West Spring Secondary School
PRELIMINARY EXAMINATION 2020

CHEMISTRY 6092/02

Paper 2

SECONDARY 4 EXPRESS

Name _____ ( ) **Date** 28 August 2020

Class _____ **Duration** 1 h 45 min

Additional Materials: Laminated Periodic Table

READ THESE INSTRUCTIONS FIRST

Section A (50 Marks)
Answer **all** questions in the spaces provided.

Section B (30 Marks)
Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

Information for Candidates
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 provided.

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

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

This document consists of **16** printed pages including the cover page.

Setter(s) Mdm Sharena

Section A

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

A1 Choose from the following elements to answer the questions below.

ammonia	bromine	calcium
chlorine	copper	fluorine
hydrogen	iron	nitrogen
silver	sodium	zinc

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

Which element

(a) is found in Group VII and Period 2 of the Periodic Table, ... [1]

(b) can form a charge of 2+ and more reactive than zinc, ... [1]

(c) is a liquid at room temperature, ... [1]

(d) is a metal with low density, ... [1]

(e) has the highest percentage composition in air, ... [1]

(f) is used for galvanising? ..... [1]

A2 **(a)** Which of the following statements about carbon monoxide is(are) **true** and which is(are) **false**?

Put a tick (✓) in one box for each row.

	true	**false**
It is the main reducing agent in iron extraction in the Blast Furnace.		
It is not an acidic oxide.		
It is removed in a catalytic converter by reaction with nitrogen.		
It can be detected by smell when incomplete combustion of carbon-containing fuels occurs.		

[2]

(b) Carbon reacts with sulfur to form carbon disulfide, CS_2, which is a simple covalent compound used in manufacturing polymers and fibres.

Draw a 'dot-and-cross' diagram to show the bonding in carbon disulfide.

Show the outer shell electrons only.

[2]

(c) Sulfur reacts with magnesium to form an ionic compound called magnesium sulfide.

Draw 'dot-and-cross' diagrams to show the arrangement of outer shell electrons in magnesium sulfide.

[2]

A3 Elements in the same group in the Periodic Table can show different physical properties.

For example, Group VII elements chlorine and bromine exist in different physical states.

In another example, the melting points of Group IV elements are shown in the table.

element	C	Si	Ge	Sn	Pb
melting point / °C	>3550	1410	937	232	327

(a) State the melting point trend of the Group VII elements from chlorine to iodine.

……. [1]

(b) Carbon, silicon and germanium are solids with the same type of structure.

(i) What type of structure is present in carbon, silicon and germanium?

……. [1]

(ii) Suggest why the melting point of these elements decreases from carbon to germanium.

……

……. [1]

(iii) State the physical states of bromine and germanium at room temperature.

Explain, in terms of bonding, why the physical states of bromine and germanium are different.

……..

……..

……..

……. [4]

A4 Aspirin is a medicine that is used as a painkiller. It is made from salicylic acid.

(a) A student makes a sample of aspirin. He thinks it contains impurities.
The student tests the melting point of his sample of aspirin.

Explain how he can use the result of the test to find out whether his sample contains impurities.

……..

……... [2]

(b) Aspirin is a *weak* acid.

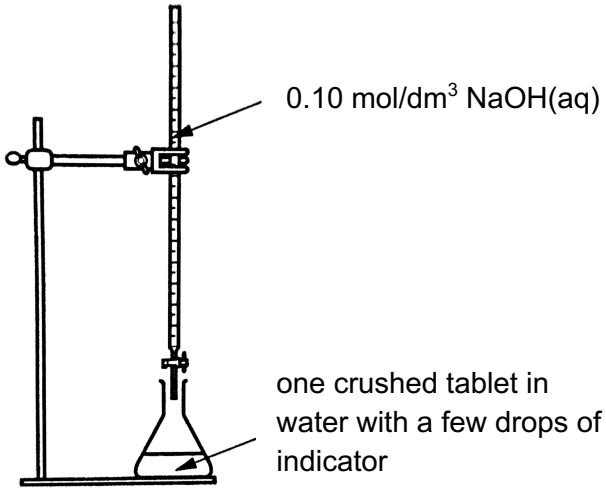
Explain what is meant by the term *weak* acid.

