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**

Paper 2 (Structured and Free Response)

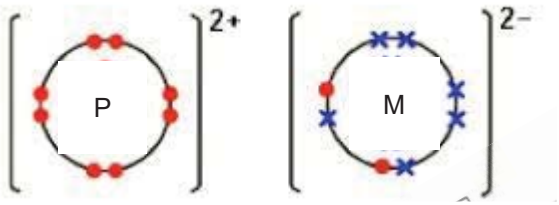
A1 **(a)** N [1]
Comment incorrect answer is M. M is an ion and not an atom.

(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.

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

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

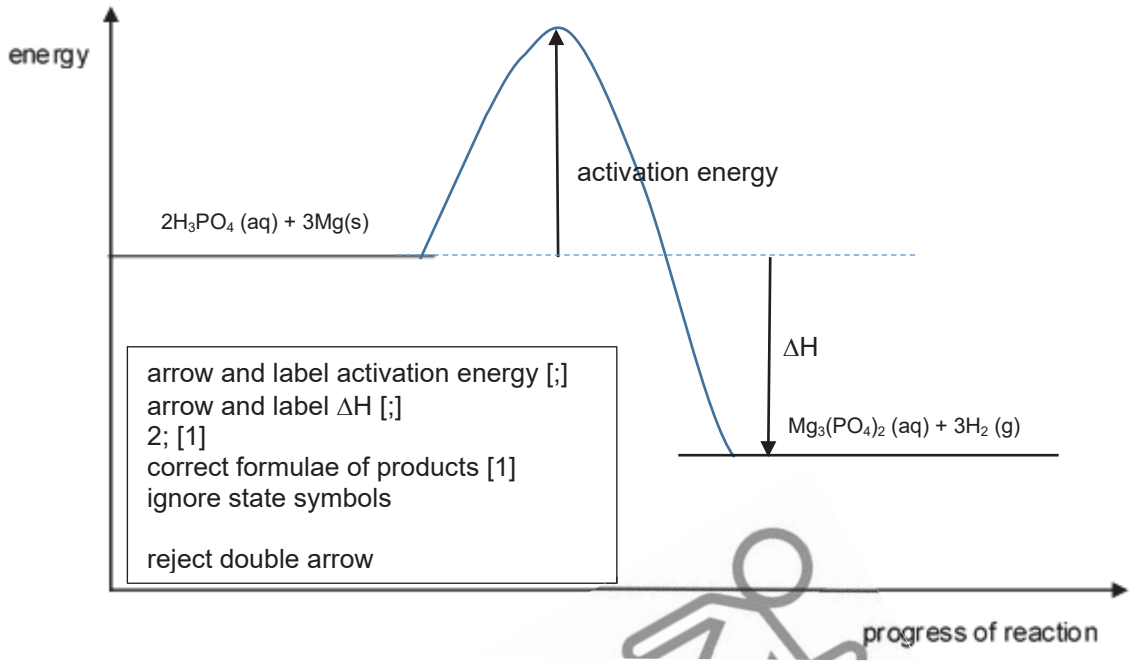
Accept
If step 1 or method is incorrect but step 2 and 3 correct, 1 m awarded.

(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]

(iii)



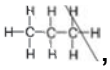
[2]

Accept if equation not balanced.

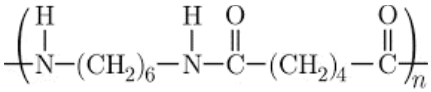
A handful still drew the profile for endothermic reaction
temperature of mixture increases → exo
some did not revise for this topic.

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

(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.

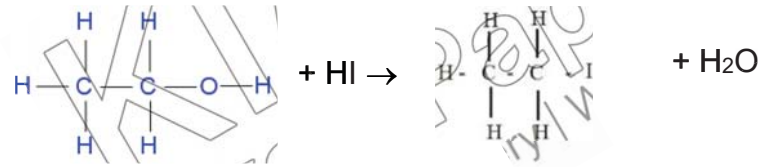
(ii) As the halogen atom changes from C*l* to I, the boiling point of the alkyl halide increases. [1] [3]

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.

(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.

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]

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.

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^+.

(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.

(e) [4]

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	$4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$

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 3.6×10^{-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 1.2×10^{-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.

(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

(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.

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 <u>undergoes</u> addition polymerisation.
Y has sweet smell, X has no sweet smell.
X has no linkage.

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 × 60 = 40 dm^3 [1]
Percentage yield of ammonia = 6/40 × 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.