Name	Register Number	Class

GREENRIDGE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2020
Secondary 4 Express

CHEMISTRY **6092/02**
Paper 2

28 Aug 2020 **1 hour 45 minutes**
Friday 0800 – 0945

Additional Materials: No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class on this cover and all the work you hand in.
Write in blue pen or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use paper clips, glue or correction fluid.
The use of an approved scientific calculator is expected, where appropriate.

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

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

A copy of Periodic Table is printed on page **19**.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
Section B	
Total	**/ 80**

Section A

This section carries 50 marks.
Answer **all** the questions in this section in the spaces provided.

A1 Both carbon and silicon form sulfides of the formula **X**S_2. The table below compares some of their properties.

	CS_2	**SiS_2**
melting point / °C	−111.6	1090
appearance at room temperature and pressure	colourless liquid	white solid

(a) Draw a 'dot-and-cross' diagram to show the arrangement of outer shell electrons in a carbon disulfide.

[2]

(b) Explain, in terms of structure and bonding, the difference in melting points of CS_2 and SiS_2.

……

……

……

……

…….. [3]

(c) Predict the solubility of CS_2 and SiS_2 in water.

…….. [1]

(d) Predict the electrical conductivity for both CS_2 and SiS_2. Explain your answer.

……

…….. [2]

[Total: 8]

A2 Choose from the following substances to answer the questions below.

sulfur dioxide	**ammonia**	**potassium iodide**
silicon dioxide	**chlorine**	**calcium carbonate**
iron(III) oxide	**zinc oxide**	**manganese(IV) oxide**

Each substance can be used once, more than once or not at all.

Name a substance which

(a) is a liquid that turns acidified potassium manganate(VII) from purple to colourless,

…….. [1]

(b) dissolves in both sodium hydroxide solution and dilute hydrochloric acid,

…….. [1]

(c) is added in excess to neutralise acidic pond water without causing the water to become alkaline,

…….. [1]

(d) forms acid rain when produced during a natural disaster,

…….. [1]

(e) is the main impurity in the Blast Furnace to be removed by neutralisation,

…….. [1]

(f) has both ionic and covalent bonds present,

…….. [1]

(g) is a catalyst that speeds up the decomposition of hydrogen peroxide.

…….. [1]

[Total: 7]

A3 Precipitation may occur when two aqueous solutions are mixed.

(a) Complete the following table.

solution mixed together	formula of precipitate formed	colour of precipitate formed
(i) copper(II) nitrate and sodium hydroxide	$Cu(OH)_2$	
(ii) potassium iodide and lead(II) nitrate		

[3]

(b) Write an ionic equation for reaction in **(a)(ii)**.

…….. [1]

(c) 20.0 cm^3 of 1.0 mol / dm^3 copper(II) nitrate solution was mixed with 30.0 cm^3 of 2.0 mol / dm^3 aqueous sodium hydroxide.

$$Cu(NO_3)_2 + 2NaOH \rightarrow 2NaNO_3 + Cu(OH)_2$$

(i) Determine the limiting reactant of the reaction.

[2]

(ii) Hence, find the mass of the precipitate formed.

[1]

