Candidate Name: _____ Class _____ Index No. _____

FUHUA SECONDARY SCHOOL

Secondary Four Express

Preliminary Examinations 2019

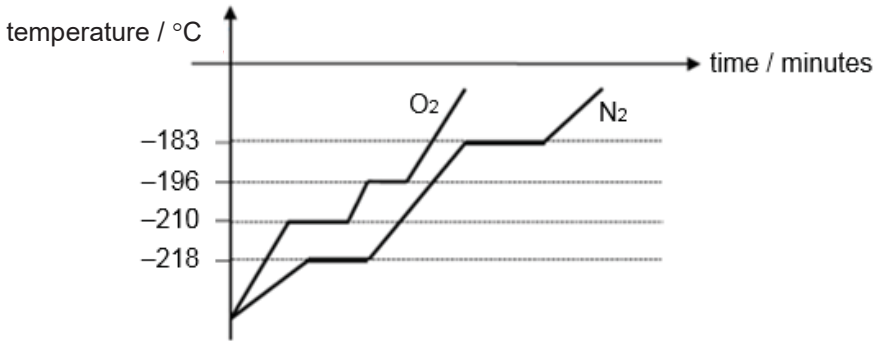
4E

*Fuhua Secondary Fuhua Secondary Fuhua Secondary

Multiple Choice Questions [40 marks]

Answer **all** questions and shade your answers on the OMR sheet provided.

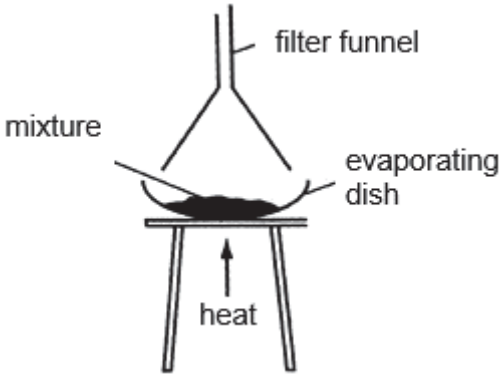
1 The graphs (not drawn to scale) show the heating curves of oxygen and nitrogen over a period of time.



Which of the following statements about a mixture of oxygen and nitrogen is correct?

A At -190°C, both oxygen and nitrogen exist as a liquid.
B At -200°C, both oxygen and nitrogen exist in the same state.
C At -215°C, both nitrogen and oxygen molecules are vibrating about fixed positions.
D At -185°C, both oxygen and nitrogen molecules move rapidly in all directions.

2 Refer to the following setup.



Which of the following mixtures can be separated into its components using this setup?

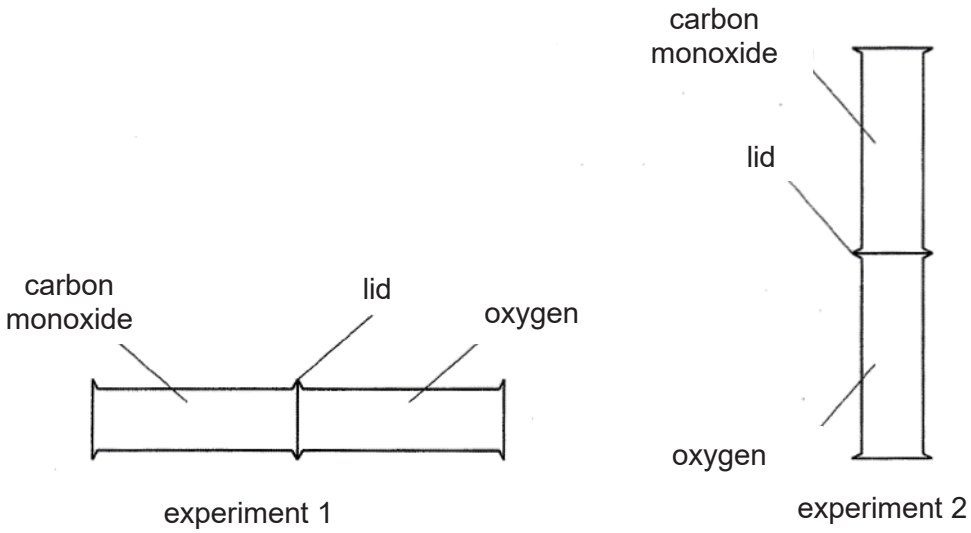
A ammonium chloride and iodine
B copper(II) sulfate and sodium chloride
C potassium iodide and copper(II) sulfate
D sodium chloride and ammonium chloride

3 Which of the following substances does **not** contain atoms bonded to other atoms by four covalent bonds?

A graphite
B polypropene
C silicon dioxide
D terylene

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4 The diagram shows the start of experiment 1 and 2 using gas jars of carbon monoxide and oxygen arranged in two different orientations.
All other conditions are kept constant.



The lids are removed and the gases are allowed to mix.
Which of the following observations would you expect for the experiments?

A The rate of oxygen diffusing is much faster than rate of carbon monoxide diffusing in both experiments.
B The rate of carbon monoxide diffusing is much faster in experiment 1 than in experiment 2.
C In experiment 2, the final concentration of carbon monoxide in the top jar will be less than its original concentration.
D The final concentration of carbon monoxide in the left jar in experiment 1 is the same as the final concentration of carbon monoxide in the top jar in experiment 2.

5 A salt, P, on warming with aqueous sodium hydroxide, showed no visible reaction. When aluminium powder was added, a gas that turned damp red litmus paper blue evolved. What is salt P?

A $Ca(NO_3)_2$
B KNO_3
C NH_4Cl
D NH_4NO_3

6 Tritium is an isotope of hydrogen and has the symbol T.
Which formula is **incorrect** for a tritium compound?

A CaOT
B NT_3
C TNO_3
D T_2O

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7 Compound X contains two elements, metal Y and non-metal, Z.

X consists of a lattice of positive and negative ions. Each positive ion is surrounded by eight anions and each negative ion is surrounded by four cations.

What ions are present in, and what is the formula of, compound X?

	ions present	formula
A	$Y^+ Z^{2-}$	Y_2Z
B	$Y^{2+} Z^-$	YZ_2
C	$Z^+ Y^{2-}$	Z_2Y
D	$Z^{2+} Y^-$	ZY_2

8 Which of the following substances contain delocalised electrons?

1 iron
2 steel
3 diamond
4 graphite

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

9 Aqueous lead(II) nitrate can be distinguished from aqueous zinc nitrate by adding any of the following solution except

A aqueous potassium chloride.
B aqueous sodium sulfate.
C dilute sulfuric acid.
D sodium hydroxide solution.

10 5 g of element X reacted completely with 8 g of element Y to form a compound with the formula XY_2.
Given that the relative atomic mass of Y is 80, what is the relative atomic mass of X?

A $\frac{5}{13} \times 80 \times 2$

B $\frac{5}{13} \times 80 \times \frac{1}{2}$

C $5 \times \frac{8}{80} \times \frac{1}{2}$

D $5 \times \frac{80}{8} \times 2$

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11 In an experiment, 8.0 cm^3 of 1.00 mol/dm^3 aqueous barium chloride was mixed with 8.0 cm^3 of 1.00 mol/dm^3 of aqueous silver nitrate.
Which of the following ions are present in the solution produced?

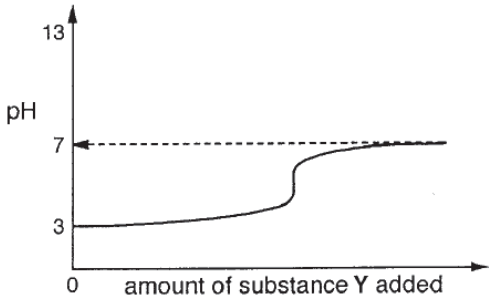
1 Ba^{2+}
2 Cl^-
3 Ag^+
4 NO_3^-

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

12 Solutions P and Q were tested with a few drops of Universal Indicator.
Solution P turned the indicator red while solution Q turned the indicator yellow.
It can be deduced that

A Solution P has a higher pH than solution Q.
B Solution Q is more alkaline than solution P.
C Solution Q reacts with calcium carbonate to give carbon dioxide gas.
D The concentration of hydrogen ions in Q is higher than the concentration of hydrogen ions in solution P.

13 Substance Y was added bit by bit, with stirring, to aqueous solution Z.
The changes in pH of the mixture are shown in the graph.



What could Y and Z be?

	Y	Z
A	aluminium oxide	hydrochloric acid
B	calcium oxide	nitric acid
C	sodium oxide	ethanoic acid
D	zinc oxide	propanoic acid

14 An element burns in air to form a compound which does not react with both acids and alkalis.
Which element could it be?

A aluminium
B carbon
C iron
D phosphorus

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15 Which of the following properties shows that a certain substance, M, is alkaline?

A Solution M dissolves copper(II) oxide.
B On adding dilute hydrochloric acid to solution M, carbon dioxide is given off.
C Solution M when warmed with aqueous ammonium chloride gives off ammonia gas.
D Solution M forms brown precipitate when reacted with iron(III) chloride solution.