……..

…….. [1]

(c) The student buys and tests some tablets that contain aspirin.

He performs a titration using a crushed tablet and aqueous sodium hydroxide.



The formula for aspirin can be represented as ▭—COOH. The equation for the reaction between aspirin and aqueous sodium hydroxide is shown.

▭—COOH + NaOH → ▭—COONa + H_2O

The table shows the results of the student's titration.

concentration of aqueous sodium hydroxide	0.10 mol/dm^3
volume of aqueous sodium hydroxide needed for neutralisation	16.70 cm^3
relative molecular mass of aspirin	180

The label on the bottle of tablet states that each tablet contains 300 mg of aspirin.
(1000 mg = 1g)

Do the student's results agree with this value? Show your working.

[3]

(d) Some tablets that contain aspirin also contains citric acid.

The student does another titration using one of these tablets.

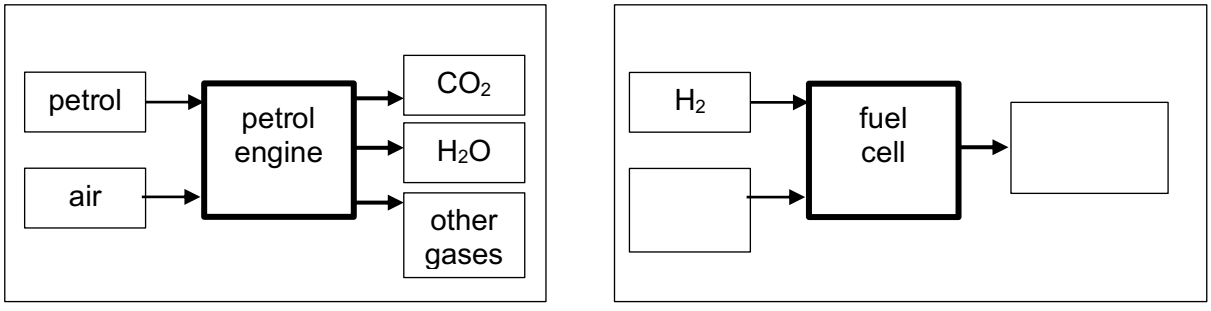
Explain why the mass of aspirin he calculates from his titration results is incorrect.

……

…….. [2]

A5 Most vehicles have petrol or diesel engines, but some use fuel cells.

The flow charts show the substances entering and leaving a petrol engine and a fuel cell.



(a) Complete the flowchart for the fuel cell by filling in the empty boxes. [1]

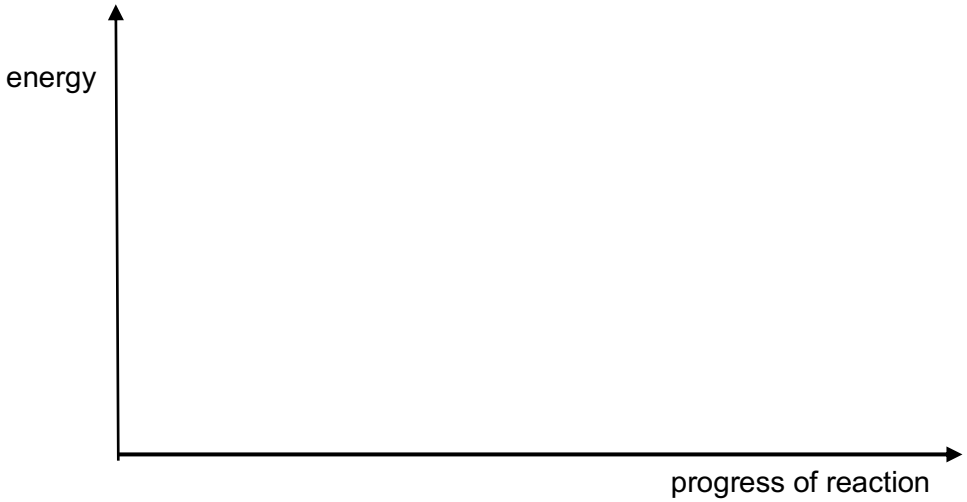
(b) Hydrogen for fuel cells can be obtained from electrolysis of water.

