Candidate Name _____ Class | Register No.

PEIRCE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2021
SECONDARY 4 EXPRESS

CHEMISTRY
Paper 1 (Theory)

6092/01
27 August 2021
1 hour

Additional Materials:
Multiple Choice Answer Sheet

INSTRUCTIONS TO CANDIDATES

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Index number on the Answer Sheet in the spaces provided.

There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the one you consider correct and record your choice in soft pencil on the separate answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This paper consists of **18** printed pages and **no** blank page.
Setter: Mr Ashwin

Class | Register Number

Candidate Name _____

PEIRCE SECONDARY SCHOOL

Department of Science

GCE 'O' Level Preliminary Examination I for Secondary Four Express

CHEMISTRY **6092**

Wednesday **9 May 2018** **0900 – 1000**

Time: **1 hour**

INSTRUCTIONS TO CANDIDATES

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Index number on the Answer Sheet in the spaces provided.

There are forty questions in this paper. Answer all questions. For each question, there are four possible answers, A, B, C and D. Choose the one you consider correct and record your choice in soft pencil on the separate answer sheet.

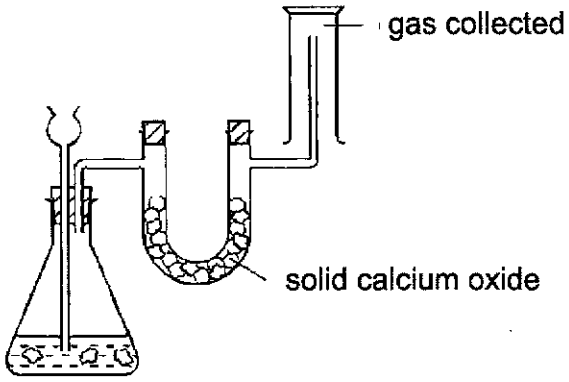
INFORMATION FOR CANDIDATES
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page **19**.

This paper consists of **15** printed pages.

Setter: Mr Ashwin Selvarajan

Section A (40 marks)

1 The diagram below shows the setup for a chemical reaction which produces a gas. The gas is then dried and collected.



What could the gas be?

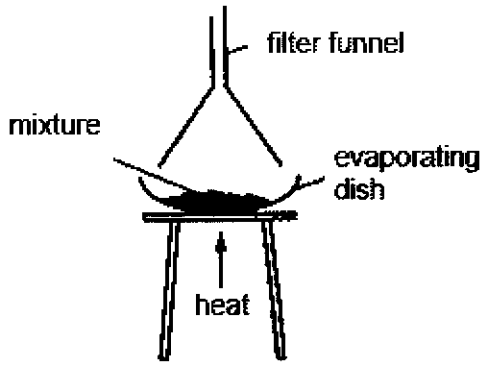
A hydrogen
B hydrogen fluoride
C oxygen
D sulfur dioxide

2 The table below shows the information of some pure substances.

Which of the underlined substances has been **wrongly** classified as an element, mixture or compound?

	Property	classification
A	White solid melts over 56 – 58 °C.	mixture
B	Green powder on heating leaves black residue and a colourless gas is evolved.	compound
C	Black powder burns in air forming a colourless gas as the only product.	element
D	Colourless substance produces two colourless gases when an electric current is passed through it.	mixture

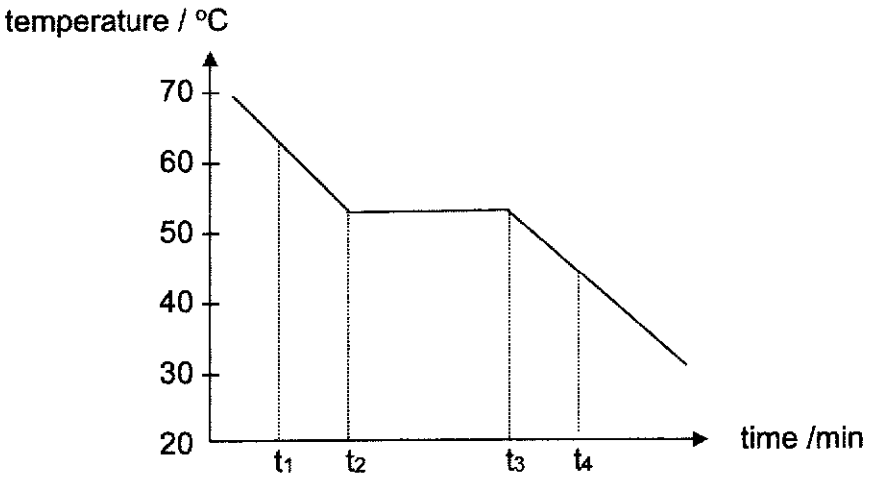
3 Refer to the following setup.



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

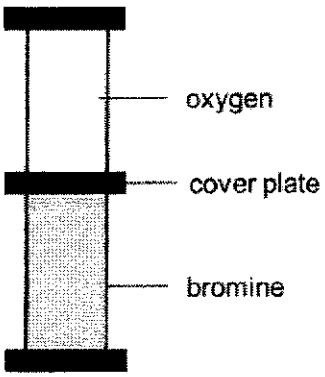
4 Stearic acid is a solid at room temperature. The cooling curve of stearic acid is shown below.



From the graph, we can infer that

A at time t_2, all the stearic acid exists as a solid.
B at the time interval t_2 to t_3, crystals of stearic acid are formed.
C at the time interval t_2 to t_3, all the stearic acid exists as a solid.
D at the time interval t_1 to t_2, heat is absorbed from the surroundings.

5 The cover plate was removed from the gas jars shown in the diagram. After several days, the colour of the gas was the same in both jars.



Which statement explains this change?

A Oxygen and bromine gases have equal densities.
B Oxygen and bromine molecules are in random motion.
C Oxygen and bromine diffuse at the same rate.
D Equal volumes of oxygen and bromine contain equal number of molecules.

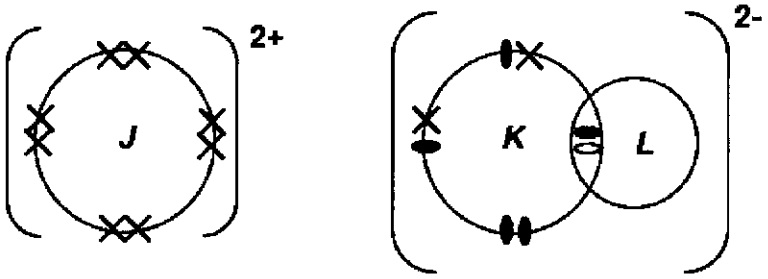
6 Which statement about atoms is true?

A The atomic mass can be less than the atomic number.
B The electrons and nucleus will repel each other.
C The mass of an atom is mainly from the nucleus.
D The minimum number of electrons in the outermost shell is 2.

7 The relative atomic mass of naturally occurring chlorine on planet Jupiter is found to be exactly 36.0. What **cannot** be a reason for this?

A All the chlorine atoms on Jupiter have 19 neutrons.
B Half the chlorine atoms on Jupiter have 18 neutrons and the rest have 20 neutrons.
C There is only one type of chlorine atom found on Jupiter.
D The chlorine atoms on Jupiter have different number of neutrons but same number of protons.

8 *J*, *K* and *L* are three different elements in the Periodic Table. The electronic diagram (showing only the valence electrons) of the compound formed between *J*, *K* and *L* is shown below:



Which of the following statements are correct?

I Element *K* could be nitrogen.
II Element *J* belongs to Group II of the Periodic Table.
III Element *K* and element *L* are bonded together by covalent bond.
IV Element *L* is a metal.

A I, II and III
B I, II and IV
C I, III and IV
D II, III and IV

9 Three atoms **L**, **M** and **N** have atomic masses of 235, 238 and 239 respectively. **L** has 92 electrons, **M** has 92 protons and **N** has 145 neutrons.

Which atoms are isotopes?

A **L** and **M** only
B **L** and **N** only
C **M** and **N** only
D **L**, **M** and **N**

10 In the lattice structure of ionic compounds, the coordination number of each ion is the number of neighbouring ions of opposite charge.

The table below shows the ions present and the coordination number of the ions in some ionic compounds. Taking sodium chloride for instance, each sodium ion is surrounded by 6 chloride ions, while each chloride ion is surrounded by 6 sodium ions. Hence, the coordination number for both the sodium ions and chloride ions is 6.

Ionic compound	ions present		coordination number of		formula
	cation	anion	cation	anion	
Sodium chloride	Na^+	Cl^-	6	6	NaCl
Titanium (IV) oxide	Ti^{4+}	O^{2-}	6	3	TiO_2
Compound **P**	Q	R	4	8	?

Using information from the table, determine the formula of compound **P**.