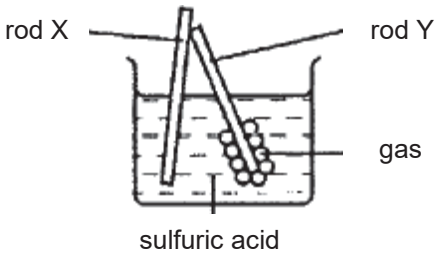
16 In which of the following experiments will a redox reaction occur?

A Adding nitric acid to aqueous ammonia.
B Adding copper turnings to aqueous silver nitrate.
C Adding chlorine water to aqueous potassium fluoride.
D Adding aqueous sodium hydroxide to aqueous copper(II) nitrate.

17 In which of the following does vanadium have the lowest oxidation number?

A V^{3+}
B VO^{2+}
C NH_4VO_3
D V_2O_5

18 In an experiment, two different metal rods, X and Y, were dipped in dilute sulfuric acid, with their top ends touching. A gas was collected around rod Y.



Which of the following can you conclude about this experiment?

A Electrons flow from rod Y to X.
B Rod X is more reactive than rod Y.
C Rod Y reacts with acid to produce hydrogen gas.
D Ions of Y can be found in the solution but not ions of X.

19 Which of the following reactions is **not** involved in the manufacture of iron from the blast furnace?

A Coke burns in air to form carbon dioxide.
B Acidic impurities are removed by calcium oxide.
C Limestone is decomposed to form calcium oxide.
D Haematite is reduced by carbon dioxide to form iron.

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20 W, X, Y and Z are four metals which form cations W^+, X^{2+}, Y^+ and Z^{2+}.
The following are information on some of the reactions that the metals undergo.

$X^{2+}(aq) + W(s) \rightarrow$ no reaction
$Z^{2+}(aq) + 2W(s) \rightarrow 2W^+(aq) + Z(s)$
$Y_2CO_3(s) \xrightarrow{heat}$ no reaction
$Z(s) + 2H^+(aq) \rightarrow Z^{2+}(aq) + H_2(g)$

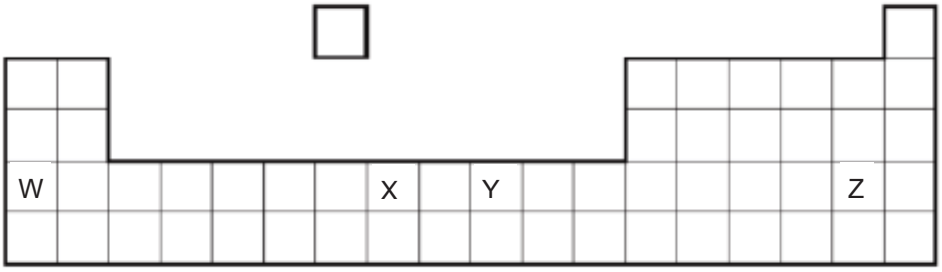
The order of decreasing reactivity of the metals are

A X, W, Z, Y.
B X, Y, Z, W.
C Y, X, W, Z.
D Z, W, X, Y.

21 Which of the following method is most likely used to extract an element with an electronic structure of 2.8.8.2?

A electrolysis of its aqueous chloride
B electrolysis of its molten ore
C reduction with carbon
D reduction with hydrogen

22 Part of the Periodic Table is shown below.



1 Elements W, X and Y have high melting points.
2 Y is less reactive than W.
3 Z can form both ionic and covalent compounds.
4 X and Y form compounds that are coloured.

Which of the following statements are correct?

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

23 Which statement is most likely to be true for astatine, which is in Group VII of the Periodic Table?

A Astatine is a stronger oxidising agent than chlorine.
B Astatine reacts with hydrogen to form a compound with formula HAt_2.
C Aqueous potassium astatide reacts with aqueous silver nitrate to form aqueous silver astatide.
D Sodium astatide is less stable than sodium chloride.

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24 Which of the following reactions is endothermic?

A $2H \rightarrow H_2$
B $H_2O(l) \rightarrow H_2O(g)$
C $2H_2 + O_2 \rightarrow 2H_2O$
D $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

25 What are the effects of temperature of reactants and use of a catalyst on the activation energy and enthalpy change of a reaction?

	effect of temperature		effect of catalyst	
	activation energy	enthalpy change	activation energy	enthalpy change
A	decreases	no change	decreases	no change
B	decreases	decreases	no change	no change
C	no change	no change	decreases	no change
D	no change	no change	no change	no change

26 In the reaction between calcium carbonate and ethanoic acid, the following changes could be made to the conditions.

1 Increase the concentration of ethanoic acid
2 Increase the particle size of calcium carbonate.
3 Increase the temperature of the system.
4 Increase the pressure of the system.

What changes would increase the rate of reaction?

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

27 Refer to the following bond energy table.

bond	bond energy / kJ mol^{-1}
F - F	158
H - H	436
H - F	556

It can be deduced that

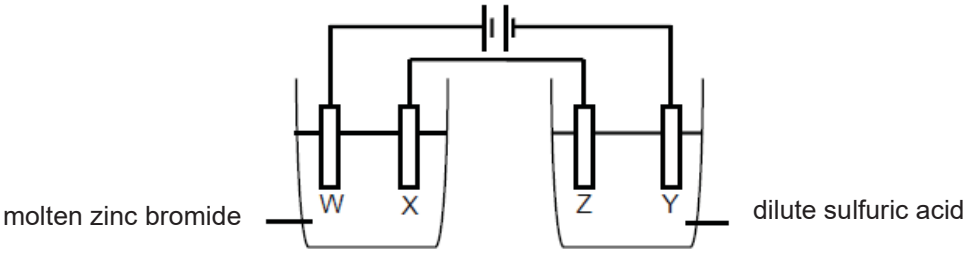
A the bonds in fluorine is the strongest.
B fluorine gas is more reactive than hydrogen gas.
C hydrogen fluoride molecules are the least stable.
D the energy produced when forming 1 mole of hydrogen fluoride molecules from its elements is 518 kJ.

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28 Which statement is true for both simple and electrolytic cells.

	simple cell	electrolytic cell
A	It converts electrical energy into chemical energy.	It converts chemical energy into electrical energy.
B	Oxidation occurs at negative electrode.	Oxidation occurs at positive electrode
C	Electrons flow from the cathode to the anode.	Electrons flow from the cathode to the anode.
D	Mass of the anode will decrease.	Mass of the anode may increase.

29 Refer to the following electrolytic setup. All electrodes used are graphite.



What could be observed after a few minutes?

A A silvery solid is formed at electrode W.
B A red brown liquid is formed at electrode X.
C A pale yellow gas is formed at electrode Y.
D A colourless and odourless gas is formed at electrode Z.

30 In electroplating a silver spoon with copper, which combination of anode, cathode and electrolyte is the most suitable?

	anode	cathode	electrolyte
A	copper	silver spoon	copper(II) nitrate solution
B	copper	silver spoon	silver nitrate solution
C	silver spoon	copper	copper(II) nitrate solution
D	silver spoon	copper	silver nitrate solution

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31 Some properties of substances P, Q, R and S are given in the table below.

substance	percentage composition by mass	electrical conductivity when solid	effect of heat
P	constant	yes	solid burns in air to form an oxide.
Q	varies	no	liquid burns to form carbon dioxide and water.
R	constant	no	solid decomposes to form two products.
S	varies	yes	solid melts

Which classification of the substances as an element, a mixture or a compound is correct?

	element	mixture	compound
A	P	S	Q, R
B	S	Q	P, R
C	R	S	P, Q
D	P	Q, S	R

32 Ammonium nitrate, NH_4NO_3, ammonium sulfate, $(NH_4)_2SO_4$, urea, $(NH_2)_2CO$ and ammonium phosphate, $(NH_4)_3PO_4$ are all fertilisers that can be produced from ammonia.

Which of these contains the most nitrogen per kilogram of fertiliser?

A ammonium nitrate
B ammonium sulfate
C ammonium phosphate
D urea

33 The Haber process is a reversible reaction as some of the ammonia formed is unstable as it decomposes readily back into its reactants.
Which of the following method is used to prevent this from happening?

A Adding water to dissolve ammonia.
B Cooling the mixture to liquefy ammonia.
C Filter the mixture to remove ammonia.
D Fractional distil the mixture to separate ammonia gas.

34 What is the volume of air required for a mixture of 20 cm^3 of methane and 40 cm^3 of carbon monoxide to burn completely?

A 60 cm^3
B 80 cm^3
C 300 cm^3
D 400 cm^3

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35 Which of the following reagents could be used to distinguish between samples of ethanol and ethanoic acid?

