Name: …….. ( ) Class: Sec 4A

Queenstown Secondary School

Preliminary Examination 2020
Secondary Four Express
Chemistry
6092/02

25 August 2020
Tuesday

Time: 1100 – 1245h
Duration: 1 hour 45 minutes

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

READ THESE INSTRUCTIONS FIRST

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

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

Section B
Answer all **three** questions.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 21.

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

Examiner's Use	
Section A	/50
Section B	/30
B1	
B2	
B3	
TOTAL	**/80**

Section A

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

The total mark for this section is 50.

A1 Fig. 1 describes some of the substances that result from the chemical reactions of a mixture of two salts **P** and **Q**.

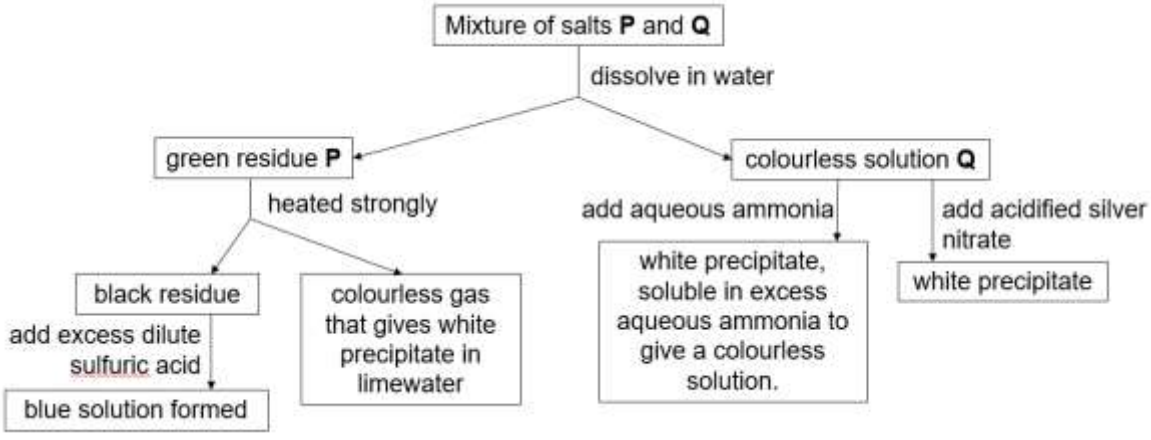


Fig. 1

(a) Identify the salts.

P …… **Q** …… [2]

(b) Write a balanced chemical equation for any **one** of the reactions included in Fig. 1.

…… [1]

[Total: 3]

A2 In many industries, steel and other metals are usually coated with chromium to increase the durability. When metals are plated with chrome, they are more resistant to corrosion.

There are several factors that affect the quality of the deposition of chromium on the surface of the metal during electroplating.

The table below shows how temperature of the electrolyte affects the grain size of chromium deposited and the hardness of the plated object.

temperature / °C	chromium grain size / μm	hardness / MPa
20	290	500
30	280	550
40	74	650
50	28.6	670

(a) Suggest why steel is more useful than pure iron.

……..

…….. [1]

(b) Describe the relationship between the temperature of the electrolyte and the grain size of chromium.

Explain this relationship, using ideas about collisions between particles.

……..

……..

……..

…….. [3]

(c) Draw and label the experimental setup to electroplate an object with chromium. Suggest a suitable electrolyte.

[2]

[Total: 6]

A3 The table below shows the physical properties of some Group I elements.

element	melting point / °C	relative thermal conductivity	atomic radius /pm
lithium	181	84	182
potassium	63	-	280
sodium	98	142	227
rubidium	39	58	290

(a) Use information from the table to suggest why it is difficult to predict the relative thermal conductivity of potassium.

……..

…….. [1]

(b) **(i)** The reactivity is based on the readiness of the metal atom to lose its electrons.

A student mentioned that the reactivity of the element is related to the atomic radius, thus, the larger the atomic radius, the more reactive the metal element.