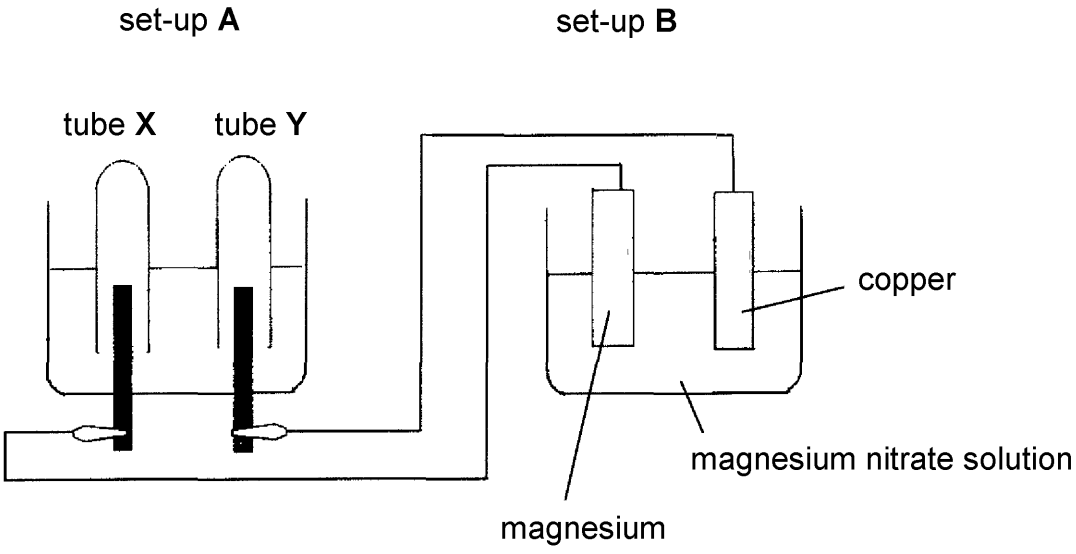
(iii) Describe what you see in at the end of the reaction.

…….....

……..... [2]

[Total: 9]

A4 The following experimental set-up which was used by a student to perform a experiment. The two black colour electrodes used are graphite electrodes.



(a) What is the function of set-up **B** in this experiment?

……

…….. [1]

(b) Describe what you see in set-up **B**?

……

…….. [2]

(c) If the electrolyte used in set-up **A** is dilute aqueous copper(II) chloride, name the products produced at the cathode and anode in set-up **A**.

cathode : …….

anode : ……. [2]

(d) Give the half equation of the reaction that occur at the cathode in set-up **A**.

…….. [1]

(e) If the electrolyte used in set-up **A** is changed to concentrated magnesium chloride solution and both the electrodes changed to copper.

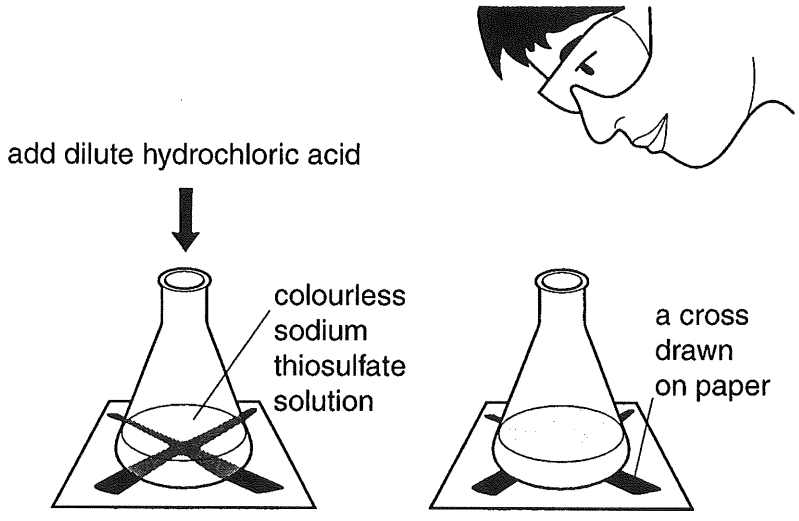
Give the half equation of the reactions that occur at the cathode and anode respectively.

cathode : …… [1]

anode : …… [1]

[Total: 8]

A5 The rate of the reaction between dilute hydrochloric acid and sodium thiosulfate solution, $Na_2S_2O_3(aq)$, can be investigated using a cross drawn on a piece of paper.



The reaction between dilute hydrochloric acid and sodium thiosulfate solution produces sodium chloride, sulfur, sulfur dioxide and water.

(a) Write a balanced chemical equation for the above reaction.

..... [2]

(b) Explain why it becomes more difficult to see the cross as the reaction progresses.

.....

.....

..... [2]

(c) The table shows the results of some experiments to investigate the rate of reaction, using sodium thiosulfate at different temperatures.

A student measured the time from when the acid was added until the cross can no longer be seen.

The same concentration and volume of dilute hydrochloric acid and the same concentration and same volume of sodium thiosulfate were used each time.

temperature of $Na_2S_2O_3$ / °C	**time until cross cannot be seen /s**
20	50
30	**x**
40	13
50	6

(i) Use ideas about collisions between particles to explain the trend in the results.