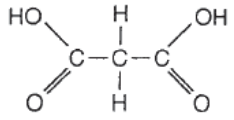
1 aqueous bromine
2 sodium carbonate
3 aqueous sodium chloride
4 litmus solution

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

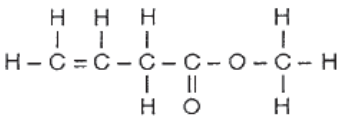
36 How does the number of carbon, hydrogen and oxygen atoms in an ester differ from the total number of carbon, hydrogen and oxygen atoms in the alcohol and carboxylic acid from which the ester was derived?

	carbon atoms	hydrogen atoms	oxygen atoms
A	same	same	same
B	less	same	less
C	same	less	less
D	less	less	less

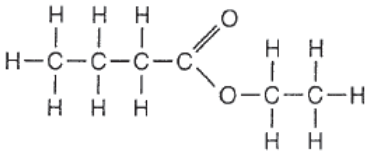
37 Which of the following tests can be used to distinguish the following organic compounds, I, II and III separately from each other.



I



II



III

test	1	Adding aqueous bromine.
	2	Adding powdered magnesium.
	3	Warming with acidified potassium manganate(VII).

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

38 The chemical equation for a reaction is shown below.

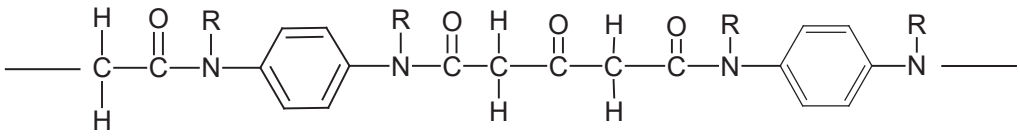
$$CH_3COOH + Br_2 \leftrightharpoons CH_2BrCOOH + HBr$$

This reaction is an example of a/an

A addition reaction.
B condensation reaction.
C esterification reaction.
D substitution reaction.

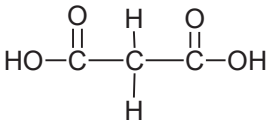
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39 A section of a polymer is shown below.

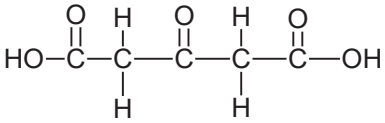


Which of the following shows a monomer involved in the formation of the above polymer?

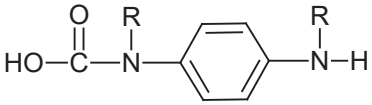
A



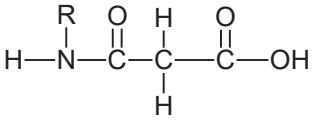
B



C



D



40 Three metal oxides each have the formula G_2O_3.
Which statements about these oxides are correct?

1 If the relative molecular mass for the oxide is 152, metal G is a transition element.

2 If the relative molecular mass for the oxide is 160, the oxide of metal G can react with both acid and alkali.

3 If the relative molecular mass for the oxide is 102, the oxide of G is formed when metal G reacts with steam.

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

End of Paper

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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											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.).

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Secondary Four Express

Preliminary Examinations 2019

4E

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CHEMISTRY 6092/02

Paper 2

28 August 2019
1115 – 1300
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces provided on top of this page.

Write in dark blue or black pen.

You may use a HB pencil for any diagrams or graphs.

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

Section A (50 marks)
Answer **all** questions.
Write your answers in the spaces provided.

Section B (30 marks)
Answer all **three** questions, the last question is in the form of either/or.
Write your answers in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 22.

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

PARENT'S SIGNATURE

FOR EXAMINER'S USE		
Section A	Section B	**Total**
/50	**/30**	**/80**

Setter: *Mdm Hia Soo Ching* Vetter: *Mr Elton Tan*

This question paper consists of 22 printed pages including this page.

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Section A [50 marks]

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

A1 Table A1.1 shows sub-atomic particles found in particles, L to S. The letters are not the symbols of the elements.

particle	electrons	protons	neutrons
L	6	6	6
M	10	8	8
N	8	8	10
O	12	12	12
P	10	12	12
Q	13	13	13
R	1	1	1
S	13	13	14

Table A1.1

Use the letter(s) to answer the following questions.

(a) Which particle is an atom of oxygen?

_____ [1]

(b) Which particle will combine with oxygen atoms to form a compound that does **not** react with alkali and acid?

_____ [1]

(c) Which pair of particles are isotopes?

_____ [1]

(d) **(i)** Which pair of particles are found in a compound that can conduct electricity in aqueous and molten states?

_____ [1]

(ii) Draw a 'dot-and-cross' diagram for the compound in **(d)(i)**.
Show outer electrons only.

[2]

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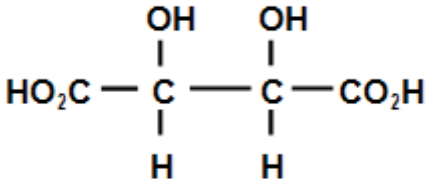
(e) Which particle is an atom of an element that can have oxidation states +1, 0 and -1? Explain your answer.

[2]

[Total: 8]

A2 Both phosphoric acid and tartaric acid are weak acids. The formulae of both acids are given as follows:

H_3PO_4



phosphoric acid

tartaric acid

(a) Describe a simple test that can be used to show that tartaric acid or phosphoric acid is a weak acid.

[1]

(b) Describe a chemical test to distinguish phosphoric acid from tartaric acid respectively.

[2]

(c) A solution of 0.200 mol/dm^3 potassium hydroxide was titrated against phosphoric acid and tartaric acid separately.
Deduce the ratio of the volume of potassium hydroxide used in titrating fixed volumes and concentrations of phosphoric acid and tartaric acid respectively.

[1]

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(d) Tartaric acid and its salts have many applications. One such salt is copper(II) tartarate which is insoluble in water.

Describe how you will prepare a pure and dry sample of this salt in the laboratory,

[2]

(e) A 2.0 cm length of magnesium ribbon was added to 100 cm^3 of 2.00 mol/dm^3 phosphoric acid. All the magnesium reacted and the temperature of the acid increased by 6.0°C.

(i) Predict the temperature change when 1.0 cm length of magnesium ribbon was reacted with 100 cm^3 of 2.00 mol/dm^3 phosphoric acid.

[1]

(ii) Predict the temperature change when 2.0 cm length of magnesium ribbon was reacted with 100 cm^3 of 2.00 mol/dm^3 tartaric acid. Again, all the magnesium reacted. Explain your answer.

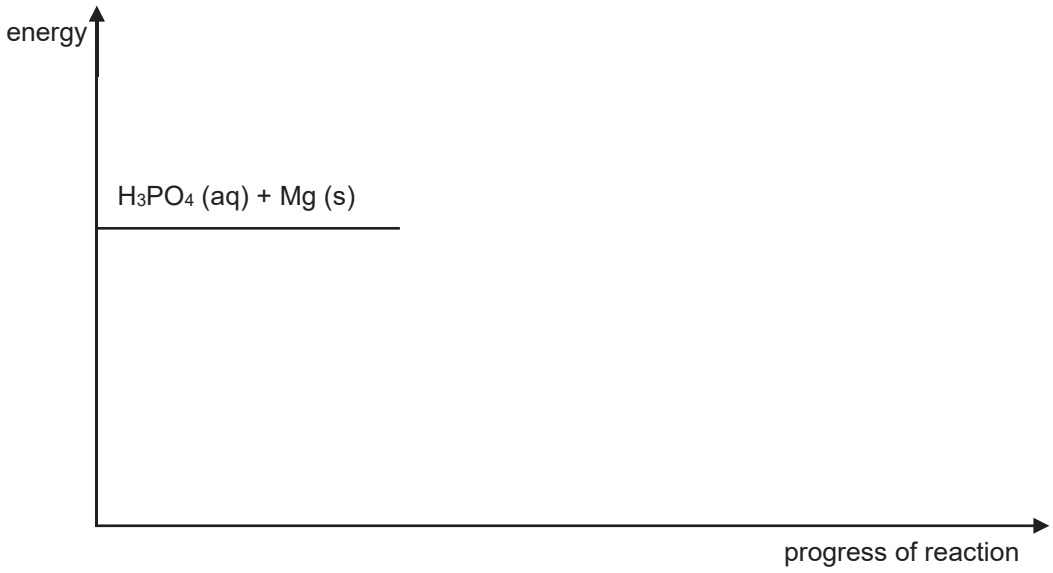
[3]

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(iii) Complete the energy profile diagram for the reaction between magnesium ribbon and phosphoric acid.

Your diagram should include:

- the formulae of the products,
- the activation energy and
- a label for the enthalpy change of reaction.



[2]

[Total: 12]

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A3 **(a)** Table A3.1 shows information about some organic compounds.
Complete the table by filling in the missing name, formulae and by completing the description of the processes.

