Bukit Batok Secondary School

PRELIMINARY EXAMINATION 2018

SEC 4 EXPRESS

CHEMISTRY
Paper 1 Multiple Choice

6092/01
24 August 2018
0745 - 0845
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, index number and class on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** 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 at the end of the question paper.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of 15 printed pages.

1 The reaction scheme shows how hydrated copper(II) sulfate, $CuSO_4.5H_2O$, changes when heated.

$$CuSO_4.5H_2O \xrightarrow{90\ ^oC} CuSO_4.H_2O \xrightarrow{250\ ^oC} CuSO_4$$

A little water was accidentally spilled into a dish containing hydrated copper(II) sulfate. What could be done to remove the water, leaving pure, dry $CuSO_4.5H_2O$?

A Heat the dish over a boiling water-bath.
B Heat the dish to a constant mass.
C Heat the dish with a Bunsen burner.
D Let the dish stand in direct sunlight.

2 Aluminium sulfate is sometimes used in water treatment to remove impurities. Aqueous aluminium sulfate is acidic. The table shows the results of tests on four different samples of treated water.
To which sample had an excess of aluminium sulfate been added?

sample	pH of sample	reaction with an excess of aqueous ammonia
A	3	white precipitate
B	3	no reaction
C	7	no reaction
D	11	white precipitate

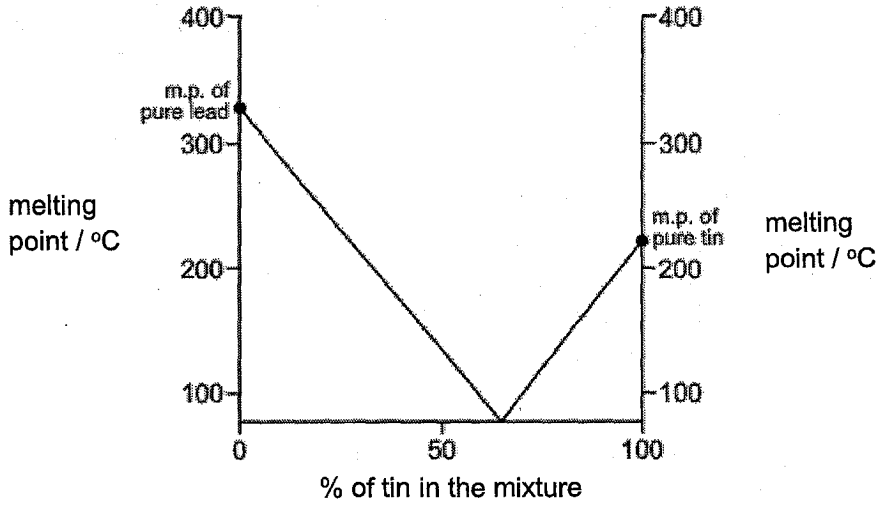
3 An acid, X, was added to a solution of the nitrate of a metal, Y. A dense white precipitate was formed
What are X and Y?

	acid X	metal Y
A	hydrochloric	calcium
B	nitric	zinc
C	sulfuric	aluminium
D	sulfuric	barium

4 A student tested a solution by adding aqueous sodium hydroxide. A precipitate was not seen because the reagent was added too quickly.
What could **not** have been present in the solution?

A Al^{3+} **B** Ca^{2+} **C** NH_4^+ **D** Zn^{2+}

5 The graph gives the melting points (m.p.) of mixtures of lead and tin.



The graph shows that any mixture of lead and tin must have a melting point that is

A above that of tin.
B below that of lead.
C below that of both tin and lead.
D between that of tin and lead.

6 The isotopes of carbon and oxygen are given in the table.

Isotopes of carbon	^{12}C	^{13}C	^{14}C
Isotopes of oxygen	^{16}O	^{17}O	^{18}O

A molecule of carbon dioxide with molecular mass 46 could contain

A one ^{12}C atom and two ^{16}O atoms.
B one ^{14}C atom and two ^{18}O atoms.
C one ^{12}C atom, one ^{16}O atom and one ^{18}O atom.
D one ^{14}C atom, one ^{16}O atom and one ^{18}O atom.

7 Particles with the same electron arrangement are said to be isoelectronic.
Which of the following compounds contains ions which are isoelectronic?

A $CaCl_2$
B KBr
C $MgCl_2$
D Na_2S

8 The table shows information about particles X and Y.

	number of protons	number of neutrons	electronic structure
X	9	10	2, 8
Y	17	20	2, 8, 8

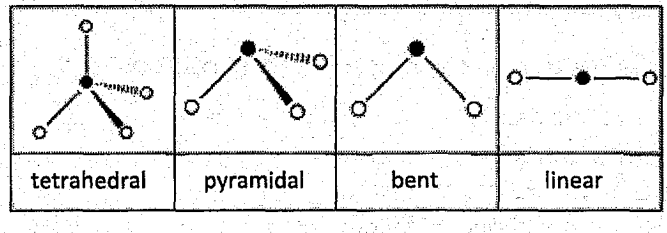
Which statement is correct for both X and Y?

A They are atoms of metals.
B They are atoms of noble gases.
C They are isotopes of the same element.
D They are negative ions.

9 The table shows some properties of four substances.
Which substance is an ionic compound?

	melting point /°C	conducts electricity when solid	dissolves in water	conducts electricity in aqueous solution
A	-102	no	yes	yes
B	801	no	yes	yes
C	842	yes	yes	yes
D	3000	yes	no	no

10 The shapes and names of some molecules are shown below.



Phosphine is a compound of phosphorus, an element in Group V, and hydrogen. The shape of a molecule of phosphine is likely to be

A bent.
B linear.
C pyramidal.
D tetrahedral.

11 Which sulfide contains the greatest mass of sulfur in a 10 g sample?

sulfide	formula	mass of one mole /g
A	NiS	91
B	FeS_2	120
C	MoS_2	160
D	PbS	239

12 Two of the reactions used in the manufacture of nitric acid, HNO_3, are shown.

$$2NO + O_2 \rightarrow 2NO_2$$
$$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$$

What is the maximum number of moles of nitric acid which could be formed from one mole of nitrogen monoxide, NO?

A 0.5 **B** 1.0 **C** 2.0 **D** 4.0

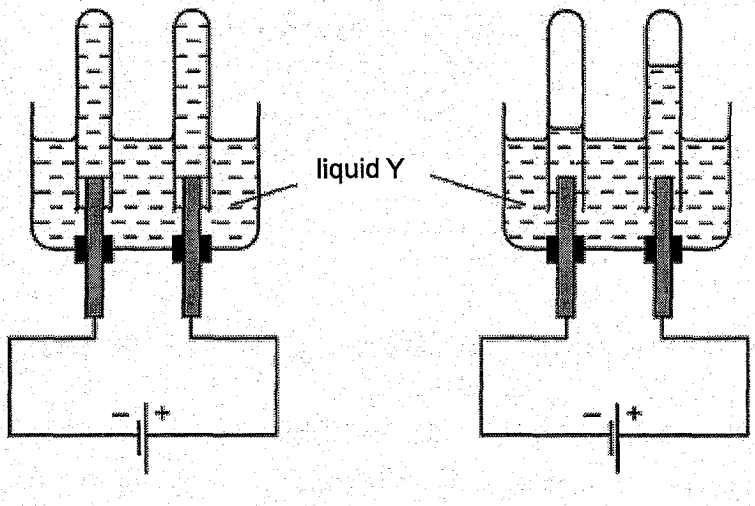
13 A piece of chalk has a mass of 23.0 g. Chalk is impure calcium carbonate. When analysed, the chalk is found to contain 0.226 moles of calcium carbonate.
What is the percentage purity of the piece of chalk?

A 0.983% **B** 1.02% **C** 77.0% **D** 98.3%

14 Which element requires the smallest number of electrons for one mole of atoms to be liberated during electrolysis?

A aluminium
B calcium
C copper
D sodium

15 The diagrams show an electrolysis experiment using inert electrodes.



Which could be liquid Y?

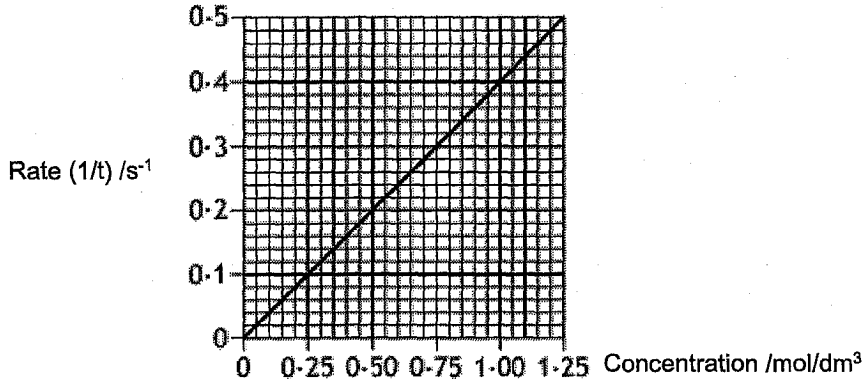
1 aqueous copper(II) sulfate
2 aqueous sodium nitrate
3 concentrated aqueous sodium chloride
4 dilute sulfuric acid

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

16 A student carries out a single experiment to determine the speed of reaction between calcium carbonate and an excess of hydrochloric acid.
Which of the following does **not** change during the course of the reaction?