……

……

……

……

……

……

…… [3]

(ii) Estimate value of **x**.

…… [1]

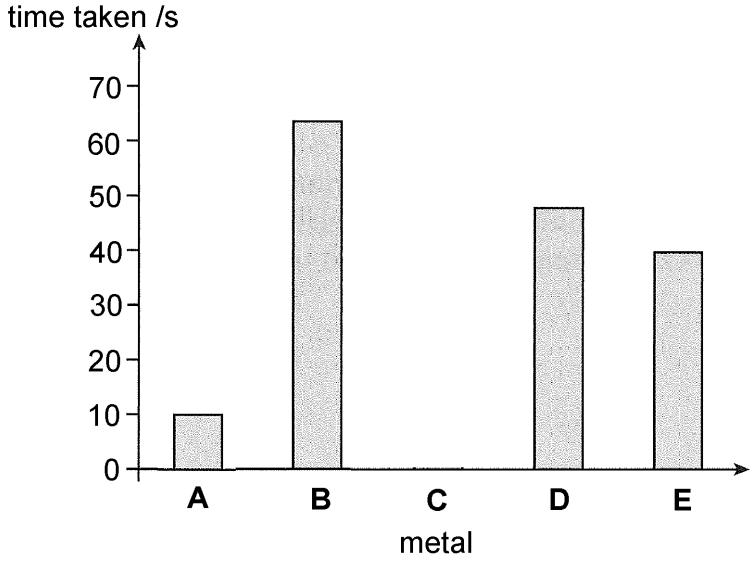
(d) Suggest another change to the conditions that can speed up the rate of reaction between dilute hydrochloric acid and sodium thiosulfate solution.

……

…… [1]

[Total: 9]

A6 An equal mass of five metals, **A**, **B**, **C**, **D** and **E**, were reacted separately with 30 cm^3 of hydrochloric acid. The graph below shows the time taken to collect 100 cm^3 of the gas produced from the above reactions.



(a) Calculate the rate of reaction of metal **E**.

[1]

(b) Arrange the metals in the order of decreasing reactivity.

…… [1]

(c) A student claimed that reaction between metal and acid is a redox reaction. With reference to the reaction between magnesium metal and hydrochloric acid, explain in terms of change in oxidation state if the claim is true.

……

……

……

…… [2]

(d) Name the gas produced. Describe a test to confirm its identity.

……

…… [2]

(e) The carbonates of each of the five metals are heated with same heat intensity in separate test tubes. The gas is collected and measured over 5 minutes.

Which metal has a carbonate that will produce the greatest volume of carbon dioxide gas in 5 minutes?

…… [1]

(f) Explain your answer in **(e)** in terms of thermal stability and reactivity.

……

……

……

……

…… [2]

[Total : 9]

Section B

This section carries 30 marks.
Answer all **three** questions in this section.
Question 9 is in the form of an either/or and only one of the alternatives should be attempted.

B7 **Ionisation energy** is the minimum energy (in kJ / mol) required to remove one electron from a single atom of an element in its gaseous state, per mole of atom.

It is quantitatively expressed as

$$\mathbf{X}(g) + \text{energy} \rightarrow \mathbf{X}^{+}(g) + e^{-}$$

where **X** is any atom capable of ionisation,
$\mathbf{X}^{+}$ is that atom with an electron removed,
e^{-} is the removed electron.

The process of removing this electron is known as ionisation.

First ionisation energy is defined as the ionisation energy to remove the first electron from a gaseous atom.

The equation for the first ionisation energy is : $\mathbf{X}(g) \rightarrow \mathbf{X}^{+}(g) + e^{-}$

Second ionisation energy is defined as the ionisation energy to remove the second electron from a gaseous atom.

The equation for the second ionisation energy is : $\mathbf{X}^{+}(g) \rightarrow \mathbf{X}^{2+}(g) + e^{-}$

The magnitude of ionisation energy is a measure of how “tightly” the electron is held in the atom. The higher the ionisation energy, the more difficult it is to remove the electron. When an electron is removed from an atom, the repulsion among the remaining electrons decreases, while the positive charge of the nucleus remains the same.