A QR_2
B Q_2R
C QR_4
D Q_4R

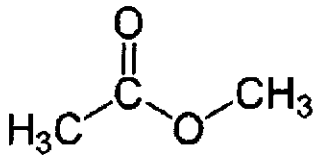
11 Which substance is made up of both ions and mobile electrons?

A Graphite
B Lithium hydride
C Sulfur
D Zinc

12 The addition of powdered graphite to a lock will allow the key to turn more easily because

A the carbon atoms are bonded in two-dimensional sheets which can slide freely over one another.
B the bonds between the carbon atoms are weak and the carbon atoms can easily slide over one another.
C each carbon atom has four bonds and can form an unreactive film over which the metal can slide.
D the tetrahedral arrangement of bonds around each carbon atom causes the neighbouring atom to slide past one another easily.

13 The diagram below shows the structure of an organic molecule.



What is the name of this molecule and the total number of electrons used for bonding in this molecule?

	name	total number of electrons used for bonding
A	ethyl methanoate	11
B	ethyl methanoate	22
C	methyl ethanoate	11
D	methyl ethanoate	22

14 The formulae of some oxides are shown below.

Li_2O CO Al_2O_3 NO_2 CuO

Which row gives the correct number of each type of oxide?

	number of each type of oxide		
	acidic	amphoteric	basic
A	1	1	2
B	2	0	3
C	2	1	2
D	1	1	3

15 Aluminium is an important metal with many uses. Some of its properties are listed below.

I It is a good conductor of heat.
II It has a low density.
III It has an oxide layer that prevents corrosion.

Which of these properties explains why aluminium is used to make cans which are used to store food?

A I only
B I and II only
C II and III only
D I, II and III

16 A pure compound contains 24 g of carbon, 4 g of hydrogen and 32 g of oxygen.
What is the empirical formula of the compound?

A CHO
B CH_2O
C CH_4O
D C_2H_2O

17 When exposed to polluted air, the white pigment in oil paintings forms lead(II) sulfide, PbS, which is black in colour. To restore the white colour, a solution of hydrogen peroxide, H_2O_2 is used as shown in the chemical equation below.

$$PbS(s) + 4H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$$

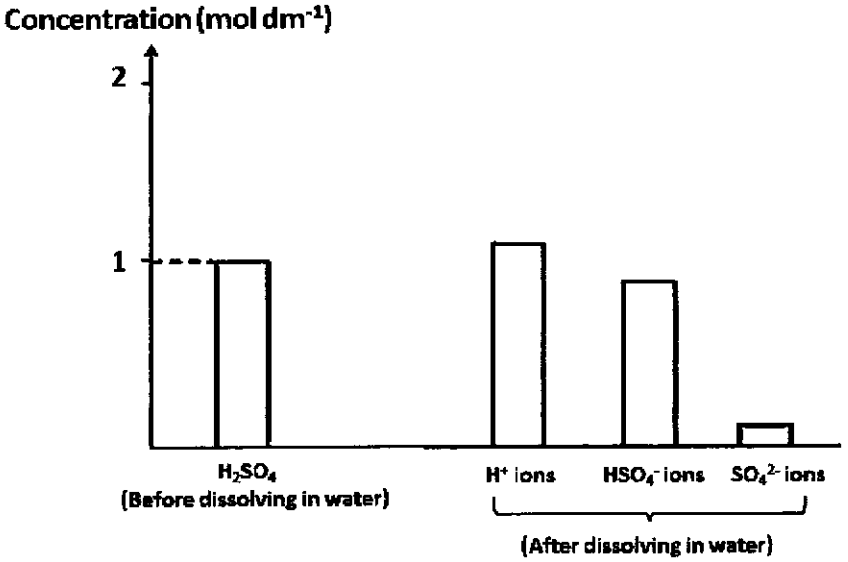
What mass of hydrogen peroxide is required to react with 0.239 g of lead(II) sulfide?

A 0.034 g
B 0.072 g
C 0.136 g
D 0.303 g

18 A sample of 50 cm^3 of carbon monoxide was burnt in 50 cm^3 of oxygen. What is the final volume of the gas(es) remaining at room temperature and pressure?

A 25 cm^3
B 50 cm^3
C 75 cm^3
D 100 cm^3

19 The following bar chart shows the concentration of the various ions formed when 1 mol of sulfuric acid, H_2SO_4, is dissolved and marked up to 1 dm^3 with water.



A student inferred the following from the bar chart.

I H_2SO_4 is a strong acid.
II HSO_4^- is a weak acid.
III H_2SO_4 is a weak acid.
IV HSO_4^- is a strong acid.

Which of the statement(s) is / are correct?

A I only
B I and II only
C III only
D III and IV only

20 A student carried out the following series of tests on an aqueous solution of sodium carbonate and recorded his results as shown in the table below.

Which test should be repeated because of an incorrect observation entered in the table?

	test	observation
A	add barium chloride solution	white precipitate formed
B	add copper(II) sulfate solution	blue/green precipitate formed
C	add dilute hydrochloric acid	effervescence occurred
D	add sodium hydroxide solution	white precipitate formed

21 Methylamine, CH_3NH_2, has very similar chemical properties to ammonia, NH_3. Methylamine reacts with hydrogen chloride to form a white crystalline salt, methylammonium chloride.

$$CH_3NH_2 + HCl \rightarrow CH_3NH_3^+Cl^-$$

A sample of methylammonium chloride is heated with aqueous sodium hydroxide. What are the products?

A ammonia, sodium chloride and water
B ammonia, sodium hydrogencarbonate and sodium chloride
C methylamine, hydrogen chloride and water
D methylamine, sodium chloride and water

22 The following equation and statements describe three metals, **X**, **Y** and **Z**.

I $\mathbf{Y} + 2\mathbf{X}NO_3 \rightarrow \mathbf{Y}(NO_3)_2 + 2\mathbf{X}$

II $\mathbf{Z}NO_3$ decomposes readily at room temperature to form **Z**.

III $\mathbf{X}NO_3$ and $\mathbf{Y}(NO_3)_2$ decompose only at temperatures above 250 ^{0}C.

What is the reactivity of the three metals, starting from the most reactive?

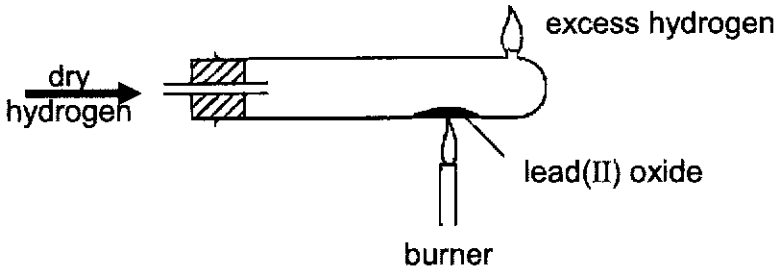
A **X, Y, Z**
B **Y, X, Z**
C **Z, X, Y**
D **Z, Y, X**

23 The table below shows some bond energies. Which of the following statements could be considered to be consistent with these values?

bond	kJ/mol
C – C	346
C – H	413
Si – Si	176
Si – H	318

A Si – Si chains are more stable than C – C chains.
B Si – Si bonds are the least readily broken of those listed.
C Methane, CH_4, is chemically more stable than silane, SiH_4.
D 346 kJ is the energy evolved when 1 mole of graphite sublimes.

24 The diagram shows lead(II) oxide being reduced by hydrogen to lead. After reduction is completed, the burner is turned off but the flow of hydrogen is continued until the tube is cool.

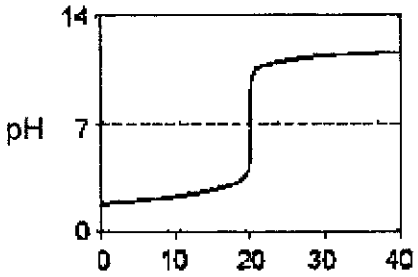


Which is the purpose of allowing hydrogen to flow through the tube during cooling?

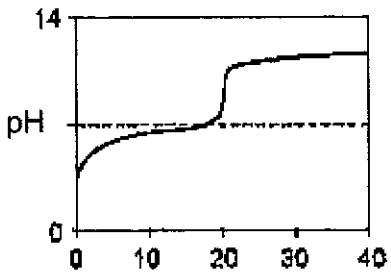
A to allow the tube to cool slowly
B to lessen the risk of explosion in the hot tube
C to prevent lead from reacting with the air
D to remove any traces of water left in the tube

25 A titration was conducted by adding aqueous sodium hydroxide from a burette to hydrochloric acid in a conical flask. The pH of the solution in the flask was recorded during the titration and Graph 1 was obtained.

A second titration was conducted by adding aqueous sodium hydroxide to a different acid. The pH of the solution in the flask was recorded during the titration and Graph 2 was obtained.



