Register No.	Class
	4R1

Name ______________________________

BENDEMEER SECONDARY SCHOOL
2018 PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS
CHEMISTRY PAPER 1
6092/01

DATE : 20 August 2018
DURATION : 1 hour

READ THESE INSTRUCTIONS FIRST

Write in 2B pencil.
Do not use paper clips, glue or correction fluid.
Write your name, class and register number on the question paper and OTAS 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 **2B pencil** on the OTAS sheet.

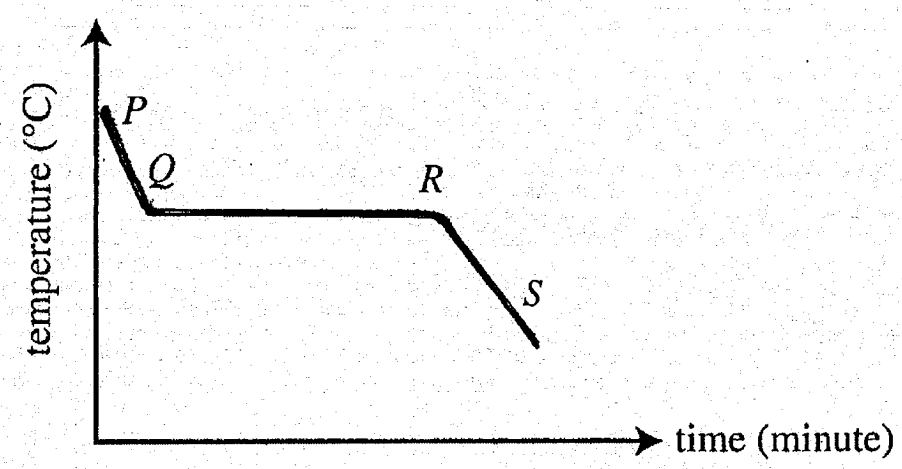
Read the instructions on the OTAS sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

A copy of the Periodic Table can be found on page **18**.

/ 40

1 A sample of solid X is heated until it is completely melted. The graph shows how its temperature varies with time as molten X is cooled.



Which of the following statements are true about the particles in X?

I They are closer to each other at stage RS than at stage PQ.
II The forces of attraction are stronger at stage P than at stage S.
III The arrangement is more orderly at stage RS than at stage PQ.
IV Their total energy content at stage QR is lower than at stage RS.

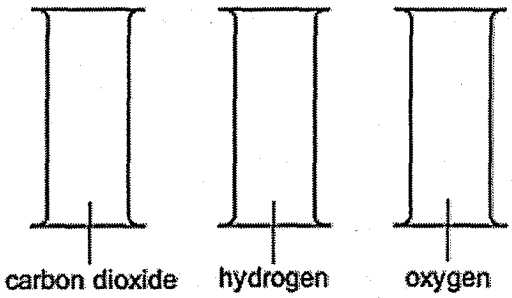
A I and II are correct
B I and III are correct
C II and III are correct
D II and IV are correct

2 In a volumetric experiment involving the addition of dilute hydrochloric acid to 25.0 cm^3 of aqueous sodium hydroxide, it is necessary to determine when the reaction has just completed.

Which piece of apparatus could be used to determine the end-point of the reaction?

A electronic balance
B gas syringe
C stop watch
D thermometer

3 The gas jars shown below contain carbon dioxide, hydrogen and oxygen.



Which test could be used to identify the gases in each jar?

A a glowing splint
B a lighted splint
C damp blue litmus paper
D limewater

4 Which procedure shows the best method to obtain a pure sample of silver nitrate, from a mixture of silver nitrate and silver chloride salts?

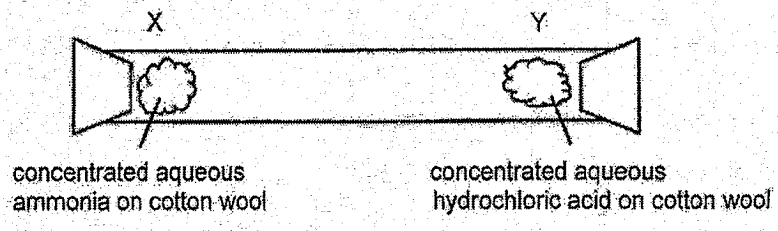
	step 1	step 2	step 3	step 4
A	dissolution	filtration	evaporation	crystallisation
B	dissolution	crystallisation	filtration	evaporation
C	dissolution	evaporation	crystallisation	filtration
D	filtration	dissolution	crystallisation	evaporation

5 Argon is used to reduce the evaporation of the metal filament in electric light bulbs. There are three isotopes of argon: argon-36, argon-38 and argon-40.

Which of the following about these three isotopes is correct?

A They have different chemical properties.
B They have different rates of diffusion.
C They have different numbers of electrons.
D They have different numbers of protons.

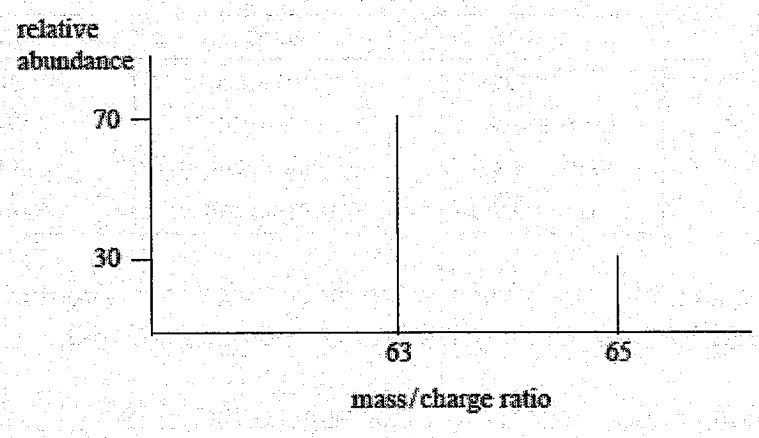
6 The apparatus was set up with two cotton wool plugs soaked in concentrated aqueous ammonia and concentrated aqueous hydrochloric acid respectively.
These plugs were placed at opposite ends of a long glass tube as shown. After some time, a white solid was formed within the tube. The experiment was then repeated at a higher temperature.



Which was true of the repeated experiment?

A The white solid was formed even closer to X as compared to the first experiment.
B The white solid was formed even closer to Y as compared to the first experiment.
C The white solid was formed at a much faster rate as compared to the first experiment.
D Yellow solid was formed instead.

7 A metal Y was analysed and found to contain only two isotopes, Y-63 and Y-65. The graph below shows the relative abundance of the two isotopes.



What is the relative atomic mass of Y?

A 63.2 **B** 63.4 **C** 63.6 **D** 64.0

8 The table below shows the proton number and nucleon number of elements M and N.

element	proton number	nucleon number
M	13	27
N	8	16

When M and N combine together to form a compound, what will be the mass of one mole of the compound?

A 43 **B** 70 **C** 102 **D** 113

9 Hexasulfur was prepared by M.R. Engel in 1891 by reacting concentrated hydrochloric acid with thiosulfate, $HS_2O_3^-$. It is orange-red and forms a rhombohedral crystal. It has a formula of S_6.

What can you deduce from the information given above?

A Hexasulfur contains only one element.
B Hexasulfur is a compound which contains 6 atoms.
C Hexasulfur is a compound which contains 6 elements.
D Hexasulfur is a mixture which contains 6 elements.

10 Since 1850, most books have been printed on acidic paper which eventually becomes brittle and disintegrates. These books can be preserved by treatment with diethylzinc vapour, $Zn(C_2H_5)_2$, which reacts with both acid and also with small amounts of water retained in paper.

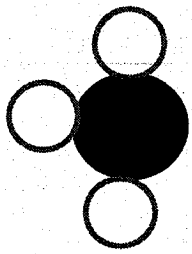
The reaction below shows the reaction of diethylzinc with an acid.

$$Zn(C_2H_5)_2 + 2H\mathbf{X} \rightarrow Zn\mathbf{X}_2 + 2C_2H_6$$

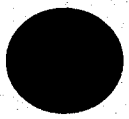
Which products are likely to result from the reaction of diethylzinc with water?

A $ZnH_2 + C_2H_5OH$
B $ZnH_2 + C_2H_6$
C $Zn(OH)_2 + C_2H_5OH$
D $Zn(OH)_2 + C_2H_6$

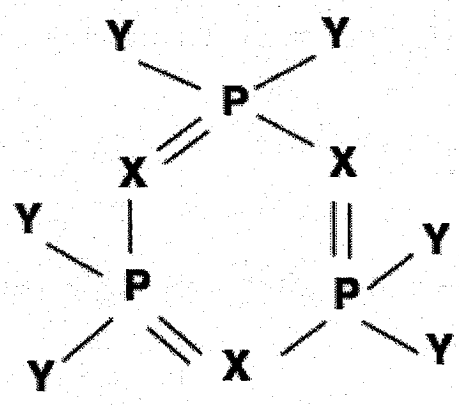
11 The following diagram shows the structure of one molecule of a substance.



