Name and Index Number: ( )	Class:

SENG KANG SECONDARY SCHOOL
PRELIMINARY EXAMINATION

CHEMISTRY (REVISED) 6092/01

Secondary 4 Express

16 August 2018

Paper 1 Multiple Choice

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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 Multiple Choice Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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

A copy of the Periodic Table is printed on page 16.

Parent's / Guardian's Signature: .....

Do not turn over the page until you are told to do so.

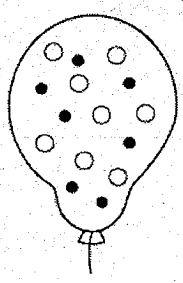
1 Which diagram shows the arrangement of particles inside a balloon containing a mixture of the gases nitrogen and oxygen?

key

● nitrogen atom

O oxygen atom

A



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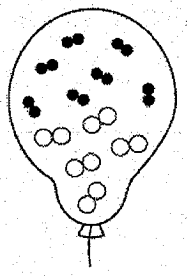

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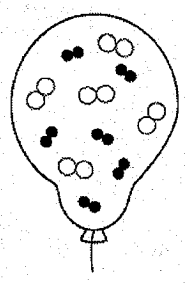

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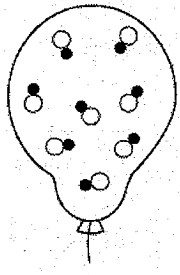
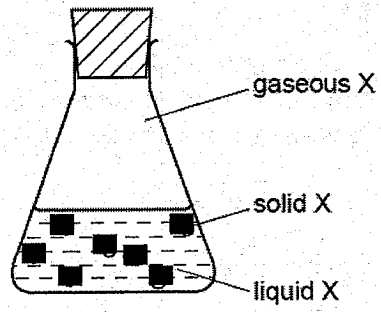


2 The conical flask contains compound X which is present in solid, liquid and gaseous states.



Which statement is correct?

A A gaseous X molecule has a lower mass than a liquid X molecule.

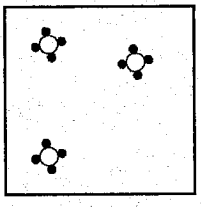
B Energy is released when X changes from liquid to solid.

C Liquid X is at a higher temperature than solid X.

D Liquid X molecules vibrate about fixed positions.

3 Which diagram represents the arrangement of particles in an alloy?

A



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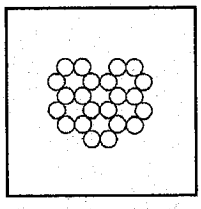

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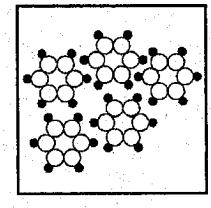

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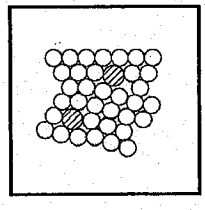
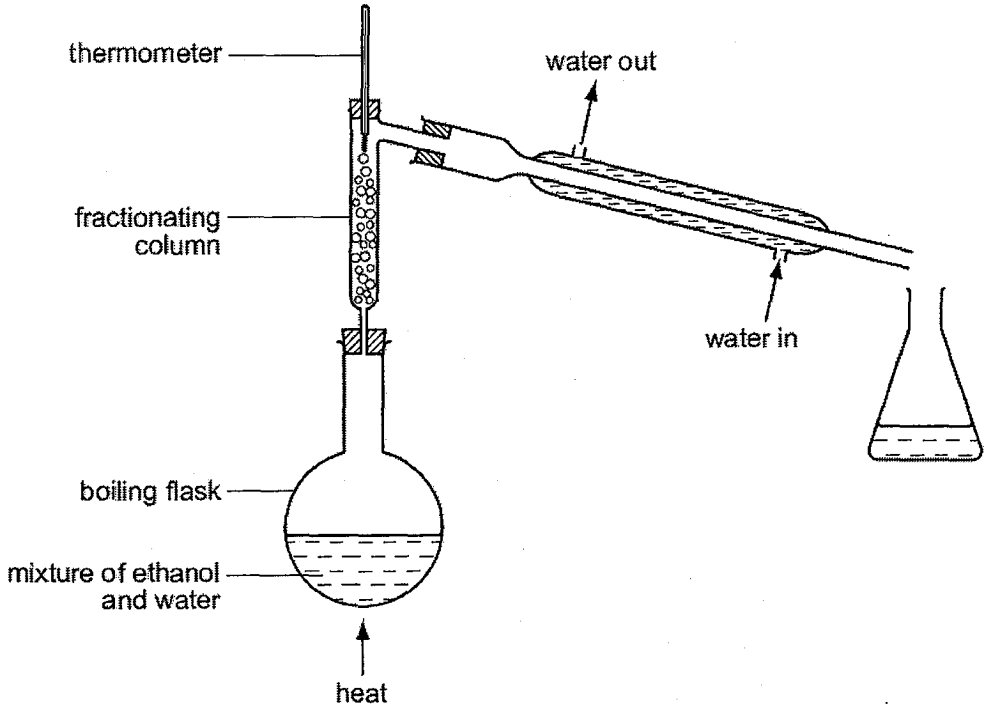
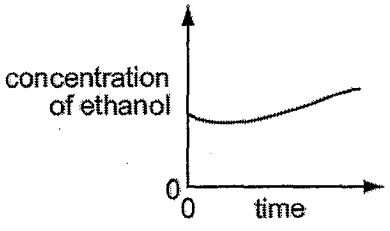