Volume of NaOH added / cm^3
Graph 1



Volume of NaOH added / cm^3
Graph 2

The table below shows some indicators that could be used to identify the endpoint of titrations. For the first titration, the appropriate indicator could be methyl red, bromothymol blue or cresolphthalein.

Which indicator in the table is appropriate for the second titration?

indicator	acidic colour	range of colour change	alkaline colour
methyl orange	red	3.1 – 4.4	yellow
methyl red	red	4.4 – 6.2	yellow
bromothymol blue	yellow	6.0 – 7.6	blue
cresolphthalein	colourless	8.1 – 9.7	red
alizarin yellow	yellow	10.1 – 12.0	red

A alzarin yellow
B cresolphthalein
C methyl orange
D methyl red

26 Chlorine reacts with phosphorus to form phosphorus trichloride in the equation shown below.

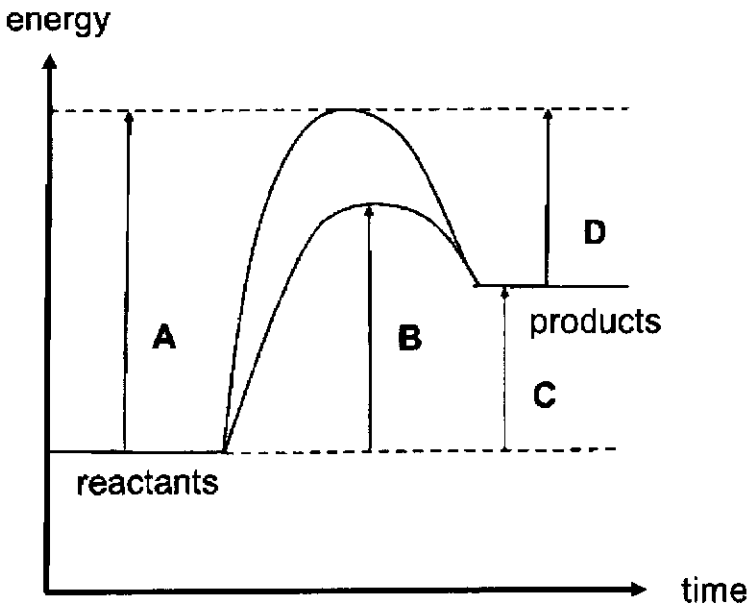
The yield of phosphorus trichloride can never reach 100%. What is the reason for this?

$$2P_{(s)} + 3Cl_{2\,(g)} \leftrightharpoons 2PCl_{3\,(l)}$$

A The phosphorus trichloride produced is a volatile liquid and would have evaporated away.
B The reversible reaction will form back phosphorus and chlorine as the reactants.
C The solid state of phosphorus is more stable than the liquid state of phosphorus trichloride.
D There are impurities present in the chemical reaction.

27 The diagram shows the energy level diagrams (catalysed and non-catalysed) for a chemical reaction.

Which energy change shows the activation energy for the catalysed reaction?



28 Black copper(II) oxide catalyses the decomposition of aqueous hydrogen peroxide to give oxygen and water.

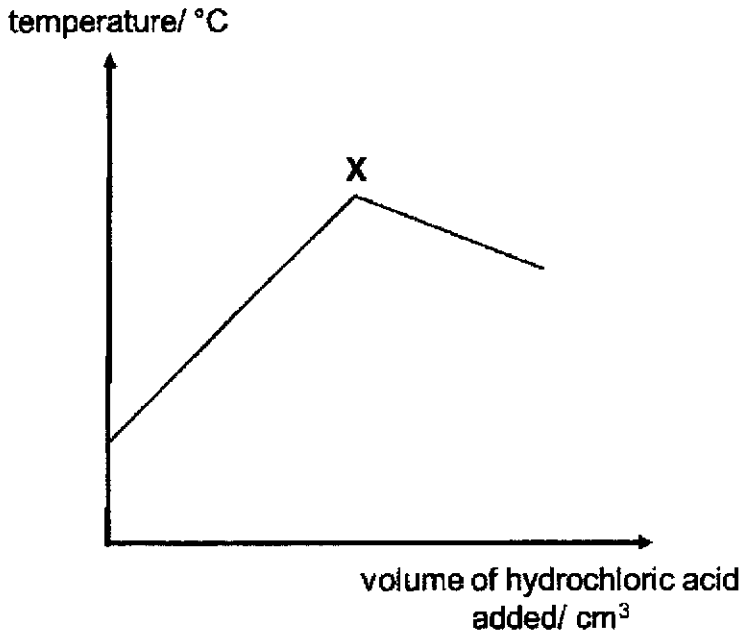
In a laboratory experiment, aqueous hydrogen peroxide was shaken with 0.5 g of copper(II) oxide in a conical flask.

What is seen in the flask when the reaction was completed?

A a black solid and a colourless liquid
B a black solid and a light blue solution
C a light blue solid and a colourless liquid
D a pink brown solid and a colourless liquid

29 Hydrochloric acid is added to a fixed volume of potassium hydroxide in a conical flask. The mixture is stirred and the temperature readings are recorded.

The graph below shows the results obtained for the experiment.



Why does the temperature reading drop beyond point **X** on the graph?

A The reaction becomes increasingly exothermic.
B The reaction becomes increasingly endothermic.
C The reaction has completed and heat is lost to the surroundings.
D The reaction has completed and heat is absorbed from the surroundings.

30 Lithium and rubidium are both in Group I of the Periodic Table.

Which statement is correct?

A Lithium atoms and rubidium atoms have the same number of electrons in their outer shell.
B Lithium atoms are larger than rubidium ions.
C Lithium ions and rubidium ions have the same number of electrons in their outer shell.
D Rubidium ions are larger than rubidium atoms.

31 Which statement about both the Group I and Group VII elements is correct?

A They conduct electricity when molten.
B They form covalent compounds when bonded to non-metals.
C They exist as diatomic molecules.
D When Group I elements combine with Group VII elements, ionic compounds form.

32 The ionic equations for four reactions are shown below.

$$V + T^{2+} \rightarrow V^{2+} + T$$

$$V + 2S^{+} \rightarrow V^{2+} + 2S$$

$$T + 2S^{+} \rightarrow T^{2+} + 2S$$

$$U + V^{2+} \rightarrow U^{2+} + V$$

What is the order of reactivity of the four metals, **S**, **T**, **U** and **V**?

	most reactive ⟶			least reactive
A	**S**	**T**	**V**	**U**
B	**T**	**S**	**U**	**V**
C	**U**	**V**	**T**	**S**
D	**V**	**S**	**T**	**U**

33 It has been suggested that the cars of the future could be powered by fuel cells. One type of fuel cell uses the chemical reaction between oxygen and hydrogen to produce electricity.

What would be a disadvantage of using this type of fuel cell to power a car?

A A car cannot be powered by electricity.
B The hydrogen tank might split in an accident, leading to an explosion.
C The product of the reaction between oxygen and hydrogen is toxic.
D The oxygen would need to be obtained from air.

34 Which statement describes what happens when hydrogen and oxygen are used in a fuel cell?

A Electricity is generated due to flow of electrons from cathode to anode.
B Hydrogen is burned to form steam.
C Hydrogen is oxidised by losing electrons at the anode.
D Oxygen is oxidised by gaining electrons from hydrogen.

35 The anti-cancer drug, cisplatin, has the formula $Pt(NH_3)_2Cl_2$. In the human body, one of the chloride ions of cisplatin is replaced by one water molecule to form an aqua complex.

$$Pt(NH_3)_2Cl_2 + H_2O \rightarrow \underset{\text{aqua complex}}{[Pt(NH_3)_2(H_2O)Cl]^+} + Cl^-$$

What is the oxidation number of platinum in each of these substances?

	cisplatin	aqua complex
A	+2	+1
B	+2	+2
C	+4	+3
D	+4	+4

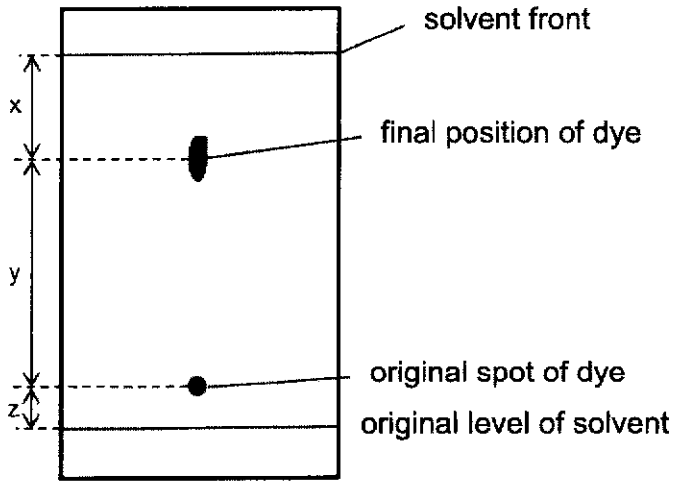
36 In which reaction is the underlined substance behaving as an oxidising agent?