What are the possible electronic configurations for the elements in the above substance?

		
A	1	2.3
B	2.6	2.5
C	2.7	2.3
D	2.8.7	2.5

12 A molecule consists of three types of elements, P, X and Y.



If P is phosphorus, what could X and Y be?

	X	Y
A	Al	H
B	N	Cl
C	O	H
D	Si	Cl

13 A student was given four bottles containing different solutions.
He mixed pairs of the solutions together and obtained the following results.

solutions	observations
1 and 2	effervescence
2 and 3	white ppt.
2 and 4	no visible reaction
1 and 3	white ppt.
1 and 4	white ppt.

Which of the following correctly identifies each solution?

	solution 1	solution 2	solution 3	solution 4
A	hydrochloric acid	sodium carbonate	barium nitrate	lead(II) nitrate
B	lead(II) nitrate	barium nitrate	sodium carbonate	hydrochloric acid
C	sodium carbonate	hydrochloric acid	lead(II) nitrate	barium nitrate
D	barium nitrate	lead(II) carbonate	hydrochloric acid	sodium carbonate

14 Which of the following pairs of solutions will show no visible change when mixed?

A barium nitrate and hydrochloric acid
B copper(II) sulfate and lead(II) nitrate
C magnesium chloride and sodium carbonate
D zinc and iron(II) sulfate

15 The following results are obtained from an experiment involving the reduction of an oxide of lead to lead metal.

Mass of test tube = 21.28 g
Mass of test tube + lead oxide = 27.26 g
Mass of test tube + lead = 26.46 g

What is the empirical formula of this oxide of lead?

A PbO **B** Pb_2O_3 **C** PbO_2 **D** Pb_3O_4

16 Which aqueous acid neutralizes the greatest volume of aqueous sodium hydroxide?

A 1 dm^3 of H_2SO_4 of concentration 4 mol/dm^3
B 2 dm^3 of H_3PO_4 of concentration 2 mol/dm^3
C 3 dm^3 of HNO_3 of concentration 2 mol/dm^3
D 4 dm^3 of CH_3COOH of concentration 1 mol/dm^3

17 5 g of barium sulfate is contaminated with barium carbonate. The mixture is added to excess nitric acid and filtered. The mass of the residue and filtrate is found to be 2.8 g and 9 g respectively.

What is the percentage purity of barium sulfate?

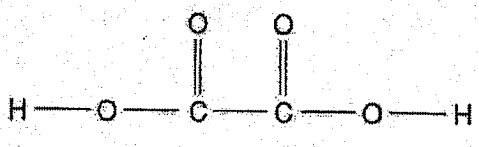
A $\frac{2.2}{5} \times 100\%$

B $\frac{2.8}{5} \times 100\%$

C $\frac{5}{9} \times 100\%$

D $\frac{9}{5} \times 100\%$

18 The structure of oxalic acid is shown below.



A 25.0 cm^3 solution of oxalic acid reacts completely with 15.0 cm^3 of 2.5 mol/dm^3 sodium hydroxide.

What is the concentration of the oxalic acid solution?

A 0.667 mol/dm^3
B 0.750 mol/dm^3
C 1.33 mol/dm^3
D 1.50 mol/dm^3

19 Nitrogenous fertilizer such as ammonium nitrate is used to increase crop yield. Which substance can be added to increase pH of the acidic soil without causing a loss of nitrogen?

A calcium carbonate
B calcium hydroxide
C magnesium hydroxide
D magnesium sulfate

20 Which pair of elements would react together most vigorously?

A potassium and bromine
B potassium and iodine
C sodium and chlorine
D sodium and fluorine

21 Elements X and Y are in the same Group of the Periodic Table.

Which statement must be correct?

A Atoms X and Y have similar electronic structure.
B Atoms X and Y have the same physical properties.
C If X has a smaller proton number than Y, it is less metallic.
D The number of electronic shells in atoms X and Y must be the same.

22 Which statement about the manufacture of ammonia by the Haber process is correct?

A The reactants are both obtained from air.
B The reactants and product are compounds.
C The reactants and product are elements.
D The reactants and product are gases.

23 An alloy contains copper and zinc. Some of the zinc has been oxidized to zinc oxide. What is the result of adding an excess of sulfuric acid to the alloy?

A A blue solution is formed and a white solid remains.
B A colourless solution is formed and a pink solid remains.
C The alloy dissolves completely to form a blue solution.
D The alloy dissolves completely to form a colourless solution.

24 Ethyne (H–C≡C–H) undergoes addition of hydrogen to form ethane as shown.

$$C_2H_2\ (g) + 2H_2\ (g) \rightarrow C_2H_6\ (g)$$

The average bond energies of the bonds in the substances involved are shown in the table below.

bond	C–H	C–C	C=C	C≡C	H–H
bond energy / kJ/mol	413	347	612	839	432

What is the enthalpy change for this reaction?

A –296 kJ/mol
B -176 kJ/mol
C +176 kJ/mol
D +296 kJ/mol

25 Ammonium chloride dissolves in water according to the equation below.

$$NH_4Cl\ (s) \rightarrow NH_4Cl\ (aq) \qquad \Delta H = +15.0\ kJ/mol$$

When 0.2 moles of ammonium chloride dissolves in 50.0 cm^3 of water,

1. the concentration of the solution is 4.0 mol/dm^3.
2. the energy level of NH_4Cl increases.
3. the heat liberated is 3.0 kJ.
4. the temperature of water falls.

Which of the above statements are correct?

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

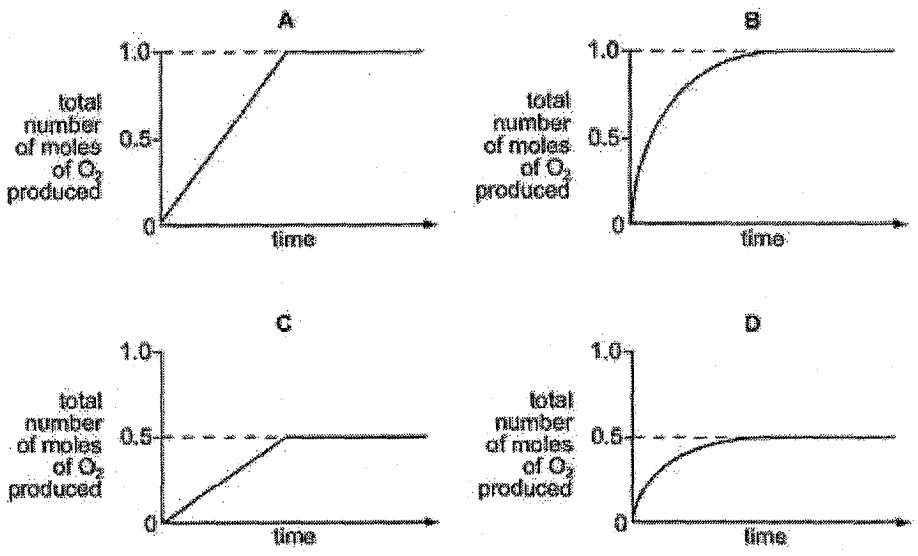
26 The anti-cancer drug, cisplatin, has the formula $Pt(NH_3)_2Cl_2$. In the human body, one of the chloride ions of cisplatin is replaced by one water molecule to form an aqua complex.

$$Pt(NH_3)_2Cl_2 + H_2O \rightarrow \underset{\text{aqua complex}}{[Pt(NH_3)_2(H_2O)Cl]^+} + Cl^-$$

What is the oxidation number of platinum in each of these substances?

	cisplatin	aqua complex
A	+2	+1
B	+2	+2
C	+4	+3
D	+4	+4

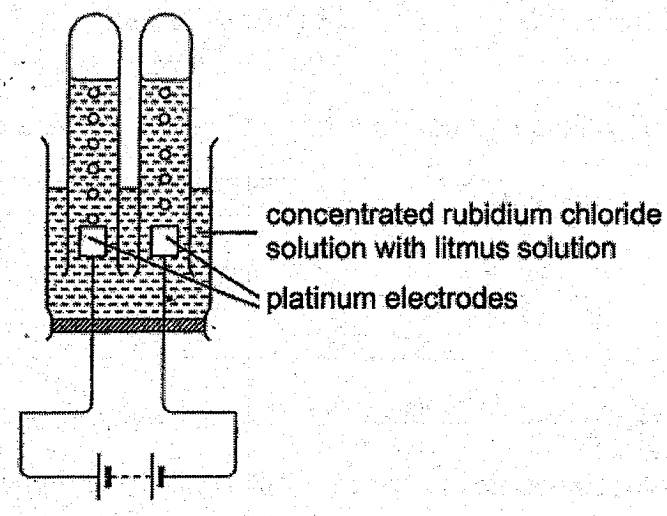
27 Manganese(IV) oxide catalyses the decomposition of hydrogen peroxide (H_2O_2) into oxygen and water.
Which curve represents the decomposition of 1.0 mol of hydrogen peroxide?