The electronic configuration of an element is closely related to its chemical properties. This is because the chemical properties of any atom are determined by its number of valence electrons. The stability of these valence electrons is reflected directly in the atom’s ionisation energies.

Table 1 shows the first to third ionisation energies of the first four elements in Group I.

Table 1

Group I element	electronic configuration	ionisation energy / kJ / mol		
		first	second	third
lithium	2,1	526	7296	11810
sodium	2,8,1	504	4563	6913
potassium	2,8,8,1	425	3069	4420
rubidium	2,8,18,8,1	410	2650	3860

Table 2 shows the first to third ionisation energies of the first four elements in Group II.

Table 2

Group II element	electronic configuration	ionisation energy / kJ / mol		
		first	second	third
beryllium	2,2	899	1757	14849
magnesium	2,8,2	738	1450	7730
calcium	2,8,8,2	590	1145	4941
strontium	2,8,18,8,2	549	1064	4207

(a) **Third ionisation energy** is defined as the ionisation energy to remove the third electron from a gaseous atom.

Write the equation for the third ionisation energy of element **X**.

…… [1]

(b) Rank the four elements in Table 1 according to the stability of their valence electron, from the lowest stability to the highest stability.

……

…… [1]

(c) **(i)** Describe the trend in the first ionisation energy of the Group I elements.

……

…… [1]

(ii) Describe the relationship between first ionisation energy and reactivity of Group I metals.

……

……

…….. [1]

(iii) Using your understanding of atomic structure and the Periodic Table, explain the trend described in **c(ii)**.

……

……

……

……

……

……

……

…….. [3]

(d) Using the data in Table 1 and 2, explain why the values of the second ionisation energies are much higher for Group I elements as compared to Group II elements.

……

……

……

……

…… [2]

(e) Predict the trend in the first ionisation energy across Period 2 from lithium to neon.

…… [1]

(f) State one similarity and one difference between the first ionisation energies of Group I and Group II elements.

……

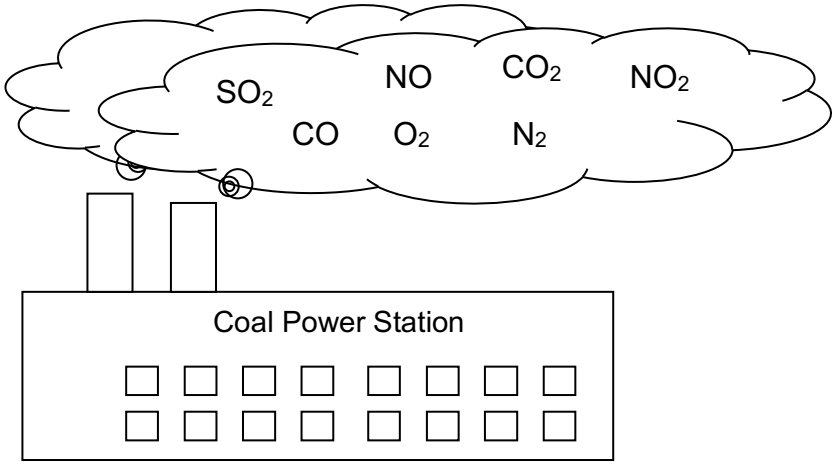
……

……

…… [2]

[Total: 12]

B8 The diagram shows the formulae of some gases emitted by a typical coal power station.



(a) Use the formulae from the diagram to answer the following questions:

(i) a poisonous gas that is produced by **incomplete** combustion of coal.

…… [1]

(ii) two gases that produces acid rain.

…… [2]

(iii) two gases that are involved in both respiration and photosynthesis.

…… [2]

(b) Carbon dioxide is one of main products in the combustion of coal in a coal power station. Excessive carbon dioxide is harmful to the environment.

Briefly describe how the carbon cycle helps to regulate the amount of carbon dioxide in the atmosphere.

……

……

……

……

……

…… [3]

[Total : 8]

Either

B9 Fig. 9.1 shows the manufacturing of a common fertilizer, ammonium nitrate.