A $\underline{BaCl_2} + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$
B $3CuO + 2\underline{NH_3} \rightarrow 3Cu + N_2 + 3H_2O$
C $2\underline{FeCl_2} + Cl_2 \rightarrow 2FeCl_3$
D $2NaI + \underline{Br_2} \rightarrow 2NaBr + I_2$

37 Which of the following is an endothermic reaction?

A the combustion of ethanol in air
B the oxidation of carbon to carbon dioxide
C the reaction between hydrogen and oxygen
D the formation of a carbohydrate and oxygen from carbon dioxide and water

38 The diagram shows the chromatogram obtained by analysis of a single dye. Three measurements are shown.



How is the R_f value of the dye calculated?

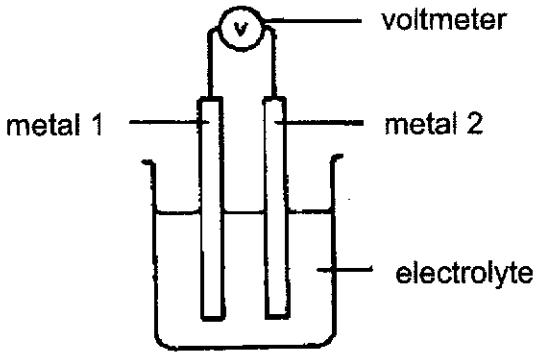
A $\frac{x}{x+y}$

B $\frac{y}{x+y}$

C $\frac{x}{x+y+z}$

D $\frac{y}{x+y+z}$

39 The diagram below shows a simple electric cell.



Which metals would produce the highest voltage?

	metal 1	**metal 2**
A	copper	magnesium
B	iron	copper
C	zinc	magnesium
D	zinc	copper

40 Which of the following physical processes could be used to separate a mixture of ethanol and water?

A filtration
B fractional distillation
C sublimation
D use of separation funnel

– The End –

Class	Register No.

Candidate Name _____

PEIRCE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2021
SECONDARY 4 EXPRESS

CHEMISTRY **6092/02**
Paper 2 (Theory) **24 August 2021**
1 hour 45 minutes

Additional Materials:
Nil

INSTRUCTIONS TO CANDIDATES
Write your name, class and register number in the spaces provided at the top of this page.
Write in dark blue or black pen. You may use a soft pencil for any diagrams, graphs or rough working.

Section A [50 marks]
Answer **all** questions in the spaces provided.

Section B [30 marks]
Answer three questions in the spaces provided. The last question is in the form either/or.
At the end of the examination, fasten any separate answer paper used securely to the question paper.

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

PARENT'S SIGNATURE

For Examiner's Use	
Section A	
Section B	
Total	

This paper consists of **23** printed pages and **1** blank page.
Setter: Mr Ashwin

Class	Register Number

Candidate Name _____

PEIRCE SECONDARY SCHOOL

Department of Science

GCE 'O' Level Preliminary Examination I for Secondary Four Express

CHEMISTRY **6092 / 2**
Wednesday **2 May 2018** **0900 -1045**

Duration **1 hr 45 mins**

INSTRUCTIONS TO CANDIDATES

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

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

Section B (30 marks)
Answer all questions. Write your answers in the spaces provided on the question paper

PARENT'S SIGNATURE

For Examiner's Use		
Section A		
Section B	B9	
	B10	
	B11	
Total		

This paper consists of **26** printed pages.
Setter: Mr Ashwin Selvarajan

Section A (50 marks)

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

A1 Elements **W**, **X**, **Y** and **Z** are all in the same period but in different groups of the Periodic Table.

W reacts with oxygen to form W_2O, a strongly basic oxide.
X reacts with oxygen to form XO_2, an acidic oxide and a gas at room temperature.
The oxide of **Y** is Y_2O_3, which can react with both an acid and a base.
Z produces an ion Z^-.

Use the information given to answer the following questions:

(a) Place **W**, **X**, **Y** and **Z** to their respective groups in the Periodic Table. **[1]**

.....

(b) Write the formulae for the sulfate and hydride of **W**. **[1]**

.....

(c) What type of bonding is present in the oxide XO_2? Give a reason for your answer. **[2]**

.....

.....

(d) Write the formula for the compound formed between **Y** and **Z**. **[1]**

.....

(e) Write the equation for the reaction that occurs when element **W** reacts with oxygen. **[1]**

.....

[Total: 6 marks]

A2 Lead is an excellent roofing material. It is malleable and resistant to corrosion. Lead rapidly becomes coated with basic lead (II) carbonate which protects it from further corrosion.

(a) Lead has a typical metallic structure. This structure is held together by attractive forces called a metallic bond.

(i) Explain why there are attractive forces in a metallic structure. **[1]**

.....

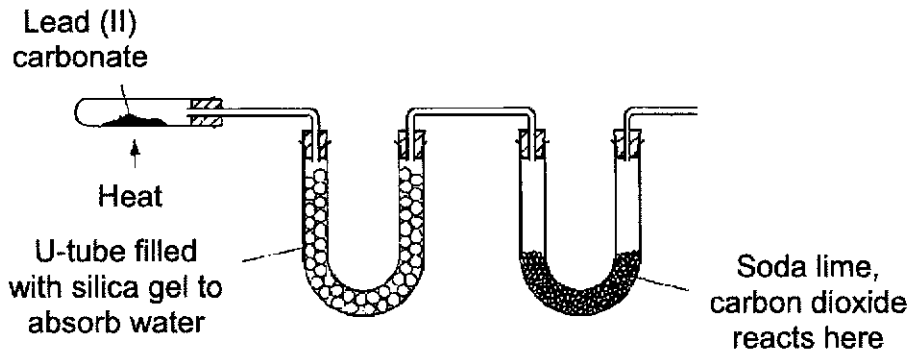
.....

(ii) Explain why a metal, such as lead, is malleable. **[1]**

.....

.....

(b) Lead (II) carbonate is heated in the apparatus shown below. Water and carbon dioxide are produced.



(i) Silica gel absorbs water and it often contains anhydrous cobalt (II) chloride. Suggest the observation of silica gel in the experiment. **[1]**

.....

(ii) Soda lime is a mixture of sodium hydroxide and calcium oxide. Why do these two substances react with carbon dioxide? **[2]**

.....

.....

(iii) Name two substances formed when soda lime reacts with carbon dioxide. **[2]**

.....

[Total: 7 marks]

A3 Fig. 3.1 shows the Haber process.

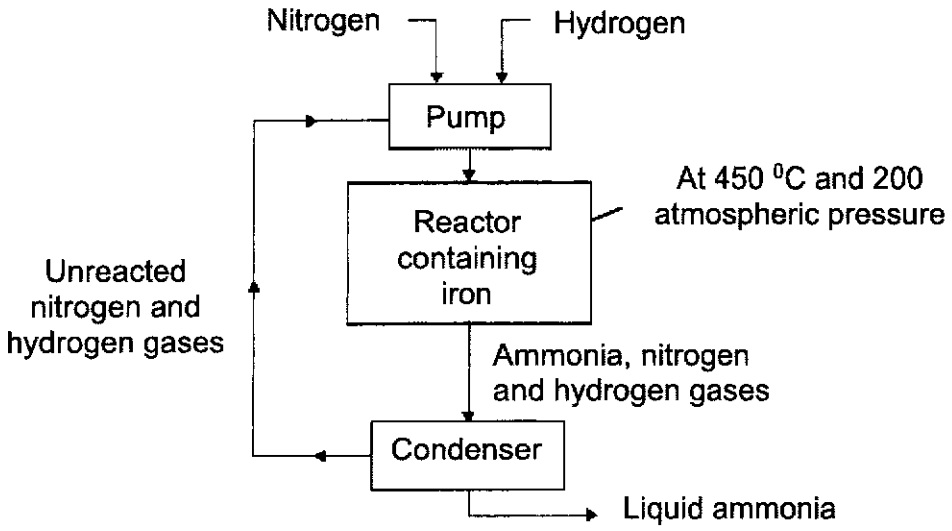


Fig. 3.1

Fig. 3.2 shows the yield of ammonia that is made under different conditions.