28 In which reaction is the underlined substance behaving as an oxidising agent?

A $\underline{BaCl_2} + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$
B $3CuO + 2\underline{NH_3} \rightarrow 3Cu + N_2 + 3H_2O$
C $2\underline{FeCl_2} + Cl_2 \rightarrow 2FeCl_3$
D $2NaI + \underline{Br_2} \rightarrow 2NaBr + I_2$

29 A few drops of litmus solution were added to concentrated rubidium chloride solution and the resultant solution was electrolysed using platinum electrodes.

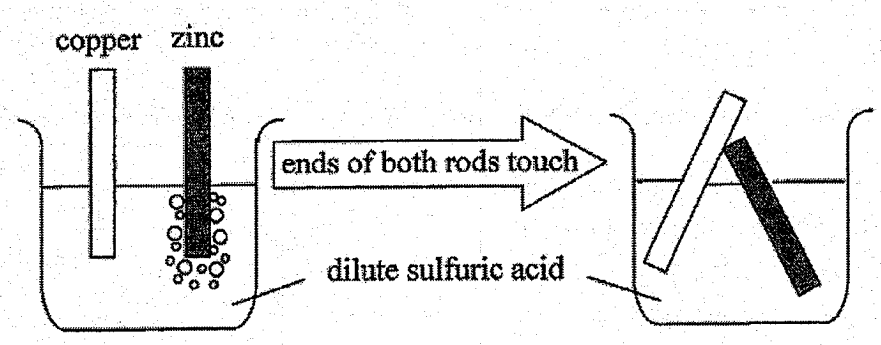


Which statement is true?

A A greenish-yellow gas is formed at the cathode.
B The anode decreases in mass.
C The pH of the electrolyte decreases.
D The solution turns purple around the cathode.

30 In an experiment, a copper rod and a zinc rod are placed into a beaker of sulfuric acid as shown below. Bubbles of gas are produced around the zinc rod only.

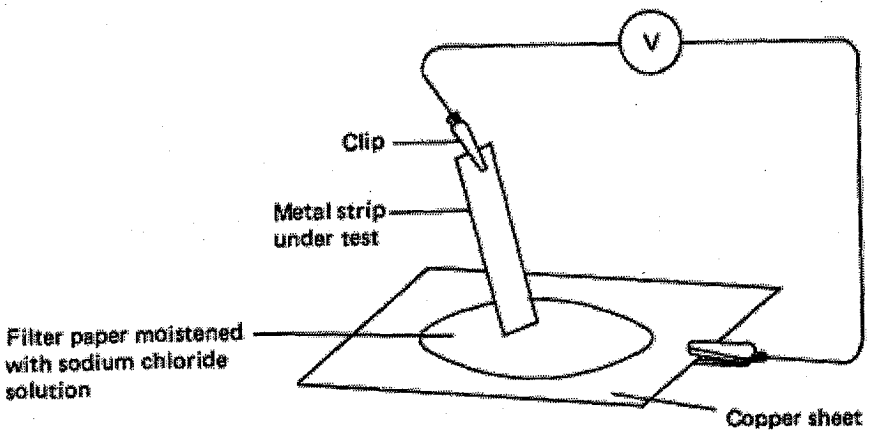
The experiment is repeated with the ends of both rods touching each other.



What happens when the ends of both rods touch each other?

A Bubbles of gas collect around both rods.
B Bubbles of gas collect around copper rod only.

31 The diagram shows the apparatus used to investigate the relative reactivity of four metals. Strips of these metals were connected in turn with the copper sheet and the voltage was recorded in the table below.



Results table:

metal under test	direction of electron flow	voltage recorded (volts)
W	from W to Cu	+ 0.78
X	from Cu to X	– 2.22
Y	from Y to Cu	+ 1.39
Z	from Z to Cu	+ 0.28

What is the order of decreasing reactivity of the four metals?

	most reactive ⟶ least reactive			
A	W	Z	X	Y
B	X	Y	W	Z
C	Y	W	Z	X
D	Z	W	Y	X

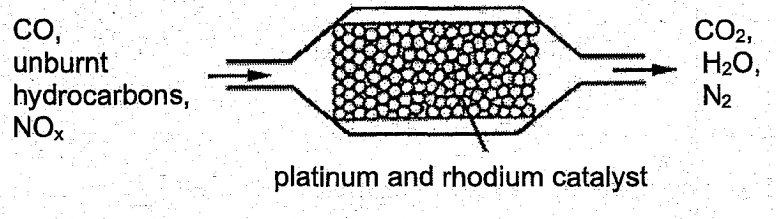
32 The table shows the results of adding weighed pieces of zinc metal in salt solutions of metals P, Q and R.

salt solution	initial mass of zinc / g	final mass of zinc after 15 minutes / g
P	6.0	0.0
Q	6.0	6.0
R	6.0	4.5

Which of the following shows the correct arrangement of metals in increasing reactivity?

A P, R, zinc, Q
B P, zinc, Q, R
C Q, P, R, zinc
D Q, zinc, R, P

33 The diagram below represents a section of a catalytic converter on the exhaust system of a car. Harmful gases are converted into carbon dioxide, nitrogen and water vapour.



Which process(es) take(s) place in this catalytic converter?

I. Carbon monoxide and unburnt hydrocarbons react together.
II. Carbon monoxide and nitrogen oxides react together.
III. Platinum and rhodium catalyse redox reactions.

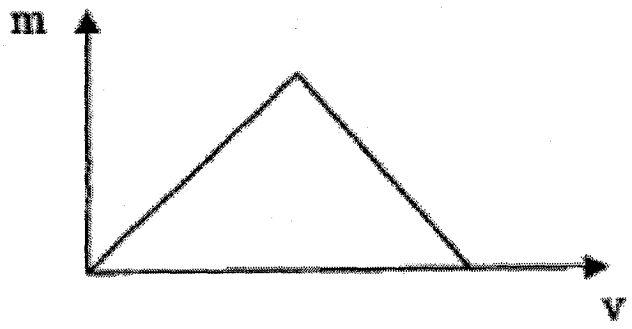
A I only
B I and II only
C II and III only
D I, II and III

34 A salt has the chemical formula $(NH_4)_2Fe(SO_4)_2.12H_2O$.
Excess aqueous sodium hydroxide was added slowly, with shaking, to a hot solution of the salt in a boiling tube until there were no further reaction. The boiling tube was then left to stand for some time.

Which observation would not be made?

A A green precipitate was produced.
B A pungent gas which turned damp red litmus paper blue was produced.
C On standing, the precipitate turned brown.
D The precipitate dissolved in excess aqueous sodium hydroxide.

35 In a test for the presence of a cation in an aqueous salt solution, aqueous sodium hydroxide is added slowly until in excess. The diagram shows how the mass (m) of the precipitate varies with the volume (v) of sodium hydroxide added.



Which could not be the aqueous salt?

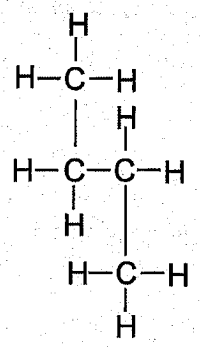
A aluminium nitrate
B calcium nitrate
C lead(II) nitrate
D zinc nitrate

36 1 mole of a compound X reacts completely with 2 moles of hydrogen gas in the presence of a catalyst to form 1 mole of alkane.

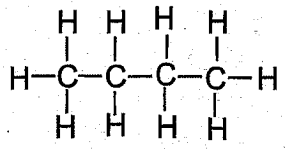
Which compound could X be?

A $CH_2=CH-CH=CH-CH=CH_2$
B $CH_2=CH-CH_2-CH_2-CH=CH_2$
C $CH_2=CH-CH_2-CH_2-CH_2-CH_3$
D $CH_2=CH-CH_2-CH_2-COH=CH_2$

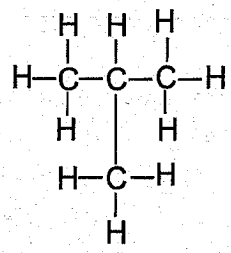
37 Which of these molecules have the same boiling points?



P



Q



R

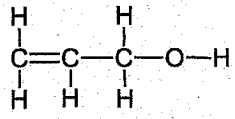
A P and Q
B P and R
C Q and R
D P, Q and R

38 An organic compound S has the following reactions:

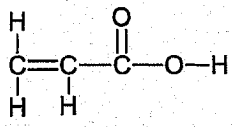
- neutralises sodium hydroxide
- decolourises aqueous bromine

Which structure represents S?

