate rather than iron(III) sulfate is formed when iron is dissolved in dilute sulfuric acid.

.....

.....

..... [2]

(c) In an experiment, hydrated iron(II) sulfate was gently heated to constant mass, leaving behind anhydrous iron(II) sulfate.

The following table shows the results obtained.

mass of hydrated salt at the start	27.8 g
mass of anhydrous salt at the end	15.2 g

Use the results to work out the empirical formula of the hydrated iron(II) sulfate used in this experiment.

[2]

[Total: 10]

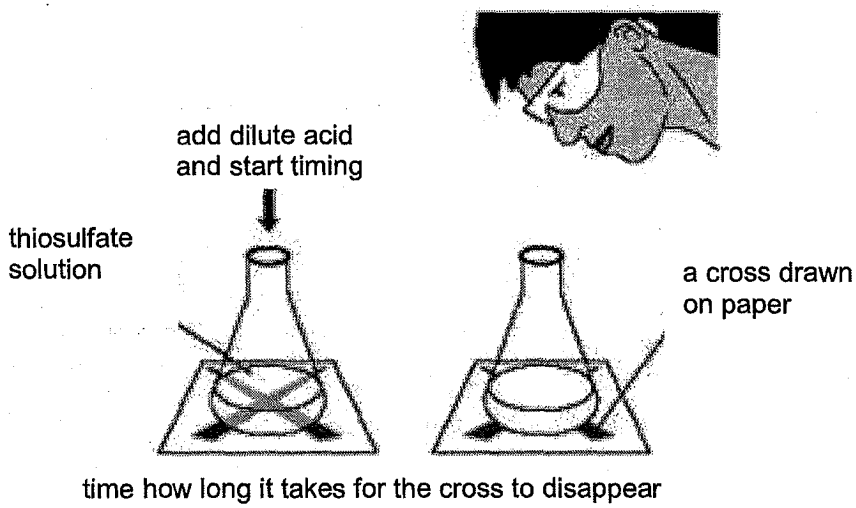
16

Either

B11 Aqueous sodium thiosulfate, $Na_2S_2O_3$, reacts with dilute hydrochloric acid. The reaction was used in an experiment to determine the effects of varying concentration and temperature on the speed of the reaction.

The equation for the reaction is:

$$Na_2S_2O_3\,(aq) + 2HCl\,(aq) \rightarrow 2NaCl\,(aq) + S\,(s) + SO_2\,(g) + H_2O\,(l)$$



A cloudy suspension of sulfur forms and covers the cross (X) slowly. When the cross completely disappears from top view, the time taken is recorded.

The table below shows the results obtained in different experiments using 10 cm^3 of acid and 10 cm^3 of 1 mol/dm^3 aqueous sodium thiosulfate.

experiment	concentration of acid / mol/dm^3	temperature / °C	time taken / s	1/time / s^{-1}
A	0.15	20	65	
B	0.10	30	45	
C	0.10	20	85	
D	0.05	30	55	
E	0.05	20	105	

17

(a) **(i)** Complete the table by calculating the values of 1/time for each experiment. Leave your answers to 3 significant figures. [1]

(ii) Explain the significance of 1/ time.

.....

.....

..... [2]

(b) Which of the experiments (**A** to **E**) are suitable to be used to show the effect of concentration on the speed of the reaction? Explain your answer.

.....

.....

..... [2]

(c) Explain, using the collision theory, the effect of concentration on the speed of the reaction.

.....

.....

.....

..... [2]

(d) In trying to explain the effect of temperature on the speed of the reaction, a student said, "The higher the temperature, the faster is the speed of the reaction. This is because at a higher temperature, the activation energy of the reaction is lowered. Thus, more effective collisions can occur."

Is the student correct? Justify your answer.

.....

.....

.....

.....