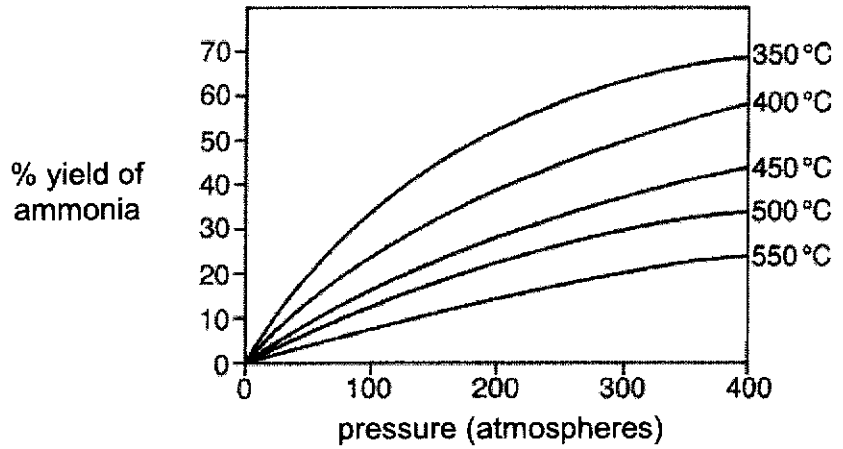


Fig. 3.2

(a) In the condenser, ammonia is separated out as a liquid. Explain how this is achieved. **[1]**

.....

.....

(b) The percentage yield for the production of ammonia is typically low. Explain why. **[1]**

.....

.....

(c) 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]**

.....

.....

.....

.....

(d) **(i)** Write a chemical equation for the production of ammonia, in the Haber Process **[1]**

.....

(ii) 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. **[1]**

[Total: 6 marks]

A4 Peroxodisulfate (VII) ions, $S_2O_8^{2-}$, react with iodide ions in aqueous solution.

$$S_2O_8^{2-}(aq) + 2I^-(aq) \longrightarrow 2SO_4^{2-}(aq) + I_2(aq)$$

Table 4.1 shows how the relative rate of this reaction changes when different concentrations of peroxodisulfate ions and iodide ions are used.

Table 4.1

experiment	concentration of $S_2O_8^{2-}$ in mol/dm^3	concentration of I^- in mol/dm^3	relative rate of reaction
1	0.008	0.02	1.7
2	0.016	0.02	3.3
3	0.032	0.02	6.8
4	0.008	0.04	3.4
5	0.008	0.08	6.9

If a small amount of Fe^{2+} ions are added to the reaction mixture, they will react with the peroxodisulfate ions, forming Fe^{3+} ions, which will then react with the iodide ions via the following two stages:

Stage 1: $2Fe^{2+}(aq) + S_2O_8^{2-}(aq) \longrightarrow 2Fe^{3+}(aq) + 2SO_4^{2-}(aq)$

Stage 2: $2Fe^{3+}(aq) + 2I^-(aq) \longrightarrow 2Fe^{2+}(aq) + I_2(aq)$

Use the information given above to answer the following questions.

(a) Using collision theory, state and explain the effect of the concentration of peroxodisulfate ions on the relative rate of reaction. **[2]**

.....

.....

.....

.....

.....

(b) State the role of Fe^{2+} ions in this chemical reaction. **[1]**

.....

.....

(c) Explain why stage 2 is a redox reaction, in terms of electrons. **[3]**

.....

.....

.....

.....

.....

.....

(d) One drop of sodium astatide solution was added to the solution after the Fe^{2+} ions were removed at the end of Stage 2 leaving behind iodine. State all observations and explain. **[2]**

.....

.....

.....

.....

[Total: 8 marks]

A5 Some metals have unique properties such as exhibiting variable oxidation states in their compounds and forming coloured compounds.

These metals are also widely used as catalyst in industrial processes.

(a) In an experiment, small amounts of metals such as zinc, chromium and copper, were added to their aqueous metal nitrates solutions.

The results are shown in Table 5.1.

Table 5.1

	salt solution		
metal	**zinc nitrate**	**chromium (III) nitrate**	**copper(II) nitrate**
zinc	no visible reaction	green solution turned colourless and grey metal coated with a silvery solid	blue solution turned colourless and grey metal coated with a pink solid
chromium		no visible reaction	
copper	no visible reaction	no visible reaction	no visible reaction

Describe the observations for chromium metal in zinc nitrate and copper(II) nitrate. **[3]**

.....

.....

.....

.....

.....

(b) The main ore of copper is copper pyrite, $CuFeS_2$.

Copper ore contains the impurity, iron(II) oxide.

The following information shows the steps involved in the extraction of copper from copper pyrite.

Step 1: Roasting of copper pyrite

$$2CuFeS_2 + 4O_2 \rightarrow Cu_2S + 2FeO + 3SO_2$$

Step 2: Removal of iron(II) oxide

The reaction is heated strongly with sand (silica, SiO_2) in a furnace.

Iron(II) oxide reacts with silica to form iron(II) silicate as slag and is run off.

$$FeO + SiO_2 \rightarrow FeSiO_3$$

Step 3: Conversion of copper(I) sulfide to copper

As more air is blown into the furnace, the copper(I) sulfide produced is converted to copper.

$$Cu_2S + O_2 \rightarrow 2Cu + SO_2$$

(i) Identify the acidic and basic oxide in step 2. **[2]**

acidic oxide: ..... basic oxide: .....

(ii) Describe one possible environmental impact from the extraction of copper. **[2]**

.....

.....

.....

[Total: 7 marks]

A6 (a) Chemical **X** is a mixture of aqueous zinc nitrate and dilute sulfuric acid.

In Table 6.1, write down the chemical tests that you would carry out to identify the following three ions present in chemical **X**. Your answer should include the expected observations for each chemical test. **[6]**

Table 6.1

Ions	Chemical Tests	Expected Observations
Zinc		
Nitrate		
Sulfate		

(b) Solid zinc nitrate could undergo thermal decomposition to produce solid zinc oxide, nitrogen dioxide gas and oxygen gas. **[2]**

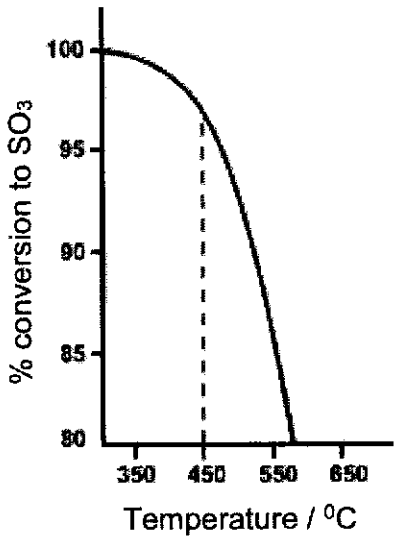
Construct a balanced equation, including state symbols, for the thermal decomposition of zinc nitrate.

.....

[Total: 8 marks]

A7 Graph 7.1 shows the percentage conversion to sulfur trioxide from sulfur dioxide and oxygen gas during the Contact Process.

$$2SO_2 + O_2 \longrightarrow 2SO_3$$



Graph 7.1

(a) Using data from the graph, give two reasons, other than cost, why the optimal temperature for Contact Process is 450 ^{0}C. **[2]**

.....

.....

.....

.....

(b) Explain, in terms of bond breaking and bond forming, why the conversion of sulfur dioxide and oxygen to sulfur trioxide is an exothermic reaction. **[3]**

.....

.....

.....

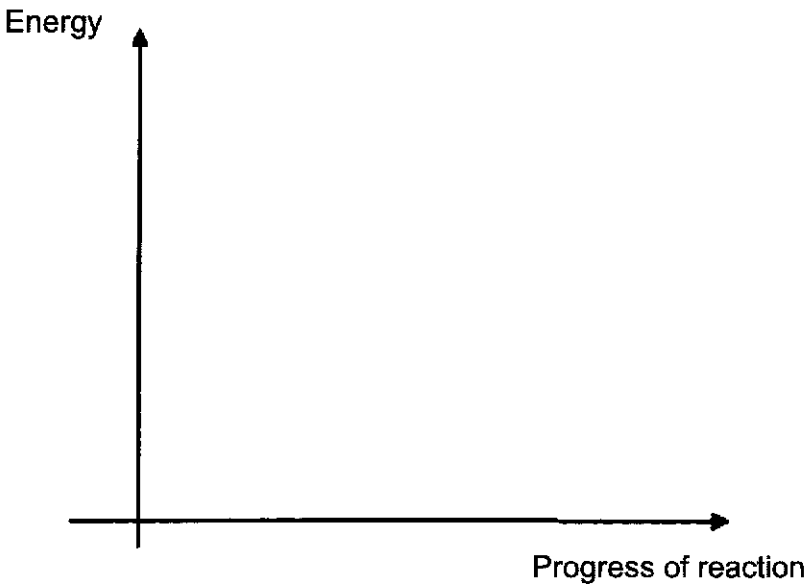
.....

.....