Do you agree with the statement? Explain your answer.

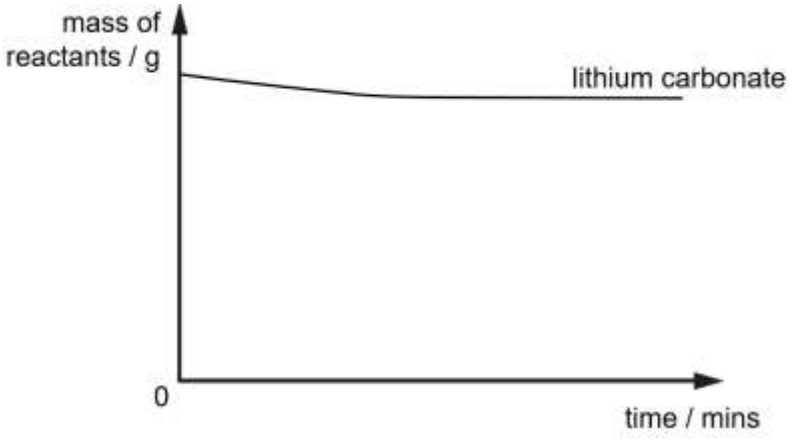
……

…….…… [1]

(ii) An element, **R**, was found to have 2 valence electrons, with an atomic radius of 231 pm.

An experiment which involved heating the same mass of metal carbonate over 10 minutes was carried out for the carbonates of metal **R** and lithium.

The graph below was obtained.



Add to the graph above how the reaction for the same mass of the carbonate of **R** would look like.

Explain your answer.

……

……

……

…… [3]

[Total: 5]

A4 **(a)** Brine is a mixture of aqueous sodium chloride and aqueous calcium chloride.

Calcium chloride can be removed when brine reacts with aqueous sodium carbonate.

Write a balanced chemical equation for the reaction.

…….. [1]

(b) Chlorine is made in the laboratory through the electrolysis of concentrated sodium chloride.

(i) Write ionic equations for the reactions at the cathode and anode.

at the cathode ……

at the anode …… [2]

(ii) Calculate the maximum volume of chlorine which can be obtained from 175.5 kg of sodium chloride, at room temperature and pressure.

maximum volume of chlorine = …….. [2]

(iii) Chlorine and sodium chloride have different boiling points.

Explain this difference with reference to their bonding and structures.

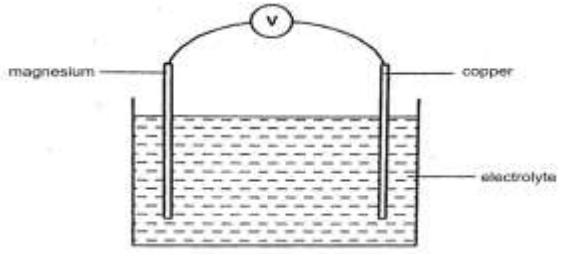
……

……

……

…… [3]

(c) Electricity can also be generated using an electric cell as shown below.



(i) In the diagram above, draw an arrow to show the direction of the electron flow in the electric cell. [1]

(ii) Explain the flow of electrons in the diagram.

……

…… [1]

(iii) Explain why aqueous copper(II) sulfate is not a good electrolyte to use in the simple cell above.

……

…… [1]

[Total: 11]

A5 P_2O_5 reacts with water to form phosphoric acid, H_3PO_4, which is a weak acid. Sodium phosphate, a salt used in medicines for constipation, can be prepared by an acid-base titration between phosphoric acid and sodium hydroxide.

(a) Describe how sodium phosphate solution can be prepared in the laboratory. Include a suitable indicator.

……..

……..

……..

……..