A concentration of the hydrochloric acid solution
B mass of the calcium carbonate
C volume of carbon dioxide evolved
D volume of hydrochloric acid solution

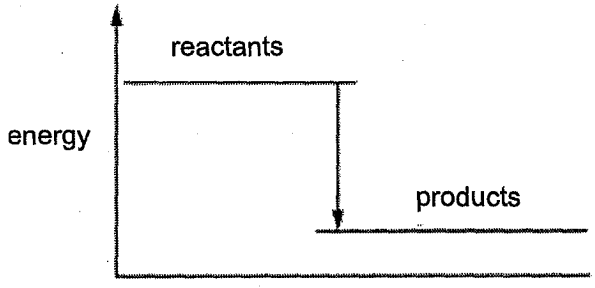
17 The graph shows how the rate of a reaction varies with the concentration of one of the reactants.



What is the reaction time, in seconds, when the concentration of the reactant was 0.50 mol/dm^3?

A 0.2 **B** 0.5 **C** 2.0 **D** 5.0

18 A diagram for the energy change during a chemical reaction is shown.



For which reaction(s) would this be an appropriate diagram?

1 $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
2 $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
3 $2C + O_2 \rightarrow 2CO$

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

19 The oxide of titanium, TiO_2, is used as a 'whitener' in toothpaste. It is obtained from the ore iron(II) titanate, $FeTiO_3$. What is the change, if any, in the oxidation number of titanium in the reaction $FeTiO_3 \rightarrow TiO_2$?

A It is oxidized from +3 to +4.
B It is reduced from +3 to +2.
C It is reduced from +6 to +4.
D There is no change in the oxidation number.

20 The pH of an aqueous solution of hydrochloric acid is 2.
What will be the pH of the acid after the addition of 10.0 g of sodium chloride?

A 2 **B** 5 **C** 7 **D** 9

21 Which row in the table correctly shows the properties of 0.100 mol/dm^3 hydrochloric acid when compared with 0.100 mol/dm^3 ethanoic acid?

	pH	conductivity	Rate of reaction with magnesium
A	lower	lower	slower
B	higher	higher	faster
C	lower	higher	faster
D	higher	lower	slower

22 Consider the three reactions below.

- reaction between nitric acid and calcium hydroxide
- ethane burning in air
- reaction between ethanoic acid and ethanol

A student made three statements about the three reactions above.

1 carbon dioxide is produced in all reactions
2 water is produced in all reactions
3 a salt is produced in all reactions

Which statement(s) is/are true?

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

23 Methylamine, CH_3NH_2, has very similar chemical properties to ammonia, NH_3. Methylamine reacts with hydrogen chloride to form a white crystalline salt, methylammonium chloride.

$$CH_3NH_2 + HCl \rightarrow CH_3NH_3^+Cl^-$$

A sample of methylammonium chloride is heated with aqueous sodium hydroxide. What are the products?

A ammonia, sodium chloride and water
B ammonia, sodium hydrogencarbonate and sodium chloride
C methylamine, hydrogen chloride and water
D methylamine, sodium chloride and water

24 A student has five reagents.

- dilute hydrochloric acid
- dilute sulfuric acid
- dilute nitric acid
- solid calcium carbonate
- solid copper(II) carbonate

How many soluble salts can be prepared?

A 3 **B** 4 **C** 5 **D** 6

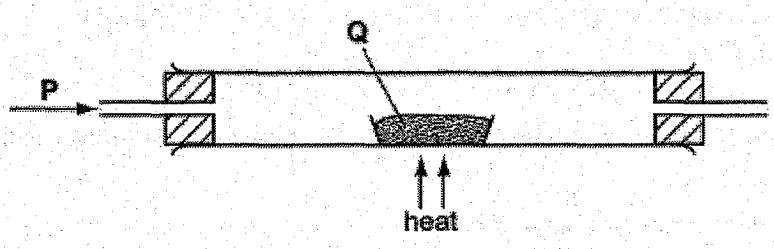
25 How can a pure sample of barium sulfate be obtained from barium carbonate?

A Dissolve it in dilute hydrochloric acid, add dilute sulfuric acid, filter and crystallise.
B Dissolve it in dilute hydrochloric acid, add dilute sulfuric acid, filter and wash.
C Dissolve it in water, add dilute sulfuric acid, filter and crystallise.
D Dissolve it in water, add dilute sulfuric acid, filter and wash.

26 An alloy of copper and zinc is added to an excess of dilute hydrochloric acid. The resulting mixture is then filtered.
Which observations are correct?

	filtrate	residue
A	colourless solution	none
B	colourless solution	pinkish brown
C	blue solution	grey
D	blue solution	none

27 In the apparatus shown, gas P is passed over solid Q.



No reaction occurs if P and Q are

	P	Q
A	hydrogen	lead(II) oxide
B	hydrogen	magnesium oxide
C	oxygen	carbon
D	oxygen	sulfur

28 The period 4 elements gallium (Ga), germanium (Ge), arsenic (As) and selenium (Se) are elements below aluminium, silicon, phosphorus and sulfur in the Periodic Table, a portion of which is shown below.

period 3 elements	Al	Si	P	S
period 4 elements	Ga	Ge	As	Se

The properties of each period 4 element resemble those of the period 3 element directly above it.
Which period 4 elements form oxides that dissolve in water to give an acid solution?

A As and Se
B Ga and Ge
C Ga and Se
D Se only

29 When a mineral was heated in a Bunsen flame to a constant mass, a colourless gas that produced a white precipitate in limewater, was given off. The remaining solid was cooled and then added to aqueous hydrochloric acid. Vigorous effervescence was seen. What was the mineral?

A aragonite, $CaCO_3$
B artinite, $MgCO_3.Mg(OH)_2.3H_2O$
C barytocalcite, $BaCO_3.CaCO_3$
D dolomite, $CaCO_3.MgCO_3$

30 Listed below are four solutions.

1 aqueous sodium hydroxide
2 aqueous silver nitrate
3 aqueous potassium sulfate
4 dilute hydrochloric acid

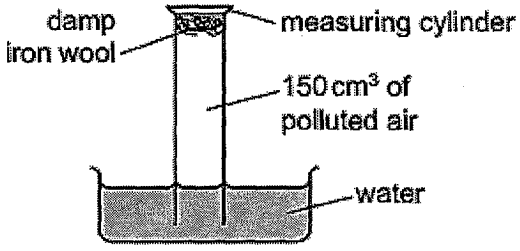
Which of the following solution(s) will react with magnesium metal?

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

31 Attaching pieces of magnesium to underground iron pipes can protect the iron from corrosion.
Which reaction protects the iron from corrosion?

A $Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e$
B $Fe(s) \rightarrow Fe^{2+}(aq) + 2e$
C $Mg^{2+}(aq) + 2e \rightarrow Mg(s)$
D $Mg(s) \rightarrow Mg^{2+}(aq) + 2e$

32 An experiment to find the percentage of oxygen in 150 cm^3 of polluted air is shown.



The apparatus is left for one week.
After this time, the volume of gas in the measuring cylinder is 122 cm^3.
What is the percentage of oxygen, to the nearest whole number, in the polluted air?

A 19 % **B** 21% **C** 28 % **D** 81%

33 The depletion of the ozone layer in the upper atmosphere reduces the Earth's natural protection from harmful ultraviolet radiation.
Which compound would cause the most depletion of the ozone layer?

A CCl_2F_2 **B** CF_4 **C** $CHClF_2$ **D** CH_2F_2

34 The compound, C_8H_{18} undergoes the following process.

$$C_8H_{18} \xrightarrow{\text{Process X}} \text{Ethene} + \text{Compound Y}$$

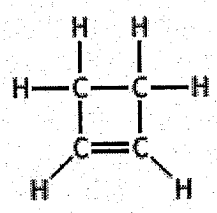
Which row in the table correctly identifies Process X and Compound Y?

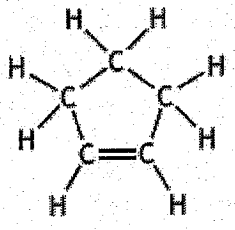
	Process X	Compound Y
A	cracking	hexane
B	cracking	hexene
C	distillation	hexane
D	distillation	hexene

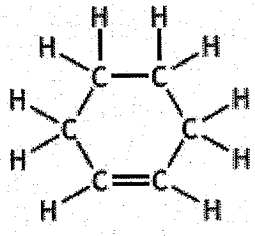
35 How many moles of hydrogen chloride are formed when one mole of methane is added to a large excess of chlorine in the dark?

A 0 **B** 1 **C** 2 **D** 4

36 Three members of the cycloalkene homologous series are shown:







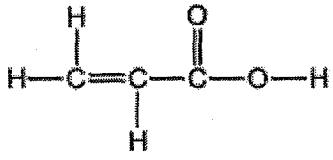
Which of the following is the general formula for this homologous series?

A C_nH_{2n-4}
B C_nH_{2n-2}
C C_nH_{2n}
D C_nH_{2n+2}

37 Oil contains carbon-carbon double bonds which can undergo addition reactions with iodine. The iodine number of an oil is the mass of iodine in grams that will react with 100 g of oil.
Which row in the table shows the oil that is likely to have the lowest melting point?

	oil	iodine number
A	corn	123
B	linseed	179
C	olive	81
D	soya	130

38 A compound has the following structure.



Which reaction(s) will occur with this compound?

1 Bromine water will decolourise.
2 It will react with an alcohol to form an ester.
3 It will react with sodium metal.

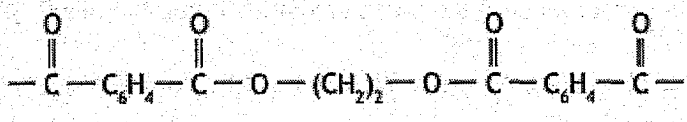
A 1 only
B 1 and 2 only
C 2 and 3 only
D 1, 2 and 3

39 Polyvinyl chloride (PVC) is a man-made polymer used mainly in the manufacture of pipes. PVC pipes are strong, lightweight and does not rot.
Which statements correctly describe the polymer, polyvinyl chloride, PVC?