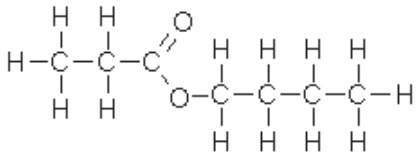
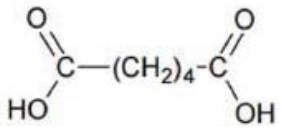
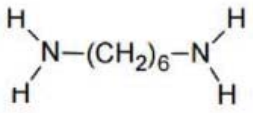
name of compound	structural formula	process(es) used to produce the compound
		Warming of _____ and _____ with concentrated sulfuric acid.
propane		Catalytic _____ _____ to propene.
polybutene		_____ of butene
nylon-6,6		_____ of monomers  and  .

Table A3.1

[4]

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(b) Alkyl halides are a homologous series of organic compounds. They are formed when one halogen atom (X = C*l*, Br, I) bonds with carbon atoms.

Table A3.2 shows the condensed formulae and boiling points of some alkyl halides.

condensed formula	**boiling point / °C**		
	X		
	C*l*	**Br**	**I**
CH_3X	-24.2	3.6	42.4
CH_3CH_2X	12.3	38.4	72.3
$CH_3CH_2CH_2X$	46.6	71.0	102.5
$CH_3CH_2CH_2CH_2X$	78.4	101.6	130.5

Table A3.2

(i) Besides having the same functional group, use the information in the table to give **two** other pieces of evidence that suggest that alkyl halides are a homologous series.

[2]

(ii) Describe and explain the trend in boiling points of alky halides when the halogen atom changes from C*l* to I.

[3]

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(iii) Alkyl halides can be prepared by the reaction of halogen acids with alcohols. For example, hydrochloric acid reacts with methanol to produce methyl chloride and water.

Write an equation for the preparation **ethyl iodide**, showing the displayed formulae of all organic compounds.

[2]

[Total: 11]

A4 Three reactions take place in the catalytic converter installed in car exhaust systems.

1. Conversion of nitrogen oxides (NO, NO_2) into nitrogen.
2. Conversion of carbon monoxide into carbon dioxide.
3. Conversion of hydrocarbons into carbon dioxide and water.

The air/fuel ratio in the car engine affects the conversion efficiency of the catalytic converter. A 'lean' air/fuel mixture to the engine has a higher ratio of air to fuel while a 'rich' air/fuel mixture has a lower ratio of air to fuel.

Figure A4.1 gives the conversion efficiency of a converter based on air/fuel ratio.

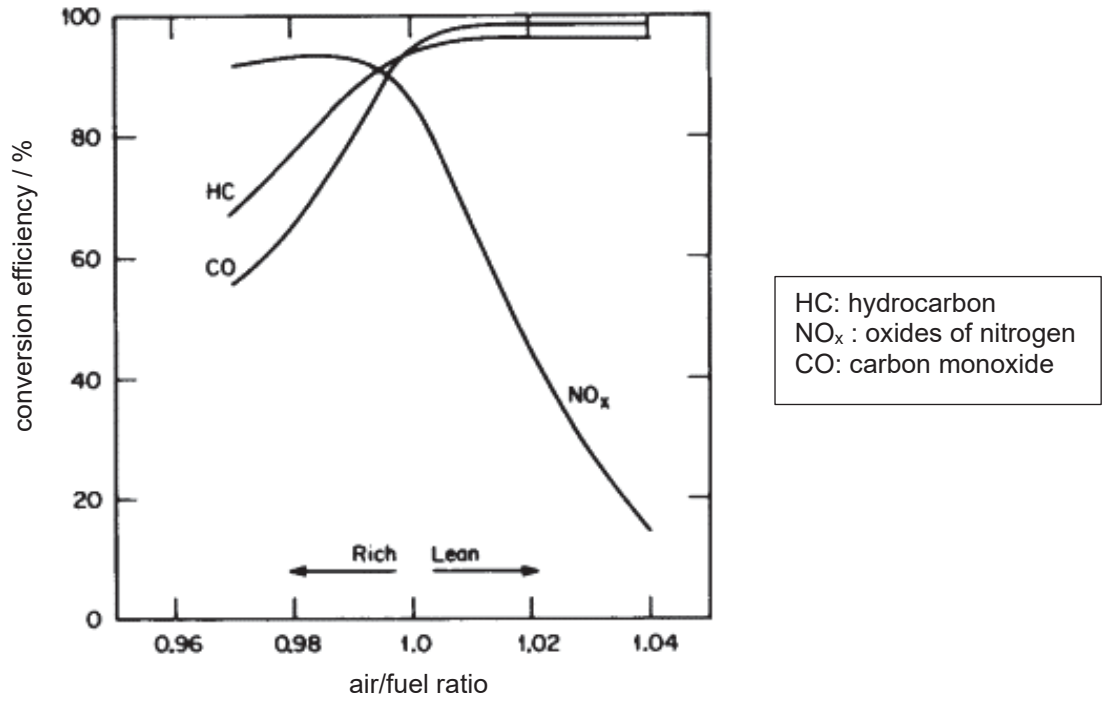


Figure A4.1

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(a) Use oxidation states to explain whether reaction 1 and 2 involves oxidation and reduction.

[2]

(b) Describe and explain how does changing the air/fuel ratio from 'rich' to 'lean' affect the conversion efficiency of carbon monoxide, nitrogen monoxide and hydrocarbons in the catalytic converter.

[4]

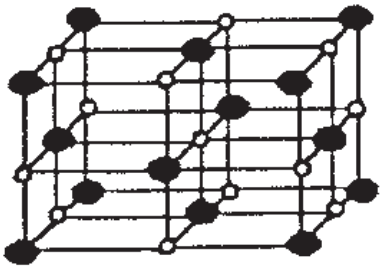
(c) The exhaust gas from vehicles without catalytic converters cause more harm to human health than those from vehicles fitted with catalytic converters.
Explain why this is true.

[2]

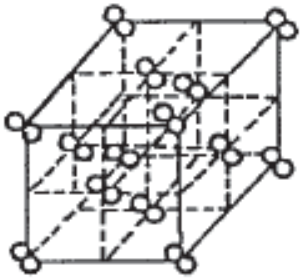
[Total: 8]

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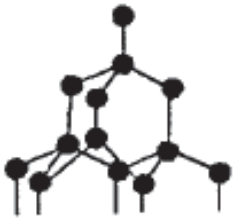
A5 Figure A5.1 shows the structures of four solids, A to D.



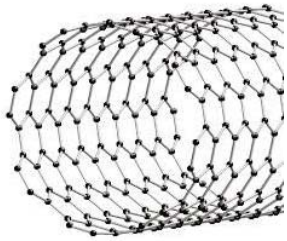
A



B



C



D

Figure A5.1

Solid C and D are both allotropes of carbon.

(a) State one similarity and one difference in the structure and bonding of solids B and C.

_____

_____

_____

_____ [2]

(b) Compare the electrical conductivity of solids C and D.
Explain in terms of bonding and structure.

_____

_____

_____

_____ [2]

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(c) Both copper(II) oxide and potassium chloride have similar structure as solid A. Explain why the melting point of copper(II) oxide is much higher than that of potassium chloride.

[2]

[Total: 6]

A6 Some samples of carbonates are heated strongly until there is no further change in mass. Table A6.1 shows the mass of solid remaining at the end of the heating.

carbonate	mass before heating / g	mass after heating / g
copper(II) carbonate	2.00	1.29
magnesium carbonate	2.00	0.95
sodium carbonate	2.00	?
zinc carbonate	2.00	1.30

Table A6.1

(a) Although each carbonate is fixed at 2.00 g, the mass of solid remaining is different. Explain why.

[2]

(b) State the mass of solid remaining when sodium carbonate is heated strongly.

[1]

(c) Pure metal can be extracted by further heating the mass of the solid remaining at the end of the reaction in Table A6.1 with dry hydrogen.
State the metal(s) that can be extracted. Write the chemical equation for one such reaction.

[2]

[Total: 5]

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Section B: Free Response Questions [30 marks]

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 The Electrochemical Series

When electrodes of metallic and non-metallic elements in contact with their ions are arranged on the basis of the values of their **standard reduction potentials**, E°, the resulting series is called the **electrochemical series** of the elements.

The **standard reduction potential** of an element is the measure of the tendency of the element to get reduced by gaining electrons. All reduction potentials are measured against the standard hydrogen electrode which is the reference electrode.

The standard potential of any metal or non-metal is measured when in contact with aqueous solutions of their ions at a concentration of 1 mol/dm^3 and temperature of 25 °C. Any gases involved are maintained at a pressure of 1 atmosphere.

Figure B7.1 shows the setup to measure the standard reduction potential of copper. The Cu/Cu^{2+} half-cell is connected to the hydrogen half-cell.