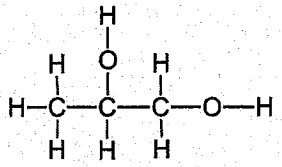
A



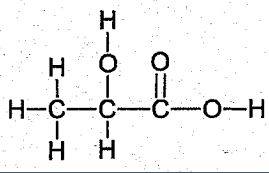
B



C



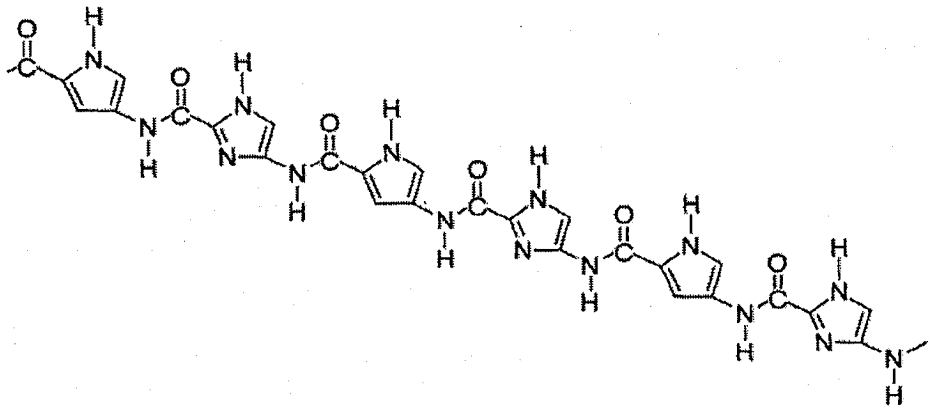
D



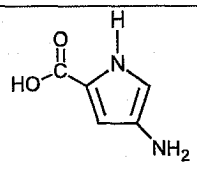
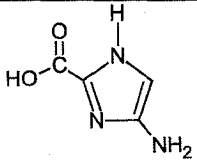
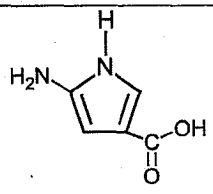
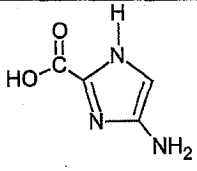
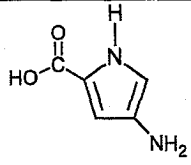
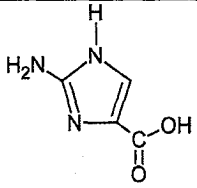
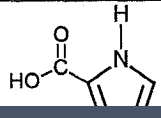
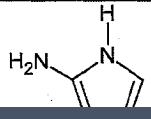
39 Which statement describes the property of the first fraction obtained from the fractional distillation of crude oil?

A It gives the most sooty flame when burnt.
B It has the highest boiling point.
C It is the most miscible with organic solvent.
D It is the most viscous.

40 The structure below shows part of a polymer.



Which option shows the correct monomers?

	monomer 1	monomer 2
A		
B		
C		
D		

The Periodic Table of Elements

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	Key: proton (atomic) number / atomic symbol / name / relative atomic mass									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.).

	Register No.	Class
Name		4R1

BENDEMEER SECONDARY SCHOOL
2018 PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS
CHEMISTRY PAPER 2
6092/02

DATE : **15 August 2018**
DURATION : **1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on the work you hand in.
Write in dark blue or black pen.
You may use a 2B pencil for any diagrams or graphs.
Do not use paper clips, glue or correction fluid.

Section A
Answer **all** questions.

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

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.

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 can be found on page **22**.

/ 80

Section A

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

A1 This question refers to the elements shown in the section of the Periodic Table below.

							H										He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

From this list of elements, identify in each case one element that has the property described. Give the symbol of the element.

(a) An element that sinks in cold water and reacts readily with it.

..... [1]

(b) An element that forms an oxide that is a reducing agent.

..... [1]

(c) An element in Period 3 that forms the smallest cation.

..... [1]

(d) 2 elements that react the most violently together to form a solid.

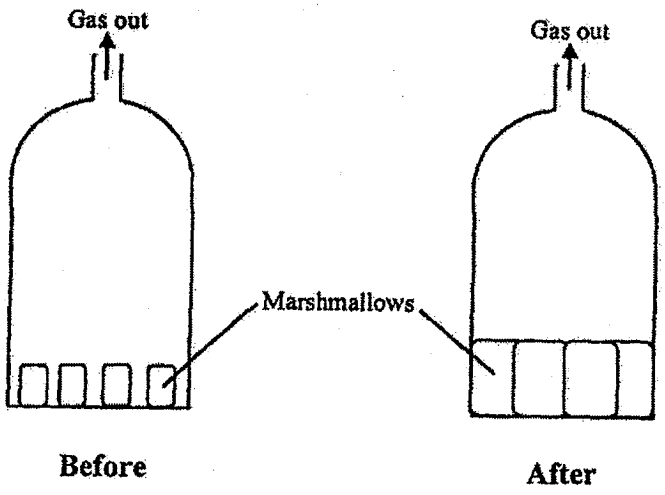
..... [1]

(e) An element that produces a reddish-brown solution with potassium iodide.

..... [1]

[Total: 5]

A2 A student carried out an experiment where she removed some gas from a gas chamber containing marshmallows.



The marshmallows were observed to have increased in size after some gas was removed from the sealed gas chamber.

(a) In the boxes below, draw the diagram for the gas in the chamber before and after some gas was removed from the chamber.

Before

After

[1]

(b) Using the kinetic particle theory, provide an explanation for why the marshmallows increased in size.

.....

.....

..... [2]

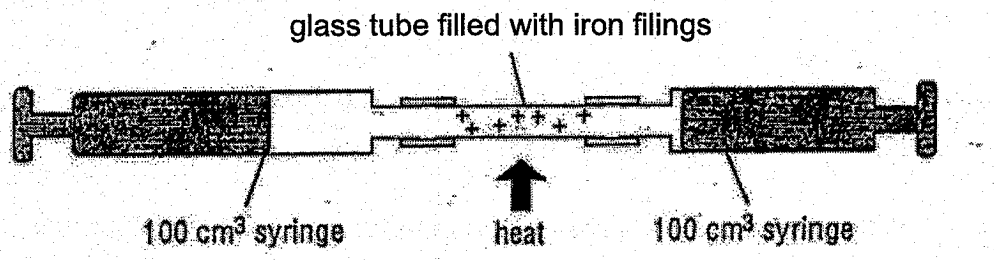
(c) When heat was applied to the gas chamber before gas was removed, the student theorized immediately that the space between the gas particles will be increased. Do you agree? Explain your answer.

.....

..... [2]

[Total: 5]

A3 (a) The percentage of oxygen in air can be determined by using the apparatus shown below. The glass tube was filled with iron filings (in excess) and the total volume of air in the syringes was 80 cm^3.



(i) Calculate the expected total volume of gas left remaining at the end of the experiment.

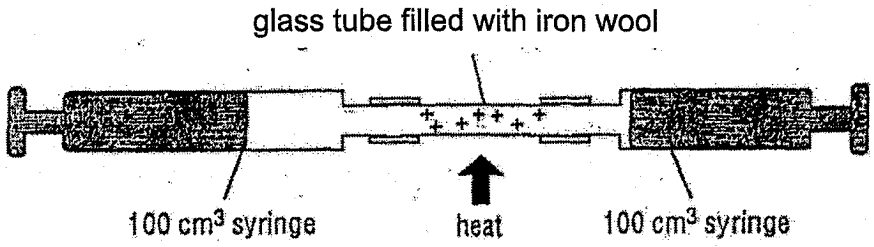
[1]

(ii) A student commented that the glass tube should be fully packed with iron to ensure accurate results.
Explain why the results obtained would be less accurate if the glass tube were only partially filled with iron filings.

.....

..... [1]

(b) The Haber Process which is used to manufacture ammonia can be demonstrated in the laboratory by the method shown below.



The mixture of nitrogen and hydrogen is passed back and forth over the hot iron wool until there is no further reaction.

(i) Suggest why it is important to ensure that no air is present in the apparatus shown above.

.....

..... [1]

(ii) Write a balanced chemical equation for the reaction between nitrogen and hydrogen.

..... [1]

(c) Aqueous ammonia is formed when ammonia gas is dissolved in water. When aqueous ammonia is added dropwise to a sample of contaminated water, a mixture of white and blue precipitate is formed initially.
Upon adding excess aqueous ammonia, a dark blue solution is formed.

(i) Write the formula(e) of the possible cations present in the water sample.

..... [2]

(ii) Write the ionic equation with state symbols for the reaction that forms the blue precipitate.

..... [1]

[Total: 7]

A4 At a children's birthday party, a magician told the children that he can change 'water' to 'milk' and then to a colourless fizzy drink like 7-up.

The magician had three glasses.
He began by holding the glass containing colourless solution **A** which he called 'water'. He then continued:

Step 1: The colourless solution **A** was poured into a seemingly empty glass containing a colourless solution **B** (which appeared to be invisible to the children). The 'water' turned into 'milk' instantly.

Step 2: The 'milk' was poured into another seemingly empty glass containing colourless solution **C** (which appeared to be invisible to the children). The 'milk' turned colourless and fizzing was observed.

The following chemicals were found in the magician's bag:

ammonia solution	calcium carbonate	methyl orange
sodium carbonate	magnesium carbonate	iron(III) chloride
sodium hydroxide	lead(II) nitrate	zinc sulfate
hydrochloric acid	acidified potassium manganate(VII) solution	

(a) What could be the substances involved in this demonstration?

solution **A**: ..... [1]

solution **B**: ..... [1]

solution **C**: ..... [1]

(b) What is the chemical name of the 'milk' formed?