Electricity is used to provide energy for the electrolysis.

Complete the energy profile diagram for the electrolysis of water.

Your diagram should include

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



[3]

(c) The waste products from vehicles with petrol engines cause more harm to human health than those from vehicles with fuel cells.

Explain why this statement is true.

……

……

……

……

……... [3]

A6 An alloy was found to be containing a mixture of two metals. Two separate samples of the alloy were brought to the laboratory for further tests.

The first sample of the alloy dissolved completely in excess concentrated nitric acid to form a blue solution.

The second sample was divided and placed in two test tubes. Excess sodium hydroxide solution and aqueous ammonia was added to the test tubes separately, producing white precipitate which dissolved in excess to give a colourless solution.

(a) Identify the blue solution and white precipitate.

blue solution : ……

white precipitate : …… [2]

(b) Construct a balanced chemical equation, with state symbols, for the formation of the blue solution.

……... [2]

A7 The reaction of iron(III) sulfate with potassium iodide is a redox reaction.

$$Fe_2(SO_4)_3 + 2KI \rightarrow 2FeSO_4 + I_2 + \textbf{product X}$$

(a) At the end of the reaction, the solution turns brown.

Explain why.

……... [1]

(b) Give the formula and name of **product X**.

formula ……..

name ……... [2]

(c) **(i)** Complete the table to show the oxidation states of iron and iodine.

element	oxidation state in reactants	oxidation state in products
iron		
iodine		

[2]

(ii) Which substance has been reduced in the reaction?

With the aid of an equation, explain your answer in terms of **electron transfer**.

……..…….....

……. [2]

A8 A 'barium meal' is used in radiology to improve X-ray images of the gastrointestinal tract (the gut). It also helps to observe digestion and to detect ulcers and tumours in the stomach.

The 'barium meal' is administered to the patient as follows:

I. The patient takes some citric acid and sodium hydrogen carbonate ($NaHCO_3$) tablets. This produces a salt, sodium citrate, water and a gas which helps to expand the stomach and gut walls.

II. The patient drinks a suspension of barium sulfate, which will not be absorbed by the body.

III. Barium sulfate prevents X-rays from passing through and thus images can be clearly seen.

(a) State a word or phrase in the information given above which tells you that barium sulfate is insoluble in water.

…….. [1]

(b) Describe a chemical test to identify the gas produced in step (I).

……

……... [1]

(c) Describe briefly how a dry sample of barium sulfate can be prepared in the laboratory. Include the names of the reagents in your answer.

……

……

……

……... [3]

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.

B9 The table below gives the current estimate percentage by mass of some of the elements found in the Earth's crust and the Earth's core.

Earth's crust		Earth's core	
element	**% by mass**	**element**	**% by mass**
oxygen	40.6	iron	31.0
silicon	24.7	oxygen	24.0
nickel	8.1	magnesium	16.0
aluminium	8.1	silicon	13.0
iron	5.0	nickel	11.7
calcium	3.6	aluminium	0.1
sodium	2.8	sodium	0.1
potassium	2.6	hydrogen	0.05
magnesium	2.1	potassium	0.04
zinc	0.0078	calcium	0.04
copper	0.0068		
tin	0.00022		

(a) Which metallic elements are more abundant in the Earth's crust compared to the Earth's core?

……. [1]

(b) Suggest a reason why oxygen is the most abundant element in the Eath's crust.