4 The apparatus shown is used to distil a dilute solution of ethanol (boiling point: 78°C) in water.



Which graph shows a change in concentration of the ethanol in the boiling flask as the distillation proceeds?

A



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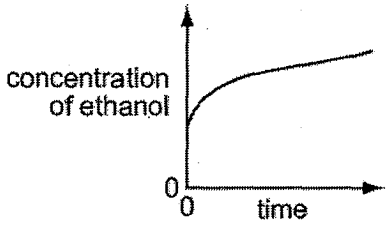

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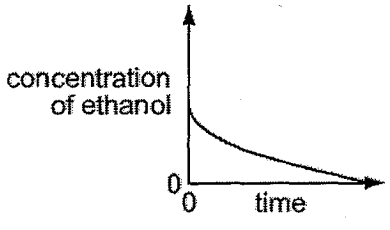

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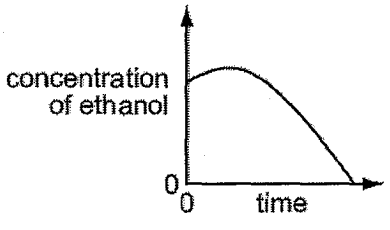
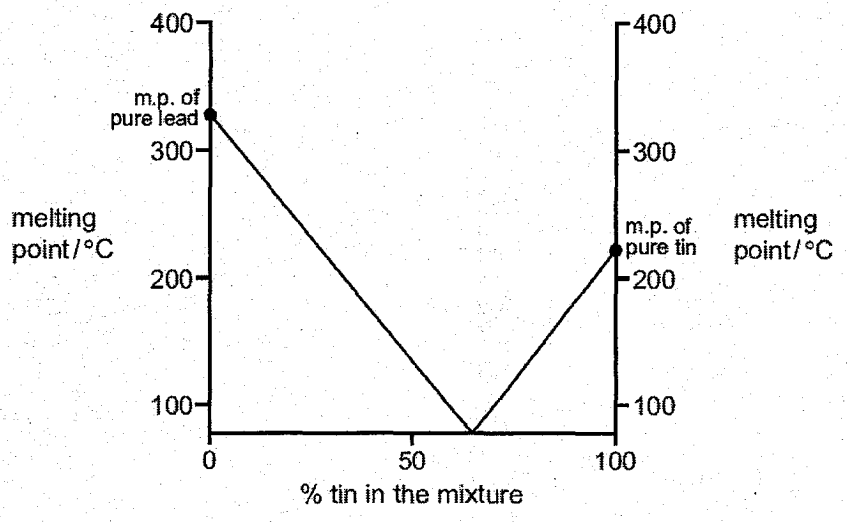


5 The graph shows the melting points (m.p.) of mixtures of lead and tin.



The graph shows that any mixture of lead and tin must have a melting point that is

A above that of tin.

B below that of lead.

C below that of both lead and tin,

D between that of lead and tin.

6 Naturally-occurring bromine has a relative atomic mass of 80 and consists entirely of two isotopes of relative isotopic masses 79 and 81.