…….. [3]

(b) In a titration, 30.0 cm^3 of 1 mol/dm^3 of aqueous sodium hydroxide was added to 10.0 cm^3 of 1 mol/dm^3 of phosphoric acid. 1.23 g of sodium phosphate was obtained. Calculate the percentage yield of sodium phosphate.

percentage yield = …….. [3]

[Total: 6]

A6 The table below shows the percentage of ammonia present at different temperatures and pressures in the Haber Process.

temperature / °C	ammonia present / %				
	pressure / atm				
	10	25	50	100	200
100	88.2	91.9	94.9	96.8	98.9
200	50.6	63.7	74.0	81.6	89.0
300	14.8	27.4	39.5	52.6	67.1
400	3.0	8.5	15.3	25.2	38.9
500	1.2	2.8	5.9	10.7	18.3

(a) **(i)** Describe the effect of decreasing pressure on the percentage of ammonia present.

……

…… [1]

(ii) Describe the effect of decreasing temperature on the percentage of ammonia present.

……

…… [1]

(b) **(i)** Using the information given, what conditions give the highest percentage of ammonia present.

…… [1]

(ii) Explain why the conditions used in **(b)(i)** are not used commercially.

……

……

…… [2]

(c) Explain, with the help of an equation, why the nitrogen and hydrogen are mixed in a ratio of 1:3 by volume.

……..

…….. [2]

(d) Suggest how ammonia can be made in the laboratory.

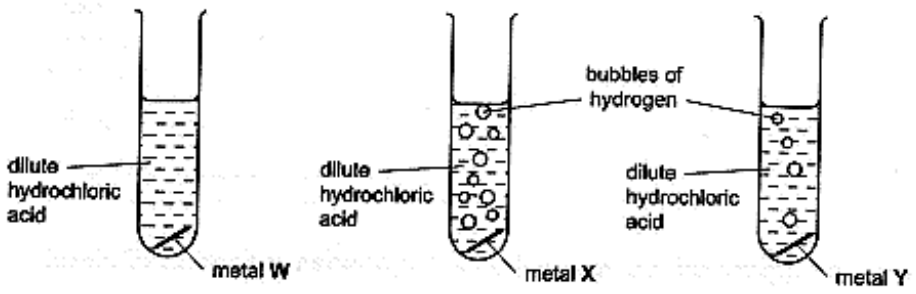
Include a chemical equation in your answer.

……..

…….. [2]

[Total: 9]

A7 The diagram below shows the reactions of metals **W**, **X** and **Y** with dilute hydrochloric acid.



(a) Based on the above results, arrange the metals in order of increasing reactivity.

…… [1]

(b) Aluminium metal was added to the acid, however, no effervescence was observed.

Explain why this is so.

……

…… [1]

(c) The effervescence observed in the test tubes was more vigorous when dilute sulfuric acid was used.

Explain why this is so.

……

……

…… [2]

(d) Explain, in terms of bonding and structure, why metals are good conductors of electricity.

……

……

…… [1]

[Total: 5]

A8 The following table shows the air pollutants found in a car exhaust during different car motions.

motion of car	% of carbon monoxide	% of nitrogen dioxide
at rest	12	1
acceleration	6	4
constant speed	6	3
deceleration	6	3

(a) Explain why the percentage of carbon monoxide is highest when the car is at rest.

……..

……..

…….. [2]

(b) Catalytic converters are fitted in cars so as to help reduce toxic gases that are released into the atmosphere. Palladium is the main catalyst used in catalytic converters.

(i) Explain how palladium helps to remove the toxic gases from the exhaust.

……

……..……..…… [1]

(ii) In a catalytic converter, nitrogen monoxide reacts with carbon monoxide to produce harmless gases.

Explain the role of carbon monoxide in the reaction with the help of an equation.