..... [3]

[Total: 10]

18

OR

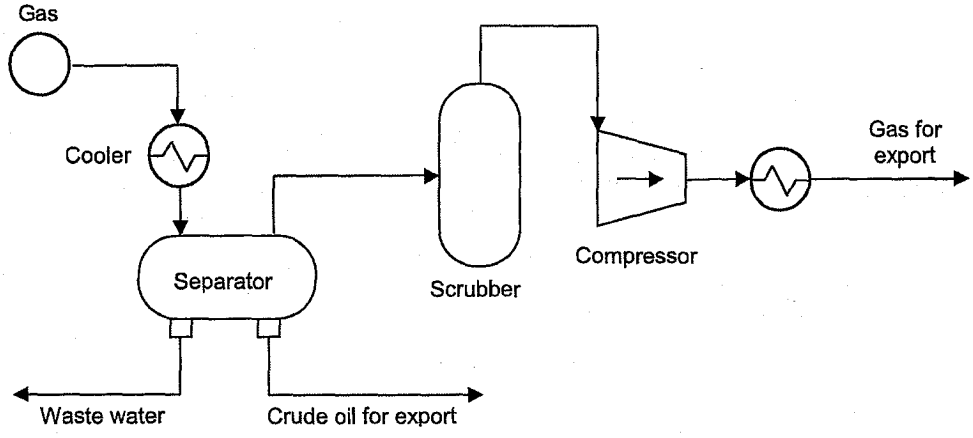
B11 Natural gas is a mixture of hydrocarbon compounds formed from the remains of dead plants and animals over a long period of time. It is often found together with other fossil fuels such as crude oil.

An example of components of natural gas is shown in the table.

name	formula	percentage composition / %	boiling point / °C	liquid density / g/cm^3
methane	CH_4	70	- 162	0.423
ethane	C_2H_6	10	- 89	0.546
propane	C_3H_8	10	- 42	0.493
others (carbon dioxide, hydrogen sulfide, etc.)	-	10	-	-

Adapted from: www.naturalgas.org

Natural gas that is extracted from the ground must be purified before it can be used. A simplified diagram showing the process of purification is given in the diagram below. The first step is to cool the mixture and remove water and other dense components like crude oil. The raw gas is then sent to a series of scrubbers, compressors and coolers. Finally, the gas is either compressed or liquefied, and then exported.



Compressed natural gas (CNG) is compressed to 200 to 250 times atmospheric pressure, such that it occupies about 1% of the volume it would otherwise have occupied, and stored in high-pressure tanks. Liquefied natural gas (LNG) is cooled to about -170°C, where it occupies about 1/600th of the volume it would otherwise have occupied, and stored in special insulated tanks.

19

(a) **(i)** What is the main component of natural gas?

..... [1]

(ii) Draw a dot and cross diagram to show the bonding of one molecule of the main component of natural gas stated in **(a) (i).**
You only need to show the outer shell electrons.

[2]

(iii) Explain, using ideas about bonding and structure, why natural gas is volatile.

.....

.....

.....

.....

.....

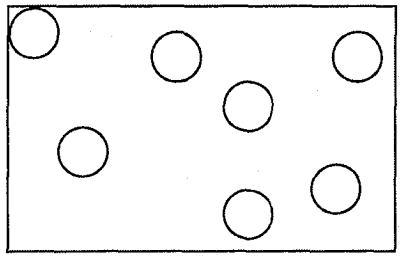
..... [2]

(b) Name a piece of apparatus found in the school laboratory which functions on the similar principle as the separator shown in the diagram.

..... [1]

20

(c) **(i)** The diagram shows the arrangement of particles in natural gas at room temperature and pressure. Draw similar diagrams to show the arrangement of the same number of particles in liquefied natural gas (LNG) and compressed natural gas (CNG).



LNG **CNG**

[2]

(ii) Using the information given, suggest **one** advantage of using liquefied natural gas (LNG) over compressed natural gas (CNG).

.....

.....

.....

.....

.....