..... [1]

(c) Explain why fizzing was observed in Step 2.

..... [1]

(d) The magician further demonstrated how he could change 'lemon drink' (yellow solution) to 'rose syrup' (pink solution).

(i) Which two substances did the magician use to prepare the yellow solution?

[1]

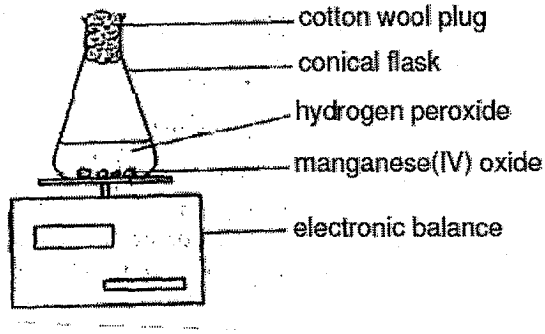
.....

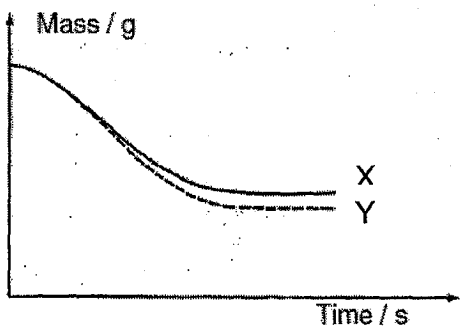
(ii) What is the colourless solution that the magician poured into the yellow solution to get a pink solution?

..... [1]

[Total: 7]

A5 The following experiment was carried out to investigate the rate of decomposition of hydrogen peroxide. A catalyst, manganese(IV) oxide, was added to a conical flask containing 50 cm^3 of aqueous solution of hydrogen peroxide. The mass of the flask was measured by an electronic balance as shown. The results were recorded and the graph obtained was labelled X.





(a) Write the chemical equation for the decomposition of hydrogen peroxide.

..... [1]

(b) Suggest the use of the cotton wool.

..... [1]

(c) Curve Y shows the results that is expected to be obtained.
Explain the difference between the actual curve X and theoretical curve Y.

.....

..... [1]

(d) State one other way in which the rate of decomposition of aqueous hydrogen peroxide can be increased.

..... [1]

(e) Describe what you would do to show that manganese(IV) oxide is acting as a catalyst in this decomposition.

.....

.....

.....

..... [3]

[Total: 7]

A6 A photographic plate is made up of a plastic base covered with a layer of 0.50 g silver bromide. After a photograph is taken, 35% of the silver bromide is reduced to silver. The image is then fixed by reacting the remaining silver bromide with aqueous sodium thiosulfate as shown in the equation below.

$$AgBr + 2Na_2S_2O_3 \rightarrow Na_3Ag(S_2O_3)_2 + NaBr$$

(a) What is the mass of silver bromide remaining on the plate after a photograph is taken?

mass of silver bromide = ...

[1]

(b) How many moles of sodium thiosulfate is needed to fix the plate?

moles of sodium thiosulfate = ...

[2]

(c) A 100 cm^3 sample of 0.200 mol/dm^3 sodium thiosulfate is used in the fixing process. Calculate the number of moles of thiosulfate left after the process.

(d) Explain using oxidation states, why the silver bromide is said to be reduced to silver.

.....

..... [1]

(e) Silver bromide is a pale yellow insoluble halide salt. Briefly describe how a pure and dry sample of silver bromide can be prepared starting from silver nitrate.

.....

.....

.....

..... [2]

[Total: 8]

A7 On a camping trip, a boy scout can only pack 1 kg of fuel for use. He has to decide which fuel to bring along. The table below shows the energy released by the complete combustion of some compounds used as fuels.

compound	M_r	boiling point/ °C	ΔH in kJ/mol
methane	16	-162	-880
propane	44	-42	-2200
heptane	100	98	-4800

(a) Explain why the fuels have relatively low boiling point.

.....

..... [1]

(b) Which fuel produces the most energy when 1 kg of the compound is burnt? Hence, determine the fuel which the boy scout is most likely to bring along.

(c) The boy scout finally decided to bring along heptane for his camping trip. Using the data from the table, suggest why his decision differs from your answer in **(b)**.

.....

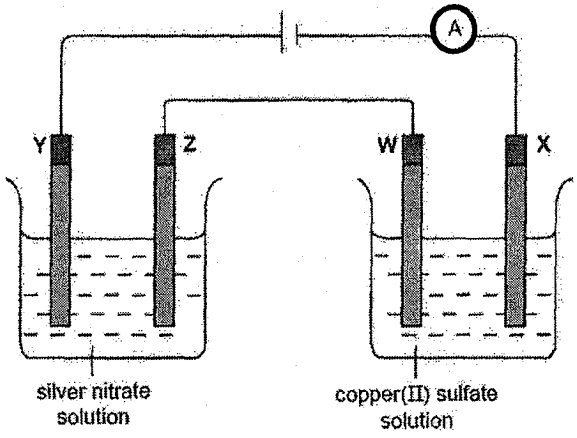
..... [1]

(d) Calculate the bond energy of the O=O bond in the combustion of methane given the following bond energies.

bond	bond energy in kJ/mol
C – H	410
O – H	460
C = O	740

[2]
[Total: 6]

A8 The diagram below shows the set-up of an electrolysis experiment.



W and X are copper electrodes while Y and Z are silver electrodes.

(a) Electrodes X and Z will increase in mass after some time.
Explain why, using half-equations to illustrate your answer.

.....

.....

..... [3]

(b) Electrode Z will increase in mass at a faster rate than electrode X.
Explain why this is so.

.....

.....

..... [2]

[Total: 5]

Section B

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

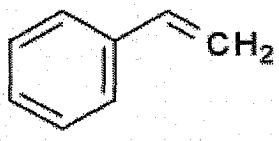
B9 Styrene, a liquid hydrocarbon that is important chiefly for its marked tendency to undergo polymerisation.

Styrene is employed in the manufacture of polystyrene, an important plastic, as well as a number of specialty plastics and synthetic rubbers.

Pure styrene is a clear, colourless, flammable liquid that boils at 145 °C and freezes at −30.6 °C.

Unless treated with inhibitor chemicals, it has a tendency to polymerise spontaneously during storage. It is slightly toxic to the nervous system if ingested or inhaled, and contact with the skin and eyes can cause irritation. Although it is suspected of being carcinogenic, studies have not proved it to be so.

The chemical formula for styrene is C_8H_8, but its structural formula, $C_6H_5CH{=}CH_2$, more clearly reveals the sources of its commercially useful properties.



Structural formula of styrene

Styrene is a member of a group of chemical compounds broadly categorised as vinyls—organic compounds whose molecules contain a double bond between two carbon atoms.

Under the action of chemical catalysts or initiators, this link contributes to the formation of polystyrene, in which thousands of styrene units are linked along a carbon backbone. Hanging from this backbone are phenyl groups (C_6H_5)—large ring-shaped units that interfere with the spontaneous motion of the chainlike polymer and lend polystyrene its well-known rigidity.

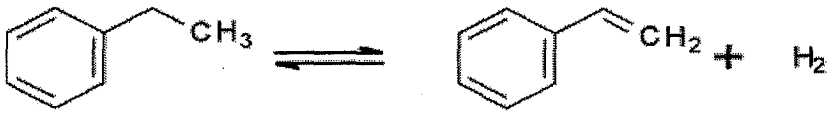
The phenyl group is one of the aromatic rings. Styrene, which gives off a penetrating sweetish odour, is therefore one of the aromatic hydrocarbons.

Industrial production from ethylbenzene

The modern method for production of styrene by *dehydrogenation* of ethylbenzene was first achieved in the 1930s. The production of styrene increased dramatically during the 1940s, when it was popularised as a feedstock for synthetic rubber.

Because it is produced on such a large scale, ethylbenzene is in turn prepared on a

a solid catalyst bed. Most ethylbenzene dehydrogenation catalysts are based on iron(III) oxide, promoted by several percent potassium oxide or potassium carbonate.



Dehydrogenation of ethylbenzene

Steam serves several roles in this reaction. It is the source of heat for powering the *endothermic* reaction, and it removes coke that tends to form on the iron(III) oxide catalyst through the water gas shift reaction. The potassium promoter enhances this decoking reaction. The steam also dilutes the reactant and products, shifting the position of chemical equilibrium towards products.

A typical styrene plant consists of two or three reactors in series, which operate under vacuum to enhance the conversion and selectivity. Typical per-pass conversions are 65% for two reactors and 70-75% for three reactors. Selectivity to styrene is 93-97%. The main byproducts are benzene and toluene. Because styrene and ethylbenzene have similar boiling points (145 °C and 136 °C, respectively), their separation requires tall distillation towers and high return/reflux ratios. At its distillation temperatures, styrene tends to polymerise. To minimize this problem, early styrene plants added elemental sulfur to inhibit the polymerisation.

During the 1970s, new free radical inhibitors consisting of nitrated phenol-based retarders were developed. More recently, a number of additives have been developed that exhibit superior inhibition against polymerization. However, the nitrated phenols are still widely used because of their relatively low cost. These reagents are added prior to the distillation.