……

……..……

…… [2]

[Total: 5]

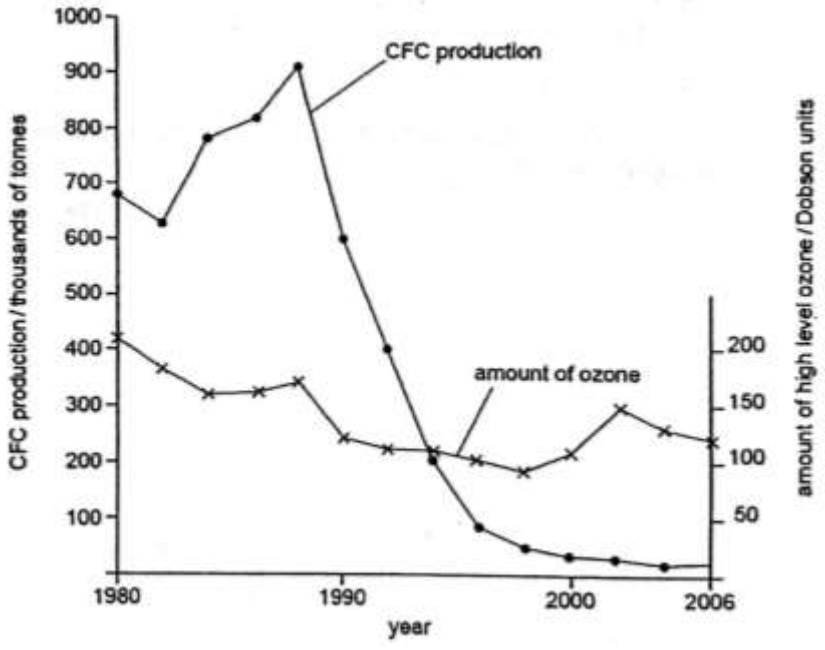
Section B

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

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

B1 Ozone, O_3, is an allotrope of oxygen. In the lower atmosphere, it can cause respiratory problems in humans. In the upper atmosphere, it helps to shield the harmful ultra-violet rays from the Sun.

Chlorofluorocarbons (CFCs) produced from aerosol sprays are released into the atmosphere, and they catalyse the conversion of ozone to oxygen in the upper atmosphere. The graph below shows the amount of CFC produced and how the amount of ozone in the upper atmosphere near the South Pole have changed over the years, from 1980 to 2006.



(a) Describe how the world production of CFCs has changed from 1980 to 2006.

……..

…….. [1]

(b) What evidence, if any, is there to show the relationship between the production of CFC and the amount of ozone at the South Pole?

Explain your answer.

……..

…….. [1]

(c) Ozone reacts with nitric oxide in the lower atmosphere to form nitrogen dioxide in the following equation:

$NO + O_3 \rightarrow NO_2 + O_2$

(i) Explain, in terms of oxidation states, why this is a redox reaction.

……

……

…… [2]

(ii) Explain how this reaction causes harm to our environment.

……

…… [1]

(d) In 1990, 85% of the CFCs detected in the atmosphere were mainly trichlorofluorocarbon, $CFCl_3$, which decomposes as shown in the following equation:

$$CFCl_3 \rightarrow CFCl_2 + Cl$$

The chlorine atoms, Cl, then destroy the ozone molecules in the following reactions:

$$Cl + O_3 \rightarrow ClO + O_2$$

$$ClO + O \rightarrow Cl + O_2$$

(i) Draw a 'dot-and-cross' diagram to show the bonding in $CFCl_3$.

Show outer shell electrons only.

[2]

(ii) Write an overall equation for the breakdown of ozone.

…… [1]

(iii) Explain how the equations show that chlorine atoms act as a catalyst for the breakdown of ozone.

……

…… [1]

(e) Hydrofluorocarbons (HFCs) were used to replace CFCs because it depletes the ozone layer to a smaller extent than CFCs. HFC acts as a greenhouse gas.

A sample of a HFC contains 0.12 g of carbon, 0.01 g of hydrogen and 0.57 g of fluorine. Deduce the empirical formula of this HFC.

empirical formula = …….. [2]

(f) One of the ways to remove compounds from the atmosphere is through deposition, “rain out”. This involves the removal of compounds that are soluble in water by precipitation. This is also the main cause of acid rain.

However, CFCs cannot be removed by this method. Explain why.