..... [2]

[Total: 10]

End of Paper

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										2 He helium 4
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 –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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 –

140

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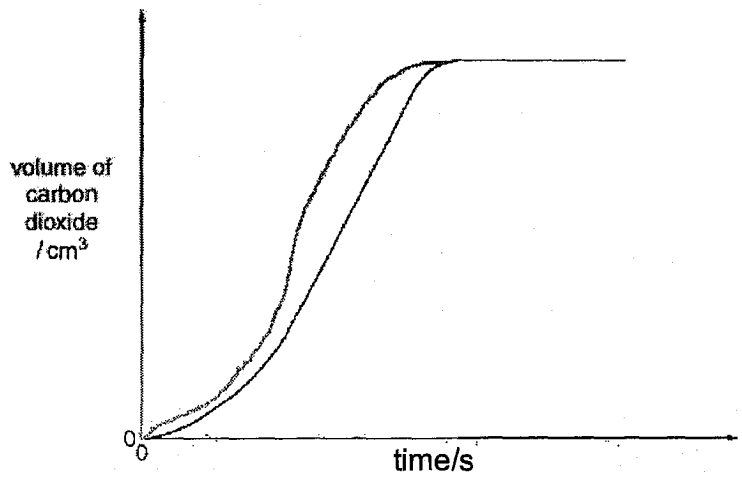
4E Pure Chem MYE P1 MS 2018

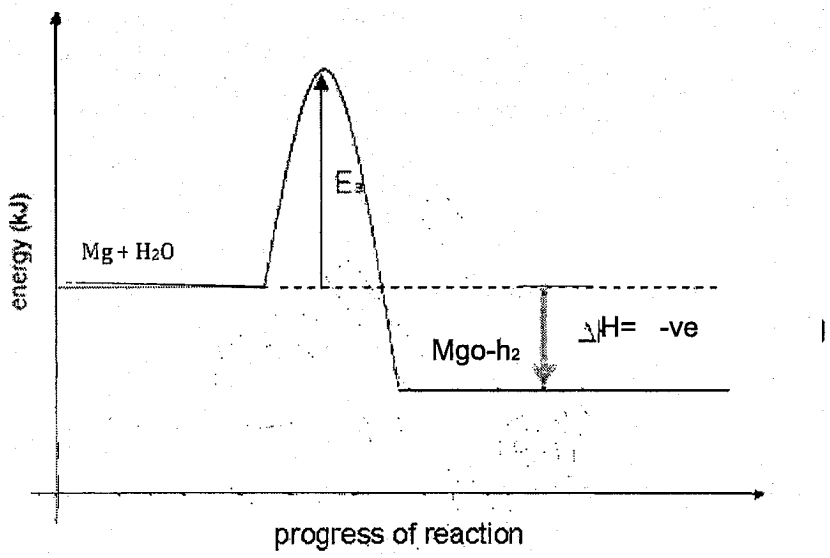
Q1	C
Q2	D
Q3	A
Q4	C
Q5	D
Q6	A
Q7	B
Q8	B
Q9	C
Q10	B
Q11	A
Q12	D
Q13	D
Q14	A
Q15	D
Q16	C
Q17	D
Q18	C
Q19	D
Q20	C

