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JURONGVILLE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2023
Secondary 4 Express

STUDENT NAME

CLASS

INDEX NUMBER

CHEMISTRY

6092/01

Paper 1 Multiple Choice

28 August 2023

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number in the spaces at the top of this page.

There are **forty** questions on 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 Multiple Choice Answer Sheet.

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 15.
The use of an approved scientific calculator is expected, where appropriate.

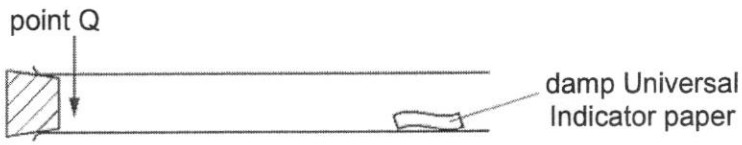
DO NOT OPEN THE BOOKLET UNTIL YOU ARE TOLD TO DO SO

For Examiner's Use
40

Setter: Mdm Ethel Chng

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

1 A gas is released at point Q in the apparatus shown.



Which gas changes the colour of the damp Universal Indicator paper most quickly?

A chlorine

B hydrogen

C hydrogen chloride

D oxygen

2 The reaction between aqueous sodium thiosulfate and hydrochloric acid forms a pale yellow precipitate.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$$

A student follows the rate of this reaction by measuring the time taken for a cross to disappear.

Besides a white tile marked with a cross, what other apparatus would be needed in the student's experiment?

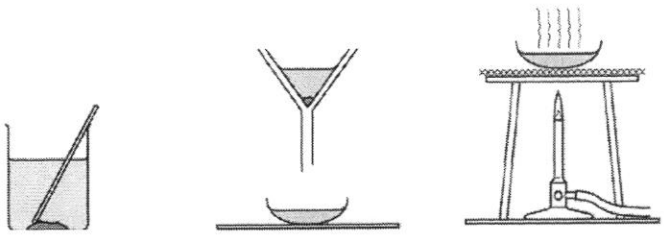
A burette, pipette, stopwatch, thermometer

B conical flask, electronic balance, stopwatch

C conical flask, measuring cylinder, stopwatch

D gas syringe, measuring cylinder, stopwatch

3 The diagram shows the steps for separating a mixture.



Which mixture **cannot** be separated into its components by these steps?

A charcoal and sugar

B copper(II) sulfate and iron

C magnesium nitrate and potassium carbonate

D marble chips and sodium chloride

4 Which observation is **not** possible for a solid element?

A It dissolves in water.

B It melts at a fixed temperature.

C When heated in air, it forms an oxide.

D When it is electrolysed in its molten state, two products are formed.

5 An unknown solid was added to dilute hydrochloric acid. Effervescence was observed and the gas formed a white precipitate in limewater.

Addition of aqueous sodium hydroxide to the resulting mixture produced a white precipitate. Upon addition of more aqueous sodium hydroxide, the white precipitate remained insoluble.

What could the unknown solid be?

A $CaCO_3$ **B** $NaHCO_3$ **C** $Pb(OH)_2$ **D** $ZnCO_3$

6 Chromium has four stable isotopes and forms ions of variable oxidation states.

A particle formed from its most abundant isotope can be written as $^{52}_{24}Cr^{3+}$.

Which statements are correct about the particle shown?

1 It has 27 electrons.

2 It has 28 neutrons.

3 It has 24 protons.

4 It has same number of electron shells as $^{53}_{24}Cr$.

A 1 and 3 only **B** 1 and 4 only **C** 2 and 3 only **D** 2 and 4 only

7 Two elements, X and Y, are in the same period of the Periodic Table.

Each atom of X contributes 2 electrons to its 'sea of electrons', while each atom of Y shares 1 electron with another atom of Y.

Which statements describe the compound formed by X and Y?

1 It conducts electricity when dissolved in water.

2 It exists as a solid at room temperature.

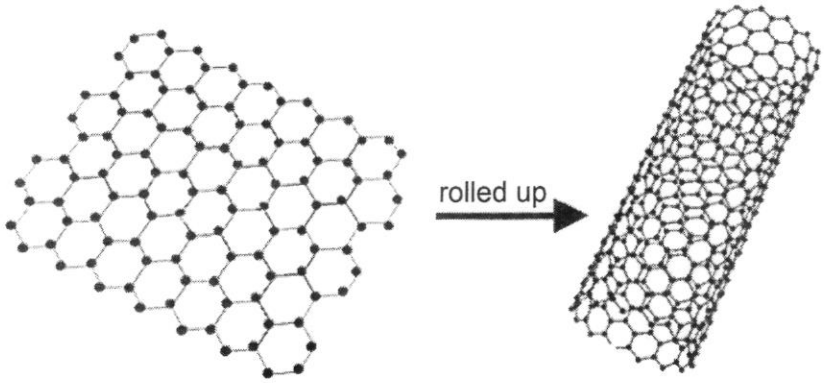
3 It has a crystal lattice structure similar to that of sodium chloride.

4 Its elements can be obtained by electrolysis of its aqueous solution.

A 1 and 2 only **B** 1, 2 and 3 only **C** 1 and 4 only **D** 2 and 3 only

8 Allotropes of carbon include graphenes and carbon nanotubes.

By rolling up a graphene sheet into a tube, a carbon nanotube is formed.



graphene sheet carbon nanotube

Which statement is **not** true of a carbon nanotube?

A It acts as a lubricant.

B It conducts electricity.

C It has a high melting point.

D It is insoluble in water.

9 The following substances all contain covalent bonds.

1 carbon tetrafluoride

2 ethene

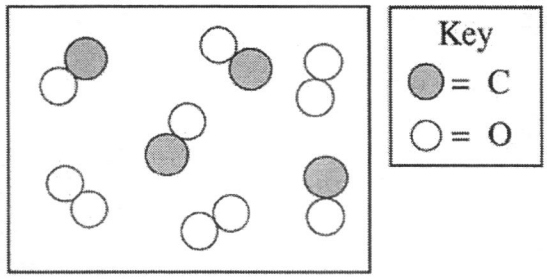
3 oxygen

4 propanol

Which substances contain only single covalent bonds?

A 1, 2 and 4 only **B** 1 and 4 only **C** 2 and 4 only **D** 3 and 4 only

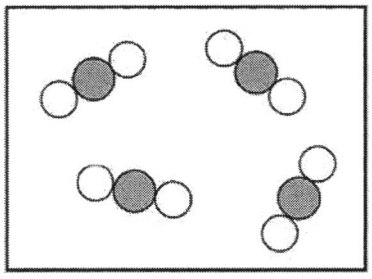
10 A mixture of carbon monoxide and oxygen is placed in a reaction vessel.



A reaction occurs, forming carbon dioxide.

Which diagram represents the gaseous reaction mixture in the vessel after the reaction is complete?

A



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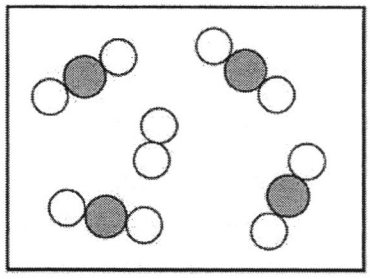

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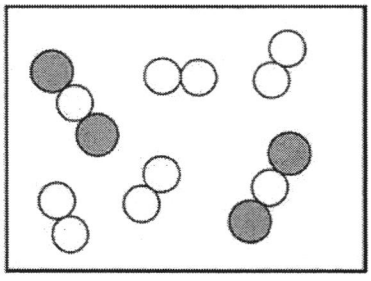
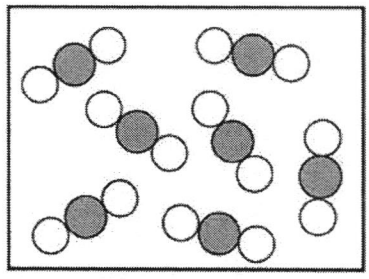


D



11 Which element contains the greatest number of atoms in 1 g?

A argon **B** chlorine **C** magnesium **D** oxygen

12 Phosphorus pentachloride reacts with water to form phosphoric acid and hydrochloric acid.

$$PCl_5(s) + 4H_2O(l) \rightarrow H_3PO_4(aq) + 5HCl(aq)$$

When 130 g of an impure sample of phosphorus pentachloride is reacted with an excess of water, 3 moles of hydrochloric acid are formed.

What is the percentage purity of phosphorus pentachloride in the impure sample?

A 32.1% **B** 46.2% **C** 76.9% **D** 96.2 %

13 Ammonium nitrate fertiliser is manufactured from ammonia by a two-stage process.

stage 1	$NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$
stage 2	$HNO_3 + NH_3 \rightarrow NH_4NO_3$

What is the maximum mass of fertiliser that can be made if only 17 tonnes of ammonia is available?

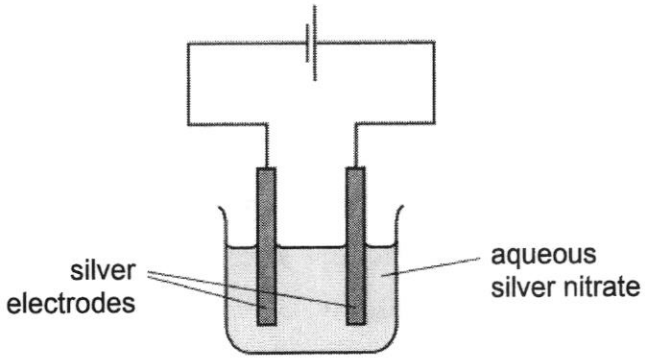
A 34 tonnes **B** 40 tonnes **C** 80 tonnes **D** 97 tonnes

14 Dilute aqueous copper(II) bromide and concentrated aqueous potassium bromide are electrolysed using inert electrodes in separate experiments.