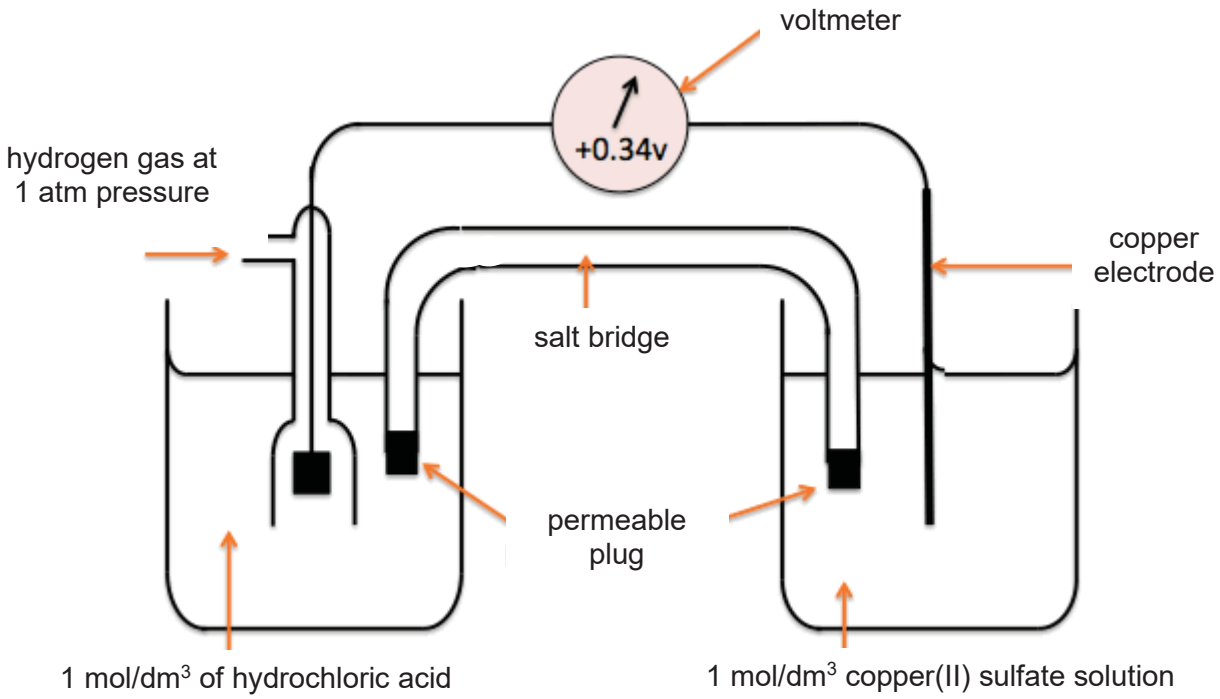


Figure B7.1

[*Source:* https://derekcarrsavvy-chemist.blogspot.com/]

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By international convention, the standard potentials of electrodes are tabulated for reduction half reactions. Electrodes with positive E° values indicate the tendencies of the electrodes to gain electrons more readily and behave as cathodes.

Table B7.2 gives the standard reduction potential, E° of some elements.

element	electrode reaction	standard reduction potential, E° / V
Li	$Li^+ + e^- \rightarrow Li$	-3.05
K	$K^+ + e^- \rightarrow K$	-2.93
Na	…	-2.71
Zn	…	-0.76
Cr	$Cr^{3+} + 3e^- \rightarrow Cr$	-0.74
Fe	$Fe^{2+} + 2e^- \rightarrow Fe$	-0.44
Ni	$Ni^{2+} + 2e^- \rightarrow Ni$	-0.25
Sn	$Sn^{2+} + 2e^- \rightarrow Sn$	-0.14
H_2	$2H^+ + 2e^- \rightarrow H_2$	0.00
Cu	…	+0.34
I_2	…	+0.54
Ag	…	+0.80
Cl_2	…	+1.36
F_2	…	+2.87

Table B7.2

Predicting Displacement Reactions

The electrochemical series help us to predict whether displacement reactions can occur.

Metallic elements having lower reduction potential will lose electrons more readily and will displace elements having higher reduction potential from its salt solution. For example, zinc will displace copper from its salt solution because it has E^o value of -0.76V while copper has E^o value of +0.34V

On the contrary, non-metallic elements with higher reduction potential will displace other non-metallic elements with lower reduction potential.

For displacement of hydrogen from dilute acids by metals, the metal which can provide electrons to H^+ ions present in dilute acids for reduction, evolve hydrogen from dilute acids. Metals having negative values of reduction potential possess the property of losing electron(s).

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Determining the Products of Electrolysis

In the event that two or more positive ions are present in the solution during electrolysis, the ion which is the stronger oxidising agent or has the higher value of standard reduction potential is discharged first at the cathode. For example, in a solution containing potassium and silver ions, silver ions are discharged first.

(a) It is difficult to set up the Na/Na^+ and K/K^+ half cells to measure their E° value and hence sometimes scientists have to conduct indirect experimental methods and perform calculations to estimate these values.
Explain why it is difficult to set up these half cells.

_____

_____ [1]

(b) **(i)** With reference to Table B7.2, construct the electrode equation for I_2.

_____ [1]

(ii) Using the reaction between chlorine and aqueous solution containing iodide ions as an example, explain why '*non-metallic elements with higher reduction potential displace other non-metallic elements with lower reduction potential*'.

_____

_____

_____ [1]

(c) Which of the following displacement reactions is likely to occur?
Put a tick (√) if a reaction is likely to occur.

	chromium	tin
aqueous solution of nickel(II) ions		
aqueous solution of iron(II) ions		
dilute nitric acid		

[2]

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(d) Describe how the trend in reactivity of Group I and Group VII elements compare to their trends in standard reduction potentials as shown in Table B7.2.

[3]

(e) Complete the following table for the electrolysis of different aqueous solutions using platinum electrodes.

solutions	name of products of electrolysis that would be produced first		ionic equation for the reaction at each electrode
concentrated magnesium chloride	at negative electrode		
	at positive electrode		
mixture of aqueous silver nitrate and aqueous copper(II) chloride	at negative electrode		
	at positive electrode		

[4]

[Total:12]

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B8 Nitrogen monoxide and hydrogen reacts at 400 °C according to the following equation.

$$2NO\ (g) + 2H_2\ (g) \rightarrow N_2\ (g) + 2H_2O\ (g)$$

Different initial concentrations of nitrogen monoxide and hydrogen were used to investigate the rate of reaction. In each experiment, the initial rate of reaction was measured.

Table B8.1 shows the results obtained in each experiment.

experiment	initial concentration of NO / mol dm^{-3}	initial concentration of H_2 / mol dm^{-3}	initial rate of reaction / mol dm^{-3} s^{-1}
1	0.0060	0.0010	1.8×10^{-4}
2	0.0060	0.0020	3.6×10^{-4}
3	0.0010	0.0060	0.3×10^{-4}
4	0.0020	0.0060	1.2×10^{-4}
5	0.0040	0.0030	?

Table B8.1

(a) A student makes the following statement.

> Increasing the concentration of NO increases the rate of reaction to a greater extent than increasing the concentration of H_2.

Does the information in the table support the statement made by the student? Explain your reasoning.

[3]

(b) Experiment 5 was conducted using 0.0040 mol dm^{-3} of NO and 0.0030 mol dm^{-3} of H_2. Predict the initial rate of formation of N_2.

[1]

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(c) Calculate the final volume of gases remaining in the reaction vessel when 20 cm^3 of NO reacted with 15 cm^3 of H_2 at 400 °C.
Show all working clearly.

[2]

(d) Explain, in terms of collisions between (reacting) particles, how operating at a lower temperature of 250 °C affects the rate of reaction in the reactor.

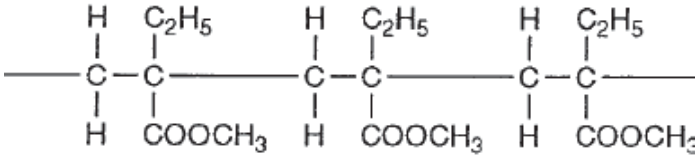
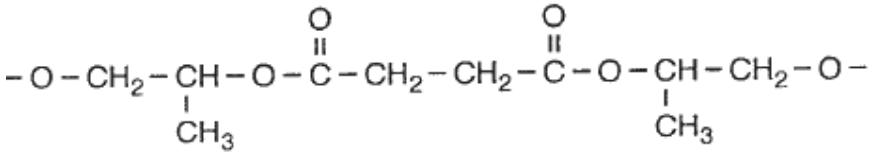
[2]

[Total: 8]

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B9 ***Either***

The structures of two polymers X and Y are shown below.

polymer X	
polymer Y	

(a) A potential customer requires the chain length of the polymer X to be controlled so that the polymer molecules have an average relative molecular mass in the range of 20 000 to 50 000.

What is the range of the average number of repeat units in the polymer molecules? Show your working.

[2]

(b) **(i)** Draw the structural formulae of the monomers where polymer Y could be made from.

[2]

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(ii) Calculate the mass of polymer Y produced when 1 kg of each of the monomers reacted.

[3]

(c) Describe three differences between polymer X and polymer Y.

[3]

[Total: 10]

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B9 *OR*

Figure B9.1 shows the Haber process.