…….

…….

…… [1]

(c) The estimated mass of the Earth's crust is 2.125×10^{16} kg. The annual production of iron is 3.32×10^{9} tonnes. Assuming that the demand for this metal is the same each year, determine the number of years before the supply of iron from the Earth's crust runs out.
[I tonne = 1000 kg]

[2]

(d) Briefly describe one advantage and one disadvantage of recycling metals.

Advantage : ……..

……

Disadvantage : ……

…… [2]

(e) Globally, iron and aluminium are the most recycled metals because of the ease of recycling them. Suggest a property of each of these two metals that accounts for this.

iron : ……..……..

……

aluminium : ……..……

…… [2]

A student studied the action of heat on four dIfferent substances (A, B, C and D). He knew that two of them were metals, and the other two were carbonates of the same two metals. He weighed out 5.00 g of each of the four solids and heated them in separate crucibles.

The table below shows the appearances and masses of the four solids before and after strong heating for some time.

solid	appearance		mass / g	
	before	after	before	after
A	brown	black	5.00	6.25
B	green	black	5.00	3.22
C	white	white	5.00	5.00
D	silvery	white	5.00	6.73

(f) Based on the data given above, suggest which two of the metals and which two were the metal cabonates. Explain your answers.

Metals : solid …… and solid …….

Metal carbonates : solid …… and solid ……. [1]

Explanation : ……

……

……

……

…… [3]

B10 Some companies make products to sell to farmers as soil improvers.

Some compounds in the products neutralise acidity.

The table shows information about some substances that companies use to make these products.

substance	chemical composition	effectiveness at neutralising acidity	other points
limestone	$CaCO_3$	fair	Insoluble in water. Needs to be ground to a very fine powder.
quicklime	CaO	very high	Made by heating limestone to a high temperature. Reacts exothermically with water to make an alkaline solution.
slaked lime	$Ca(OH)_2$	very high	Made by adding water to quicklime. Slaked lime is an alkali.
blast furnace slag (solid waste from the blast furnace)	Mixture of $CaCO_3$ and $CaSiO_3$ with other impurities.	fair	Insoluble in water. Impurities include silicon oxides and other non-metal compounds. Composition of mixture varies.

(a) Use the information in the table to suggest why limestone is less effective at neutralising acidity than quicklime and slacked lime.

……

……

…… [2]

(b) **(i)** Suggest an advantage of making products from blast furnace slag rather than the other substances.

……

…… [1]

(ii) Blast furnace slag may contain impurities of Group IV and Group V oxides. These impurities cause the slag to be less effective at neutralising acidity.

Explain why Group IV and Group V oxides are less effective at neutralising acidity.

……

…… [2]

(c) One mole of gas occupies 24 dm^3 at room temperature and pressure (r.t.p)

Quicklime is made by strongly heating limestone in a kiln. The reaction produces calcium oxide and carbon dioxide as shown in the equation.

$$CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g)$$

A kiln can hold 25 tonnes of limestone. (1 tonne = 1 000 000 g)

Assuming that limestone is pure calcium carbonate, calculate the volume of carbon dioxide (at r.t.p) that is produced when 25 tonnes of limestone are heated.

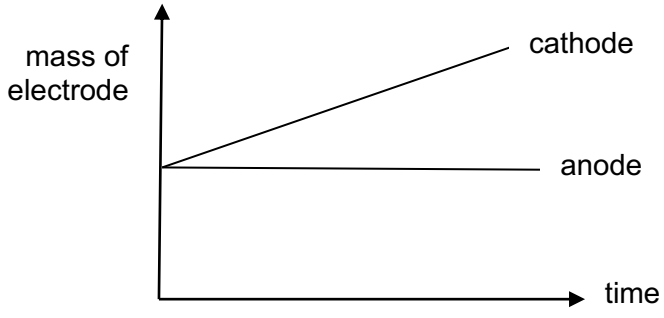
[3]

Either

B11 A student was given two different types of electrodes (carbon and copper electrodes), a fixed volume of 1.0 mol/dm^3 of copper(II) sulfate solution, some electrical wires and batteries.