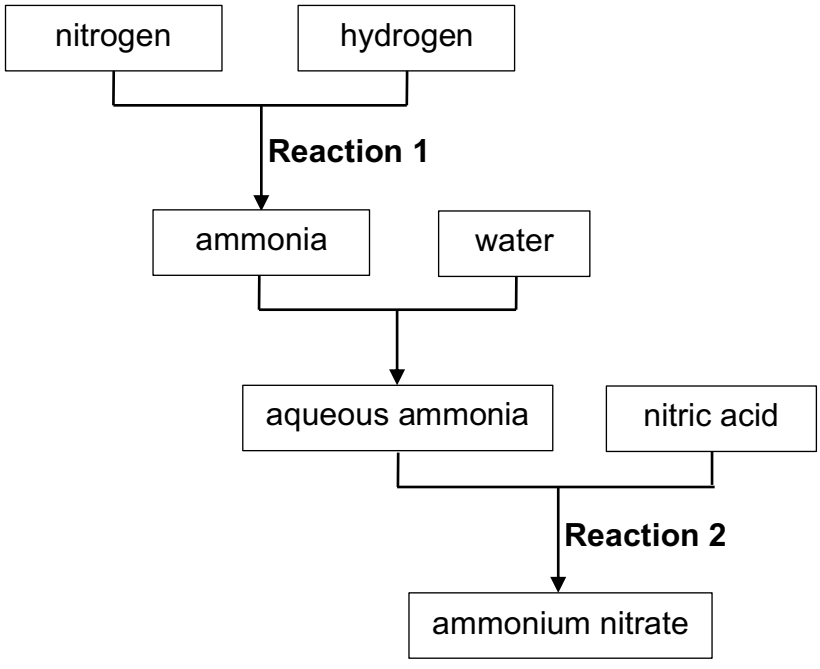


Fig. 9.1

(a) Name of the industrial process for **Reaction 1.**

…… [1]

(b) Write a balanced chemical equation for **Reaction 1.**

…… [1]

(c) Describe the conditions required for **Reaction 1** to take place.

……

…… [2]

(d) Use the bond energy table to calculate the enthalpy change for the formation of 1 mole of ammonia gas.

bond	energy (kJ / mol)	bond	energy (kJ / mol)
H–H	432	N=N	418
N–H	391	N≡N	941

[2]

(e) Sketch the energy profile diagram for decomposition of 1 mole of ammonia gas into nitrogen and hydrogen. Show clearly the enthalpy change.

[2]

(f) Describe how a pure sample of ammonium nitrate crystals can be obtained from the products of **Reaction 2**.

……

……

……

…… [2]

[Total : 10]

OR

B9 Barium is a group II element. Barium hydroxide is soluble in water to form aqueous barium hydroxide of concentration up to 0.1 mol / dm^3.

20.0 g of an impure sample of barium hydroxide, $Ba(OH)_2$, is dissolved in water to produce 1 dm^3 of an aqueous solution. 25.0 cm^3 of this alkaline solution is titrated against nitric acid with a concentration of 0.200 mol / dm^3.

The results obtained is shown in Table 9.1.

Table 9.1

titration number	1	2	3	4
final reading / cm^3	24.55	49.05	24.55	24.10
initial reading / cm^3	0.00	25.00	1.00	0.00
volume of nitric acid used / cm^3				
best titration results				

(a) Complete Table 9.1 to obtain the volume of nitric acid used in the 4 sets of titrations. [1]

(b) Choose the best titration results by putting a tick (√) and calculate the average volume of nitric acid used.

average volume of nitric acid used = ……. cm^3 [1]

(c) Write a balanced chemical equation, including state symbols, for the neutralisation reaction.

…… [2]

(d) Calculate the concentration of the barium hydroxide solution in mol / dm^3.

[2]

(e) Calculate the percentage of barium hydroxide in the impure sample.

[2]

(f) If the conical flasks that were used in this experiment had been rinsed with the barium hydroxide solution before carrying out a titration, how would this have affected the answer in **(e)**?

……

……

……

……

……

……

…… [2]

[Total: 10]

END OF PAPER

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.).