Which row shows the products of their experiments?

	dilute aqueous copper(II) bromide		concentrated aqueous potassium bromide	
	negative electrode	positive electrode	negative electrode	positive electrode
A	bromine	copper	bromine	potassium
B	copper	oxygen	hydrogen	bromine
C	hydrogen	bromine	potassium	oxygen
D	oxygen	hydrogen	oxygen	hydrogen

15 The diagram shows the electrolysis of aqueous silver nitrate using silver electrodes.



Which statement is correct?

A Molten silver is deposited at the negative electrode.

B No gas is evolved at both electrodes.

C Oxygen is produced at the positive electrode.

D The mass of one electrode remains unchanged.

16 In separate experiments, a cell is made to supply electrical energy.

The table shows the results when rods of three metals, R, S and T are placed with a more reactive metal magnesium.

rod 1	rod 2	voltmeter reading / V
magnesium	R	1.10
magnesium	S	2.72
magnesium	T	0.78

What is the correct order of reactivity for these metals?

	least reactive ⟶ most reactive			
A	R	S	T	Mg
B	R	T	S	Mg
C	S	R	T	Mg
D	T	R	S	Mg

17 The table shows the bond energies of some covalent bonds.

bond	bond energy in kJ/mol
C*l* – C*l*	242
H – C*l*	431
H – H	436

HC*l*(g) can be made from $H_2(g)$ and $Cl_2(g)$ following these steps.

1 $Cl_2(g) \rightarrow 2Cl(g)$

2 $H_2(g) + Cl(g) \rightarrow HCl(g) + H(g)$

3 $H(g) + Cl_2(g) \rightarrow HCl(g) + Cl(g)$

4 $H(g) + Cl(g) \rightarrow HCl(g)$

Which steps have a positive value of enthalpy change?

A 1 and 2 only **B** 1, 2 and 4 only **C** 1 and 4 only **D** 3 and 4 only

18 Copper does not react with dilute acids, however it reacts with concentrated nitric acid to form copper(II) nitrate, nitrogen dioxide gas and water.

$$Cu(s) + 4HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$$

In one student's experiment, this reaction proceeded at a much slower rate than it did in the other students' experiments.

Which statement could explain the slower reaction rate?

A The concentration of acid used was 4.0 mol/dm^3 instead of 20 mol/dm^3.

B The mass of metal used was 2 g instead of 1 g.

C The metal pieces were much smaller.

D The reaction mixture was heated as the acid was added.

19 Disproportionation is a reaction in which the same element is both oxidised and reduced.

Which reaction is an example of disproportionation?

A $2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$

B $Cu_2O + H_2SO_4 \rightarrow Cu + CuSO_4 + H_2O$

C $2KClO_3 \rightarrow 2KCl + 3O_2$

D $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

20 Which pair of reactants gives a neutral solution when they are mixed together in equal number of moles?

A hydrochloric acid and calcium hydroxide

B nitric acid and calcium hydroxide

C nitric acid and potassium hydroxide

D sulfuric acid and sodium hydroxide

21 In which reaction is sodium hydroxide **not** behaving as an alkali?

A $NaOH + NH_4NO_3 \rightarrow NaNO_3 + H_2O + NH_3$

B $2NaOH + 2Al + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$

C $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

D $3NaOH + FeCl_3 \rightarrow 3NaCl + Fe(OH)_3$

22 Quicklime is used to treat flue gas from a factory.

Which substance is removed by quicklime?

A ammonia

B nitrogen

C oxygen

D sulfur dioxide

23 The ionic equation for a reaction is shown.

$$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$$

How does this reaction take place most readily?

A adding excess barium carbonate to sulfuric acid

B adding excess barium oxide to sulfuric acid

C mixing barium hydroxide with calcium sulfate

D mixing barium nitrate solution with sodium sulfate solution

24 A student wants to prepare these three salts: ammonium sulfate, lead(II) nitrate, and zinc carbonate.

Which statement describes the methods for preparing these salts?

A All three salts require different preparation methods.

B All three salts require the same preparation method.

C Only one of the salts does not require precipitation method.

D Only one of the salts does not require titration method.

25 Why is iron used in the Haber process?

A It increases the yield of ammonia.

B It lowers the activation energy of the forward reaction.

C It makes the manufacture of ammonia exothermic.

D It prevents the backward reaction from occurring.

26 Livermorium, an element discovered in 2000, has an atomic number of 116.

What is the formula of the product obtained when livermorium reacts with hydrogen gas?

A HLv **B** H_2Lv **C** Lv_2H **D** Lv_2H_3

27 Which statement about the Group VII elements is correct?

A All their vapours are coloured.

B Bromine has less oxidising power than iodine.

C Only astatine is a black solid at room temperature.

D Reaction occurs between aqueous sodium chloride and bromine.

28 The table shows some properties of four metals.

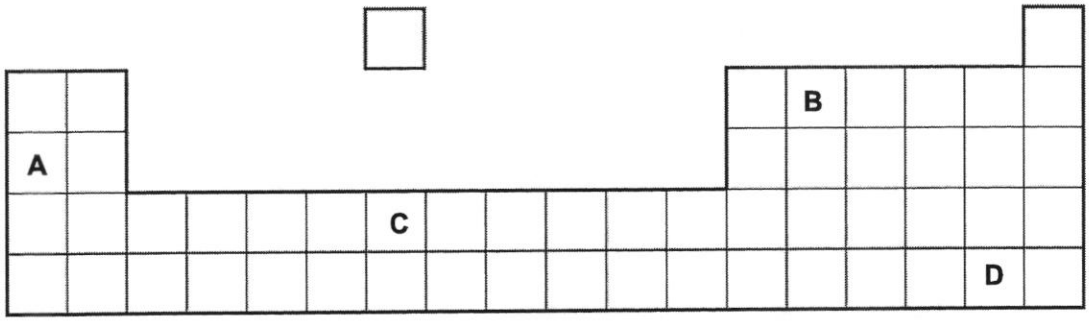
Which metal is an alkali metal?

metal	density in g/cm^3	melting point / °C
A	1.74	649
B	8.90	1495
C	7.28	232
D	0.97	98

29 The diagram shows part of the Periodic Table.

Which letter identifies the element described below?

- It is a silvery solid added to make steel harder and more corrosion resistant.
- It reacts with dilute hydrochloric acid to form a pink solution.



30 Which statement explains why metals are often used in the form of alloys?

A Alloys conduct electricity by the movement of electrons and ions.

B Alloys have a much lower density compared to metals.

C Alloys melt at higher temperatures.

D Alloys react less readily with oxygen in the air.

31 Beryllium does not react with cold water, but it reacts with hydrochloric acid.

It cannot be extracted from its ore by heating with carbon.

Where is beryllium placed in the reactivity series?

magnesium

A

zinc

B

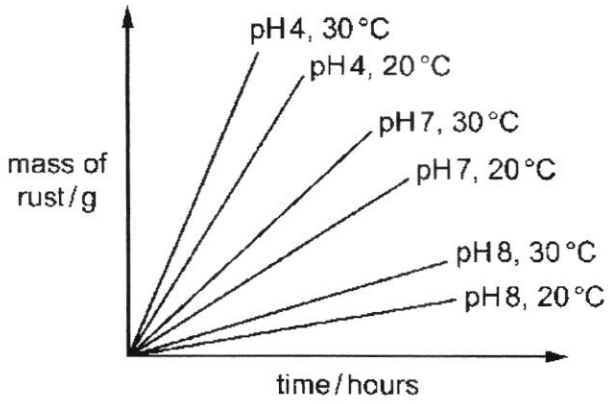
iron

C

copper

D

32 The graph shows the rate of rusting at different pH values and temperatures.



How do higher pH and temperature values affect the rate of rusting?

	higher pH	higher temperature
A	faster rusting	faster rusting
B	faster rusting	slower rusting
C	slower rusting	faster rusting
D	slower rusting	slower rusting

33 Which reaction takes place in the blast furnace to produce a substance to manufacture iron?

A $C + O_2 \rightarrow CO_2$

B $CaCO_3 \rightarrow CaO + CO_2$

C $CaO + SiO_2 \rightarrow CaSiO_3$

D $CO_2 + C \rightarrow 2CO$

34 Why are catalytic converters fitted to car exhaust systems?

A to reduce emissions of carbon dioxide

B to reduce emissions of oxides of nitrogen

C to remove soot or smoke

D to use catalysts for energy production

35 Petroleum can be separated into fractions using fractional distillation.

Which row is correct?

	fraction	use
A	bitumen	making polishes
B	kerosene	bottled gas for heating
C	naphtha	making chemicals
D	petroleum gas	fuel for aircraft

36 Which statement about fuels is **not** correct?

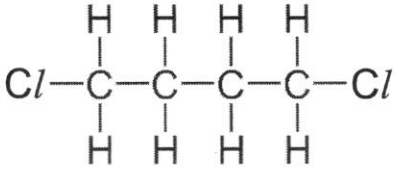
A Burning of fuels can be endothermic or exothermic.

B Ethanol is a less volatile fuel than petrol.

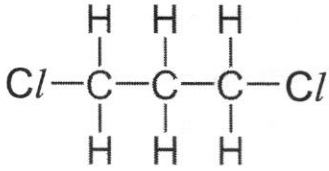
C Hydrogen is used as a fuel although it is difficult to store.