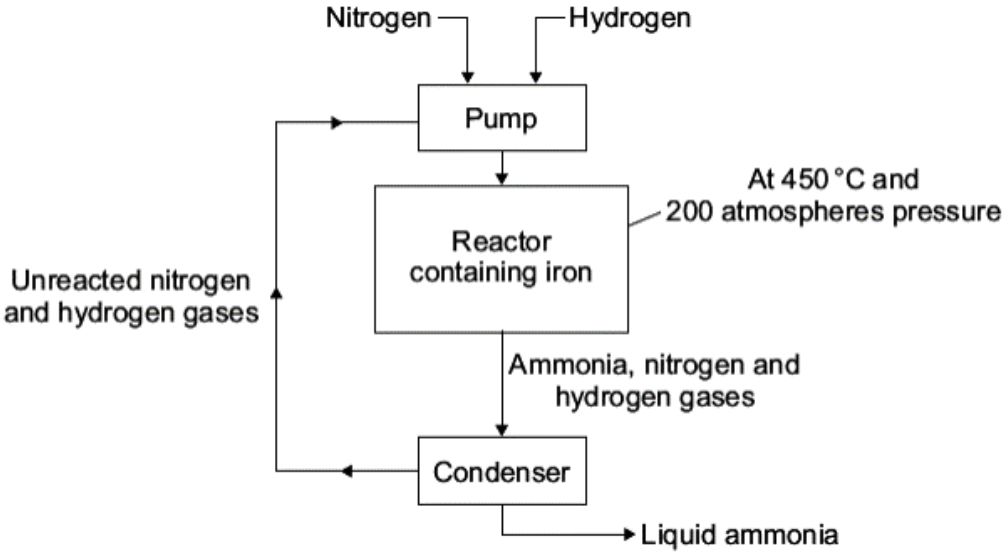


Figure B9.1

Figure B9.2 shows the yield of ammonia that is made under different conditions.

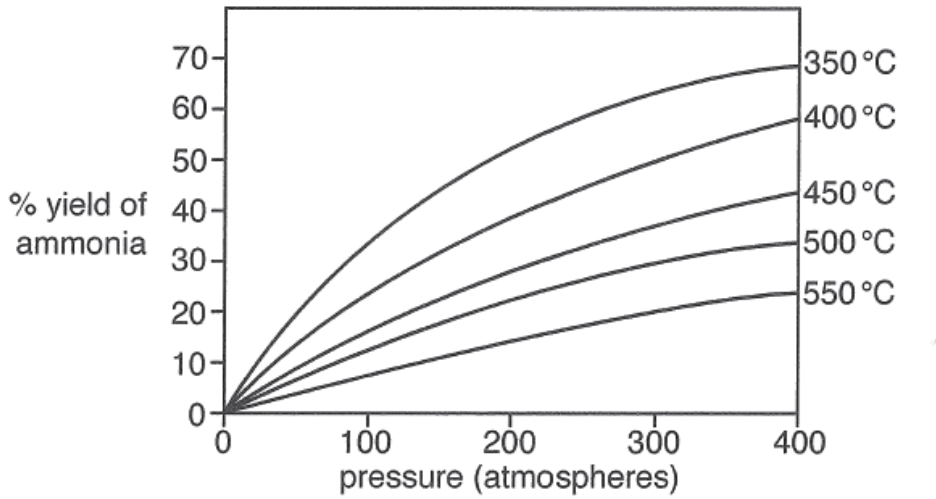


Figure B9.2

(a) In present times, the Haber process has been adapted to work at a lower temperature of 250 °C. Predict and explain how a lower temperature affects the relative amounts of ammonia, nitrogen and hydrogen that leaves the reactor.

[2]

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(b) In the condenser, ammonia is separated out as a liquid. Explain how this is achieved.

[1]

(c) The percentage yield for the production of ammonia is typically low. Explain why.

[1]

(d) 60 dm^3 of nitrogen and 60 dm^3 of hydrogen were each pumped into the reactor The volume of ammonia produced was found to be 6 dm^3.
Calculate the percentage yield of ammonia for the reaction.

[2]

(e) Aqueous ammonia is formed when ammonia gas is dissolved in water. When aqueous ammonia is added dropwise until excess to a sample of contaminated water, a mixture of white and blue precipitate was formed initially. The resulting mixture was a dark blue solution.
State the formula(e) of the possible cations present in the water sample.

[2]

(f) Ammonium nitrate is a common fertiliser used by farmers. Rain water can wash ammonium nitrate off the farmland and into rivers and lakes. Ammonium nitrate in drinking water supplies is harmful to health.
Describe tests to identify the presence of ammonium nitrate in drinking water.

[2]

[Total: 10]

End of Paper

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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.).

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2019 Preliminary Examination **Fuhua Secondary School**
Marking scheme for Secondary 4
CHEMISTRY 6092/1

Paper 1 (Multiple choice questions)

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

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Paper 2 (Structured and Free Response)

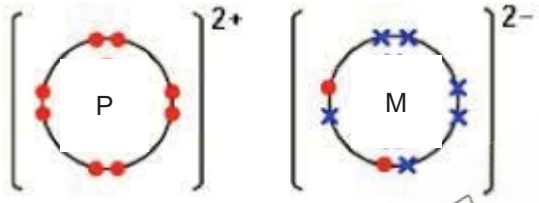
A1 **(a)** N [1]
Comment incorrect answer is M. M is an ion and not an atom.

(b) L or R or L and R [1]

(c) Q and S [1]

(d) **(i)** P and M [1]
Badly done.
The particles found in the ionic compound must be ions.

(ii) [2]



ion of P [1]
ion of M [1]
Although (d)(i) is incorrect,
Accept $Mg^{2+}O^{2}$
Accept $O^{2+}N^{2-}$

(e) R.[1] [2]

Atom of H can gain 1 electron to form H^- [;] or
lose 1 electron to form H^+ [;] to achieve stable electronic structure of a noble gas. Hence having oxidation state of -1 and +1. [1]
Atoms of H can be covalently bonded to form H_2 with an oxidation state of 0. [;] 3; [1]

Many scored only 1 m.
Accept because o.s of H is 0 in H_2, +1 in HCl and -1 in NaH.
Accept when H combine with metal, o.s. -1, combine with non-metal o.s. +1 and with itself o.s. 0.

A2 **(a)** Measure each sample of acid with a pH meter [1] [2]
If the pH reading ranges from 3 to 6, then it is a weak acid [1]

OR 2;[1]
Add a few drops of Universal Indicator to each sample.
Reject 'indicator'
Reject red

If the indicator changes to a yellow or orange colour, it is a weak acid.
'simple test' – reject use of chemical reagents. This is in the UCLES report.

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(b) Warm each sample with acidified potassium manganate(VII). [1] [2]
All conditions to be mentioned such as 'warming/heating' , 'acidified'.

If acidified potassium manganate(VII) turned colourless, the sample is tartaric acid. If it remains purple, the sample is phosphoric acid. [1]

Badly done, many did not discover the presence of –OH group in tartaric acid.

Accept
- just one significant postitive observation for one sample.

- react with alcohol/carboxylic acid in presence of conc. sulfuric acid and warm and if sweet smell is detected, the sample is tartaric acid. OR

- react a fixed concentration and volume of each acid with a fixed mass of Mg of same particle size, measure the volume of gas given off in a fixed time. The sample that gives a larger volume of gas is phosphoric acid.

(c) volume ratio 3: 2 [1]

Badly done. There is a similar question in the alcohols worksheet.
Accept
- vol of tartaric acid : KOH = 1: 2, phoshoric acid : KOH = 1 : 3

(d) 1. Add aqueous sodium tartarate to a fixed volume of aqueous copper(II) nitrate in a beaker till no more precipitate is formed. [1] [2]
'aqueous' must be stated for ionic precipitation method

2. Filter the mixture to obtain copper(II) tartarate as a residue
3. Wash the residue with a little distilled water and pat dry between pieces of filter paper.
step 2 and 3 [1]

Accept
If step 1 or method is incorrect but step 2 and 3 correct, 1 m awarded.