…….. [1]

[Total: 12]

B2 The table gives some properties of the elements in Group VII.

The properties of astatine are missing in the table.

element	electronic structure	melting point/ °C	boiling point/ °C	atomic radius/ pm
fluorine	2.7	-220	-188	64
chlorine	2.8.7	-101	-35	99
bromine	2.8.18.7	-7	59	114
iodine	2.8.18.18.7	113	183	133
astatine	-	-	-	

(a) Describe the trend in atomic radius of halogens.

Hence, predict the atomic radius of astatine.

……..

…….. [2]

(b) Using information from the table, suggest which halogen contains particles that are sliding about freely at room temperature and pressure.

…….. [1]

(c) Fluorine gas has a higher rate of diffusion as compared to that of chlorine.

Explain this phenomenon.

……..

…….. [2]

(d) State and explain what you would see when chlorine gas reacts with a sample of potassium iodide solution.

Include a chemical equation with state symbols.

……..

……..

…….. [3]

[Total: 8]

B3 EITHER

(a) Dilute sulfuric acid behaves as a *strong acid* but ethanoic acid behaves as a *weak acid*.

Describe an experiment, other than measuring pH, that you could carry out to show that sulfuric acid is a strong acid but ethanoic acid is a weak acid.

State what measurements you would make and what results you would expect.

……..

…….

……. [2]

(b) Propene undergoes complete combustion as shown in the following equation.

$$C_3H_6 + 4.5O_2 \rightarrow 3CO_2 + 3H_2O$$

The table lists the bond breaking energies of the following substances.

bond	bond energy / kJ mol^{-1}
C – C	346
C – H	411
C = C	602
O = O	498
C = O	799
H – O	459

(i) Calculate the enthalpy change for the reaction.

enthalpy change = …….. [3]

(ii) Explain, in terms of bond breaking and bond making, why this reaction is exothermic.

……

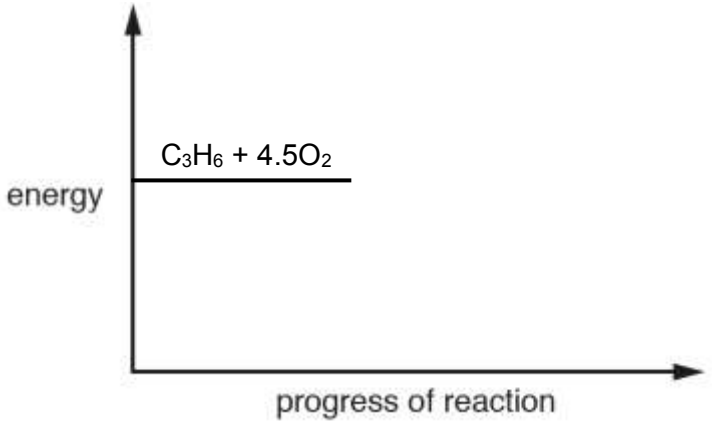
……

…… [3]

(iii) Complete the energy profile diagram for the combustion of propene.

Your diagram should include

- a label for the **enthalpy change of reaction**
- a label for the **activation energy**

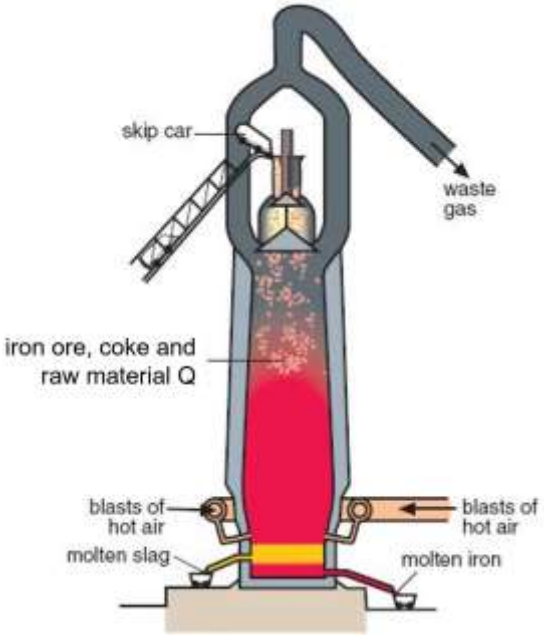


[2]

[Total: 10]

B3 OR

(a) The diagram below shows how iron is extracted using the Blast Furnace.