D Natural gas is a cleaner fuel than diesel oil.

37 The structures of two compounds are shown.



compound 1



compound 2

Which statement identifies the compound with the higher boiling point and provides the correct explanation for the higher boiling point?

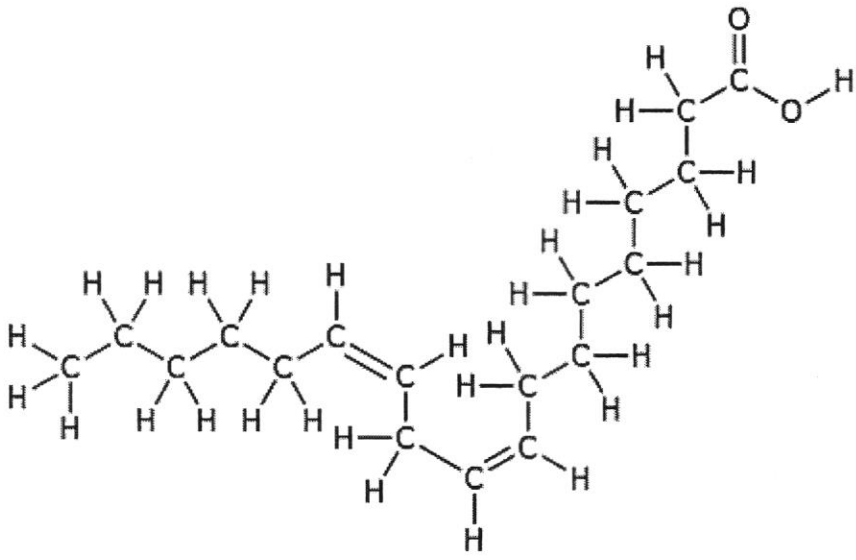
A Compound 1, as it has stronger covalent bonds than compound 2.

B Compound 1, as it has stronger intermolecular forces of attraction than compound 2.

C Compound 2, as it has stronger covalent bonds than compound 1.

D Compound 2, as it has stronger intermolecular forces of attraction than compound 1.

38 The structure of a compound is shown.



Which statements describe the compound?

1 It decolourises acidified potassium manganate(VII).

2 It decolourises bromine water.

3 It reacts with magnesium.

4 It reacts with magnesium carbonate.

A 1 and 2 only **B** 2 and 3 only **C** 2, 3 and 4 only **D** 3 and 4 only

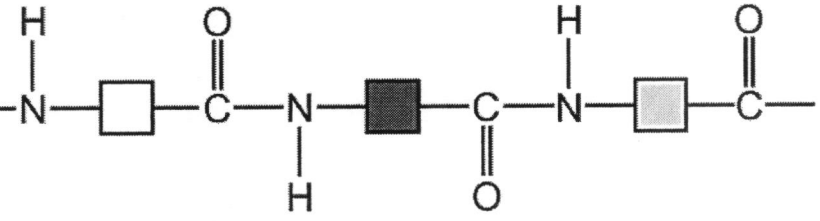
39 The formula of an ester is $CH_3CH_2CH_2COOCH_2CH_2CH_3$.

Which carboxylic acid and alcohol react together to make the ester?

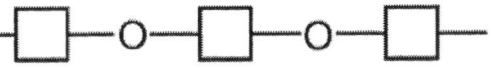
	acid	alcohol
A	butanoic acid	butanol
B	butanoic acid	propanol
C	propanoic acid	butanol
D	propanoic acid	propanol

40 Which structure represents Terylene?

A



B



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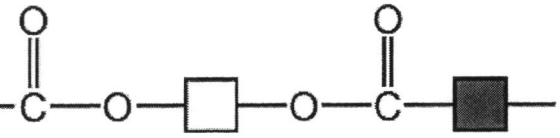

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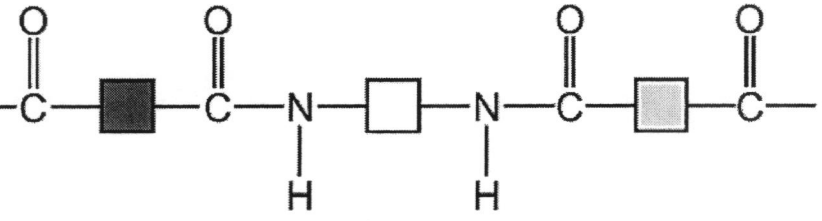

End of Paper

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JURONGVILLE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2023
Secondary 4 Express

STUDENT NAME			
CLASS		INDEX NUMBER	

CHEMISTRY

6092/02

Paper 2

23 August 2023

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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

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.

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 20.

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

For Examiner's Use	
Section A	/ 50
Section B	/ 30
Total	/ 80

Setter: Mdm Tan Li Lim

Section A

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

A1 The equations below describe a series of different reactions.

A $CaCO_3 \rightarrow CaO + CO_2$

B $Ca(NO_3)_2 + Na_2SO_4 \rightarrow CaSO_4 + 2NaNO_3$

C $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

D $Fe(NO_3)_3 + 3NaOH \rightarrow 3NaNO_3 + Fe(OH)_3$

E $2FeO + C \rightarrow 2Fe + CO_2$

F $2H_2 + O_2 \rightarrow 2H_2O$

G $2MgO \rightarrow 2Mg + O_2$

Use the letters **A** to **G** to answer the following questions.

Each letter can be used only once or not at all.

(a) Which equation shows a reaction in which a white precipitate is formed?

..... [1]

(b) Which equation shows a reaction that takes place in an electrolytic cell?

..... [1]

(c) Which equation shows a thermal decomposition reaction?

..... [1]

(d) Which equation shows a redox reaction with an acidic compound formed?

..... [1]

(e) Which equation shows a reaction in which a black substance reacts to give a blue solution?

..... [1]

[Total: 5]

A2 Desiccants are dehydrating agents which absorb water vapour from the surroundings. Desiccants are often used in the storing of electronic equipment such as cameras. The desiccant absorbs moisture, preventing fungal growth on the camera lens.

Common desiccants include silica gel, phosphorus pentoxide and calcium oxide.

(a) Silica gel is a form of silicon dioxide. It can absorb up to 25% of its own mass of water before it becomes saturated.

Suggest and explain how a saturated silica gel should be treated so that it can be reused.

.....

..... [1]

(b) Phosphorus pentoxide P_4O_{10} is a very powerful desiccant. However, it becomes corrosive after absorbing moisture.

Explain why phosphorus pentoxide becomes corrosive after absorbing moisture.

.....

.....

.....

..... [2]

(c) Phosphorus pentoxide reacts with calcium oxide.

Suggest a reason why there is a reaction between these two oxides.

..... [1]

(d) Calcium oxide can be used for drying gases.

Name a gas that can be dried using calcium oxide.

..... [1]

[Total: 5]

A3 Two experiments were carried out to measure the rate of reaction between excess powdered calcium carbonate and dilute hydrochloric acid.

(a) In **Experiment 1**, 25 cm^3 of 0.1 mol/dm^3 hydrochloric acid was used.

Calculate the total volume of carbon dioxide produced from this reaction at room temperature and pressure.

volume of carbon dioxide produced = ... cm^3 [2]

(b) In **Experiment 2**, the same excess powdered calcium carbonate was used, but with dilute hydrochloric acid of different concentration and volume

The results of **Experiments 1** and **2** are shown in Fig. 3.1. The volumes of carbon dioxide produced were measured at room temperature and pressure.

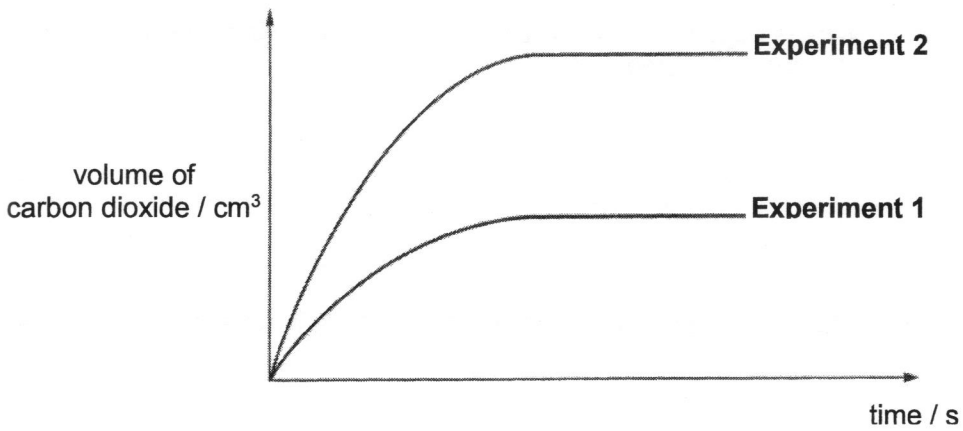


Fig. 3.1

Suggest the concentration and volume of the hydrochloric acid used in **Experiment 2**.

concentration: ..... mol/dm^3

volume: ..... cm^3

[2]

[Total: 4]

A4 Acid rain is caused by the sulfur dioxide and nitrogen dioxide that are emitted into the atmosphere from factories and vehicles. These gases react with moisture and oxygen in the atmosphere to form acids.

(a) **(i)** Describe and explain the source of nitrogen dioxide in the waste gases emitted from factories and vehicles.

.....

.....

..... [2]

(ii) Write the chemical equations for the formation of sulfuric acid and nitric acid in acid rain.

formation of sulfuric acid:

..... [1]

formation of nitric acid:

..... [1]

(b) Aluminium hydroxide is commonly found in soil clay.