(e) **(i)** 3.0°C [1] [1]

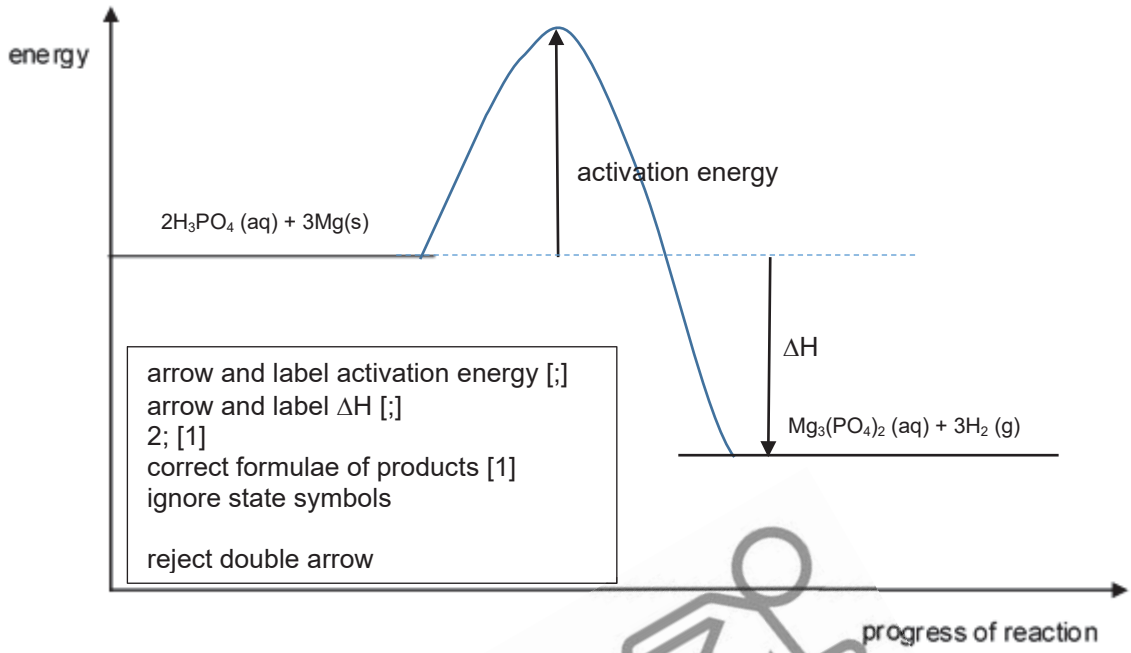
(ii) 6.0°C [1] [3]

Since the magnesium ribbon is the limiting reactant [1],
amount of heat energy given out is the same for 2.0 cm ribbon and phosphoric acid [1]

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(iii)



arrow and label activation energy [;]
arrow and label ΔH [;]
2; [1]
correct formulae of products [1]
ignore state symbols

reject double arrow

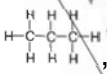
[2]

Accept if equation not balanced.

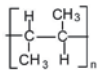
A handful still drew the profile for endothermic reaction
temperature of mixture increases → exo
some did not revise for this topic.

A3 (a) butyl propanoate, butanol, propanoic acid [1] [4]

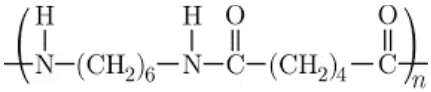
Common incorrect answer 'butyl-propanoate', 'buthyl'

, addition of hydrogen [1]

Accept catalytic hydrogenation.

, addition polymerisation [1]

Reject 'additional polymerisation'

, condensation polymerisation [1]

Common incomplete response left out $(\ )_n$

Award 1 m if structure correct but left out $(\ )_n$ for both polymers

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(b) **(i)** Any two of the following: [2]

- Members have the same general formula $C_nH_{2n+1}X$
- There is gradual increase in boiling point as the number of carbon atoms increases
- Successive members differ from the next by a $–CH_2$ group.

Take note: If three evidences stated, and one is incorrect, it would negate a correct mark awarded. This is stated in UCLES report.

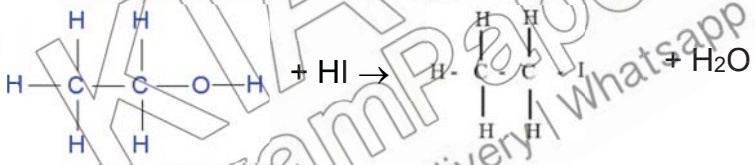
(ii) As the halogen atom changes from C*l* to I, the boiling point of the alkyl halide increases. [1] [3]

The size of halogen atom increases from C*l* to I, <u>molecular mass / molecular size of alky halide increases</u> [1] and hence boiling point increases.

<u>Intermoleular forces of attraction between molecules increases</u> and <u>amount of energy taken in to overcome these forces increases</u> [1]

Many misconceptions:
- reactivity of halogen affect the boiling points of alkyl halides.
- break covalent bond between C-X
Note: ' akyl halides consist of molecules held by weak intermolecular forces of attraction'

(d) [2]



displayed formulae of organic compounds [1]
balanced equation and formulae of other chemicals [1]

A4 **(a)** The oxidation state of nitrogen decreases from +4 in NO_2 / +2 in NO to 0 in N_2. Hence conversion of NO_x to nitrogen involves reduction.[1] [2]

The oxidation state of carbon increases from +2 in CO to +4 in CO_2. Hence conversion of CO to CO_2 is involves oxidation. [1]

Omission of 'increase/decrease' only 1 mark awarded.
Focus of this question is on the conversion of NO_x in reaction 1 and CO in reaction 2.

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(b) As the air/fuel ratio changes from rich to lean, the conversion efficiency of CO and HC increases but that of NO_x decreases. [1] [4]

As the air/fuel ratio changes from rich to lean, the amount of oxygen available to oxidise CO to CO_2 increases, [1]
amount of oxygen available to oxidise HC to CO_2 increases. [1]
lesser CO amount available to reduce NO and hence conversion of NO_x decreases [1]
Reject less incomplete combustion and hence lesser CO, this is catalytic converter and not internal combustion engine.

Badly done.

Reactions in the engine are not the same as reactions in the catalytic converter – refer to O levels 2015 B8.

Common misconceptions:
'Combustion of CO and HCs take place in catalytic converter.'
The reactions in the catalytic converter are redox and for CO and HCs are oxidation reactions.

(c) Any two health effects [2] [2]

- Nitrogen oxide causes respiratory problems/ irritate eyes and lungs
- Inhalation of carbon monoxide prevents haemoglobin from absorbing oxygen and may lead to suffocation / organ failure / headaches.
- Unburnt hydrocarbons cause cancer / carcinogenic

[NB: discuss effect of each gas separately]
Common mistakes:
NO_x cause respiratory problems but not breathing difficulties.
CO causes breathing difficulties but not respiratory problems.

Take Note: It is necessary to discuss the health effect of each gas separately.
This is stated in the UCLES markers' report.

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A5 **(a)** Similarity: [2]
In both B and C, the atoms are held by strong covalent bonds. [1]

Difference:
Any one of the two: [1]

- B has simple covalent structure while C has giant molecular structure.
- B consists of molecules held by weak intermolecular forces of attraction while C does not contain molecules and only atoms held by strong covalent bonds' .

Bonding remains the most important topic that candidates do not fare well in
Common misconception:
- 'B is ionic compound.' B has structure of solid iodine which has a simple covalent structure consisting of diatomic I_2 molecules held by weak intermolecular forces of attraction.

(b) C cannot conduct electricity while D conducts electricity [no mark given] [2]

In C, each carbon atom uses 4 out of 4 outer electrons to form covalent bonds and hence there are no mobile electrons [1]
Accept: each C atom uses all its valence electrons in bonding.
Reject: C has all valence electrons used in bonding with no mention of atoms at all. Question states both C and D are allotropes of carbon.
while in D, each carbon atom uses 3 out of 4 outer electrons to form covalent bonds, leaving one unused.These delocalised electrons conduct electricity. [1]

delocalised/mobile electrons must be mentioned in first or second point to get full credit.

The focus of this answer is on the 'valence electrons of each C atom'

But many candidates based their responses on each C atom is bonded to three / four other C atoms → meant for question involving hardness or m.pt.

Award 1 m although not in answer scheme
- In C, one C atom bonded to 4 other C and in D, each C atom bonded to 3 other C atoms.

(c) Cu^{2+} and O^{2-} have a higher charge than K^+ and Cl^-. [1] [2]
Reject CuO have a higher charge.

Stronger electrostatic forces of attraction between Cu^{2+} and O^{2-} ions
and hence larger amount of energy required to overcome these forces. [1]

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A6 **(a)** The relative formula masses or M_r of the carbonates are different.[1] [2]

Hence the same mass of carbonate will produce different number of moles of carbon dioxide and hence different mass of carbon dioxide given off and thus varying decrease in mass [1]

Very badly done.

Common misconception:
- No such thing as 'reactivity of carbonates' – reactivity of metals and relate to thermal stability of the metal carbonates.
- Most did not explain how CO_2 produced leads to a decrease in mass of carbonate.

(b) 2.00 g [1] [1]
Badly done. Many did not understand sodium carbonate is not decomposed.

(c) Copper [1] [2]
$CuO + H_2 \rightarrow Cu + H_2O$ [1]

Accept
- copper(II) carbonate

Incorrect answers are
copper, zinc, lead (lead carbonate not even an entry in the table.)
ZnO is not reduced by hydrogen.

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B7 **(a)** Sodium and potassium are alkali metals which **react readily with water** in aqueous salt solution to form alkali and hydrogen gas.[1] [1]
Not possible for Na/K to remain as an electrode in aqueous **solutions** to measure potential difference.

Accept: react with oxygen in the air, react explosively causing hazard, which links to question of being difficult to set up the half cells

Reject: react with acid / only mention reactive but not linked to why it is difficult to set up half-cell.