(i) Suggest the purpose of adding raw material Q to the furnace.

…… [1]

(ii) Explain how iron ore is reduced to form iron in the Blast Furnace.

Include a chemical equation to illustrate your answer.

……

……

…… [2]

(iii) Suggest if this method is suitable for the extraction of potassium from its ore. Explain your answer.

……

…… [1]

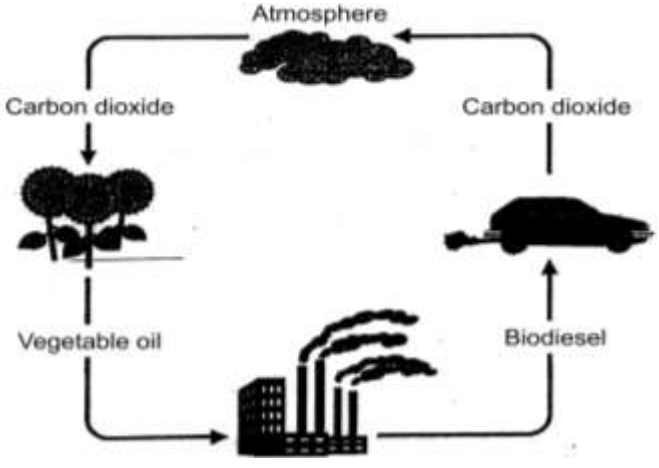
(iv) A layer of a different metal could be coated on the iron product to prevent it from rusting.

Suggest a suitable metal and explain your choice.

……

…… [1]

(b) Biodiesel can be produced from the diagram shown below.



Both extraction of iron and combustion of biodiesel produce carbon dioxide gas.

However, there are views that combustion of biodiesel does not cause an increase to the amount of carbon dioxide in the atmosphere.

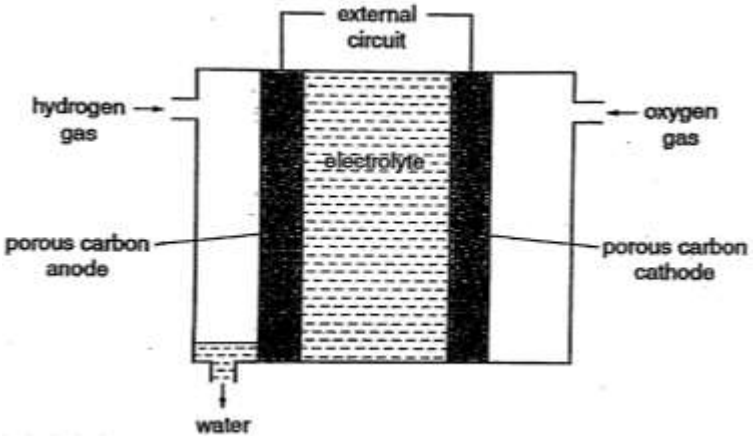
Explain why this is so.

……..

……..

…….. [2]

(c) One of the first buses to use hydrogen as a fuel was operated in Germany in 1996. The hydrogen was stored in thick pressurised tanks on the top of the buses. The diagram below shows a hydrogen fuel cell.



(i) The half equation at the anode is shown below.

H_2 (g) + $2OH^-$ (aq) → $2H_2O$ (*l*) + $2e^-$

State the type of reaction. Explain your answer.

……

…… [2]

(ii) Oxygen reacts with water to produce hydroxide ions at the cathode.

Write the ionic half equation at the cathode.

…… [1]

[Total: 10]