When acid rain seeps into the soil, it reacts with the aluminium hydroxide in the soil. The aluminium is said to be 'mobilised' and becomes toxic to plants. The 'mobilised' aluminium affect root growth and absorption of nutrients in the soil.

(i) Why is aluminium hydroxide in the soil not toxic to the plants but the 'mobilised' aluminium become toxic?

.....

.....

..... [2]

(ii) State and explain what farmers should do to restore the soils polluted by acid rain.

.....

..... [1]

[Total: 7]

A5 When chlorine gas is used as a disinfectant in swimming pools, it may sometimes be added in excessive amounts. One technique to remove the excess chlorine is to add an aqueous solution of sodium thiosulfate, $Na_2S_2O_3$, which reacts with chlorine to produce sulfate ions, SO_4^{2-}, chloride ions, Cl^-, and hydrogen ions, H^+.

$$S_2O_3^{2-} + 4Cl_2 + 5H_2O \rightarrow 2SO_4^{2-} + 8Cl^- + 10H^+$$

(a) What is the change in oxidation state of sulfur in this reaction?

oxidation state of S: ..... to ..... [1]

(b) Aqueous sodium thiosulfate also reacts with iodine solution.

$$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$$

(i) State an observation for the reaction between aqueous sodium thiosulfate and iodine solution.

..... [1]

(ii) In a titration experiment, it was determined that 0.0532 mole of iodine has been reacted with 2.5 mol/dm^3 of sodium thiosulfate solution.

Calculate the volume of sodium thiosulfate solution used.

volume of sodium thiosulfate solution used = ... cm^3 [2]

(iii) Determine the change in oxidation state of sulfur in this reaction between sodium thiosulfate solution and iodine, then conclude if chlorine or iodine is the stronger oxidising agent in the reaction with sodium thiosulfate solution.

Explain the reason for your answer.

oxidation state of S: ..... to ..... [1]

.....

.....

..... [1]

(c) **(i)** Why are elements in Group VII of the Periodic Table, like chlorine and iodine, described as oxidising agents?

.....

..... [1]

(ii) Based on the conclusion made in **(b)(iii)**, state the trend in oxidising power of the elements down Group VII of the Periodic Table and suggest an explanation for the trend.

.....

.....

.....

..... [2]

[Total: 9]

A6 Phosgene, $COCl_2$, is a colourless and poisonous gas that was used as a chemical weapon during World War I. Phosgene can be produced by reacting carbon monoxide and chlorine gas. as represented by the equation below.

$$CO + Cl_2 \rightarrow COCl_2 \quad \Delta H = -108 \text{ kJ/mol}$$

(a) Draw a 'dot and cross' diagram for phosgene.

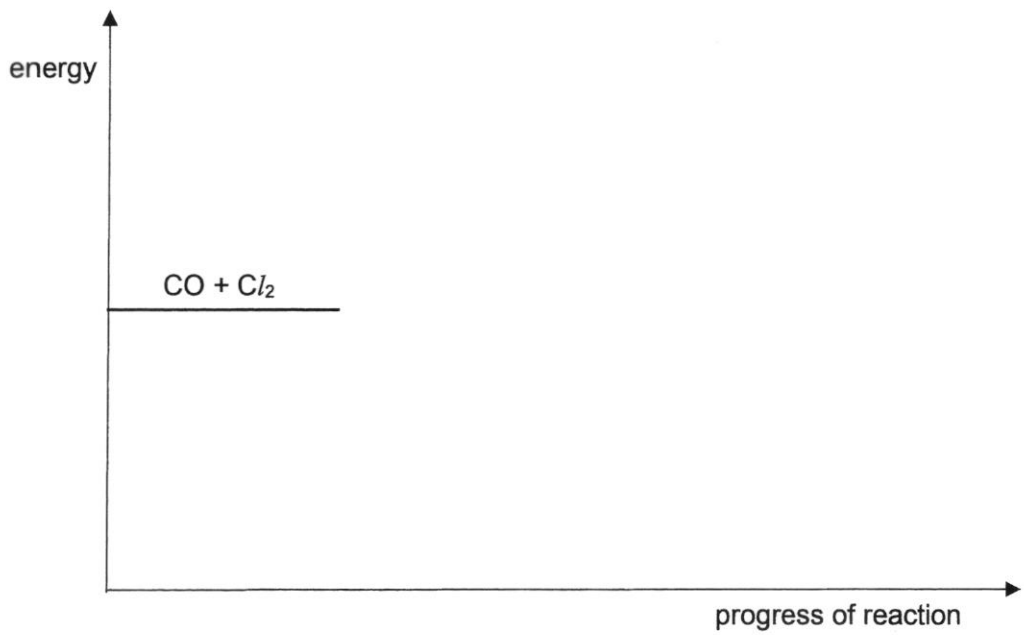
Show outer electrons only.

[3]

(b) Complete the energy profile diagram for the reaction between carbon monoxide and chlorine gas.

Your diagram should show:

- the product of the reaction,
- the activation energy, E_a, and the enthalpy change of the reaction, ΔH.



[3]

(c) Industrially, phosgene is produced by passing purified carbon monoxide and chlorine gas through a bed of activated charcoal which serves as a catalyst.

(i) Sketch the energy profile diagram of the catalysed reaction on the same diagram in **(b)**.

Label the activation energy of the catalysed reaction, E_a'. [1]

(ii) Explain, in terms of energy and particle collisions, how a catalyst increases the rate of a reaction.

.....

.....

.....

..... [2]

[Total: 9]

A7 There are two steps in the extraction of copper from the copper ore chalcocite, Cu_2S. The extraction process is also known as smelting.

Step 1: $2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$

Step 2: $Cu_2O + C \rightarrow 2Cu + CO$

(a) **(i)** State the chemical name of chalcocite.

..... [1]

(ii) Write the overall equation for reaction of chalcocite with oxygen and carbon.

..... [1]

(iii) The ores of zinc and lead contain mainly their oxides, zinc oxide and lead(II) oxide. Zinc and lead are extracted from their ores by reduction with carbon.

State and explain which metal oxide, zinc oxide or lead(II) oxide, is more easily reduced by carbon.

.....

.....

..... [2]

(b) Most of the copper extracted is used in electric circuits. Copper extracted by smelting is about 99% pure. This is purified to 99.9999% pure copper by electrolysis.

Fig. 7.1 shows how the presence of impurities change the electrical conductivity of copper.

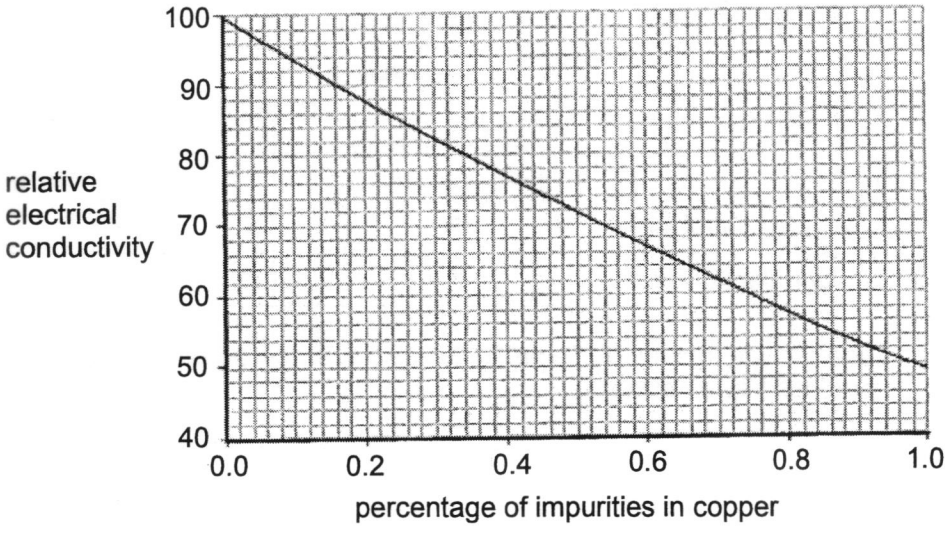


Fig. 7.1

Use information from Fig. 7.1 to explain why copper is purified to 99.9999% purity.

.....

.....

..... [2]

(c) Fig. 7.2 shows the set-up of how impure copper produced by smelting is purified by electrolysis.

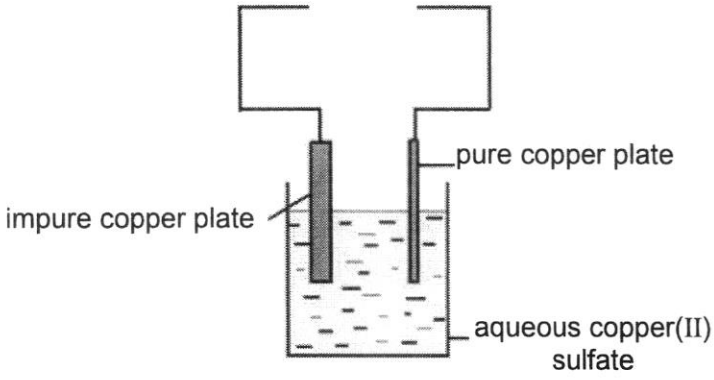


Fig. 7.2

(i) Complete Fig. 7.2 to show the terminals of the battery. [1]

(ii) Explain how copper metal and aqueous copper(II) sulfate conducts electricity differently.

.....

.....

.....

..... [2]

(ii) In an experiment, the electrodes are weighed before and after electrolysis.

The results are given in Table 7.1.