Q21	A
Q22	D
Q23	D
Q24	A
Q25	A
Q26	C
Q27	D
Q28	B
Q29	D
Q30	A
Q31	B
Q32	B
Q33	D
Q34	C
Q35	B
Q36	A
Q37	D
Q38	B
Q39	C
Q40	D

4E Chemistry Paper 2 2018
Mark scheme

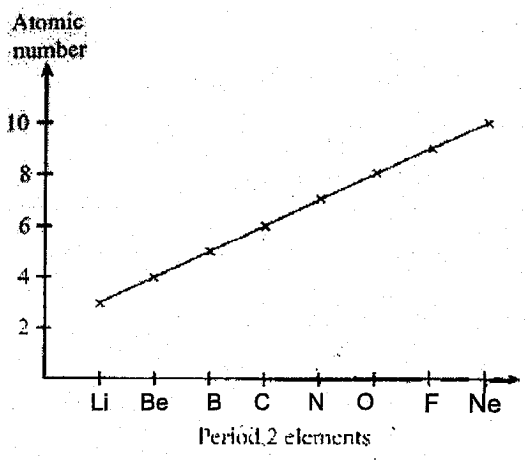
A1			
(a)	D		[1]
(b)	C		[1]
(c)	B and C		[1]
(d)	A and E		[1]
			Total: 4
A2			
(a)	The components have <u>different solubilities</u> in the solvent.		[1]
(b)	3 components [1] correct distance (relative height): • chlorophyll b – 0.8 to 1 cm • chlorophyll a – 1.0 to 1.2 cm • carotene – 1.8 to 2.1 cm [1]		[2]
(c)	• The chromatography should be allowed to run until the solvent front almost reaches the top of the filter paper/ • The drop of extract spotted on the filter paper should be as small as possible. • Cover with a lid to ensure consistent acetone/water compostition. • Use a longer chromatography paper. NB: Do not award: solvent level should be below starting line/ startling line should be drawn in pencil		[1]
(d)	Spinach extract consists of substances that are soluble only in acetone-water mixture.		[1]
			Total: 5
A3			
(a)	carbon monoxide, nitrogen oxides, sulfur dioxide, unburnt hydrocarbons (No chemical formula) Any two answers. [1] each.		[2]
(b)	(i)	$2CO + 2NO \rightarrow 2CO_2 + N_2$	[1]
	(ii)	<u>Carbon dioxide</u> [1 mk pt] is produced by the reactions in the catalytic converters and it is a <u>greenhouse gas</u> [1 mk pt] that causes <u>global warming</u>. [1 mk pt] 3 mk pts – [2] 1-2 mk pts – [1]	[2]
			Total:5
A4			
(a)	2 2 (1) → (1) 2		[1]
(b)	**<u>H_2O_2</u>** is the oxidizing agent. It oxidizes **<u>I^- to I_2</u>** which increases in oxidation number from **<u>-1 (I^-) to 0 (I_2).</u>**		[1] [1]
(c)	**<u>Colourless</u>** solution turns **<u>yellow/ brown.</u>**		[1]
			Total:4
A5			
(a)	Nitrogen – 78% [1] Oxygen – 21% [1]		[2]
(b)	(i)	At low temperature (for fractional distillation of liquefied air), <u>water is a solid</u> **[1]**. {Hence, it would block the flow of liquid air through the pumps and pipes.}	[1]
	(ii)	(distilled first) Nitrogen, Argon, Oxygen, Krypton	[1]

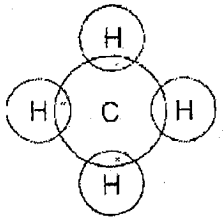
		NB: 0 M if students include Ne or compounds.	
			Total:4
A6			
(a)		Not much magnesium carbonate has achieved activation energy required. [1] Accept: The flame is not hot enough to decompose much magnesium carbonate. *Note: Many students' responses reflect a poor understanding of the question The question involves decomposition and hence responses that revolve around rate of effective collision is invalid as there's no collision of reactants involve here. Other responses which are inaccurate include 'There wasn't enough energy to overcome the activation energy'.*	[1]
(b)		 Correct graph [1] At higher temperature, rate of reaction increases because more zinc carbonate particles have sufficient energy to overcome the activation energy. [1] Volume of carbon dioxide stays constant as it is dependent on the number of moles/ mass of zinc carbonate which did not change. [1]	[3]
(c)	(i)	$FeCO_3(s) \rightarrow FeO(s) + CO_2(g)$ Correct state symbols – 1M Correct formula – 1M	[2]
	(ii)	X and Y are highly reactive metals [1], thus forming highly stable metal carbonates [1] that do not decompose on heating	[2]
	(iii)	Mass of X_2CO_3 used = 9.2 x 0.0232 = 0.2134 g [1] M_r of X_2CO_3 = 0.2134/0.002 = 106.72 A_r of X = (106.72 – 12 – 16 x 3)/2 = 23.4 [1] (3 s.f.) A_r of X = 23.4 identity of X sodium [1]	[3]
			Total: 11
A7			