He carried out the electrolysis of copper(II) sulfate solution using the different electrodes.

First, he carried out the experiment with carbon electrodes. At regular intervals, the cathode and anode were removed, dried and weighed. The results were plotted on the graph below.



(a) **(i)** Give the formulae of all the ions present in the electrolyte.

…… [2]

(ii) Explain why the cathode shows an increase in mass.

……..……..

……. [1]

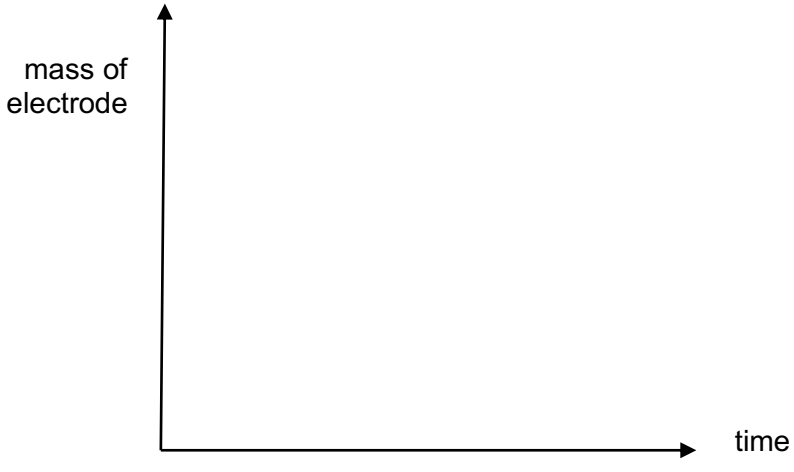
(iii) Describe what is observed at the anode, with an appropriate equation.

……..

……. [2]

He carried out the same experiment with copper electrodes. Similarly, at regular intervals, the cathode and anode were removed, dried and weighed.

(b) **(i)** Predict and draw on a separate graph how the anode and cathode will change as electrolysis takes place.



[2]

(ii) Explain how the graph for the anode is derived with a relevant equation.

……

……

…….. [2]

(iii) The student noticed that the colour of the electrolyte remained the same as electrolysis took place.

Explain why.

……..

…….. [1]

Or

B11 A student investigated the rate of reaction when dilute acid reacts with excess solid copper(II) carbonate.

He used the same volume of acid each time. He measured the time taken to collect 10 cm^3 of gas at room temperature and pressure. He also measured the total volume of gas at the end of the experiment at room temperature and pressure.

The table shows his results.

experiment	acid	concentration in mol/dm^3	time taken to collect 10 cm^3 of gas / s	total volume of gas / cm^3
1	hydrochloric	0.5	15	150
2	hydrochloric	1.0	6	300
3	hydrochloric	0.5	7	150
4	nitric	0.5	15	150

(a) Give the formula of the salt which forms in experiment 4.

…… [1]

(b) **(i)** The student carried out three experiments using acid at room temperature and one experiment using acid at a higher temperature.

Which experiment was carried out at a higher temperature?

Explain your reasoning.

……

……

……

…… [2]

(ii) Explain, in terms of collisions between reacting particles, why a higher temperature affects the rate of reaction.

……

……

……

…… [3]

(c) The student carried out another experiment at room temperature using 0.5 mol/dm^3 sulfuric acid.

He used the same volume of acid as in the previous experiments with excess solid copper(II) carbonate.

Complete the table to predict what results he should expect and explain how you arrived at your answers.

experiment	**acid**	**concentration in mol/dm^3**	**time taken to collect 10 cm^3 of gas / s**	**total volume of gas / cm^3**
5	sulfuric	0.5		

……

……

……

……

……

…… [4]

END OF PAPER 2