Table 7.1

	mass of impure copper plate / g	mass of pure copper plate / g
before electrolysis	965	80
after electrolysis	75	957

Use the information in Table 7.1 to calculate the percentage purity of the copper produced by smelting.

[2]

[Total: 11]

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.

B8 Read the following information about indium tin oxide, a material that is used to coat the surface of the screens of mobile phones and graphene, a potential alternative to indium tin oxide.

Indium tin oxide

The touchscreens of mobile phones and computers work by using an electrical sensing technique to figure out where your finger has applied pressure.

This requires the entire screen to be covered with a transparent material that conducts electricity. Indium tin oxide (ITO) is currently the most commonly used material for such a purpose.

But as you know if you have ever dropped your phone, screens are brittle. Hence, research has been conducted to find flexible alternatives to ITO. One potential alternative is graphene.

Graphene

Graphene is an allotrope of carbon. It is a single layer of graphite.

Graphene is harder than diamond yet more elastic than rubber; tougher than steel yet lighter than aluminum.

More information about graphene is given in Table 8.1.

Table 8.1

material	melting point / °C	density / g/cm^3	electrical conductivity	optical transparency
graphene	3652	2.267	good	transparent to light

(a) Indium tin oxide is a solid solution made up of indium(III) oxide and tin(IV) oxide.

(i) Write the chemical formulae of indium(III) oxide and tin(IV) oxide.

indium(III) oxide: .....

tin(IV) oxide: ..... [1]

(a) **(ii)** A sample of indium tin oxide is made by mixing 1 kg of indium(III) oxide and 1 kg of tin(IV) oxide. What is the percentage by mass of indium, tin and oxygen in this mixture?

% by mass of In = ... %; % by mass of Sn = ... %; % by mass of O = ... % [3]

(b) Both indium(III) oxide and tin(IV) oxide are amphoteric oxides.

(i) Explain the term 'amphoteric oxides'.

..... [1]

(ii) Name another example of amphoteric oxide.

..... [1]

(c) **(i)** State the two properties of graphene that makes it a potential alternative material for coating touchscreens.

..... [1]

(ii) Use ideas about bonding to explain the melting point and electrical conductivity of graphene.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

B9 Iron is extracted from haematite in a blast furnace using limestone and coke.

(a) Write the chemical equations for the three essential reactions for extracting iron from haematite in the blast furnace.

[2]

(b) 23 kg of iron was extracted from 50 kg of haematite in a blast furnace.

(i) Calculate the percentage yield of iron.

[2]

(ii) Suggest a reason why the percentage yield obtained is not 100%.

.....

..... [1]

(c) Iron is widely used in many industries in the form of steel.

What is the main advantage of using steel as a material, for example in making the car body, instead of pure iron?

Explain your answer.

.....

.....

..... [2]

(d) Whenever steel is used, precautions must be taken to prevent iron in steel from rusting.

(i) One method of preventing steel rusting is sacrificial protection, as shown in Fig. 9.1.

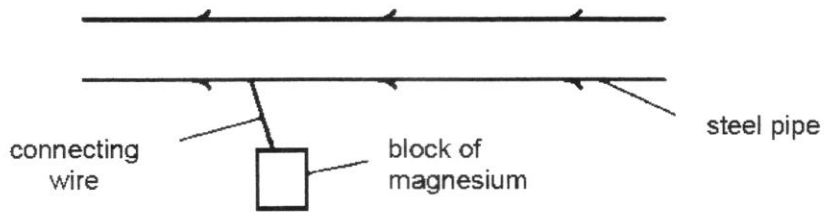


Fig. 9.1

Describe how connecting the magnesium block to the steel pipe prevents rusting.

.....

..... [1]

(ii) Another method of preventing steel rusting is impressed current cathodic protection, ICCP, as shown in Fig. 9.2.

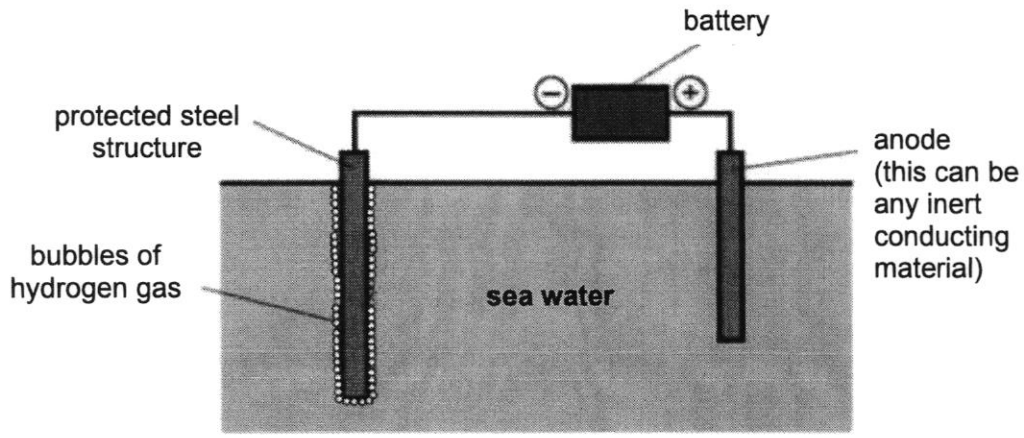


Fig. 9.2

Based on Fig. 9.1 and Fig. 9.2, describe one difference between sacrificial protection and ICCP.

.....

.....

.....

..... [2]

[Total: 10]

EITHER

B10 Read the following extract and answer the questions below.

Sugarcane and corn are the crops which have been used to produce ethanol and biodiesel. Seaweed is the new crop that can also be used to produce biofuel. A new breakthrough involved breaking down the sugars in seaweed may make the abundant marine algae central to replacing fossil fuels. Seaweed could be an ideal for biofuel as it requires no watering or fertiliser since nutrients are drawn from the ocean.

The breakthrough is credited to scientists from a Berkeley-based labarotory who used a genetically modified version of a bacteria, *Escherichia colito* (*E. coli*), to digest and convert seaweed into fuel and other chemical compounds. *E. coli* works at an optimal temperature close to our body temperature.

To test a new version of *E. coli*, the researchers mixed it up with some ground seaweed and a little water and let it stew for two days. The scientists found that between 25 to 30 °C, the solution yielded 5% ethanol. It is believed that ethanol is just the start and that the new *E. coli* could also be used to turn seaweed into a variety of molecules, for example, isobutanol, $CH_3CHCH_3CH_2OH$, a motor fuel.

(a) State one difference between fossil fuel and biofuel.

.....

..... [1]

(b) Suggest why the seaweed and water mixture was kept at a temperature between 25 to 30 °C.

.....

..... [1]

(c) Other than the temperature difference, suggest two other differences between the traditional method of using sugarcane to manufacture ethanol and this method of using seaweed to manufacture ethanol.

.....

.....

.....

..... [2]

(d) How could ethanol and isobutanol be obtained from the reaction mixture of seaweed and water after production? Give a reason to support your answer.

.....

..... [2]

(e) **(i)** What are isomers?

.....

..... [1]

(ii) Draw the full structural formula of an isomer of isobutanol.

[1]

(f) Isobutanol can react with ethanoic acid to form an ester.

(i) Draw the full structural formula of the ester formed.

[1]

(ii) State one commercial use of esters.

..... [1]

[Total: 10]

OR

B10 Crude oil is a raw material which is processed in an oil refinery. Two of the processes used are fractional distillation and cracking.

Table 10.1 shows the percentage of the supply and demand of each fraction in crude oil.

Table 10.1

fraction	number of carbon atoms per molecule	percentage of supply in crude oil / %	percentage of demand in crude oil / %
petroleum gases	1 to 4	4	11
petrol	5 to 10	11	22
naphtha	7 to 14	12	22
kerosene	9 to 16	14	20
diesel	15 to 25	16	13
lubricating oil	20 to 35	20	7
bitumen	> 30	23	5

(a) Briefly explain how crude oil is separated into different fractions by the process of fractional distillation.

.....

.....

.....

.....

..... [3]

(b) Which fractions are most likely to undergo cracking to meet the demand for petrol?

Use the information given in Table 10.1 to explain your answer.

.....

.....

..... [2]

(c) A large volume of tetradecane, an alkane with 14 carbon atoms, was subjected to cracking at high temperatures and in the presence of a catalyst. The products were mostly butane and some gas X.

Gas X was found to be unsaturated and has a relative molecular mass of 28.

Write an equation to show the cracking process.

..... [1]

(d) Another process that takes place in the refinery is a reforming process that changes the linear molecules of alkanes into branched alkanes and cycloalkanes.

Fig. 10. 1 shows the structural formula of cyclohexane C_6H_{12}, which is a cycloalkane.

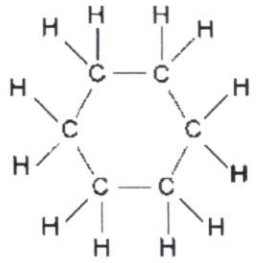


Fig. 10.1

Cycloalkanes react in a similar way as alkanes.

(i) Cyclohexane and hexene are both colourless liquids at room temperature.

Describe a test that can be carried out at room temperature to distinguish the two liquids and describe the expected observations for both liquids.

.....

.....

..... [2]

(ii) Another cycloalkane has the following percentage composition by mass.

C, 85.7% ; H, 14.3%

Show that the empirical formula of this cycloalkane is CH_2.