What can be deduced about the naturally-occurring bromine from this information only?

A Bromine contains the two isotopes in equal proportions.

B Bromine has different oxidation states.

C Bromine isotopes have different number of protons.

D Bromine is radioactive.

7 Which statement about diamond and graphite is correct?

A Both diamond and graphite are used as abrasives.

B Diamond and graphite have different arrangements of carbon atoms.

C The carbon atoms in graphite have a different number of neutrons from those in diamond.

D The carbon atoms in both graphite and diamond have four covalent bonds.

8 The complete combustion of 20 cm^3 of a gaseous alkane, Y, requires 130 cm^3 of oxygen. Both volumes were measured at r.t.p..

What could be the identity of Y?

A butane
B ethane
C methane
D propane

9 1.0 mole of Cu_3FeS_3 and 1.0 mole of O_2 are allowed to react according to the equation.

$$2Cu_3FeS_3\ (s) + 7O_2\ (g) \rightarrow 6Cu\ (s) + 2FeO\ (s) + 6SO_2\ (g)$$

Which of the following is true?

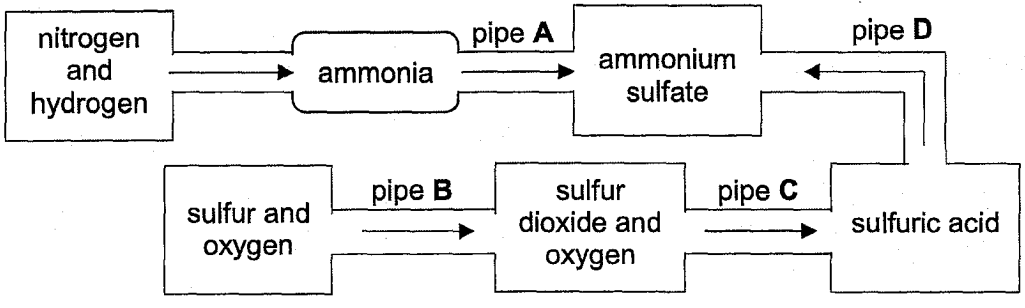
A 0.286 mole of Cu_3FeS_3 is in excess
B 0.714 mole of Cu_3FeS_3 is in excess
C 5.0 moles of O_2 is in excess
D no reagent is in excess

10 A solution containing lead(II) ions is added to a solution containing iodide ions. A yellow precipitate is formed.

What is the equation for the reaction that occurs?

A $Pb^+ + I^- \rightarrow PbI$
B $Pb^+ + 2I^- \rightarrow PbI_2$
C $Pb^{2+} + I^- \rightarrow PbI$
D $Pb^{2+} + 2I^- \rightarrow PbI_2$

11 The diagram shows some of the stages in the manufacture of ammonium sulfate.



From which of the connecting pipes would a major leak result in the highest increase in the pH of the rain?

12 A colourless solution is known to contain a sodium salt.

Tests were carried out to determine the identity of the anion in the solution.

test	observation
dilute hydrochloric acid	no reaction
dilute nitric acid followed by aqueous silver nitrate	no precipitate
dilute nitric acid followed by aqueous barium nitrate	no precipitate

Which anion could the solution contain?

A carbonate **B** chloride **C** nitrate **D** sulfate

13 Which equation represents a redox reaction?

A $4CuO + CH_4 \rightarrow 4Cu + 2H_2O + CO_2$

B $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

C $CuCO_3 \rightarrow CuO + CO_2$

D $CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

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

Which reaction is **not** an example of disproportionation?

A $2CuCl \rightarrow CuCl_2 + Cu$

B $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$

C $2H_2O_2 \rightarrow 2H_2O + O_2$

D $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

15 What is the function of silica, SiO_2, in the equation shown below?

$$CaO + SiO_2 \rightarrow CaSiO_3$$

A a basic oxide **C** an acidic oxide

B a reducing agent **D** an oxidising agent

16 Which statement is true for both aluminium and iron?

A Both are transition metals.

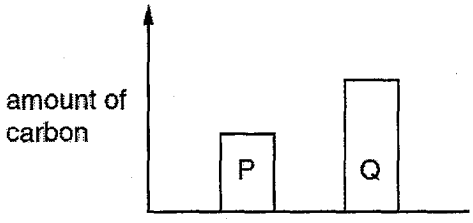
B Both form amphoteric oxides.