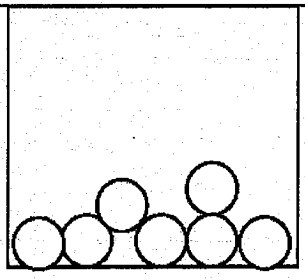
	1M for all accurate formula 1M for all accurate state symbols		
(b)	 • Correct shape [1] • Labels (Ea, ΔH); directions must be both correct [1] • Reactants and products (correct indicators of reactants and products) [1]		[3]
(c)	Heat energy **released** for **bond forming** in 1 mole of magnesium oxide and 1 mole of hydrogen is **greater** than heat **absorbed** for **bond breaking** in 1 mole of water and 1 mole of magnesium. [1] – underlined phrases i.e. where the bonds are broken and formed; [1] – bold words i.e. connecting energy released/gained to bond forming/breaking *Note: This question involves the overcoming of ionic bonds and the phrasing proves to be difficult for students. Students who gave responses such as Mg-O will be marked down as this is a denotation for covalent bond.*		[2]
			Total: 7
A8			
(a)	(i)	$Pb^{2+}(l) + 2e^- \rightarrow Pb(l)$	[1]
	(ii)	$2Br^-(l) \rightarrow Br_2(g) + 2e^-$	[1]
	(iii)	Shiny, silvery globule was found at the bottom of the beaker.	[1]
(b)	(i)	**P**: Green Universal indicator turned blue/violet. [1] **/bubbling / effervescence** of pale green gas [1] [max 2] **Q**: Green Universal indicator turned red. [1] / **bubbling / effervescence** of colourless gas [1]	[4]
	(ii)	pH will increase. [1] Hydrogen ions preferentially discharged at cathode results	[2]

		higher than that of hydrogen ions. [1] NB: reject if students write gas instead of ions are discharged.	
	(iii)	**Chlorine** gas formed at anode will oxidise iron anode away/ hydrogen ions at cathode will react iron cathode away Reject: chloride ions will react with iron. [Reaction of chloride ions with iron is slow] NB: reject if students write gas instead of ions are discharged.	[1]
			Total: 10

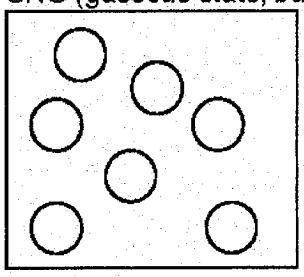
B9			
(a)	(i)	The melting points increase across Period 2 from Li to C, then decrease sharply from C to N. The melting points decreases gradually from N to Ne. [1] The electrical conductivity is high for the first elements in the period and is low for the last four elements. Boron is the exception as it is one of the first few elements in the period, yet it has poor electrical conductivity. NB: X Wrong: merely restating the table information in sentence form, *for example, "lithium, beryllium and carbon are good conductors, boron is poor and the other elements do not conduct.* √ Right: answers that identified a general trend, "the conductivity is high for the first elements in the period and is low for the last four elements' and then highlighted the exception 'except for boron' or 'except for carbon'.	[2]
	(ii)	They have high melting points that are above room temperature.	[1]
(b)	(i)	No. Electrical conductivity generally decreases across Period 2. [1] (specific mention of a trend) However, carbon is a good electrical conductor despite the preceding element, boron, being a poor conductor, and the following element, nitrogen, being a non-conductor. [1] NB: Only ans that presents the idea of a <u>general pattern</u> will be accepted.	[2]
	(ii)	Graphite. [no marks] Graphite has a giant molecular structure consisting of layers of carbon atoms. <u>Each carbon atom</u> is covalently bonded to <u>three other carbon</u> atoms. This leaves each carbon atom with <u>one valence electron not involved in bonding</u>. [1] This electron becomes <u>delocalised</u> and can <u>move freely</u> along the layers of carbon atoms, [1] thus conducting electricity. NB: Reject if students write each atom is bonded to 3 other electrons. Concept must be entirely correct.	[2]