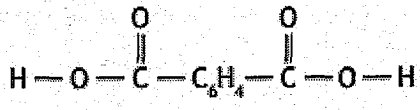
1 Combustion of PVC waste produces a highly acidic gas.
2 PVC molecules are saturated.
3 The empirical formula of PVC is the same as the empirical formula of its monomers.

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

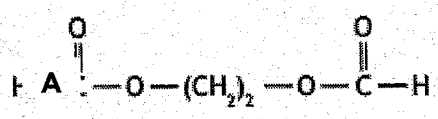
40. A section of a condensation polymer is shown below.

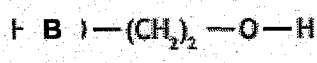


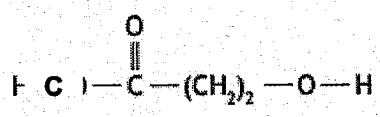
One of the monomers is

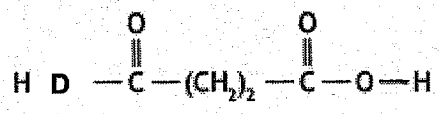


The structural formula of the other monomer is

A 

B 

C 

D 

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 –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Name: ..... Index No. ..... Class: .....

Bukit Batok Secondary School

PRELIMINARY EXAMINATION 2018

Sec 4 EXPRESS

CHEMISTRY

Paper 2

6092/02
15 August 2018
1030 - 1215
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces provided at the top of this page.
Write in dark blue or black pen
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Section B
Answer all **three** questions, the last question is in the form of either/or.
Answer **all** questions in the spaces provided.

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

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

For Examiner's use	
Section A	/50
Section B	
B7	
B8	
B9	
Total	/80

Section A

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

A1(a) The grid below represents part of a blank periodic table, the numbers being the proton number of the elements.
In the grid below, write

(i) **P** in a space which could be occupied by a noble gas which is used to fill weather balloons. [1]

(ii) **Q** in a space which the most reactive non-metal would occupy. [1]

(iii) **R** in a space which could be occupied by a metal with the lowest density. [1]

(iv) **S** in a space which could be occupied by an element forming an amphoteric hydroxide. [1]

(v) **T** in a space which could be occupied by an element with an isotope that can be represented by $^{14}_{6}X$. [1]

1							2
3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18

(b) **(i)** Describe how the metallic character of the elements in Period 3 changes across the period from left to right.

.....[1]

(ii) State how the metallic character of an element is related to its electronic structure.

..... [1]

(c) Explain what is meant by the term *periodicity*.

.....

.....[1]

[Total: 8]

A2 Carbon atoms can bond to each other to produce a variety of different structures, including diamond, graphite and buckminsterfullerene.

(a) There are similarities and differences in the structure and bonding in diamond and graphite.

(i) Describe two features of the structure and bonding in diamond that are similar to graphite.

.....

.....

.....

..... [2]

(ii) Describe two features of the structure and bonding in diamond that are different from graphite.

.....

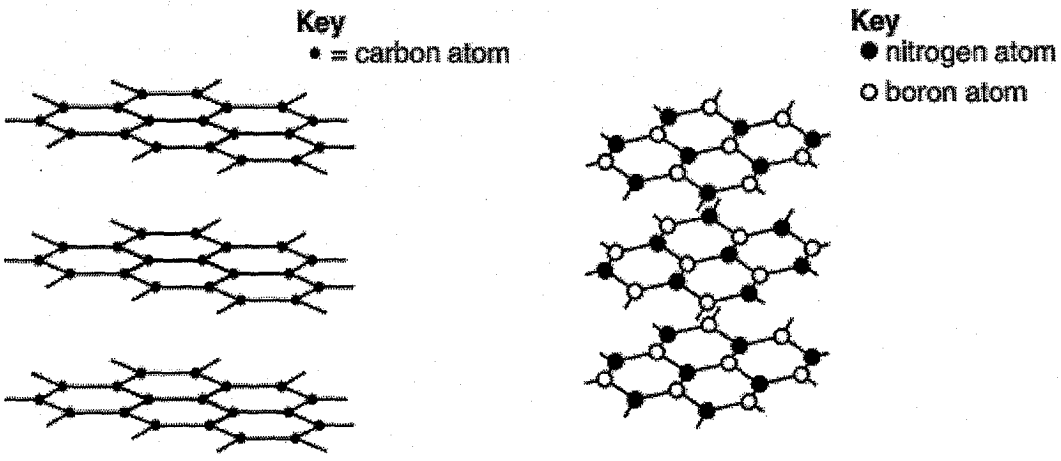
.....

.....

..... [2]

(b) Buckminsterfullerene is a form carbon with the formula C_{60}. If it is burned completely in oxygen, it forms carbon dioxide as the only product.
Calculate the mass of carbon dioxide that is released when 51 g of buckminsterfullerene is completely burned in oxygen. [2]

(c) The structures of graphite and boron nitride are shown below.



graphite boron nitride

(i) What is the chemical formula for boron nitride? .....[1]

(ii) Like graphite, boron nitride feels slippery to the touch.
Explain, in terms of bonding and structure, why boron nitride feels slippery to touch.

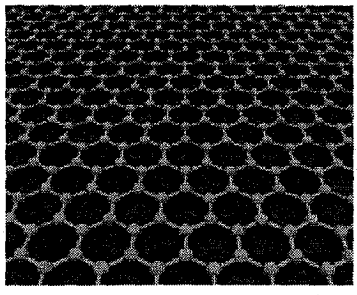
.....

.....

.....

..... [2]

(iii) The diagram below shows the structure of a solid form of carbon called graphene. Graphene contains **one layer** of carbon atoms.
Graphene is made from graphite but it is harder than graphite.



Explain, using ideas about structure and bonding, why graphene is hard.

.. ..

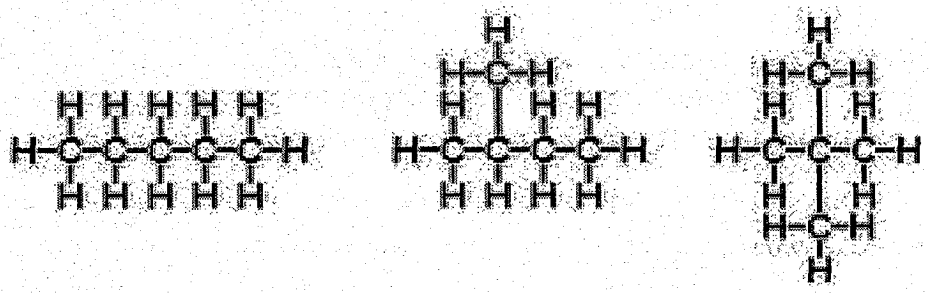
[1]

A3 Alkanes like propane and butane are found in Liquefied Petroleum Gases(LPG).

(a) An experiment shows that complete combustion of 1.0 dm^3 (measured at room temperature and pressure) of butane produces 120 kJ of energy.
Calculate a value for the enthalpy change of complete combustion (kJ/mol) of butane, giving the correct sign.

[1]

(b)(i) The alkane with 5 carbon atoms, pentane exists as several isomers shown below. One is straight chain pentane while the other two are branched chain pentane.



Will the two isomers which are branched chain pentane have the same enthalpy change on complete combustion as the straight chain pentane?
Explain your reasoning.

.....

.....[1]

(ii) The table shows the enthalpy changes of combustion of hexane and heptane.

name	formula	enthalpy change of combustion / kJ/ mol
hexane	C_6H_{14}	-4163
heptane	C_7H_{16}	-4817

Using the data given, estimate the enthalpy change of combustion in kJ/mol of octane, C_8H_{18}. Explain the method you use to arrive at your answer.

.....

.....

(c) Some students studied the graph below that shows the amount of fossil fuel burned in the world between 1960 and 2010.

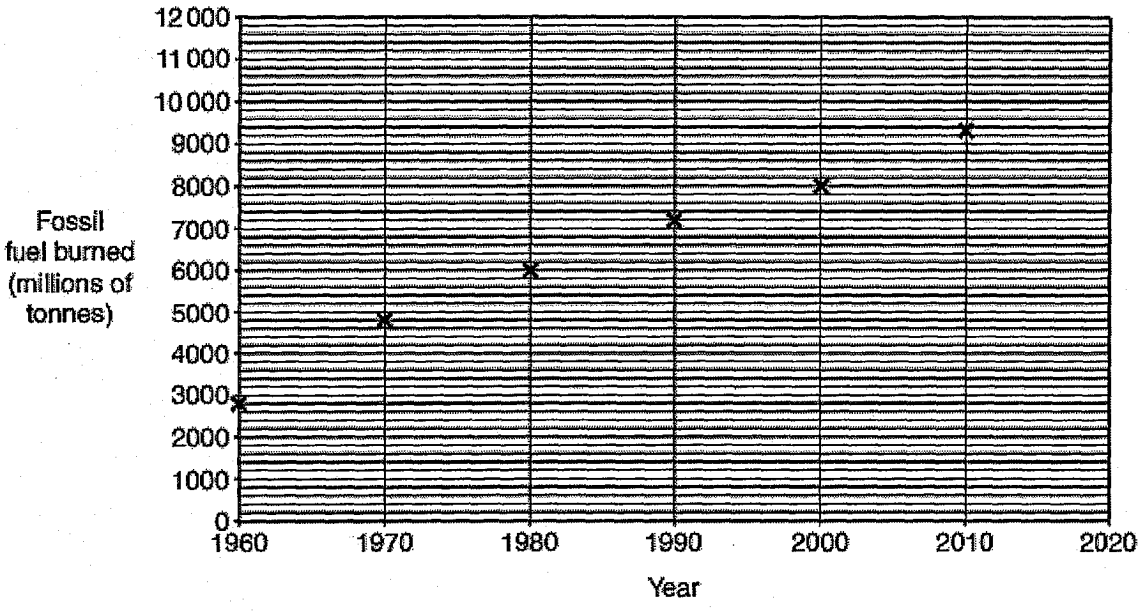


Fig 3.1

(i) One student says that the amount of fossil fuels burned has increased by the same amount every ten years.
Is the student correct? Use data from the graph to justify your answer.