C The manufacture of both metals involves the reduction of the metal ions.

17 Which oxide is most readily reduced to the metal by heating in a stream of hydrogen?

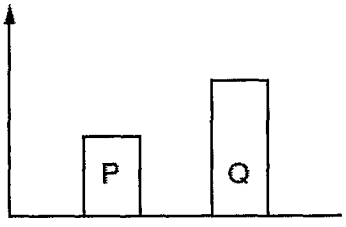
A calcium oxide
B iron(III) oxide
C sodium oxide
D zinc oxide

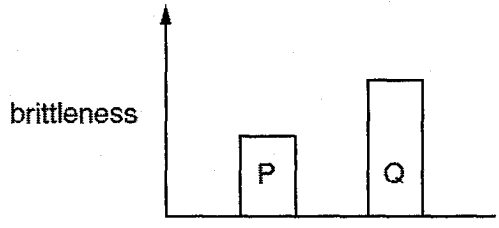
18 The diagram compares the amount of carbon in two steels, P and Q.



Which two diagrams correctly compare the strength and brittleness of P and Q?

A





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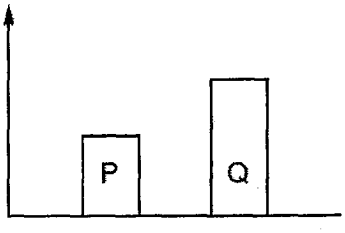

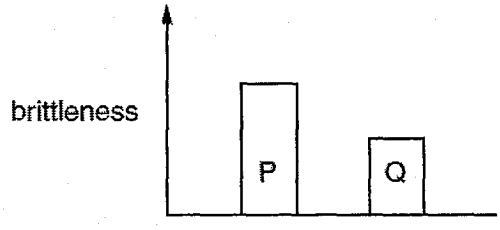

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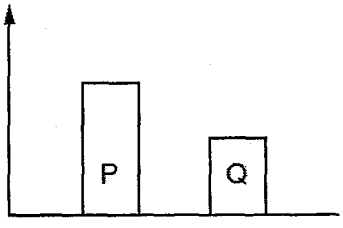

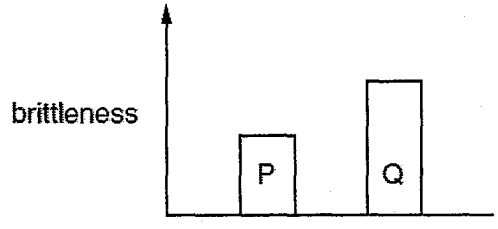

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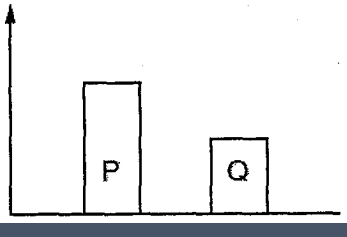
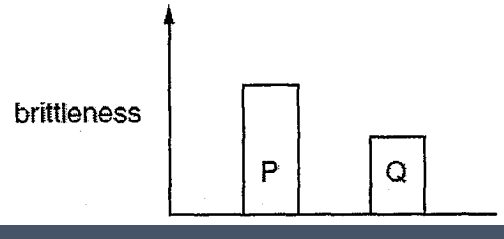




19 The element chromium liberates hydrogen from dilute hydrochloric acid although it does not react with cold water.

When a piece of chromium is placed in lead(II) nitrate solution, crystals of lead appear.

What is the order of decreasing reactivity on the three metals, lead, calcium and chromium?

A calcium, chromium, lead

B calcium, lead, chromium

C chromium, calcium, lead

D lead, chromium, calcium

20 Aluminium is often used to make caps for bottles. When thrown away and buried in the soil, the caps do not corrode.

Which of the following explains the observation above?

A Aluminium does not react with acids.

B Aluminium does not react with alkalis.

C Aluminium is alloyed with other metals.

D Aluminium is protected by a layer of oxide.