(b) **(i)** $I_2 + 2e^- \rightarrow 2I^-$ [1]

No state symbols required

Very few candidates scored this mark as many wrote the oxidation equation or placed electrons wrongly. Quite a number gave wrong charges for iodide such as I^+.

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(b) (ii) Chlorine has a higher reduction potental than iodine AND and hence chlorine can displace iodine from its solution. / chlorine gains electrons more readily. [1]

Most candidates managed to score for this question.

(c) [2]

	chromium	tin
aqueous solution of nickel(II) ions	√	
aqueous solution of iron(II) ions	√	
dilute nitric acid	√	√

All 4 ticks [2], 2 ticks [1]

Relatively well answered part for B7.

(d) [3]

	reactivity	standard reduction potentials
Group I	**Reactivity increases from Li to K / down the group** which indicates the tendency to lose electrons increases from Li to K. [;]	**Standard reduction potential increases from Li to Na then decreases from Na to K** which indicates Li lose electrons more easily than K and Na.[1]
Group VII	**Reactivity decreases from F_2 to I_2 / down the group** which indicates the tendency to gain electrons decreases from F_2 to I_2 [;] 2;[1]	**Standard reduction potential decreases from F_2 to I_2,** indicating the tendency to gain electrons decreases from F_2 to I_2 [1] Accept comparison between 2 halogens.

[1] for reactivity trend in group I and group VII.
[1] for reduction potential trend in group I
[1] for reduction potential trend in group VII
Many candidates lost marks because they did not mention about the trend in reactivity in the group or link the reactivity with the elements. Majority of candidates did not managed to identify the decrease in reduction potential from Na to K.

[1] for correct trend of group VII reduction potential without mention of elements. Eg. As the elements get more reactive in group VII, reduction potential increases.

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(e)

solutions	name of products of electrolysis that would be produced first		ionic equation for the reaction at each electrode
concentrated magnesium chloride	at negative electrode	hydrogen	$2H^+(aq) + 2e^- \rightarrow H_2(g)$
	at positive electrode	chlorine	$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$
mixture of dilute silver nitrate and copper(II) chloride	at negative electrode	silver	$Ag^+(aq) + e^- \rightarrow Ag(s)$
	at positive electrode	oxygen and water	$4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$

[4]

2 correct blanks [1]
ecf [2] for eqn given if products at electrodes are mixed up.

Common mistakes include wrong products at the electrode, giving formula rather than name as stated in question, writing ionic equation without state symbols or balancing the equation wrongly. Candidates must take note that silver ion is Ag^+ not Ag^{2+}

B8 (a) Agree. Increasing concentration of NO increases the rate to a greater extent than increasing the concentration of H_2. [3]

Comparing experiment 1 and 2 where concentration of NO was kept constant at 0.0060 mol dm^{-3} , increasing the concentration of H_2 by a factor of 2 from 0.0010 to 0.0020 mol dm^{-3} increases the rate of reaction by a factor of 2 from 1.8×10^{-4} to $3.6. \times 10^{-4}$ mol $dm^{-3}s^{-1}$.

Comparing experiment 3 and 4 where concentration of H_2.was kept constant at 0.0060 mol dm^{-3} , increasing the concentration of NO by a factor of 2 from 0.0010 to 0.0020 mol dm^{-3} increases the rate of reaction by a factor of 4 from 0.3×10^{-4} to $1.2. \times 10^{-4}$ mol $dm^{-3}s^{-1}$.

Many candidates interpreted the data wrongly by comparing the increase in rate of reaction when concentration of NO and H_2 was changed, rather than comparing the number of times the concentration changed.
[1] given quoting data correctly.

[1] for wrong interpretation of data (increase of 1.8×10^{-4} mol dm^{-3} s^{-1} from expt 1 to expt 2, is more than increase of 0.9×10^{-4} mol dm^{-3} s^{-1} from expt 3 to expt 4) but able to quote correct data.

(b) 2.4×10^{-4} mol $dm^{-3}s^{-1}$. [1]
Badly done, not many candidates are able to state the rate. Many did not include units but were not penalised.

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(c) Molar volume ratio of H_2 (g) : N_2 (g) + H_2O (g) = 2 : 3 [2]
Therefore volume of N_2 (g) + $2H_2O$ (g) produced = 3/2 × 15 = 22.5 cm^3 [1]
unreacted NO = 5 cm^3
Volume of gases remaining = 27.5 cm^3 [1]
Many candidates did not take into account unreacted NO.
A few used wrong methods to calculate the mole of gas.

(d) At lower temperature, the reacting **NO and H_2 molecules** have **less kinetic energy** and move slower / collide less frequently [;] [2]
Less reacting molecules collide with e**nergy more than or equal to the activation energy** [;]
Hence the frequency of **effective collisions** between NO and H_2 decreases[;]
3; [2]
Many candidates did not make reference to the specific reactant particles and majority did not mention the point about activaion energy.

[1] decreased number of effective collisions between NO and H_2
[1] decrease KE/move slower and lesser number of particles with energy greater than/equal to activation energy.

B9E (a) More popular of the B9 questions. Most did relatively well. [2]

Mr of repeat unit = 114
When M_r = 20 000, number of repeating units
= 20 000/114 [1]
= 175.43 = 176 [**round up**] [;]

When Mr = 50 000, number of repeating units
= 50 000/114
= 438.596 = 438 [**round down**] [;]

Therefore, the range of the average number of repeating units is between 176 and 438 [1] inclusive.

Wrong Mr but correct rounding, ecf [1]
Most are able to calculate correctly.

(b) (i) $HOOCCH_2CH_2COOH$ [1] [2]
and
$HOCH(CH_3)CH_2OH$ [1]
Well answered

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(b) (ii) M_r of dicarboxylic acid ($C_4H_6O_4$) = 118 [3]
M_r of diol ($C_3H_8O_2$) = 76
No of moles of dicarboxlic acid = 1000/118 = 8.47458
No of moles of diol = 1000/76 = 13.1579

Dicarboxylic acid is limiting. [1]

No of moles of polymer = 8.47458 [1]

Mass of polymer produced = 8.47458 × (158) [Mr of 1 repeat unit]
= 1338.9 g = 1.39 kg [1] (3sf)
Many candidates did not take into account the loss of water in calculating Mr.
-1 for sf

(c) Any three of the following [3]

Polymer X	**Polymer Y**
Formed by joining of unsaturated monomers/ monomers containing C=C carbon covalent bonds	Formed by joining monomers with two different functional groups present such as –COOH and –NH_2 or -OH.
Polymer has C-C linkage	Polymer has ester linkage.
Addition polymer is formed from joining of monomers without losing of any molecules or atoms	Condensation polymer is formed from joining of monomers with losing of atoms or small molecules eg. water
Empirical formula of polymer and monomer are same.	Empirical formula of polymer is different from that of the monomer.

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Accept: X is made up of 1 type of monomer, Y is made up of 2 types of monomers
X is formed by addition polymerisation, Y by condensation polymerisation.
Repeating unit of X has 6 carbon atoms, repeating unit of Y has 7 carbon atoms.

Reject: polymer X undergoes addition polymerisation.
Y has sweet smell, X has no sweet smell.
X has no linkage.

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B9 OR **(a)** According to the graph, as the temperature decreases, a higher percentage yield of ammonia is obtained.[1] [2]
This would result in a increase in the amount of ammonia that leaves the main reactor and an decrease in the amount of unreacted hydrogen and nitrogen.[1]

Some students did not mention that yield of ammonia will increase.

(b) By maintaing the condenser temperature to be lower than the boiling point of ammonia but higher than boiling points of nitrogen and hydrogen. / Ammonia has a higher boiling point than nitrogen and hydrogen hence will condense first when cooled. [1]

Many candidates wrote fractional distillation.

(c) The reaction of nitrogen and hydrogen to profuce ammonia is a **reversible** reaction and some ammonia produced is **decomposed/converted back** to form the reactants. [1]

Reject: turn back

(d) Molar volume ration of $N_2 : H_2 : NH_3 = 1 : 3 : 2$ [2]
Since H_2 is limiting, theoretical volume of ammonia produced = $2/3 \times 60 = 40$ dm^3 [1]
Percentage yield of ammonia = $6/40 \times 100\% = 15\%$ [1]

(e) Zn^{2+}, Cu^{2+} [2]
Most candidates able to identify Cu^{2+}

(f) Add aqueous sodium hydroxide to a sample of water and warm the mixture. [2]
If a pungent and colourless gas that turned moist red litmus blue is produced, then ammonium ion is present [1]
Add aqueous sodium hydroxide, Al foil and warm the mixture.
If a pungent and colourless gas that turned moist red litmus blue is produced, then nitrate ion is present [1]
Majority of candidates did not mention this part well, and only added sodium hydroxide and confirmed identity without aluminium foil, showing poor knowledge of test for nitrates.
Some candidates used indicator.

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