.....

..... [1]

(ii) Another student says that it is very difficult to estimate the amount of fossil fuel we will use in 100 years' time. Suggest reasons the student could give to justify this statement.

.....

.....

.....

..... [2]

(iii) The graph below shows the changes in average global temperature from 1960 to 2010.

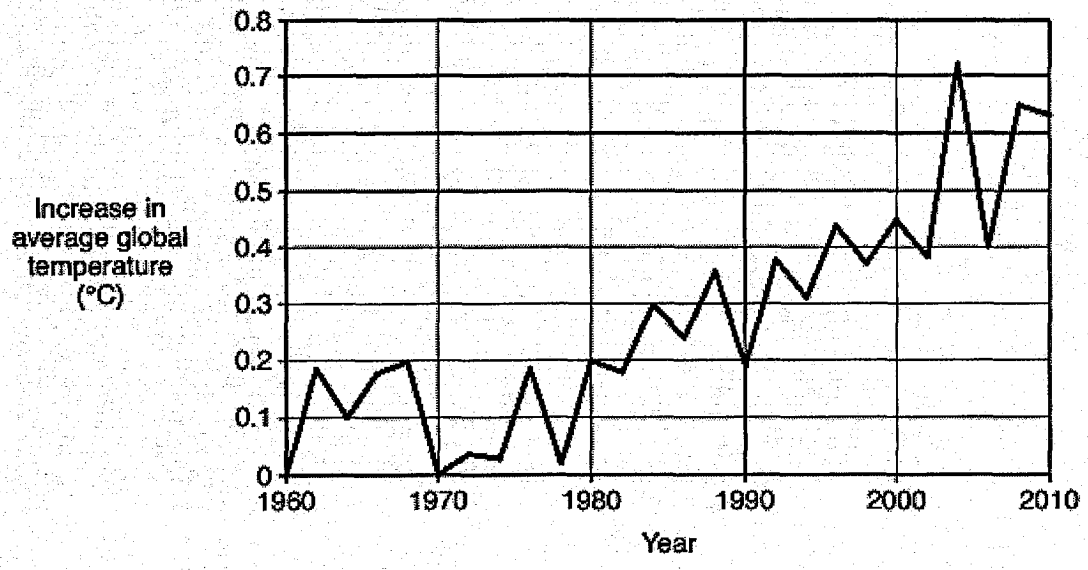


Fig 3.2

Describe the link between the trends shown in the graphs in Fig 3.1 and Fig 3.2.

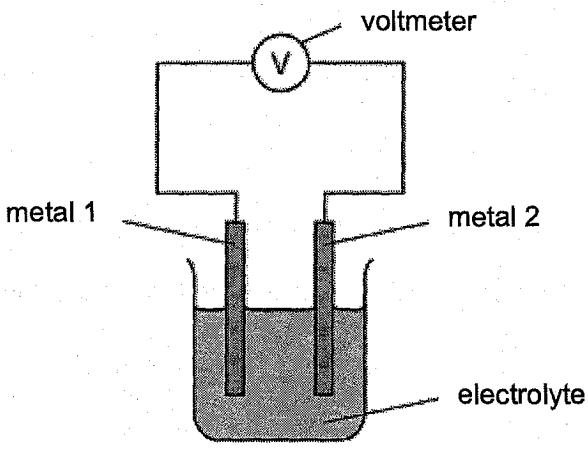
.....

.....[1]

[Total: 8]

A4 The diagram shows a simple cell, with two different metals as electrodes dipped in dilute nitric acid. A student did an experiment using the simple cell below.
The voltages were recorded in the table.

- If the voltage measured is positive then metal 2 is more reactive than metal 1.
- If the voltage measured is negative then metal 1 is more reactive than metal 2.



		metal 2				
		beryllium	cobalt	nickel	silver	vanadium
metal 1	beryllium	0.0 V	-1.6 V	-1.6 V	not measured	-0.7 V
	cobalt		0.0 V	0.0 V	-1.1 V	0.9 V
	nickel			0.0 V	-1.1 V	0.9 V
	silver				0.0 V	2.0 V
	vanadium					0.0 V

(a) (i) In the simple cell containing nickel and silver, it was observed that the electrolyte slowly turned pale green. Write the ionic equation to explain the colour change.

.....[1]

(ii) What happened to the mass of the nickel electrode?

.....[1]

(b) (i) Using the data given, state the most reactive metal in the table above.
Explain your reasoning.

.....

.....

..... [2]

(ii) Predict the voltage produced by a simple cell with beryllium as metal 1 and silver as metal 2.

(c) (i) The student wanted to rank the metals listed in the table according to their reactivity but he was not able to do so. Why?

.....[1]

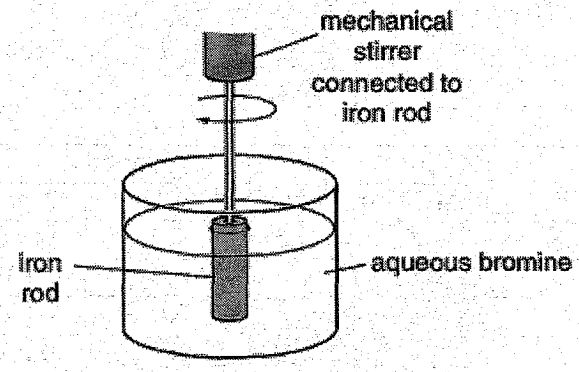
(ii) Briefly describe one **simple** experiment the student can do which will help him to solve the problem in **c(i).**

.....

.....[1]

[Total: 7]

A5 The rate of reaction of iron with aqueous bromine is determined by using the apparatus shown below.



The iron is removed at regular intervals. It is washed, dried and then weighed.
The iron is then replaced in the solution.
The experiment is repeated twice, each time with a different concentration of aqueous bromine at room temperature, 25 °C. The results are shown in the table below.

Experiment	concentration of aqueous bromine mol/dm^3	speed of reaction mg iron reacted/min
1	0.050	9.2
2	0.10	18.1
3	0.15	27.2

(a) Describe how and explain why the speed of this reaction changes with concentration of bromine.

.....

.....

[2]

(b) (i) Experiment 1 is repeated after aqueous bromine has been cooled in an ice bath to 15°C.
Predict the speed of reaction, with appropriate unit.....[1]

(ii) Using collision theory, explain your answer in **(b)(i).**

.....

.....

.....

..... [2]

(c) Suggest another method for measuring the speed of this reaction.

.....[1]
[Total: 6]

A6 Ammonia, NH_3, is a colourless, pungent-smelling gas which has been known to man from the beginning of recorded time. Chemists have discovered a novel way of 'fixing' atmospheric nitrogen (converting nitrogen gas into its compounds). Moist nitrogen is passed over a TiO_2 plate which has been coated with other chemicals. The nitrogen is thought to react with moisture in the air at room temperature and pressure to form ammonia.
A *possible* equation for the reaction is given below.

$$5N_2(g) + 6H_2O(g) \rightleftharpoons 4NH_3(g) + 6NO(g) \quad \Delta H = +1808 \text{ kJ/mol}$$

(a) (i) Explain why there are only a few reactions that 'fix' nitrogen.

.....

.....

..... [2]

(ii) Suggest and explain one advantage and one disadvantage of the process given in the equation above as a method of making ammonia compared with the Haber process.

.....

.....

.....

(b) 1.20 dm^3 of ammonia gas was dissolved in water to form 200 cm^3 of aqueous alkali at room temperature and pressure.

(i) Calculate how many moles of $NH_3(g)$ was dissolved in water.

[1]

(ii) Write the equation for the neutralisation of aqueous ammonia, $NH_3(aq)$ by dilute sulfuric acid.