	(c)	 NB: reject if axes are unlabeled.	[1]
(d)		Sodium. [no mark] A relatively low melting point (compared to other metals) [1] and good electrical conductivity are properties of Group I/alkali metals.[1]	[2]
			Total: 10
B10			
(a)	(i)	$HSO_4^-(aq) \rightarrow H^+(aq) + SO_4^{2-}(aq)$	[1]
	(ii)	$NaHSO_4$ [1] sodium hydrogensulfate [1]	[2]
	(iii)	No. of mol H_2SO_4 = (25.0/1000) x 0.10 = 0.0025 mol [1] $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$ From equation, 1 mol H_2SO_4 : 2 mol NaOH 0.0025 mol H_2SO_4:0.005 mol NaOH [1] Concentration of NaOH = 0.005 / (20.0/1000) = 0.250 mol/dm^3 [1]	[3]
(b)		Add 2 to 3 drops, and then, excess of NaOH solution [1]. If a dirty green precipitate that is insoluble in excess NaOH is formed, iron (II) sulfate is formed. [1]	[1] [1]
(c)		<table><tr><td>compound</td><td>$FeSO_4$</td><td>H_2O</td></tr><tr><td>mass/g</td><td>15.2</td><td>27.8 – 15.2 = 12.6</td></tr><tr><td>no. of moles</td><td>15.2 / 152 = 0.1 mol</td><td>12.6 / 18 = 0.7 mol</td></tr><tr><td>simplest ratio</td><td>0.1 / 0.1 = 1</td><td>0.7 / 0.1= 7</td></tr></table> Empirical formula is **$FeSO_4.7H_2O$** 1m for simplest ratio 1m empirical formula	[2]
			Total:10

B11	EITHER		
(a)	(i)	<table><tr><th>1/time/ (1/s)</th></tr><tr><td>0.0154</td></tr><tr><td>0.0222</td></tr><tr><td>0.0118</td></tr><tr><td>0.0182</td></tr><tr><td>0.00952</td></tr></table>	[1]
	(ii)	1/ time provides information about the speed of reaction. [1] The longer the time taken, the slower is the speed of the reaction. / The shorter the time taken, the faster is the speed of the reaction. [1]	[2]
(b)	The results of experiments A, C and E can be used. / The results of experiments B and D can be used. [1] These experiments were conducted using different concentrations of acid but the temperature was kept constant. [1]		[2]
(c)	The higher the concentration, the faster is the speed of the reaction. No marks awarded. With a higher concentration, there are more reactant particles in a unit volume. [1] Thus, there are more collisions between reactant particles. This results in a higher frequency of effective collisions occurring. [1]		[2]
(d)	The student is not correct. The activation energy of the reaction is not lowered with higher temperature. [1] Must mention what is wrong with the student's explanation. At higher temperatures, reactant particles possess greater amount of kinetic energy. Thus, they are able move more quickly [1] and collide into one another more frequently. This results in a higher frequency of effective collisions occurring. [1]		[3]
			Total:10
B11	OR		
(a)	(i)	Methane	[1]
	(ii)		[2]
	(iii)	• Natural gas is a mixture of covalent compounds which have a simple molecular structure. • There are weak intermolecular/ van der Waals forces of attraction between the molecules, [1] • hence little energy must be supplied to overcome these forces of attraction, and natural gas has a low boiling point, which makes it volatile. [1]	[2]
(b)	Separating funnel		[1]
(c)	(i)	LNG (liquid state) [1]	[2]



CNG (gaseous state, but closer together than original diagram) [1]



(ii) Data quoted: [2]

- Compared to the original volume of natural gas, LNG occupies **1/600th /0.167%** of the original volume, which is **100 times/ significantly less** than CNG, which occupies **1%** of the original volume. [1]

*Student must quote the data of both CNG and LNG

Implication:

- Hence,
  - LNG is likely to be **easier to transport** than CNG, [1] **OR**
  - for the same volume, LNG **contains more natural gas** than CNG [1] **OR**
  - LNG is **safer** to use than CNG because CNG is compressed but LNG is not, hence if a pressurised CNG cylinder is damaged, the danger of an explosion is much greater [1]

1m for comparison of volume/ evidence
1m for stating implication

Accept any reasonable implication of the difference in volume

[Total: 10]