[2]

[Total: 10]

End of paper

Jurongville Secondary School
Science Department 2023
Marking Scheme & Marker's Report

Assessment: Preliminary Examination Chemistry (6092) **Level / Stream:** 4 Express

Paper 1 – Multiple Choice Questions

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

Qn	Marking Scheme	Remarks	Marks	Marker's Report
	Paper 2 Section A			
1(a)	B		1	Not as well answered as expected. Students need to know basic chemistry trivia like colours of the commonly encountered copper compounds and colours of precipitates seen in QA. Common mistake: (b) F, which actually is the equation for the formation of water.
(b)	G		1	
(c)	A		1	
(d)	E		1	
(e)	C		1	
2(a)	**Heat** the saturated silica **gel by** placing it in **an** oven / placing it under the sun / gently warming it over **a flame to evaporate the water.**	owtte	1	Relatively well answered. Some students did not elaborate on how the heating is to be done; not penalized but students should improve on their answers. Accept: let the moisture evaporate Did not accept: to remove the water/moisture
(b)	Phosphorus pentoxide is an oxide of phosphorus, a non-metal. Oxides of non-metals tend to be acidic, dissolving in water to form acid, which is corrosive. *OR* Phosphorus pentoxide is an acidic oxide that dissolves in water to form acid, which is corrosive.	acidic oxide/forming acid – 1m acid is corrosive – 1m	1 1	Most students have the correct idea that an acid or something acidic is formed, and that is corrosive because it is an acid. However, many of the answers did not state these points clearly. Some answers included incorrect description of the formation of acids e.g. gained H+ ions from water; such answers are awarded only the mark on acids being corrosive./ Accept:

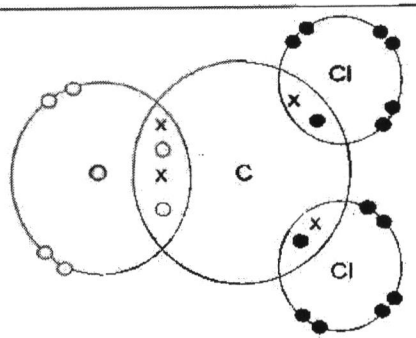
Qn	Marking Scheme	Remarks	Marks	Marker's Report
				• Phosphorus pentoxide forms phosphoric acid after absorbing moisture. [1] Phosphoric acid is corrosive. [1] • becomes acidic and hence corrosive [1 mark only] Did not accept: • phosphorus pentoxide will have hydrogen ions from water after absorbing moisture and become acidic • phosphorus(V) acid, phosphorus acid or hydrogen phosphate
(c)	**Calcium oxide** is a **basic oxide**, so it reacts with (*OR* neutralises) phophorus pentoxide which is an **acid**ic oxide to form a salt.	CaO is basic must be stated; students should have stated that phophorus pentoxide is an acidic oxide in (b); BOD to be given if possible.	1	Mark awarded as long as **calcium oxide is a basic oxide** is stated. Accept: Calcium oxide is alkaline. Calcium oxide is a base. Common mistake/misconception: Calcium oxide is amphoteric (2)
(d)	ammonia *OR* hydrogen *OR* oxygen *OR* any alkaline or neutral gas		1	Relatively well answered. Common mistake: • carbon dioxide {an acidic oxide!} Did not accept: • ammonium gas
3(a)	$2HCl + CaCO_3 \rightarrow CaCl_2 + CO_2 + H_2O$ no. of moles of HCl reacted = 0.1 × 0.025 = 0.0025 mol M1		2	Some students did not write statements in their working. Simple statements to explain what is being calculated are expected to ensure that working is understood correctly. Generally well attempted.

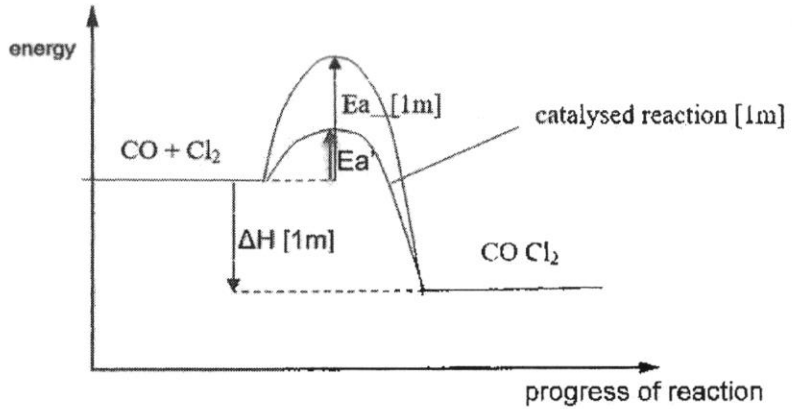
Qn	Marking Scheme	Remarks	Marks	Marker's Report
	Vol. of CO_2 produced = (**0.0025** ÷ 2) × 24 000 = 30 cm^3 A1			Careless mistakes include not using the correct stoichiometric ratio, wrong conversion of no. of moles to volume (multiplying with M_r instead of molar gas volume) and not converting volume to cm^3.
3(b)	HC*l* used in Experiment 2 is of a **higher concentration**, as the initial slope is about twice as steep. No. of moles of HC*l* is about two times that of Experiment 1 as the volume of carbon dioxide is about doubled. concentration: **0.2 mol/dm^3** volume: **25 cm^3**	accept other sensible and correct values that can give the graph of Experiment 2. [concentration > 0.1 mol/dm^3; conc × vol. ≅ 0.005 mol]	 1 1	Concentration of HCl used in Experiment 2 must be higher than > 0.1 mol/dm^3 to get the higher initial slope. This is the first consideration. So answers of concentration of 0.1 mol/dm^3 and volume of 50 cm^3 are not accepted. Common mistake: • not working out the volume of HCl correctly, such that the no. of moles of HCl is too much greater than 0.005 mol.
4(a)i	Nitrogen is present in the air that is used for combustion. At the **high temperatures** that is reached in the furnaces in factories and in the engines of vehicles, nitrogen attained the activation energy to react with oxygen, and oxides of nitrogen are formed.	owtte; *source of nitrogen that reacts with oxygen* owtte; *why there is a reaction when nitrogen and oxygen normally exists as a mixture at rtp.*	1 1	Not well attempted. Common mistakes: • lightning activity • combustion of fossil fuels • atmospheric nitrogen, atmospheric oxygen Did not accept: Nitrogen react with oxygen in the atmosphere [how nitrogen came to be burnt not explained] Good answer for reference "Nitrogen present in the air reacts with oxygen under high temperature such as in the car engines and when fuels are burn for energy in factories, to form nitrogen dioxide." – Maxwell Lye Wei Hang

Qn	Marking Scheme	Remarks	Marks	Marker's Report
(a)ii	$2SO_2 + 2H_2O + O_2 \rightarrow 2H_2SO_4$ $4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$	cao cao	1 1	Not well attempted. Common mistakes: • Omitting oxygen from the chemical equations • Writing state symbols when it is not required to do so. • Writing 2 equations for formation of sulfuric acid without combining them into one.
(b)i	Aluminium hydroxide is **insoluble**. All its ions are in fixed positions. Mobilised aluminium are the **aluminium ions** that are formed from the reaction of acid rain with aluminium **hydroxide**. These are dissolved in the soil water and can be absorbed by the root.	Key point 1: $Al(OH)_3$ is insoluble. Key point 2: Mobilised aluminium are Al^{3+} ions which are dissolved in water and can be absorbed by roots.	1 1	Not well attempted. Most students did not address why aluminium hydroxide is not toxic, and nearly everyone did not state that it is insoluble. Most answers just attempted to explain how the aluminum is toxic, instead of comparing how aluminium hydroxide is not toxic but is toxic when 'mobilised' after reacting with acid rain. Most (wrong) answers discussed the toxicity in terms of acidity of the soil. Common mistake: • relating toxicity to acidity of soil. Accept: • Aluminium hydroxide reacts with acid rain to form aluminium sulfate which will dissolve in water and be absorbed by plants.
(b)ii	Add calcium oxide *OR* quicklime / calcium hydroxide *OR* slaked lime / calcium carbonate *OR* limestone to neutralise the excess acidity / reduce the acidity / increase *OR* raise the soil pH.	Chemical to be added and purpose must both be stated in answer.	1	Straightforward question, not as well attempted as expected. Some answers just stated what is to be done without explaining what the action is to achieve. Accept: • to decrease acidity

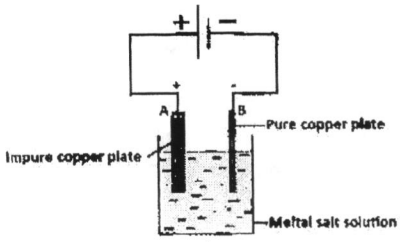
Qn	Marking Scheme	Remarks	Marks	Marker's Report
				• neutralise acidic impurities in soil Did not accept/common mistakes: • neutralise the soil [it is to neutralise the excess acidity; some crops need slightly acidic soil] • neutralise the acidity of the soil • restore soil pH to neutral [pH 7 may not be needed]
5(a)	**+2** to **+6**		1	Not well attempted. Many students could not work out the oxidation states correctly. did not accept: • digits without '+' sign • answers given in wrong format e.g. 2+, instead of +2
(b)i	Brown solution turned colourless. *OR* Brown iodine solution is decolourised.		1	Some students are not aware of the requirement of 'state an observation', and gave answer on formation of iodide ion. Common mistake: • Colourless solution turned brown Accept: • yellow to colourless Did not accept: • black to colourless • purplish black to colourless
(b)ii	no. of moles of sodium thiosulfate reacted = 2 × 0.0532 = 0.1064			Not well attempted. Some students could not use the correct method to do the calculations. Common mistakes:

Qn	Marking Scheme	Remarks	Marks	Marker's Report
	vol. of sodium thiosulfate solution used = 0.1064 ÷ 2.500 M1 = 0.04256 dm^3 = 42.56 cm^3 = **42.6 cm^3** (to 3 s.f.) A1		1 1	• did not observe the stoichiometric ratio to use from the given ionic equation • final answer not given to 3 s.f.
(b)iii	**+2 to +2.5** Chlorine is the stronger oxidising agent / has stronger oxidising power in this reaction as it can oxidise sulfur in $S_2O_3^{2-}$ to a higher oxidation state than iodine did.	allow ecf; owtte	1 1	same remarks as for (a).
(c)i	Elements in Group VII need only one more electron to achieve a fully filled outermost electron shell, *OR* the stable electronic configuration of a noble gas, so they readily gain electrons in their reactions with other substances.		1	Not well answered although this is a typical 'theory' question. Accept: • They want to gain an electron to form a fully filled outermost electron shell. • Halogens tend to gain electrons to achieve fully filled valence electron shell, so they oxidise other reagents. Did not accept: • They tend to gain electrons so they are reduced, and the other reagents are oxidised. [Did not explain why they tend to gain electrons] • They are non-metals which form anions, so they are reduced and caused other elements to be oxidized. [Did not explain why they form anions]
(c)ii	Oxidising power of elements in Group VII **decreases down the group.** The number of fully filled electron shells in an atom increases down Group VII, so the attraction of the nucleus for another electron is less down Group VII.	owtte accept other sensible explanation e.g.	1 1	First part of question not well answered although it is 'knowledge' question.

Qn	Marking Scheme	Remarks	Marks	Marker's Report
	OR The size of atom increases down the group, making it more difficult for the nucleus to attract one more electron.	increase in atomic size down the group		Did not accept: • valence electron is held further from the nucleus so the oxidizing power decrease [to mention more difficult for nucleus to attract another electron.]
6(a)		1 C=O bond; overlapping of outer electron shells of C and O with 2 shared pairs of electrons [1] 2 C-Cl bonds; overlapping of outer electron shells of C and Cl with 1 shared pair of electrons, for [1] correct number of valence electrons for all atoms [1] Note: electrons of different elements must be differentiated;	1 1 1	Quite well attempted. Only some students could not score 3 marks here, making mistakes like not drawing the valence electrons that were not used for bonding. Points to highlight to students: • do not use symbols of the same shape but different size for electrons • draw the overlapping area of electron shells large enough to draw all the shared electrons nicely • use sharpened pencil

Qn	Marking Scheme	Remarks	Marks	Marker's Report
6(b)		correct shape and chemical formula of product [1] E_a correctly marked with a correct arrow [1] ΔH correctly marked with a correct arrow [1]	1 1 1	Well attempted, but many drawings can be better. Points to highlight to students: • do not dotted lines for drawing energy profile diagram • arrows for E_a and ΔH should be drawn vertically with a ruler; with the arrows drawn to the correct points
(c)i	reaction pathway of catalysed reaction with lower E_a' labelled refer to above energy profile diagram		1	A few students did not score this mark as E_a' was not labelled as E_a', or arrow was not drawn or incorrectly drawn.
(c)ii	The catalyst **provides an alternative reaction pathway with lower activation energy.** More colliding particles possess energy equal to or greater than the activation energy. The frequency of effective collisions increases, and the speed *OR* rate of reaction increases.	owtte	1 1	Most students scored at least the first mark. Accept: • catalyst lowers the activation energy required for the reaction Did not accept: • activational energy [4 students] common mistake: • with lower activation energy, reactant particles has more energy, move faster, so collide more often and frequency of effective collisions increases
7(a)i	copper(I) sulfide		1	Only 5 students answered this correctly. common mistakes:

Qn	Marking Scheme	Remarks	Marks	Marker's Report
				• copper sulfide • copper(II) sulfide • copper(II) sulfate or sulfite • copper(II) sulfur
(a)ii	$2Cu_2S + 3O_2 + 2C \rightarrow 4Cu + 2SO_2 + 2CO$		1	Not well attempted. Many students still cannot combine two equations of different steps of a process into a single equation, and did not eliminate the intermediate product of Cu_2O from the overall equation. did not accept: • $Cu_2S + 2O_2 + 2C \rightarrow 2Cu + SO_2 + 2CO$; as student is expected to write the overall equation based on the reaction mechanism given
(a)iii	**Lead(II) oxide** is more easily reduced by carbon as lead is much less reactive than carbon, compared to zinc *OR* lead is less reactive than zinc so its oxide is less stable than zinc oxide.		1 1	Most students stated correctly that lead(II) oxide is more easily reduced by carbon. Many did not score the second mark on explanation of the answer. Accept: • the more reactive a metal is, the harder it is for carbon to reduce its oxide, and zinc is more reactive than lead • lead is ;ess reactive than zinc so carbon can displace lead more easil than zinc from their oxides • lead is less reactive than zinc so it accepts electrons more easily so it is more easily reduced by carbon Did not accept: • lead(II) oxide is less reactive than zinc oxide

Qn	Marking Scheme	Remarks	Marks	Marker's Report
7(b)	When there is nearly 1% of impurities present in copper, the relative electrical conductivity is about 50. When there is nearly 0% impurities present, relative electrical conductivity is about 100, [1] This means pure copper is twice as good an electrical conductor as 99% pure copper. [1]	data must be quoted; owtte observation on how electrical conductivity improved with no impurities	1 1	Not well attempted. Students did not understand the context of the question and did not realise that the question is actually asking about why 99% pure copper is purified to 99.9999% purity. Many students did not use the detailed information from Fig. 7.1 in their answers, but just stated generally how the relative electrical conductivity is higher when there is less impurities. Answers that consist of general statements (without quoting details from the graph) of how the relative electrical conductivity is higher when purity is higher are awarded 1 mark. Accept: • allows copper to be used to make wires that conduct electricity better • copper is used to make wires so its electrical conductivity must be high
(c)i		Correctly indicated terminals	1	Accepted correct symbol for battery even if + and – are not drawn
(c)ii	Copper conducts electricity as it has mobile electrons while aqueous copper(II) sulfate conducts electricity as it has mobile ions. [1]	owtte	1 1	Not as well attempted as expected. Students complicate the question by thinking about the copper purification

Qn	Marking Scheme	Remarks	Marks	Marker's Report
				shown in the diagram, and answering too much. Misconception: Mobile electrons present in aqueous copper(II) sulfate.
(c)iii	mass of pure copper deposited = 957 – 80 = 877 g mass of impure copper electrolysed = 965 – 75 = 890 g percentage purity of copper = (877 ÷ 890) × 100% M1 = **98.5%** (to 3 s.f.) A1		 1 1	Accept working of (877 ÷ 965) × 100% = **90.9%** (to 3 s.f.) as the 2022 prelim paper 1 used such working, with the original mass of impure copper as the basis for comparison. Mostly OK.
	Paper 2 Section B			
9(a)i	In_2O_3 SnO_2	cao Both formulae must be correct.	1	Common mistake: • Sn_2O_4
(a)ii	mass of In in 1 kg In_2O_3 = [(2 × 115) ÷ (2 × 115 + 3 × 16)] × 1000 = 827.338 g mass of Sn in 1 kg SnO_2 = [119 ÷ (119 + 32)] × 1000 = 788.079 g mass of O = 1000 – 827.338 + 1000 – 788.079 = 384.583 g	Allow ecf from (a)(i) Accept other mathematically correct methods of calculation. Ecf allowed for the last % by mass calculated.		Only 4 managed to do the calculations correctly. Most students missed out working out the masses of In and Sn in the mixture.

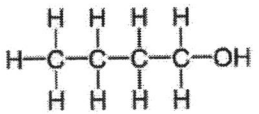
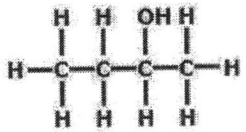
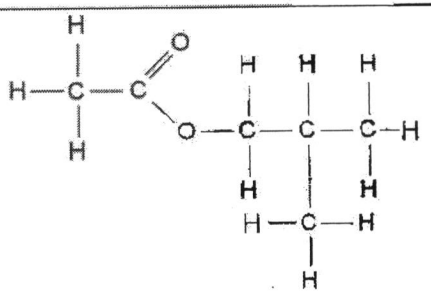
Qn	Marking Scheme	Remarks	Marks	Marker's Report
	% by mass of In = (827.338 ÷ 2000) × 100% = **41.4%** (to 3 s.f.) % by mass of Sn = (788.079 ÷ 2000) × 100% = **39.4%** (to 3 s.f.) % by mass of O = **19.2%**		1 1 1	
(b)i	Amphoteric oxides are metallic oxides that react with both acids and bases (alkalis).		1	Relatively well attempted. Did not accept: • act as both acid and base • act as both an acidic and basic oxide • has both acidic and basic properties • has properties of acidic and basic oxides
(b)ii	lead(II) oxide/ zinc oxide/ aluminium oxide		1	Relatively well attempted. However, not all students scored the mark here. Common mistake: Writing chemical formula instead of name
(c)i	**transparent** material that **conducts electricity** *OR* be able to conduct electricity and is transparent	from text "be covered with a transparent material that conducts electricity"	1	Not well attempted. Students did not seem to have read
(c)ii	Graphene has very high melting point because a lot of energy is needed to break the strong covalent bonds between carbon atoms. In graphene, each carbon atom is bonded to three other carbon atoms such that each carbon atom has one valence electron not used for bonding.	owtte	1 1	Students mostly have the idea about what they must write in their answers, but the writing is with mistakes such that mark cannot be awarded. Accept:

Qn	Marking Scheme	Remarks	Marks	Marker's Report
	These electrons are delocalized and can move freely, so graphene can conduct electricity.		1	• Graphene has mobile (or delocalized) electrons so it can conduct electricity Did not accept: • Graphene a sea of mobile electrons {'sea of mobile electrons' is reserved for metals only} Misconception: • Intermolecular forces of attraction in graphene
9(a)	$C + O_2 \rightarrow CO_2$ $CO_2 + C \rightarrow 2CO$ $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$	2 correct equations [1] 3 correct equations [2]	2	Some students wrote state symbols although these were not required by the question. Some answers included the chemical equations of the reactions of limestone and silicon dioxide; these students need to be able to differentiate the different reactions taking place in the blast furnace.
(b)i	max. possible mass of Fe in 50 kg haematite = {(2 × 56) ÷ (2 × 56 + 2 × 16)} × 50 = (112 ÷ 160) × 50 = 35 kg percentage yield = (23 ÷ 35) × 100% M1 = **65.7%** (to 3 s.f.) A1		2	Not well attempted. Common mistake: • percentage yield = (23 ÷ 50) × 100%
(b)ii	Haematite is not pure iron(III) oxide, there are **impurities like silicon dioxide present**.		1	Mostly OK. Accept:

Qn	Marking Scheme	Remarks	Marks	Marker's Report
				there are impurities in haematitie
(c)	Steel is **harder and stronger** than pure iron. The different sized atoms in steel make it difficult for the atoms to slide across one another when a force is applied.		1 1	accept: • prevents atoms from sliding over one another • stop atoms from sliding over one another did not accept: • steel is harder than iron • steel is stronger than iron
(d)i	Magnesium is more reactive than iron in steel so it reacts with oxygen more readily [*OR* loses valence electrons more readily] than iron. *OR* Magnesium corrodes in place iron, as long as magnesium is present, iron does not rust.	owtte	1	Answers must describe how magnesium is sacrificial, not just state that magnesium is a sacrificial metal. Accept: • magnesium is more reactive than steel (BOD); to highlight to students to discuss reactivity in terms of the metals on the reactivity series • magnesium rusts (BOD) in place of iron; to highlight to students that rusting happens only to iron, other metals are corroded.
(d)ii	In sacrificial protection, the flow of electrons comes about due to the more reactive metal attached to the steel structure. But in cathodic protection, the flow of electrons is due to the battery. *OR* The metal giving sacrificial protection is all reacted (used) over time [1] but in cathodic protection, the metal acting as the anode is not used up over time [1]. *OR*	observation on sacrificial protection [1] corresponding observation on cathodic protection [1]	1 1	Accepted answers that consist of correct statements about sacrificial protection even if the comparison with ICCP is not equivalent. Only 1 mark awarded for such answers. accept:

Qn	Marking Scheme	Remarks	Marks	Marker's Report
	Cathodic protection requires use of electrical power from the battery [1] while sacrificial protection does not require the use of an external source of power. [1] *OR* In cathodic protection, the protected steel structure is made to be the cathode of an electrolytic cell [1] but in sacrificial protection, the steel structure is like the cathode of an electrochemical cell.[1]			• in sacrificial protection, the metal used needs to be replaced, but in ICCP, the inert material need not be replaced • a battery needs to be used in ICCP but not in sacrificial protection Did not accept: • in sacrificial protection, magnesium corroded to prevent steel from rusting but in ICCP, hydrogen gas bubbles prevented iron from rusting. [the hydrogen bubbles will not always stay on the surface] • Reactive metal used in sacrificial protection but inert metal is used in ICCP [with no further elaboration that this metal is not used up and need not be replaced regularly; does not really show appreciation of the method]
10E (a)	Fossil fuel is derived from organic matter (*OR* plants and animals *OR* living things) that has been dead for a very long time but biofuel is derived from plants / crops that are grown specifically for the purpose of production of fuels. *OR* fossil fuels are obtained from dead organic matter while biofuels are obtained from living organic matter. Accept: fossil fuel is **non-renewable** source of energy / **limited** resource while biofuel is **renewable** / unlimited / **sustainable** / ~~env~~		1	15 students chose to answer this question. misconception: • fossil fuels produce carbon dioxide but biofuels do not produce carbon dioxide Did not accept: • Biofuels are infinite but fossil fuels is finite. [Biofuels are not infinite as there is limited land to grow the crops to produce biofuel.]
(b)	To find out if the new E.coli can digest and convert the seaweed at room temperature *OR* To ensure that the bacteria is active.	owtte;	1	Did not accept:

Qn	Marking Scheme	Remarks	Marks	Marker's Report
		accept other sensible suggestions		E. coli works best at temperature between 25 to 30 °C [in the text, it was stated that E. coil works at an optimal temperature close to our body temperature, which is > 30 °C
(c)	In the traditional method, **yeast** is used but for method using seaweed, a bacteria, the **E. coli** is used. In the traditional method, about **10 to 15% ethanol** is obtained, but in method using seaweed, **5% ethanol** obtained.		1 1	Students must get into the habit of thinking thinking about what they have learnt and draw parallels accept • traditional method takes a longer time (a few days) while new method took only 2 days • new method produces a variety of molecules • new method does not need watering or addition of fertilisers to the crop used (seaweed) but the traditional method requires watering and adding fertiliser to the crop (sugar cane) • yield of ethanol is higher with the traditional method than using the new method
10E (d)	The alcohols can be separated by from the reaction mixture by **fractional distillation**. as the **boiling points** of ethanol and isobutanol are **different** from that of water and the other liquids in the reaction mixture.		1 1	Some students did not seem to understand this question and instead suggested how ethanol and isobutanol can be made for seaweed and water. Students who understood the question answered correctly.
(e)i	Isomers are different compounds with the **same chemical** (*OR* **molecular) formulae but different structural formulae**.		1	Did not accept: isomers are hydrocarbons .... isomers are monomers ....

Qn	Marking Scheme	Remarks	Marks	Marker's Report
(e)ii	 OR 		1	Quite well attempted.
(f)i		allow ecf		Not well attempted. Some students did not know the functional group for ester. common mistake: did not draw the structure contributed by isobutanol correctly
(f)ii	Making of perfumes *OR* Used in artificial food flavourings *OR* As solvents for cosmetics and glues		1	did not accept: • perfumes • as perfumes
10O (a)	Crude oil is first heated up in the furnace and vaporised before entering the fractionating column. The smaller / lighter / shorter chain hydrocarbons with lower boiling points remain vapourised and are able to rise further up the column. They condense and are collected at the higher parts of the column. The bigger / heavier / longer chain hydrocarbons with higher boiling points condense and are collected at the lower parts of the column.	1 1 1	3	23 students chose to answer this question. [1 student did not attempt Q10 at all.] Some students do not realise that refining of crude oil is a continuous fractional distillation process where there is no substances being distilled over first or last.

Qn	Marking Scheme	Remarks	Marks	Marker's Report
				common mistake: • higher fraction, lower fraction • discussing the separation of the fractions in terms of the difference in densities; students must learn to use the correct terminology
(b)	**lubricating oil and bitumen** (diesel can be included) The demand for these fractions is lower than the supply, especially for lubricating oil and bitumen. Hence the excess can undergo cracking to form smaller hydrocarbon molecules to increase the supply of petrol.		1 1	Not well attempted. Some students did not seem to understand the process of cracking. Some students considered which fractions are suitable for cracking in terms of the number of carbon atoms in the carbon chain instead of the demand and supply of the fraction. accept: • quoting the numbers of % demand and % supply without a statement that the supply is more than the demand
(c)	$C_{14}H_{30} \rightarrow 5C_2H_4 + C_4H_{10}$		1	Not well attempted. Some students wrote the equation showing a reaction of C14H30 with another substance instead of it breaking down into shorter hydrocarbons.
(d)i	**Add aqueous bromine** (or bromine solution) to the liquid sample. If the colourless liquid turns reddish brown / aqueous bromine remains reddish-brown, it is cyclohexane.		1 1	Well attempted. All know that the bromination test is to be done but some did not describe the test accurately. did not accept:

<table>
<tr><th>Qn</th><th>Marking Scheme</th><th>Remarks</th><th>Marks</th><th>Marker's Report</th></tr>
<tr><td></td><td>If the reddish brown aqueous bromine is decolourised once it is added to the liquid and the <u>liquid remains colourless / aqueous bromine is decolourised</u>, it is <u>hexene</u>.</td><td></td><td></td><td>• add bromine to samples; 'aqueous' is necessary
• brown aqueous bromine</td></tr>
<tr><td>(d)ii</td><td><table>
<tr><td>Assuming a 100 g sample,</td><td>C</td><td>H</td></tr>
<tr><td>mass</td><td>85.7</td><td>14.3</td></tr>
<tr><td>Ar</td><td>12</td><td>1</td></tr>
<tr><td>no.of moles</td><td>85.7 ÷ 12 = 7.1417</td><td>14.3 ÷ 1 = 14.3</td></tr>
<tr><td>÷ by smaller no.</td><td>1</td><td>2.0023</td></tr>
<tr><td>ratio</td><td>1</td><td>2</td></tr>
</table>
The empirical formula of the cycloalkane is CH_2, as shown in above working.</td><td>correct no. of moles [1]

correct step of dividing by the smallest no. and correct answers [1]</td><td>2</td><td>Well-attempted. Almost all students scored 2 marks.</td></tr>
</table>

-End-