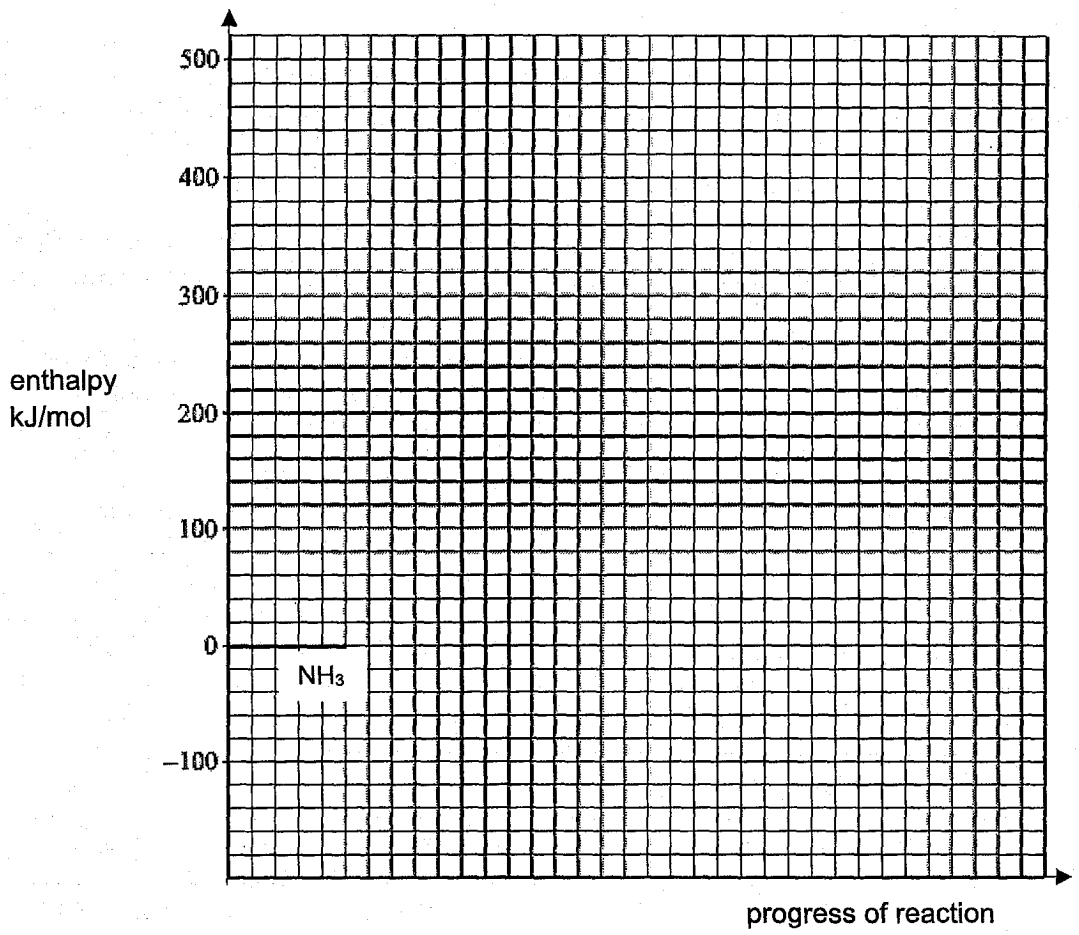
.....[1]

(c) The decomposition of ammonia is represented by the following equation.

$$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g) \quad \Delta H = +92 \text{ kJ/mol}$$

The activation energy, E_a for the uncatalysed reaction is 335 kJ/mol.
The activation energy, E_a" for the reaction when tungsten is used as a catalyst is 163 kJ/mol.

(i) On the grid provided on page 12, draw a **labelled** energy profile diagram for the uncatalysed and catalysed reactions. [3]
Include the necessary information given.



(ii) When osmium is used as a catalyst, the activation energy is 197 kJ/mol. Which catalyst, osmium or tungsten, will cause ammonia to decompose at a faster rate? Explain your answer using ideas about particles.

.....

.....

..... [1]

(iii) State the activation energy for the uncatalysed reaction of the following:

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

..... [1]

[Total:11]

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.

B7 Composition of sea water

The Earth's ocean holds about 1.5×10^{18} tonnes of water, which in turn contains 0.05×10^{18} tonnes of dissolved salts. The table below shows eight most common ions in the sea.

ion	% by mass of total dissolved solids	concentration in mol/dm^3
Chloride, Cl^-	55.04	0.535
Sodium, Na^+	30.42	0.457
Sulfate, SO_4^{2-}	7.69	0.028
Magnesium, Mg^{2+}	3.91	0.056
Calcium, Ca^{2+}	1.16	0.010
Potassium, K^+	1.10	0.0097
Carbonate, CO_3^{2-}	0.41	0.0023
Bromide, Br^-	0.19	0.00081

The dissolved ions in the sea form an essentially free source of materials to anyone with access to the sea. Evaporation of sea water produces sodium chloride and potassium chloride. The two other elements that can be obtained from sea water are bromine and magnesium.

Uses of Magnesium

Magnesium is the lightest structural metal used today, some 30% lighter than aluminium. Magnesium is the third most used metal in construction (after iron and aluminium). Nearly 70% of the world production of magnesium is used to make alloys. One example is Magnox which is an alloy of magnesium with small amount of aluminium and other metals.

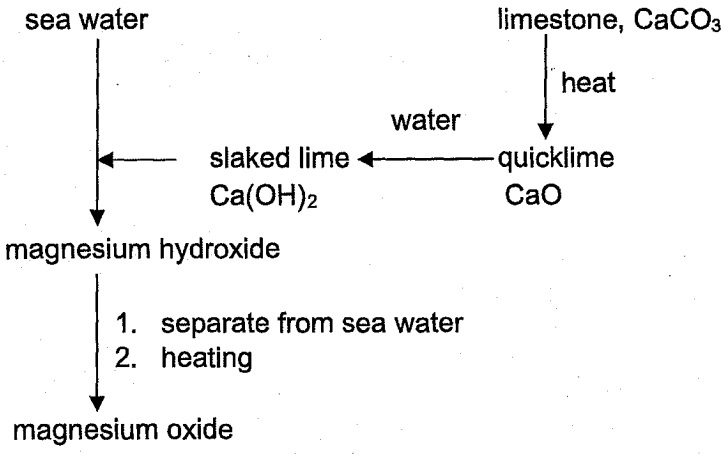
Extraction of magnesium

The first stage in the production of magnesium is to mix the sea water with a slurry of calcium hydroxide. This precipitates magnesium hydroxide.

This reaction can be represented as follows.

$$Mg^{2+}(aq) + Ca(OH)_2(aq) \rightarrow Mg(OH)_2(s) + Ca^{2+}(aq)$$

The flow chart summarises the process mentioned



Conversion to magnesium chloride is achieved by heating the oxide, mixed with carbon, in a stream of chlorine at a high temperature in the furnace.

$2MgO(s) + C(s) + 2Cl_2(g) \rightarrow 2MgCl_2(s) + CO_2(g)$

The resulting anhydrous magnesium chloride is fed into electrolytic cells.
A schematic diagram of the electrolytic cell is shown below in Fig 7.1

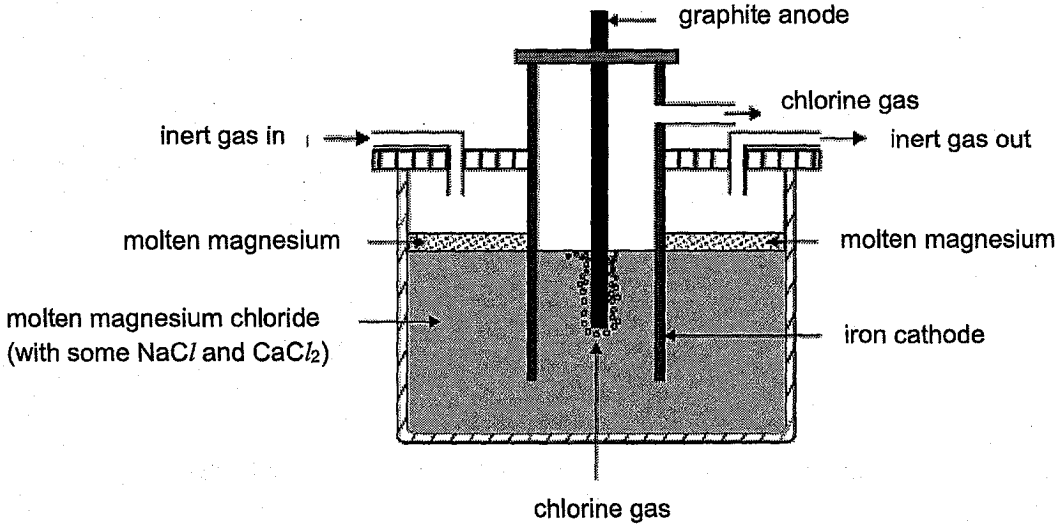


Fig 7.1

The design of this cell considers the following properties of both magnesium metal and magnesium chloride:

- molten magnesium reacts vigorously with oxygen
- at the temperature of molten magnesium chloride, magnesium is a liquid
- molten magnesium has a lower density than molten magnesium chloride and forms a separate layer on the surface.

(a) Name the most abundant ionic compound in sea water and determine the effective concentration of this compound in mol/dm^3.

[1]

(b) (i) From the information given, deduce the trend in solubility of the Group II metal hydroxide as the proton number increases.

.....

.....[1]

(ii) Calculate the mass of magnesium hydroxide precipitated when an excess of calcium hydroxide is added to 1000 dm^3 of sea water. [2]

(c) (i) Write an ionic equation for the reaction at the cathode in the electrolytic cell.

.....[1]

(ii) How does the design of the cell shown in the Fig 7.1, take into consideration the reaction of molten magnesium with oxygen?

.....

.....[1]

(d) Electrolysis is an expensive process as high consumption of energy is needed. Using the information given, what is being done to lower the cost in industrial process?

.....

(e) A technician accidentally replaced the graphite electrode with a piece of silver metal.
How would the products of electrolysis be affected? Explain your answer.
Write an ionic equation to support your answer.

.....

.....

.....

.....

.....