Laboratory synthesis

A laboratory synthesis of styrene entails the decarboxylation of *cinnamic acid*.

$C_6H_5CH{=}CHCO_2H \rightarrow C_6H_5CH{=}CH_2 + CO_2$

Incineration

If polystyrene is properly incinerated at high temperatures (up to 1000 °C) and with plenty of air (14 m^3/kg), the chemicals generated are water, carbon dioxide, and possibly small amounts of residual halogen-compounds from flame-retardants. If only incomplete incineration is done, there will also be leftover carbon soot and a complex mixture of volatile compounds. According to the American Chemistry Council, when polystyrene is incinerated in modern facilities, the final volume is 1% of the starting volume; most of the polystyrene is converted into carbon dioxide, water vapor, and heat. Because of the amount of heat released, it is sometimes used as a power source for steam or electricity generation.

Adapted from: https://www.britannica.com/science/styrene

(a) Draw the 'dot and cross' diagram of styrene, showing only the outermost electrons.

[2]

(b) Explain why styrene has a low melting point of −30.6 °C.

.....

..... [2]

(c) Explain the type of reaction that occurs in the dehydrogenation process.

..... [1]

(d) Explain why tall distillation towers are necessary for the separation of styrene and ethylbenzene.

.....

..... [1]

(e) Draw the repeating unit of polystyrene.

[1]

(f) Write down a balanced chemical equation for the incineration of polystyrene (2 repeat unit) in modern facilitates.

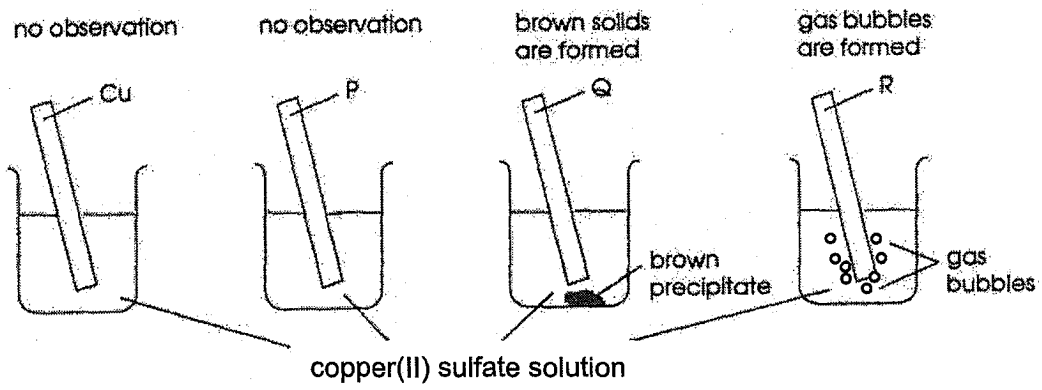
..... [1]

(g) Describe, with a balanced equation, what would be observed when sodium carbonate is put into cinnamic acid.

.....

..... [2]

B10 In the following experiment, copper and three other metals, P, Q and R are added separately to copper(II) sulfate solution.



The results for the action of heat on the oxides of copper, P, Q and R are given in the following table:

Metal oxide / Experiment	CuO	P_2O	QO	RO
Action of heat on metal oxide	No reaction	Metal P is formed	No reaction	No reaction

(a) (i) Explain the observations in the reactions of Q and R with copper(II) sulfate solution.

.....

.....

..... [2]

(ii) Write the balanced equations for these reactions.

.....

..... [2]

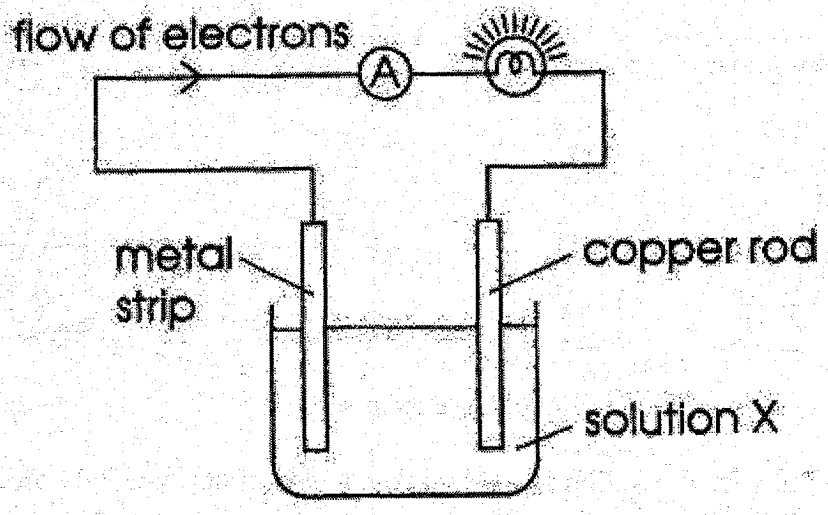
(b) Explain why metal P can be formed with direct heating on the oxide of P.

..... [1]

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

..... [1]

(d) One of the three metals, P, Q and R, is used to make a chemical cell with a copper rod. The cell is shown in the following diagram:



(i) Which metal would you choose for the metal strip?
Give a reason for your choice.

.....

..... [2]

(ii) If solution X is dilute sulfuric acid, write the ionic equations for the reactions that occur at the two electrodes.

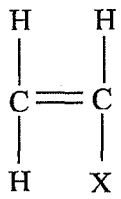
.....

..... [2]

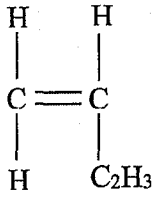
[Total: 10]

EITHER

B11 (a) Styrene-butadiene rubber is a synthetic rubber. It is made by polymerizing a mixture of the monomers butadiene and styrene.



styrene

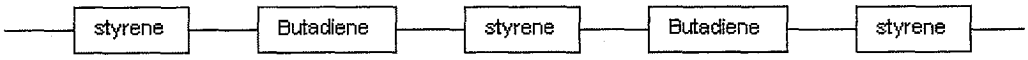


butadiene

(i) What type of polymerisation will take place when the monomers polymerize?

..... [1]

One possible structure for the polymer is shown below.



(ii) Give the full structural formula for the repeating unit in this polymer structure.

[1]

(iii) When the mixture of styrene and butadiene polymerizes, the polymer is unlikely to contain only this regular, repeating pattern. Explain why.

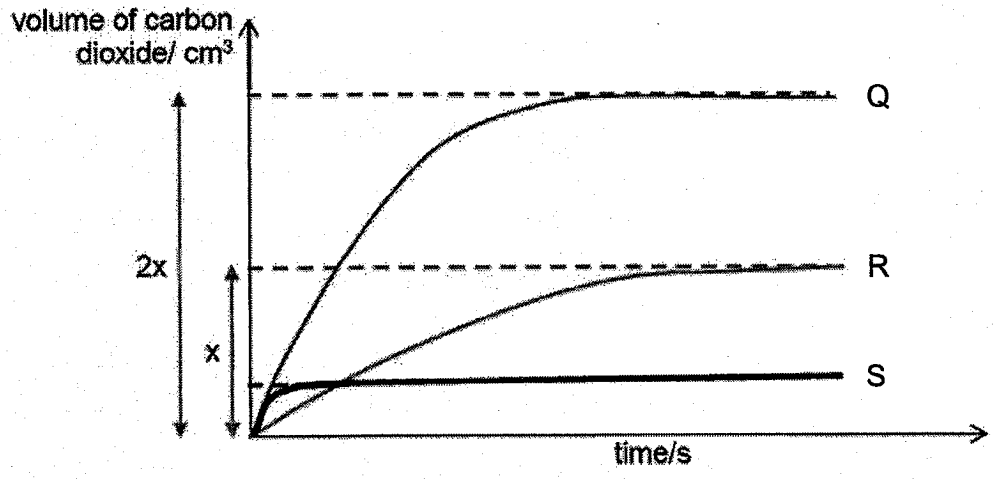
.....

..... [1]

(iv) Butadiene is obtained from the cracking of butane. 2.90 kg of butane entered the cracking tower. The percentage yield of butadiene is 75%. Calculate the mass of butadiene obtained from the cracking process.

(b) Three different experiments were carried out using metal carbonates and acids. The table below shows the reactants used in each of the experiment. The graph shows the results of the experiments.

experiment	reactants
Q	150 cm^3 of 2.0 mol/dm^3 H_2SO_4 (aq) + 26.5g Na_2CO_3 (s)
R	v cm^3 of 1.0 mol/dm^3 H_2SO_4 (aq) + excess Na_2CO_3 (s)
S	150 cm^3 of z mol/dm^3 H_2SO_4 (aq) + excess $CaCO_3$ (s)



(i) Identify the limiting reagent in experiment Q.

[2]

(ii) Calculate the volume of carbon dioxide gas produced in experiment R and hence calculate the volume, v cm^3, of sulfuric acid used.

Volume of carbon dioxide = ...

v = ... [2]

(iii) From the graph, deduce the concentration of sulfuric acid used in experiment S.