(c) Draw an energy profile diagram to show the formation of sulfur trioxide from sulfur dioxide and oxygen. **[3]**

Your diagram should show and label

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



[Total: 8 marks]

Section B (30 marks)
Answer all **three** questions from this section

The last question is in the form **EITHER/OR** and only **one** alternative should be attempted.

B8 Fig. 8.1 shows the set-up for the electrolysis of a chloride solution containing two metal ions, copper(II) and iron(II).

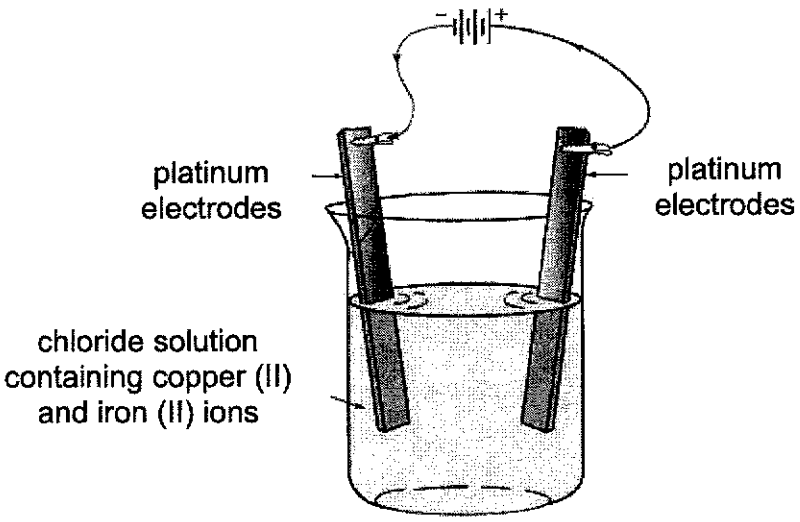


Fig. 8.1

An electric current was passed through the cell for a period of time.
The observations at different stages were recorded in the table.

Table 8.2

stage	observations
stage 1 – after 10 mins	A yellowish-green gas is observed at one of the electrodes while a brown solid is deposited at the other electrode. There was no visible change to the electrolyte.
stage 2 – after 1 hour	The same observations in stage 1 at the anode and cathode. The electrolyte became pale green.
stage 3 – after 2 hours	Colourless gases are both evolved at the anode and cathode. The pale green of the electrolyte becomes more visible.

(a) **(i)** Write the equations for the reactions taking place at the respective electrodes in stage 1. **[2]**

.....

.....

.....

(ii) The total mass of the brown solid deposited was 0.584 g. **[2]**

With the aid of equations from **(a)(i)**, calculate the volume of the yellowish-green gas produced at the other electrode.

(b) Explain why the electrolyte becomes pale green in stage 2 and then darker in stage 3. **[2]**

.....

.....

.....

.....

.....

(c) A few drops of Universal Indicator were added **at the cathode** in stage 3. **[2]**

State and explain the result of the test.

.....

.....

.....

(d) A total of three different substances were produced at the cathode throughout the whole electrolysis process. **[2]**

Identify and list the three substances in order of which they are produced.
Explain your answer.

.....

.....

.....

[Total: 10 marks]

B9 Below is some information extracted from a newspaper article. Table 9.1 shows the main greenhouse gases listed below.

Table 9.1

Air and ocean temperatures are rising around the world. Scientists believe pollution is at least partly to blame for this global warming. Fertilisers and burning fossil fuels for energy give off greenhouse gases like methane and carbon dioxide, which trap heat in the earth's atmosphere. Since modern factories and agriculture first started in the 1750s, the amount of greenhouse gases in the air has increased rapidly. There has not been this much methane and carbon dioxide in the air for 650,000 years! As greenhouse gases warm the air, glaciers are melting. Glaciers in Europe, North America, Africa and Asia are all shrinking.

Table 9.2

greenhouse gas	heat-trapping effectiveness, compared to carbon dioxide	contribution to the greenhouse effect/ (%)	current annual rate of increase in the air/ (%)
carbon dioxide	1	50	0.4
CFCs	10 000	14	2.0
methane	30	18	1.0
nitrous oxide	150	6	0.5

(a) (i) What is 'global warming'? **[1]**

.....

.....

(ii) Greenhouse gases can trap heat due to their structure. Draw the 'dot and cross' diagram of carbon dioxide. Show only valence electrons. **[2]**

(iii) Suggest a reason why 50% of the greenhouse effect is caused by carbon dioxide, though the heat-trapping effectiveness is very poor compared to the other gases. **[1]**

.....

.....

(iv) Other than its contribution to global warming, explain why a percentage annual increase of CFCs in the air of 2% is a cause for concern, even though the number might seem small. **[2]**

.....

.....

.....

.....

.....

(b) One of the ways to reduce carbon emissions is to use renewable fuels such as biodiesel. Below is another article on a biodiesel used in Brazil.

Sugarcane Ethanol

Brazil rivals the U.S in ethanol production because sugarcane yields 600 to 800 gallons an acre, twice as much as corn. The stalk is 20 percent sugar, fermented to make the alcohol, and the waste cane can be burned to power the distillery, lowering fossil-fuel use.

Brazil Retail Price (per litre, June 2007)

Petrol (25% ethanol)	: $ 4.91
Ethanol	: $ 2.92

Energy Balance

Fossil-fuel energy used to make the fuel compared with the energy in the fuel

1	:	**8**
Energy from fossil-fuel		Energy from sugarcane ethanol

Greenhouse gas emissions (production and use)

Petrol	: 10.2 kg / litre
Sugarcane ethanol	: 4.5 kg / litre

(i) With reference to the above article, suggest two reasons as to why Singapore would consider adopting the use of sugarcane ethanol to replace the current vehicle use of petrol. **[2]**

.....

.....

.....

.....

.....

(ii) Suggest a reason why Singapore would not consider adopting the use of sugarcane ethanol to replace the current vehicle use of petrol. **[1]**

.....

.....

.....

(iii) Suggest one global issue that might arise if the demand for biodiesel increases rapidly. **[1]**

.....

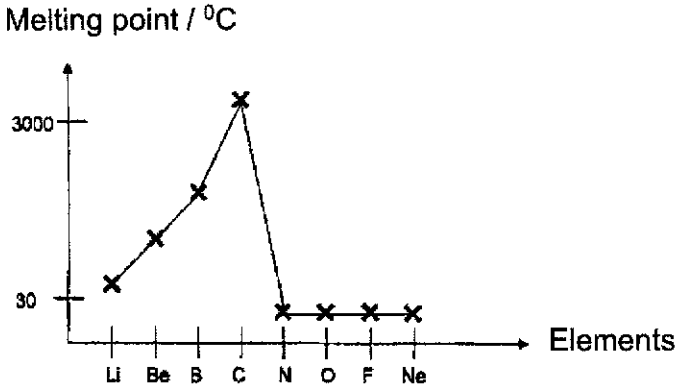
.....

[Total: 10 marks]

Either

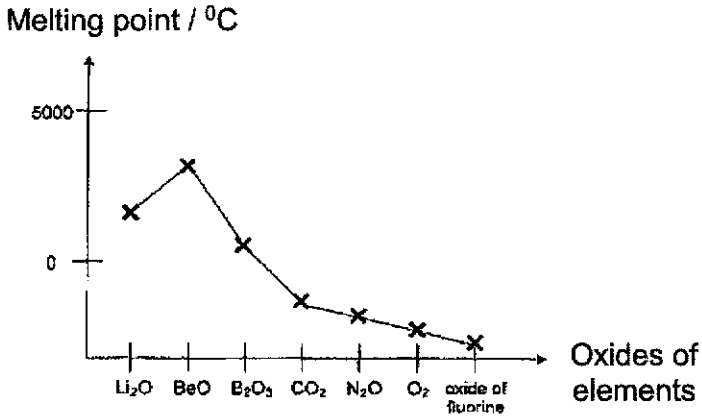
B10 An analysis of the melting points of the elements of Period 2 and their oxides was done and the information recorded in the graphs below. (Note that the graphs are not drawn to scale.)

Melting points of elements in period 2



Graph 10.1

Melting points of oxides of elements in period 2



Graph 10.2

(a) Use the information in Graph 10.1 and Graph 10.2 to describe the trend in melting points across Period 2 elements and oxides. **[3]**

.....

.....

.....

.....

.....

(b) Name the elements in Period 2 which are solids at room temperature. **[1]**

.....

(c) The form of carbon in Graph 10.1 is a good conductor of electricity. **[3]**
State the name of this form of carbon and with reference to its structure and bonding, explain why it is a good electrical conductor.

.....

.....

.....

.....

.....

(d) Explain the difference in melting point between lithium oxide and beryllium oxide. **[2]**

.....

.....

.....