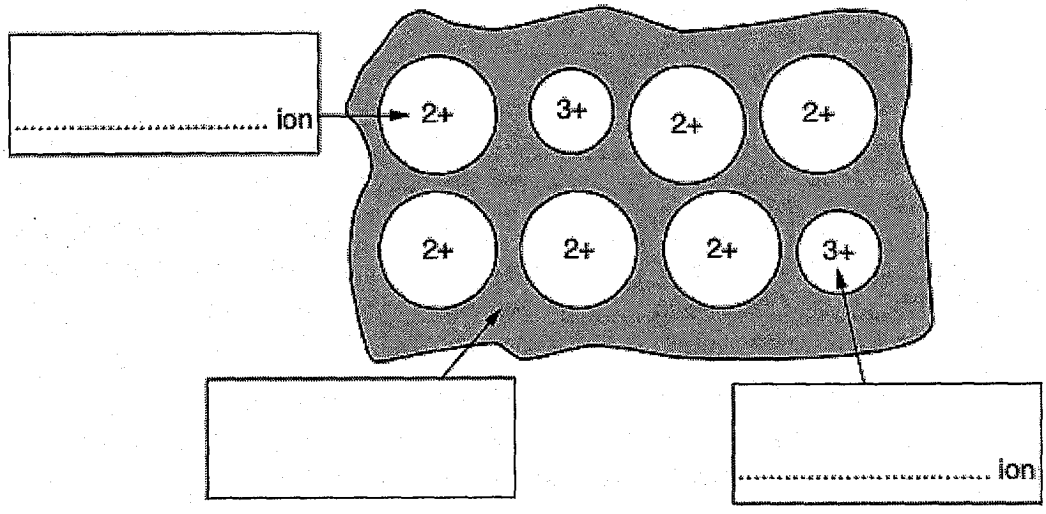
....[3]

(f) State an example of recycling that is given in the information.

.....

..... [1]

(g) The aluminium atoms in Magnox form a metallic structure with magnesium.
The figure below represents a simple illustration of the bonding in Magnox.
Use your knowledge of atomic structure and metallic bonding to label the boxes. [1]



[Total: 12]

B8 (a) A student reacted together an alcohol and a carboxylic acid under appropriate conditions to produce an ester.

A sweet smelling organic liquid, **Q**, with the empirical formula C_2H_4O was produced.

The M_r of **Q** was found by experiments to be 87.5.

(i) What is the molecular formula of **Q**? Show the necessary calculation. [1]

(ii) In the boxes below, draw the structural formula of **two** isomers with this formula that are **straight chain** esters. [2]

A sample of **Q** was heated with aqueous sulfuric acid. The product obtained was a mixture of the original alcohol and carboxylic acid. This mixture was heated under reflux with acidified potassium manganate(VII) to give a **single** product, **R**.

The product, **R**, was collected and subjected to the following tests:

- A sample of **R** gave no reaction with aqueous bromine.
- A second sample of **R** gave an effervescence with sodium carbonate.
- A third sample of **R** is completely miscible with water.

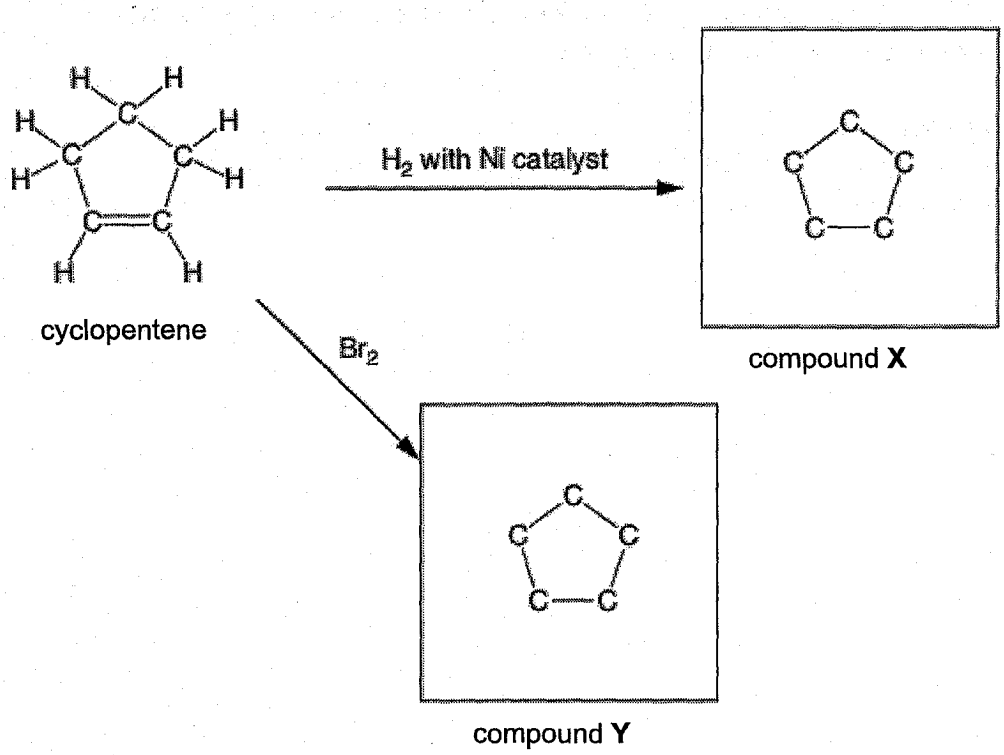
(iii) What is the identity of single organic compound **R**?

.....[1]

(b) Cyclopentene is a cyclic alkene with the formula C_5H_8. It is a colourless liquid with a petrol-like odour. It is used as a monomers for synthesis of plastics.

The figure below shows some reactions involving cyclopentene

(i) Complete the partial structures of compounds **X** and **Y** which are the products of the reactions. [2]



(ii) Write a balanced chemical equation to show the reaction between cyclopentene and aqueous bromine.

..... [1]

(iii) Cyclopentene can be polymerised to give poly(cyclopentene). Draw a section of poly(cyclopentene) to show two repeat units. [1]

B9 Either

Aqueous iron(II) bromide is a pale green solution containing iron(II) ions and bromide ions. When chlorine is passed into aqueous iron(II) bromide, the colour of the solution changes from pale green to orange-red.

When the orange-red solution is heated, it gives off a brown vapour, leaving a yellow solution **S**. The brown vapour forms a dark orange liquid **T** on cooling. When ethene gas is bubbled into **T**, the dark orange colour disappears. Sodium hydroxide solution is added to solution **S** and a reddish brown precipitate was obtained.

(a) (i) Name liquid **T.** ..... [1]

(ii) Draw 'dot-and-cross' diagram to show the electron arrangement in **T.**
Show only the outer electrons. [1]

(b) Name the yellow compound present in solution **S.**

..... [1]

(c) (i) Construct a balanced chemical equation for the reaction in which **S** and **T** are formed.

..... [1]

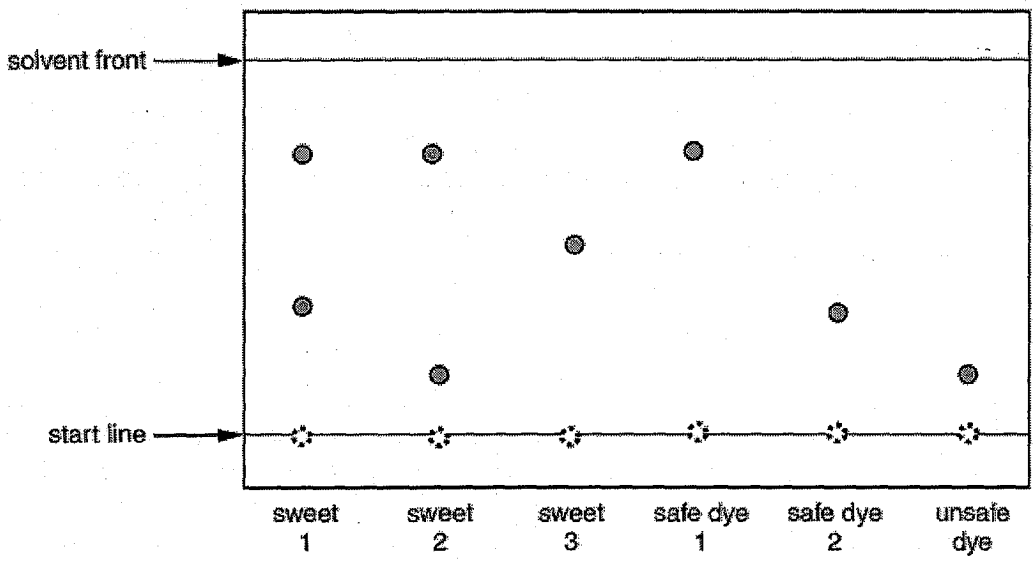
(ii) In this reaction in which **S** and **T** are formed, name the oxidising agent.
Explain your answer, using **electron transfer**.

.....

.....

.....[2]

(d) A student uses chromatography to analyse the food dyes used in a packet of sweets. The packet contains three different coloured sweets. He tests one sweet of each colour. He uses two known safe food dyes and one known unsafe dye as references.
The chromatogram below shows his results.



(i) The student looks at the results and makes this statement:
"The results show that it is possible that two of the sweets contain an unsafe dye."
Explain how the results of the chromatogram support the student's conclusion.

.....

.....

..... [2]

(ii) Calculate the R_f value of the unsafe dye given in the chromatogram above.

[1]

(iii) The student also uses chromatography to identify the **flavourings** used in the sweets. He sprays his chromatogram with a locating agent.
Why does he need to use a locating agent?

[1]

B9 Or

Both calcium and barium are elements in Group II of the Periodic Table. The trend of the reactivity of the elements in Group II is similar to that in Group I. Like Group I elements, calcium and barium form salts with the halogens.

The salt, calcium chloride, $CaCl_2$, can be made by different reactions.
A student prepared hydrated calcium chloride by carrying out the following experiment.