Concentration of sulfuric acid = ... [1]

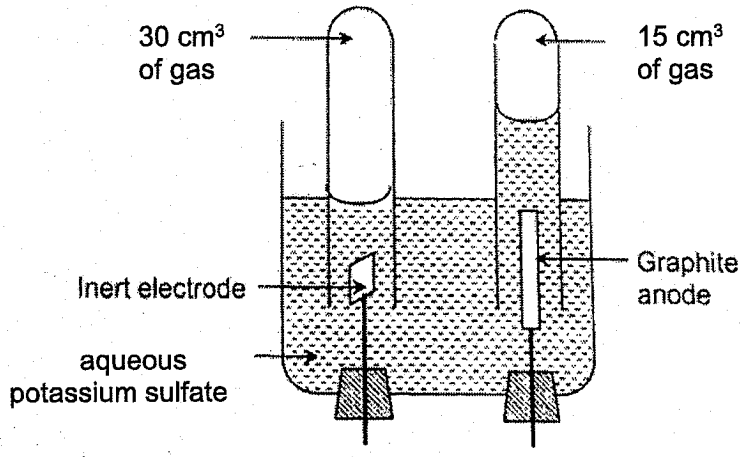
(iv) The mass of the salt formed in experiment S is much lower than expected. Write a balanced chemical equation, including state symbols, to suggest another reaction that can prepare a greater mass of this salt.

..... [1]

[Total: 10]

OR

B11 (a) When graphite anode and a very high current is used in this electrolysis, 30 cm^3 of gas is formed above the cathode and 15 cm^3 of gas is formed above the anode.



(i) Using a balanced equation, account for the volume of gas collected at both electrodes.

.....

.....

..... [2]

(ii) Explain, with a balanced equation, why the graphite anode has to be replaced periodically.

.....

.....

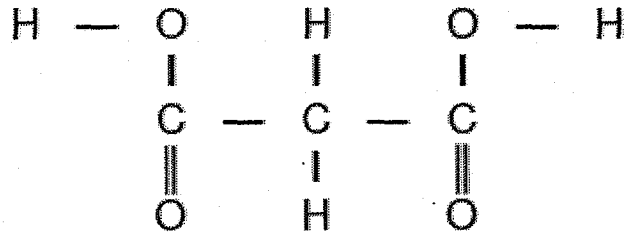
..... [2]

(b) An organic compound, X, contains carbon, oxygen and hydrogen only. The Percentage by mass of carbon and hydrogen are 47.4% and 10.5% respectively. The relative molecular mass of X is 76.

(i) Find the empirical formula of X.

[2]

(ii) X is a sharp smelling liquid at room temperature. It is soluble in water and can be oxidised to form Y whose structure is shown below.



Under suitable conditions, Y reacts with excess methanol to produce Z.
State the reagent needed to oxidise X to Y, and the colour change observed.

.....

..... [2]

(iii) Draw the full structural formula of X and Z.

[2]

[Total: 10]

End of Paper

The Periodic Table of Elements

Group																		
											III	IV	V	VI	VII	0
																2 He helium 4
											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
											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
											31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
											49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
											81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
												114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

3 Li lithium 7		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							
11 Na sodium 23																		
19 K potassium 39		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							
37 Rb rubidium 85																		
55 Cs caesium 133		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							
87 Fr francium –		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 –							

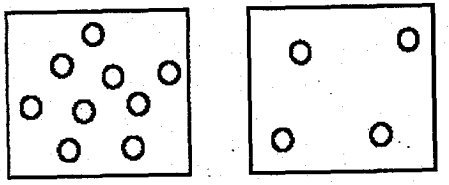
lanthanoids		57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
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 –

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

Chemistry
2018 Preliminary Examination
Answer Scheme

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

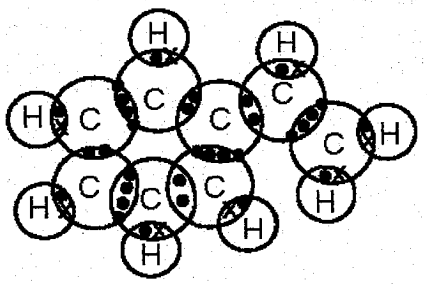
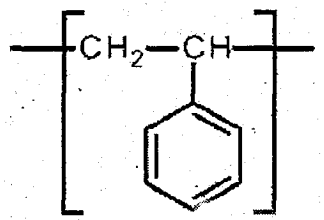
Bendemeer Secondary School
Preliminary Examination 2018
Chemistry 6092/02
Answer Scheme

Qn	Answer	Mks	Markers' Report
(a)	Ca	1	For (a), some students either cannot even recall that the only 3 metals that react with water are K, Na and Ca or Cannotrecall the properties of Group I metals as having low density. For (e), many students wrote Br as the answer. Students failed to realize that after bromine itself is reddish-brown but once it is gone after displacing iodide from KI. They failed to recall the colour of aqueous iodine as reddish-brown.
(b)	C/ S/ N/ H	1	
(c)	Na	1	
(d)	KF	1	
(e)	Cl/ F	1	
(a)	 Before After * Answer to clearly illustrate lesser gas particles (1) AND gas particles are further apart (1) when comparing before and after	1	Badly answered. Basic concepts of the kinetic particle theory is extremely weak.
(b)	When all the air particles are removed, the <u>vacuum</u> created forces the <u>air particles in the marshmallows to spread further apart</u>. This action <u>pushes</u> against the marshmallows and <u>causes it to swell / increase in size.</u>	1 1	Badly answered. Students went to talk about the increase in pressure in the marshmallows.
(c)	No, heating the chamber will cause the gas particles to <u>increase in kinetic energy</u>, making them <u>vibrate and move faster</u> OR	2	Almost all students failed to realise that gas particles have already filled up the available spaces in the

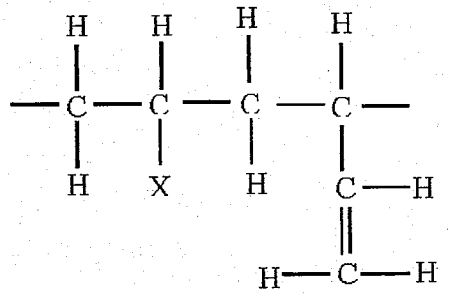
	No, the space in the gas chamber is the *same / fixed, so the particles will not move further apart. **only award max. of 1 mark for second answer as students failed to link that an increase a temperature (through heating) lead to an increase in kinetic energy.*		container. They managed to note that the gas particles will move faster with greater kinetic energy. Only Joven and Karthik realized that the number of particles is the same and hence the number of particles per unit volume remains the same.
(a)(i)	80/100 x 80 = 64 cm^3	1	Some students could not even recall that the percentage of oxygen in air is 20%.
(ii)	There would be air around the iron fillings if the glass tube is not fully filled. This would result in having more than 80 cm^3 of air present in the gas syringes.	1	Students gave very vague and ambiguous answers such as iron and oxygen would not fully react"
(b) (i)	Oxygen in air would react with the iron wool. This would make iron lose its role as the catalyst.	1	None of the students get this question correct. They could not link (a) to (b) that iron is used as a catalyst and if oxidized to iron(III) oxide, would lose its role as a catalyst and would affect the speed of reaction.
(ii)	N_2 (g) + $3H_2$ (g) → $2NH_3$ (g)	1	There is still 1 student who wrote the formula of hydrogen gas as H.
(c) (i)	Zn^{2+}, Cu^{2+}	2	Generally well answered.
(ii)	Cu^{2+} (aq) + $2OH^-$ (aq) → $Cu(OH)_2$ (s)	1	Weak students could not even recall ionic equation for precipitation.
(a)	A: sodium carbonate B: lead(II) nitrate C: hydrochloric acid	1 1 1	Badly answered. Weak students have no clue at all.
(b)	Lead(II) carbonate	1	
(c)	Carbon dioxide produced	1	Students wrote "Gas produced" without specifying the name of gas.
(d) (i)	Methyl orange and sodium hydroxide/ ammonia solution	1	Some students did not even know the colour change of methyl orange.
(ii)	Hydrochloric acid (in excess)	1	