(e) Explain why the oxide of neon was not included in the Graph 10.2. **[1]**

.....

.....

[Total: 10 marks]

Or

B10 Sulfamic acid, SO_3NH_3, is a strong monobasic acid which melts at 205 °C before decomposing at higher temperatures.

Although acids speed up corrosion of iron, they are also often used as cleaning agents to remove rust. Sulfamic acid is commonly used as a replacement for hydrochloric acid in removing rust. It does not react with hypochlorite based products such as bleach to produce chlorine gas, unlike hydrochloric acid. In general, the sulfamate salts of iron and calcium formed are water-soluble.

Table 10.1 shows the comparison between using hydrochloric acid and sulfamic acid to remove rust and limescale.

Table 10.1

	hydrochoric acid	sulfamic acid
*relative corrosivity on aluminium	5.3	1
*relative corrosivity on copper	6.7	1
*relative corrosivity on steel	4.2	1
cost per tonne	US $200	US $500

*relative corrosivity refers to the relative ease of corroding the metal.

(a) Describe what changes to the arrangement and movement of the particles in sulfamic acid when dissolved in water. **[2]**

.....

.....

.....

.....

(b) One student explains that sulfamic acid is a strong acid because there is a high concentration of hydrogen ions present. Do you agree with this statement? Explain your reasoning. **[1]**

.....

.....

(c) Use the information provided to discuss the advantage(s) and disadvantage(s) of using sulfamic acid to replace hydrochloric acid in the removal of rust. **[2]**

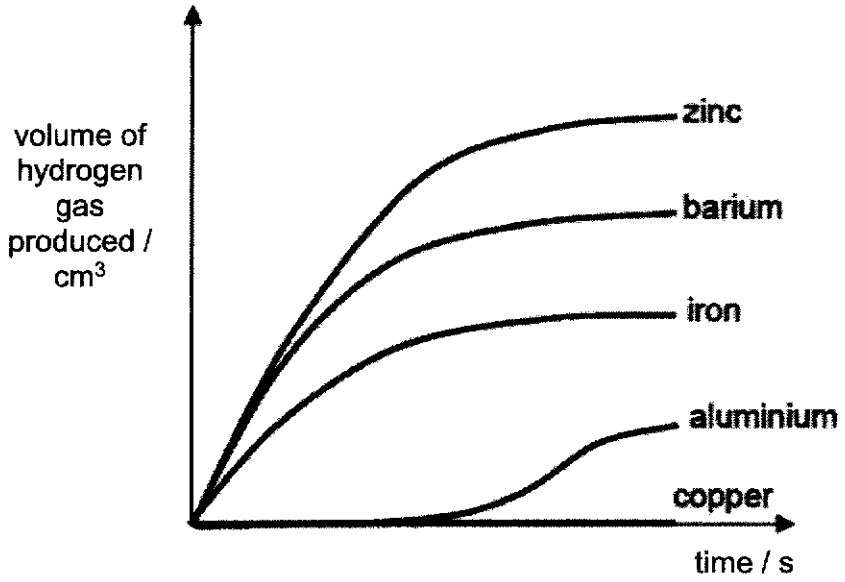
.....

.....

.....

.....

(d) Graph 10.3 was obtained when sulfamic acid reacted with several metals at room temperature.



Graph 10.3

(i) Explain the shape of graph obtained for aluminium even though aluminium is supposed to be the most reactive metal amongst the four metals. **[2]**

.....

.....

.....

.....

(ii) Another experiment of sulfamic acid and zinc was carried out at 80 °C. Explain how the rate of the reaction carried out at 80 °C would differ from the experiment carried at room temperature. **[2]**

.....

.....

.....

.....

(e) One way of protecting underground iron pipes from rusting is through the use of sacrificial protection. Describe how sacrificial protection works. **[1]**

.....

.....

[Total: 10 marks]

– The End –

PSS 2021 Sec 4 Express Chemistry 6092 Prelim

Marking Scheme

Section A (MCQ)

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

PSS 2021 Sec 4 Express Chemistry 6092 Prelim Marking Scheme

		Section A	Marks	Marker's comments
A1	(a)	X – Group VI, Y – Group III, W – Group I, Z – Group VII	1 mark	
	(b)	W_2SO_4 and WH [reject HW]	1 mark	
	(c)	Covalent bonding As XO_2 forms an acidic oxide, X must be a non-metal. Covalent bond is formed between non-metallic elements. Or Covalent compound has a low boiling point as it exists as a gas at room temperature.	1 mark 1 mark	
	(d)	YZ_3	1 mark	
	(e)	$4W + O_2 \rightarrow 2W_2O$	1 mark	
A2	(a)(i)	There are attractive forces **between lead(II)/Pb^{2+} ions and sea of delocalized electrons**.	1 mark	
	(a)(ii)	The atoms in lead are arranged orderly / regularly. When a force is applied, layers of lead ions / cations / positive ions can slide past each other	1 mark	
	(b)(i)	Change from blue to pink	1 mark	
	(b)(ii)	carbon dioxide is acidic sodium hydroxide and calcium oxide are bases / alkalis	1 mark 1 mark	

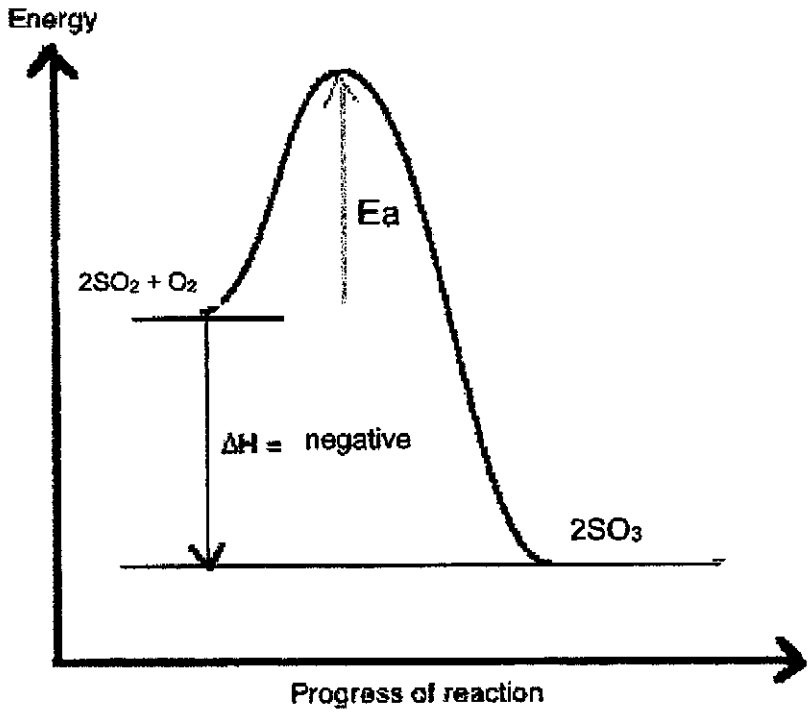
	(b)(iii)	Any two of: water, calcium carbonate and sodium carbonate	Total: 2 marks	
A3	(a)	By maintaing the condenser temperature to be lower than the boiling point of ammonia but higher than boiling points of nitrogen and hydrogen. / Or Ammonia has a higher boiling point than nitrogen and hydrogen hence will condense first when cooled. Note: Do not accept if student only wrote fractional distillation.	1 mark	
	(b)	The reaction of nitrogen and hydrogen to produce ammonia is a **reversible** reaction and some ammonia produced is **decomposed/converted back** to form the reactants. Note: Do not accept "turn back"	1 mark	
	(c)	According to the graph, as the temperature decreases, a higher percentage yield of ammonia is obtained. 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. Note: Students must mention that yield of ammonia will increase.	1 mark 1 mark	
	(d)(i)	$N_2 + 3H_2 \rightleftharpoons 2NH_3$	1 mark	
	(d)(ii)	Since H_2 is limiting, theoretical volume of ammonia produced = $2/3 \times 60 = 40\ dm^3$ Percentage yield of ammonia = $6/40 \times 100\% = 15\%$	1 mark	

A4	(a)	As concentration of peroxodisulfate doubles from 0.008 mol/dm^3 to 0.016 mol/dm^3, the rate of reaction will approximately double from 1.7 to 3.3. (Accept any other correct data.) With higher concentration there are more particles per unit volume, leading to higher frequency of effective collisions, and therefore higher rate of reaction.	1 mark 1 mark	
	(b)	It acts as a catalyst / It is regenerated at the end of stage 1.	1 mark	
	(c)	Iron (III) ions has been reduced to iron (II) ions because it has gained electrons while iodide ions have been oxidised to iodine because it lost electrons. Since both oxidation and reduction take place simultaneously in the same chemical reaction, this is a redox reaction.	1 mark 1 mark 1 mark	
	(d)	Black solid observed while the solution turns to a lighter shade of brown. Iodine, being more reactive than astatine, will displace astatine from sodium astatide solution.	1 mark 1 mark	
A5	(a)	There is **no visible reaction** between chromium metal in zinc nitrate. Chromium metal in copper(II) nitrate, **blue solution turned colourless and grey metal coated with a pink solid.**	1 mark 1 mark 1 mark	
	(b)(i)	acidic oxide: **SiO_2** basic oxide: **FeO**	1 mark 1 mark	
	(b)(ii)	Extraction of copper produces SO_2, which dissolves in rain water to form acid rain, corrodes limestone or metal buildings/harm aquatic life.	1 mark 1 mark	