Step 1 The student added an excess of a solid calcium compound, **X**, to dilute hydrochloric acid. The mixture fizzed as the solid reacted.
Step 2 The student filtered the mixture to give an aqueous solution of $CaCl_2$.
Step 3 On evaporation, colourless crystals of hydrated calcium chloride were formed.

(a) Why is calcium chloride an example of 'salt'?

.....

..... [1]

(b) A friend of the student suggested that solid **X** was calcium oxide. State one reason why the student's friend was **incorrect** and suggest a possible identity of solid **X**.

.....

.....

....[2]

(c) Hydrated calcium chloride has a molar mass of 219 g/mol.
Determine the formula of **hydrated** calcium chloride.
You must show your working. [2]

(d) Calcium chloride can also be formed by directly reacting calcium with chlorine gas. Explain, using **oxidation states**, why the formation of calcium chloride from its elements, is a redox reaction.

.....

.....

.....[2]

(e) The student decided to prepare barium sulfate, $BaSO_4$, by adding barium metal to dilute sulfuric acid . Another student said this method should not be used to prepare the salt, barium sulfate.
Give **two** reasons why the other student is correct.

.....

.....

.....

.....[2]

(f) Barium atom has the electron arrangement 2, 8, 18, 18, 8, 2. Write the electron arrangement of the barium **ion**.

.....[1]

End of paper

Key

proton (atomic) number atomic symbol name relative atomic mass

Group

I	II											III	IV	V	VI	VII	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 –		

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

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

2018 GCE O Prelim sec 4E Chemistry 6092 Paper 1

Answer & mark scheme

No.	*Ans*	*Remarks*
1	D	(A) A boiling water bath has a temperature of 100°C, so if heat over water bath, $CuSO_4.H_2O$ obtained (see eqn) (B) This will convert hydrated copper(II) sulfate to the anhydrous form. (C) Same as (B)
2	A	(See QA notes)
3	D	X has sulfate ion reacts with barium ion to form insoluble barium sulfate. This is not the reaction of the hydrogen ion in the acid.
4	B	Both aluminium ion and zinc ion forms white ppt which dissolves in excess aq NaOH giving colourless solution. Calcium ion forms white ppt that does not dissolve in excess aq NaOH.
5	B	
6	C	(add up nucleon no. given in the options and compare to 46)
7	D	(write down electron arrangement of ions given in the option and compare) Electron arrangement for: Ca^{2+} 2,8,8 Cl^- 2,8,8
8	D	(compare no. of protons and no. of electrons) X: 9 protons, 10 electrons so X is negative ion Y: 17 protons, 18 electrons, so Y is negative ion
9	B	(see the column for ability to conduct electricity in solid and in aq state)
10	C	(compare with N which is in Group V, compound of N and H is NH_3, so compound of P and H is PH_3. Check the no. of white dots which represent hydrogen atoms)
11	B	Mass of S = $\frac{\text{no. of S atom x Ar of S}}{\text{Mr}}$ x mass of sample
12	B	
13	D	Mass of calcium carbonate in the chalk = 0.226 x 100 = 22.6g % purity = 22.6 / 23.0 x 100 = 98.3%
14	D	(compare the charge of the positive ion, eg $Na^+ + e \rightarrow Na$)
15	C	Oxygen and hydrogen gas given off (see volumes of gas produced), so hydroxide ion and hydrogen ion discharged. In (1), copper(II) ion discharged instead of hydrogen ion. In (3), chloride ion discharged instead of hydroxide ion due to higher $[Cl^-]$
16	D	As reaction progresses: (A) Concentration of acid drops (B) More carbonate used (C) More gas produced
17	D	Reaction time, t = 1 / rate = 1 / 0.2 = 5.0 s
18	D	(2) is respiration which is exothermic. (see glucose react with oxygen. Both (1) and (3) are combustion of fuel so exothermic

No.	Ans	Remarks
19	D	(assign oxidation numbers) In $FeTiO_3$, oxidation number of Ti is +4, in TiO_2, oxidation number is +4
20	A	Sodium chloride is neutral, does not react with hydrogen ions in the acid, so pH unchanged
21	C	Hydrochloric acid is strong acid, total ionization. ethanoic acid is weak acid, partial ionization.
22	A	Carbon dioxide is only produced in 2nd reaction. Salt is produced in 1st reaction.
23	D	(Recall properties of ammonium compound, apply this to methyl ammonium chloride) when ammonium chloride react with aq NaOH, ammonia gas, salt (sodium chloride) and water produced.
24	C	With calcium carbonate, soluble salts will be calcium chloride, calcium nitrate. NOT calcium sulfate as it is insoluble With copper(II) carbonate, soluble salts will be **copper(II)** chloride, copper(II) sulfate, copper(II) nitrate
25	B	Barium sulfate is insoluble, so need two soluble starting reagents. Barium carbonate is also insoluble. Add barium carbonate to dilute hydrochloric acid to form soluble barium chloride, before reacting with the second soluble reagent.
26	B	Copper will not react, remain as residue. Zinc react with dil hydrochloric acid to form colourless solution zinc chloride.
27	B	(A) Lead(II) oxide will be reduced by hydrogen gas to form lead and water (B) Magnesium is higher up in the reactivity series, so hydrogen is not able to reduce magnesium oxide (C) Carbon react with oxygen to form carbon dioxide (D) Sulfur react with oxygen to form sulfur dioxide
28	A	Both P and S are non-metals, so form acidic oxides which dissolves in water to form an acid.
29	C	Going down group II, the carbonate becomes more difficult to decompose. Both magnesium carbonate and calcium carbonate decomposes, but not barium carbonate.
30	C	(2) magnesium will displace silver from silver nitrate (4) magnesium will react with acid to form salt and hydrogen
31	D	Magnesium is a more reactive metal, so loses electron more easily.
32	A	Rusting uses up oxygen. Volume of oxygen used = 150 – 122 = 28 cm^3 % of oxygen = 28 / 150 x 100 = 18.7%
33	A	Chlorine atom reacts with the ozone molecules, so choose the option with largest no. of chlorine atoms.
34	A	Y is C_6H_{14}, so it is hexane
35	A	Absence of uv light, so no substitution occurs
36	B	Cyclobutene – C_4H_6, cyclopentane – C_5H_8, cyclohexene – C_6H_{10}
37	B	The oil with the lowest bp will have the largest no. of C=C bonds.

No.	*Ans*	*Remarks*
38	D	It has C=C so will react with aq bromine With the -COOH, it is an organic acid, soreact with metal and alcohol
39	D	(1) True, Hydrogen chloride gas produed (2) True, no more C=C in addition poymers (3) True, only the polymer is produced
40	B	

Sec 4E GCE O Prelim Chemistry 6092
Answers & mark scheme

The paper was

A1a(i) P – box 2; Q – box 9; R – box 3; S – box 13 T – box 6 [1] each
(b) (i) elements becomes less metallic. [1]
(ii) metallic elements have fewer outer / valence electrons. [1]
(c) periodicity is a repeating pattern (across different periods) [1]

[Total: 8]

A2a(i) Both consists entirely of **carbon** atoms joined by **covalent** bonds; [1]
Both have giant lattice (or giant molecular) [1]
ii. In diamond every carbon atom is bonded to four other carbon atoms, but in graphite, each carbon atom is bonded to 3 atoms;
diamond has a tetrahedral arrangement of atoms but **graphite has a layered** arrangement;
graphite has delocalised electrons unlike **diamond which do not** [any 2]
b. No. of mole of C_{60} = 51 / 720 = 0.0708 (eqn – optional)
No. of mole of CO_2 = 60 x no. of mole of C_{60} = 0.0708 x 60 = 4.24 [1]
Mass of C_{60} = 4.24 x 44 = 187 g [1]
c(i) BN [1]
ii. weak Van der Waal (or intermolecular) forces of attraction between layers; [1]
layers of **atoms** can slide over each other. [1]
iii. graphene has **many** strong covalent bond between carbon atoms. [1]

[Total: 10]

A3a. ΔH = - 24 x 120 = - 2880kJ/mol [reject if no unit and sign] [1]
b(i) Yes, same(not similar) type bond and same number of bond [1]
ii. difference in ΔH = 4817 – 4163 = 654 kJ [1]
from hexane to heptane, increase in one CH_2 group
from heptane to octane, same increase of one CH_2 group
so ΔH for octane = -(4187 + 654) = -5471 kJ/mol [1]
c(i) No, quote any two data that shows a difference for every ten years. [1]
Egs of data that can be used: 1960 -70, 2000 millions of tons bigger that 1970 to 80 which has increase 1200 millions of tons, or 1990 – 2000, increase of 800 millions of tons smaller than 2000 – 2010 increase of 1300 millions of tons.
ii. alternative / renewable forms of energy being used; [1]
fossil fuel running out. [1]
iii. As the amount of fossil fuel burnt increase, the increase average global temperature is higher. [1]