(a)	$2H_2O_2$ (l) → $2H_2O$ (l) + O_2 (g)	1	There are students who do not know the products of the decomposition of hydrogen peroxide. Weak students do not even know the formula of hydrogen peroxide.
(b)	To prevent acid spray	1	Well-answered.
(c)	Curve Y shows a slightly lower mass obtained/ greater mass lost. The actual mass lost is smaller due to a small amount of oxygen dissolving in the solution.	1	Many students do not know that oxygen is soluble in water.
(d)	Heating up hydrogen peroxide solution/ using smaller pieces of manganese(IV) oxide.	1	A small number of very weak students could not even recall the factors that affect the speed of reacion.
(e)	Weigh a fixed mass of manganese(IV) oxide and add to a solution of hydrogen peroxide. Monitor the mass loss. Once the mass loss reached a constant (the end of reaction), filter and measure the mass of manganese(IV) oxide at the end of the reaction. It would be noted that the mass of manganese(IV) oxide remains the same.	1 1 1	Badly answered. Students did not read the question carefully that it is asking with respect to this decomposition reaction. Hence there is only 1 experiment involved. Many wrote the experiment as conducting 1 without MnO_2 and 1 experiment with MnO_2.
(a)	65/100 x 0.5 = **0.325g**	1	Very well-answered. Only 2 girls could not do this question. The rest of the class obtained full or close to full marks.
(b)	No. of moles of AgBr = 0.325/ (108+80) = 0.001729 No. of moles of $Na_2S_2O_3$ = 2 x 0.001728 = **0.00348**	1 1	
(c)	No. of moles of $Na_2S_2O_3$ used = 100/1000 x 0.2 = 0.02 No. of moles of $Na_2S_2O_3$ left = 0.02 – 0.00346 = **0.0165**	1 1	
(d)	Oxidation state of silver decreases from +1 in AgBr to 0 in Ag.	1	Well-answered.
(e)	Add silver nitrate to sodium bromide (any Group I bromide) until no more precipitate forms. Filter to obtain silver bromide as the residue. Wash the residue with a little distilled water and dry it in between 2 pieces of filter papers.	1 1	Many students cannot answer this simple preparation of salts question which is extracted form Sci (Chem). Some could not even differentiate between the filtrate and residue. A small number of students wrote "react silver nitrate with aqueous bromine."

(a)	They are covalent compounds with **weak intermolecular forces of attraction** which require little energy to break.	1	Some students could not even answer this lower sec bonding question.
(b)	No. of moles of methane = 1000/16 = 62.5 Amount of energy produced by burning 62.5 moles methane = 880 x 62.5 = 55 000 kJ No. of moles of propane = 1000/44 = 22.7 Amount of energy produced by burning 22.7 moles propane = 2200 x 22.7 = 49 940 kJ No. of moles of heptane = 1000/100 = 10 Amount of energy produced by burning 10 moles heptane = 4800 x 10 = 48 000 kJ Therefore, **methane** produces the most energy when burnt. The boy scout is most likely to bring along **methane**.	 1 1	Generally well-answered.
(c)	Heptane is in the liquid state at room temperature. It is easier to be transported than methane which is a gas at room temperature.	1	Generally well-answered.
(d)	$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ Bond breaking = 4(410) + 2x Bond forming = 2(740) + 4(460) = 3320 kJ 4(410) + 2x – 3320 = -880 **x = 400 kJ/mol**	 ½ ½ 1	Many students are still unable to calculate
(a)	X: Cu^{2+} (aq) + 2e → Cu (s) Z: Ag^{+}+ (aq) + e → Ag (s) Copper metal deposited on X and silver metal deposited on Z increases the mass of X and Z.	1 1 1	Generally well- answered
(b)	Silver requires 1 mole of electrons to be discharged whereas copper requires 2 moles of electrons to be discharged. Hence Z will increase at a rate double that of X.	1 1	Generally well-answered. Students who got it wrong mentioned that silver is less reactive than copper hence it will be discharged faster. This concept is wrong.

(a)		2	Dot-and-cross diagram of this compound was shown in class but students failed to register.
(b)	It is a covalent compound with **weak intermolecular forces** of attraction which **requires little energy to break**.	2	Some students could not answer this basic question.
(c)	Endothermic reaction	1	Badly done. Answer is in the data given.
(d)	They are miscible liquids with very similar boiling points.	1	Most students were able to identify that styrene and ethylbenzene have similar boiling points but they failed to mention that they are miscible.
(e)		1	Many students gave the drawing of the polymer rather than the repeating unit.
(f)	$(C_8H_8)_2 + 20O_2 \rightarrow 8H_2O + 16CO_2$	1	Many students wrote the formula of 2 repeating units as $2C_8H_8$ which is wrong. Some even wrote the formula as $C_{16}H_{16}$.
(g)	Effervesence seen. Gas produced forms white precipitate in limewater. $2C_6H_5CH=CHCO_2H + Na_2CO_3 \rightarrow 2C_6H_5CH=CHCO_2Na + CO_2 + H_2O$	1 1	Most students were able to state the observation but few got the equation correct.

(a)(i)	In the reaction of Q with copper(II) sulfate, displacement reaction takes place. Copper, the reddish-brown solid, is displaced by Q, which is more reactive. In the reaction of R, the metal R is a very reactive metal. It reacts with water in copper(II) sulfate solution to form an alkali and hydrogen gas, which is observed as gas bubbles.	1 1	Most students were able to identify the displacement reaction in Q but were unable to identify the reaction of metal R with water in.
(ii)	Q: $Q + CuSO_4 \rightarrow Cu + QSO_4$ R: $2R + 2H_2O \rightarrow 2R(OH)_2 + H_2$	1 1	Most students were able to write the equation at Q but not at R.
(b)	P oxide decomposes upon heating.	1	Some Students wrote "metal P is weak and devomposes on heating." This concept it wrong as metal P is an element.
(c)	P, Cu, Q, R	1	Most students mixed up Q and R
(d)(i)	Q. Q, being more reactive than Cu, will allow the flow of electrons from Q to Cu.	1 1	Generally well-answered
(ii)	Q: $Q(s) \rightarrow Q^{2+}(aq) + 2e$ Cu: $2H^+(aq) + 2e \rightarrow H_2(g)$	1 1	Some students missed out the state symbols and were not given credit.
(a)(i)	Addition Polymerisation	1	Not many students attempted this question. Some students wrote "polymerization" as the answer.

(ii)		1	Many students drew the structure of the polymer instead of the repeating unit.
(iii)	Poly(styrene) and Poly(butadiene) will be formed as well.	1	Many students gave vague answers like "styrene and butadiene will also combine with itself."
(iv)	0.75 x 2.9 = 2.175 kg = 2.18 kg	1	Some students were unable to calculate this straight forward question.
(b)(i)	$H_2SO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + CO_2 + H_2O$ No. of moles of H_2SO_4 = 150/1000 x 2 = 0.3 No. of moles of Na_2CO_3 = 26.5/ 2(23)+12+3(16) = 0.25 Limiting reagent = sodium carbonate	 ½ ½ 1	Generally well-answered
(ii)	No. of moles of carbon dioxide used in experiment Q = 0.25 Volume of carbon dioxide used in experiment Q = 0.25 x 24 = 6 dm^3 Volume of carbon dioxide produced in experiment R = 6/2 = **3 dm^3** No. of moles of sulfuric acid in experiment R = 0.25. Volume of sulfuric acid, v = 0.25/1.0 = **0.25 dm^3 = 250 cm^3**	 ½ ½ 1	Many students were able to calculate the volume of carbon dioxide produced but were unable to calculate the volume of sulfuric acid.
(iii)	2.0 mol/dm^3	1	
(iv)	$Ca(NO_3)_2$ (aq) + Na_2SO_4 (aq) → $CaSO_4$ (s) + 2$NaNO_3$ (aq)	1	

<table>
<tr>
<td>(a)(i)</td>
<td>$4OH^-$ (aq) + $4H^+$ (aq) → $2H_2O$ (l) + O_2 (g) + $2H_2$ (g)
From the equation, the ratio of oxygen to hydrogen is 1 : 2.
Hence the volume of hydrogen formed at the cathode is double the volume of oxygen formed at the anode.</td>
<td>1

1</td>
<td>Many students only gave half equations instead of the overall equation.</td>
</tr>
<tr>
<td>(ii)</td>
<td>Under the high temperature, oxygen produced burns the graphite anode off.
C + O_2 → CO_2</td>
<td>1

1</td>
<td>Students who answered this wrote “carbon <u>reacts</u> with oxygen.” There was no mention of the heat involved. These students were given BOD.</td>
</tr>
<tr>
<td>(b)(i)</td>
<td>
<table>
<tr><td></td><td>C</td><td>O</td><td>H</td></tr>
<tr><td>% by mass</td><td>47.4</td><td>42.1</td><td>10.5</td></tr>
<tr><td>Ar</td><td>12</td><td>16</td><td>1</td></tr>
<tr><td>No. of moles</td><td>47.4/12 = 3.95</td><td>42.1/16 = 2.63</td><td>10.5/1 = 10.5</td></tr>
<tr><td>÷ by smallest no.</td><td>3.95/2.63 = 1.5</td><td>2.63/2.63 = 1</td><td>10.5/2.63 = 4</td></tr>
<tr><td>ratio</td><td>1.5 x 2= 3</td><td>1 x 2 = 2</td><td>4 x 2 = 8</td></tr>
</table>
Empirical Formula = $C_3O_2H_8$
</td>
<td>1

1</td>
<td>Many students have forgotten how to calculate empirical formula.</td>
</tr>
<tr>
<td>(ii)</td>
<td>Add acidified potassium dichromate (VI).
Colour change from orange to green./
Add acidified potassium manganate (VII)
Colour change from purple to colourless</td>
<td>1
1</td>
<td>Well-answered.</td>
</tr>
</table>

(iii)	X Z	1	Many students were able to draw the structure of X but not Z.
		1	

9