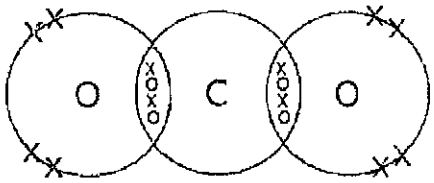
<table>
<tr>
<td>A6</td>
<td>(a)</td>
<td>
<table>
<tr><th>Ions</th><th>Chemical Test</th><th>Expected Observations</th></tr>
<tr><td>Zinc</td><td>Add aqueous ammonia dropwise to $2cm^3$ of chemical X until in excess</td><td>White precipitate is formed initially. The precipitate is soluble</td></tr>
<tr><td>Nitrate</td><td>Add 2 cm^3 of aqueous sodium hydroxide and an aluminium foil to $2cm^3$ of chemical X. Warm the mixture.</td><td>A colourless pungent gas is liberated. The gas turns damp red litmus paper blue.</td></tr>
<tr><td>Sulfate</td><td>Add $2cm^3$ of acidified aqueous barium nitrate to $2cm^3$ of chemical X.
(Accept acidified barium chloride)</td><td>A white precipitate is formed.</td></tr>
</table>
</td>
<td>2 marks

2 marks

2 marks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b)</td>
<td>$2Zn(NO_3)_2\,(s) \longrightarrow 2ZnO\,(s) + 4NO_2\,(g) + O_2\,(g)$</td>
<td>Total: 2 marks</td>
<td>1 mark for balanced equation
1 mark for correct state symbols</td>
</tr>
</table>

A7	(a)	When the temperature is too low, the speed of reaction is slow; When the temperature is too high, the yield of the reaction is low;	1 mark 1 mark	
	(b)	The total energy absorbed to break bonds in 2 moles of SO_2 and 1 mole of O_2 is less than the total energy released to form bonds in 2 moles of SO_3. (energy absorbed to break bonds; energy released to form bonds; correct comparison;	Total: 3 marks	Deduct 1 mark if reactants and products are not specified
	(c)		Total: 3 marks	reaction pathway with names of products and reactants; activation energy; enthalpy change;

	Section B			
B8	(a)(i)	Cathode: Cu^{2+} (aq) + $2e^-$ → Cu (s) Anode: $2Cl^-$ (aq) → Cl_2 (g) + $2e^-$	1 mark 1 mark	
	(a)(ii)	Number of moles of Cu = 0.584 / 64 = **0.009125 mol** For the same amount of electricity (2 mol of e^-), 1 mol of Cu and 1 mol of Cl_2 are produced. Hence, number of moles of Cl_2 produced is also 0.009125 mol. Volume of Cl_2 produced = **0.009125 x 24 = 0.219 dm^3**	1 mark 1 mark	
	(b)	At stage 2, **Cu^{2+} ions were preferentially discharged** leaving behind Fe^{2+} ions in the electrolyte which are pale green in colour. At stage 3, **H^+ and OH^- ions from water are discharged**. Hence the concentration of the electrolyte increases and the solution becomes darker due to the Fe^{2+}.	1 mark 1 mark	
	(c)	The Universal Indicator will change colour from **green to violet/purple/ blue**. **H^+ ions are preferentially discharged** at the cathode **leaving behind OH^- ions in solution / concentration of H^+ decreases which thus increases the concentration of OH^- in electrolyte** which makes the solution around the cathode alkaline.	1 mark 1 mark	
	(d)	The three substances are **copper, hydrogen gas and iron.** **Any one** of the following explanations : • Copper atoms are the least reactive, followed by hydrogen atoms, then iron atoms. Hence, • Copper(II) ions are preferentially discharged followed by hydrogen ions, then iron(II) ions • Copper(II) ions accept electrons most readily followed by hydrogen ions then iron(II) ions	1 mark 1 mark for any one of the 3	

B9	(a)(i)	Global warming is the increase in the Earth's average temperature due to the build-up of greenhouse gases in the atmosphere	1 mark	
	(a)(ii)	 1 mark – for correct sharing and bonding 1 mark – for correct number of electrons	1 mark 1 mark	
	(a)(iii)	Carbon dioxide is present naturally in the atmosphere more than the other gases.	1 mark	
	(a)(iv)	CFCs cause ozone depletion, leading to less UV radiation being filtered out. Too much UV radiation can cause skin cancer in humans.	1 mark 1 mark	
	(b)(i)	1) reduces greenhouse gas emission by more than 50% 2) amount of energy released from sugar ethanol is 8 times more than the energy released from fossil fuel, thus making it fuel efficient 3) Retail price per litre of ethanol is $1.99 cheaper than petrol	1 mark 1 mark 1 mark	
	(b)(ii)	S'pore does not have natural supply of sugarcane, hence it needs to be imported, making the fuel too expensive for public use Or Lack of land space in S'pore to grow large fields of sugarcane needed for the fuel so it will be too expensive to import from other countries, making the price of the vehicle fuel to be more costly.	1 mark	
	(b)(iii)	Large demand for foodcrops to be converted to biodiesel may cause a global decrease in supply for food, leading to rise in food prices and overall inflation.	1 mark	

B10 Either	**(a)**	Graph 10.1: **Across the period** (left to right), melting points of elements **increase from 30 ^{0}C to 3000 ^{0}C** for Li to C & **decreases sharply to below 30^{0}C from N to Ne.** All the elements after carbon have a **constant low** melting point. Graph 10.2: Generally, melting points of the oxides **decreases across the period from Li_2O to oxide of fluorine** (left to right). **BeO** however, was an exception. Even though it was placed after Li_2O, it has a higher melting point. Or Melting point of oxide increase from Li_2O to BeO & decrease from BeO to oxide of fluorine.	1 mark 1 mark 1 mark	Accept if students did not mention the "temp" because not much interval for both graphs
	(b)	Lithium, beryllium, boron and carbon	1 mark	
	(c)	Graphite Within the giant hexagonal layers of carbon atoms in graphite, **each carbon atom is bonded to 3 other carbon atoms**. This leaves **one delocalised electron** per carbon atom to carry electric charges & conduct electricity.	1 mark 1 mark 1 mark	
	(d)	The **electrostatic forces of attraction** between beryllium ions and oxide ions are **stronger** than that between lithium ions and oxide ions. (Due to higher charge of Be^{2+} compared to Li^{+}.) **More energy** needed to break the stronger ionic bonds in beryllium oxide. Hence, higher melting point.	1 mark 1 mark	
	(e)	Neon is very **unreactive or it has filled valence electron shell.** It **does not react with oxygen** to form any oxides.	1 mark	

B11 OR	**(a)**	The particle movement changes from **vibrate about fixed position** to **moving freely throughout the liquid.** The particles arrangement changes from **pack closely together** in an **orderly arrangement** to **slightly further apart in disorderly arrangement.**	1 mark 1 mark	
	(b)	No, It is a strong acid as it **dissociate completely in water** and **not** due to it having high concentration of hydrogen ions.	1 mark	
	(c)	Advantages: - Sulfamic acid will **corrode the metals** that it is cleaning to **a smaller extend** compared to hydrochloric acid as the corrosivity of HCl on steel is 4.2 times that of sulfamic acid. - It is **safer** to use sulfamic acid as it **will not react with bleach to produce Cl_2 which is toxic.** Disadvantage: - It is **2.5 times more expensive** than HCl. Accept if students did not mention 2.5 times but mentioned more expensive	1 mark for any advantage 1 mark for any disadvantage	
	(d)(I)	Aluminium might have a layer of oxide surrounding the metal. It will take some time for sulfamic acid to remove this layer of oxide before reacting with aluminium metal.	1 mark 1 mark	
	(d)(ii)	Rate of reaction will be **faster.** The sulfamic acid molecules and zinc will possess **higher** kinetic **energy greater or equal to Ea** and move faster at higher temperature. This **increases** the **frequency of effective** collision between the acid and zinc.	1 mark 1 mark	
	(e)	**Attach a more reactive metal** such as zinc to the underground pipes. It will **corrode in place of iron**, thus protecting iron from rusting.	1 mark	