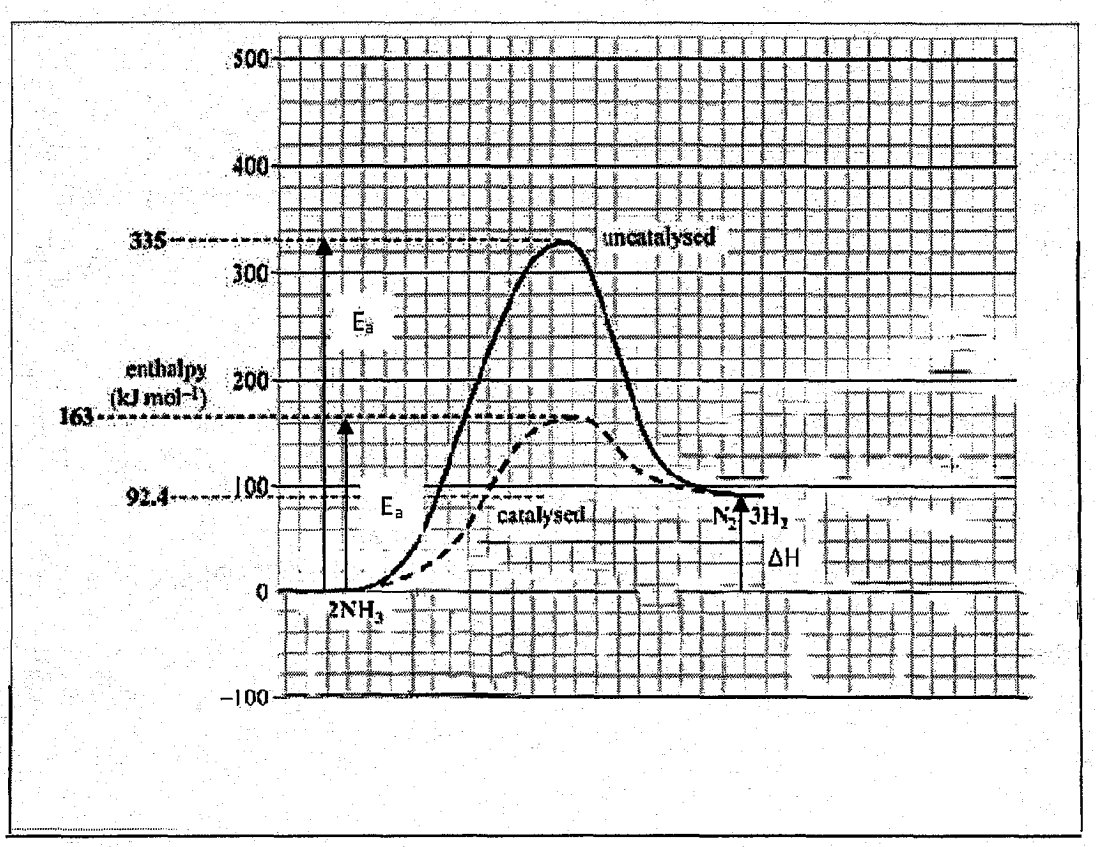
[Total: 8]

A4a(i) $Ni(s) \rightarrow Ni^{2+}(aq) + 2e$ [1]

b(i) beryllium; [1]
It has the largest voltage with cobalt/nickel [1]
ii. -2.7 V (V + Ag) + (V + Be) [1]
c(i). both nickel and cobalt has the same reactivity [1]
ii. Place a piece of nickel in cobalt nitrate solution. If nickel displaces cobalt, nickel is more reactive than cobalt. [1]
[Total: 7]

A5a. As concentration increases, the speed of this reaction increases. When concentration increases, there is greater number of particles in the same volume [1]
Particles are closer to each other so frequency of effective collision increases. [1]
b(i) 4.5 – 5.0 mg iron reacted/min (units needed)
ii. As temperature drops, particles loses energy, move slower. [1]
Number of particles with energy equal to or greater than activation energy drops. [1]
Frequency of effective collision decreases.
c. measure the colour intensity of aqueous bromine. [1]
[Total: 6]

A6a(i) N≡N triple bond; [1]
A lot of energy is needed to break the (strong covalent) bond [1]
ii. Advantage: lower temperature / lower pressure so save energy, lesser fossil fuel, or water, instead of hydrogen, water is used, so cheaper [1]
Disadvantage: nitrogen oxide produced, reacts with oxygen to form nitrogen dioxide which contribute to acid rain / an air pollutant [1]
b(i) no. of moles of ammonia = 1.20 / 24 = 0.05 [1]
(ii) $2NH_3(aq) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)$ (state symbols not needed) [1]
c(i) correct shape and location for both graphs [1m each]
correct labels of Ea, Ea" and ΔH [1]



b(ii) Tungsten: with it, the reaction has a **lower activation energy**;
which means the **higher** proportion of collisions that are successful between ammonia molecules will be higher (not more collisions, both points needed) [1]

(iii) Ea' = 243 kJ/mol (units needed) [1]

[Total: 11]

Section B

B7a. sodium chloride, Conc(mol/dm^3) = 0.457 (sodium ion is the limiting reactant) [1]

b(i) as the proton number increases, the group II metal hydroxide becomes more soluble [1]

ii. no. of mol of Mg^{2+} in 1000 dm^3 sea water = 0.056 x 1000 = 56 mols [1]
no. of mol of $Mg(OH)_2$ = no. of mol of Mg^{2+} = 56 mol
mass of $Mg(OH)_2$ = 58 x 58 = 3248 g [1]

c(i) $Mg^{2+}(l) + 2e \rightarrow Mg(l)$ [1]

ii an inert gas, instead of air, is blown through the cathode compartment above molten magnesium [1]

d. sodium chloride and calcium chloride is added to molten magnesium chloride to **lower the melting point**, saving energy. [1]

e. at the anode, silver will be oxidised instead of chloride ion. Silver ion would be produced rather than chlorine at the anode. [1]
$Ag(s) \rightarrow Ag^+(l) + e$ [1]
the silver ion would move to the cathode, get discharged and silver is produced instead

f. chlorine gas produced during electrolysis is used to convert magnesium oxide to magnesium chloride at the furnace. [1]

g. magnesium ion, aluminium ion, **delocalised** electron [all three correct -1]

[Total: 12]

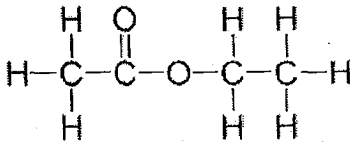
B8a(i) relative mass of C_2H_4O = 44

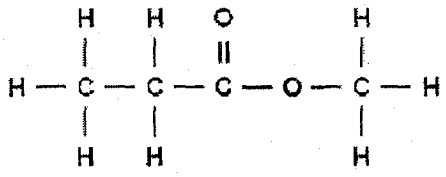
M_r ~ 88

N = 88 / 44 = 2

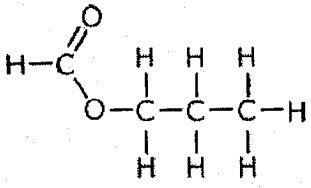
Relative molecular formula is $C_4H_8O_2$ [1]

ii. ethyl ethanoate





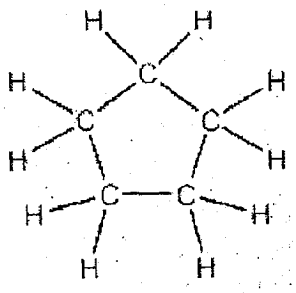
Methylpropanoate

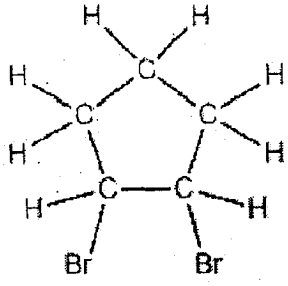


propyl methanoate [any 2]

iii. ethanoic acid [1]

b(i)

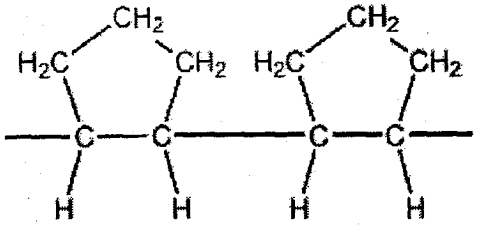




Compound X compound Y [1m for each, all H atoms needed]

ii. $C_5H_8 + Br_2 \rightarrow C_5H_8Br_2$ [1]

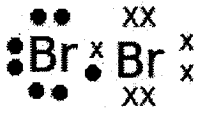
iii.



[Must have at least two repeat units and the free bonds at the end. All carbon-carbon bonds in the polymer chain must be shown.] [1]

B9 Either

a(i) bromine [1]

ii (dot-cross diagram of bromine molecule,  [1]

b. iron(III) chloride [1]

c(i) $3Cl_2 + 2FeBr_2 \rightarrow 2FeCl_3 + 2Br_2$
[1]

ii. chlorine [1]
chlorine removes electrons from iron(II) ion and bromide ion. [1]

d(i) sweet 2 contains an unsafe dye; [1]
unknown dye in sweet 3 does not match up with a safe dye [1]

ii. 0.8 / 5.2 = 0.154 (or 0.15) [1]

iii. to see the spots / make the colourless spots visible [1]
(ignore 'find / identify the spots')

[Total: 10]

B9 Or

a. Hydrogen ion / H^+ **ion** in acid replaced by calcium ion / Ca^{2+} **ion** or metal ion. [1]

b. The reaction produced a **gas** / calcium oxide does not produce a **gas** in reaction with acid. [1]
calcium carbonate. [1]

c. Mr of $CaCl_2$ = 111.

No. of water molecules = $\frac{219 - 111}{18}$ [1]

= 6

Formula: $CaCl_2.6H_2O$ [6 and $CaCl_2.6H_2O$ score the 2nd mark, allow no dot, $CaCl_26H_2O$] [1]

d. Calcium is oxidised as oxidation state of calcium increases from 0 to +2 [1]
Chlorine is reduced as oxidation state of chlorine decreases from 0 to -1 [1]

e barium is very reactive metal, so react violently with the acid, reaction not safe; [1]
barium sulfate formed is insoluble, so form a barrier on barium, preventing further reaction. [1]

(ii) 2, 8 , 18, 18, 8 [1]

[Total:10]