21 Which arrangement is used to electroplate copper onto a steel key?

	electrolyte	anode (positive electrode)	cathode (negative electrode)
A	aqueous copper(II) sulfate	piece of pure copper	steel key
B	aqueous copper(II) sulfate	steel key	piece of pure copper
C	aqueous sulfuric acid	piece of pure copper	steel key
D	aqueous sulfuric acid	steel key	piece of pure copper

22 In an electrolysis experiment, the same amount of charge deposited 54.0g of silver and 8.5g of vanadium.

What is the charge on the vanadium ion?

A 1+ **B** 2+ **C** 3+ **D** 4+

23 A simple cell can be made using two different metals as the electrodes and an aqueous solution as the electrolyte.

Which statements about simple cells are correct?

1 A greater voltage is produced using magnesium and silver than using magnesium and copper.

2 The electrolyte is an aqueous solution that contains both positive and negative ions.

3 The more reactive metal will lose electrons more readily than the less reactive metal.

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

24 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.

25 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 exists as diatomic molecules.

D When Group I elements combine with Group VII elements, ionic compounds form.

26 The table compares the strengths of the bonds for the reactions of $X_2 + Y_2 \rightarrow 2XY$.

Which reaction will be most exothermic?

	bond in X_2	bond in Y_2	bond in XY
A	strong	strong	strong
B	strong	strong	weak
C	weak	weak	strong
D	weak	weak	weak

27 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.

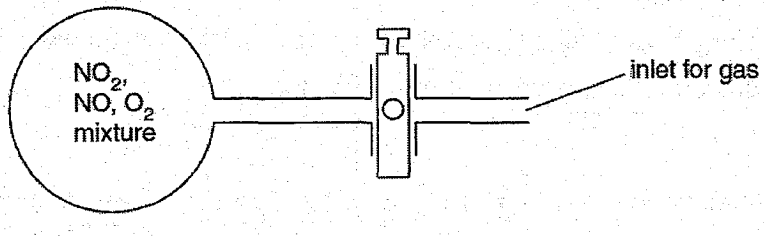
D The oxygen would need to be obtained from air.

28 Nitrogen dioxide, NO_2, is a dark brown gas that decomposes at equilibrium, as shown.

$$2NO_2\ (g) \rightleftharpoons 2NO\ (g) + O_2\ (g)$$

dark brown colourless

The diagram shows a glass flask containing a mixture of the three gases.
The mixture is pale brown.



More oxygen is formed in the flask.

What colour change is seen in the flask?

A There is no change.

B It turns colourless.

C It becomes darker brown.

D It becomes paler brown.

29 In the Haber process, nitrogen and hydrogen react to form ammonia.

$$N_2\ (g) + 3H_2\ (g) \rightleftharpoons 2NH_3\ (g) \qquad \Delta H = -92\ kJ$$

Which factor increases both the speed of reaction and the amount of ammonia produced?

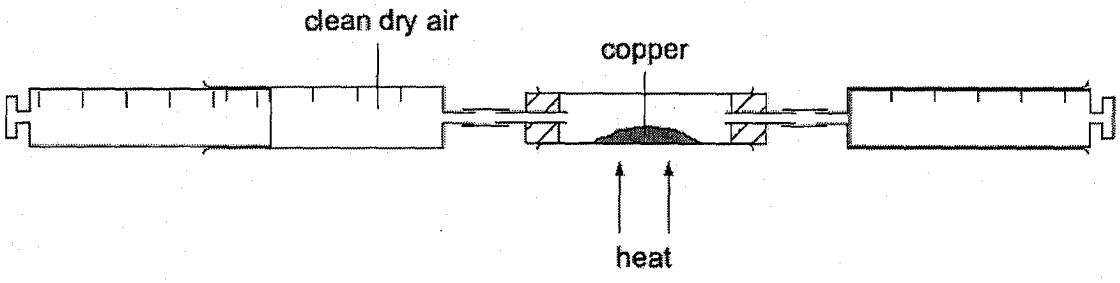
A addition of a catalyst

B decreasing the temperature

C increasing the pressure

D increasing the temperature

30 A sample of clean, dry air is passed over hot copper until all the oxygen in the air reacts with the copper.



The volume of air decreases by 30 cm^3.

What was the initial volume of the sample of air?

A 60 cm^3 **B** 100 cm^3 **C** 150 cm^3 **D** 300 cm^3

31 Why are catalytic converters fitted to car exhausts?

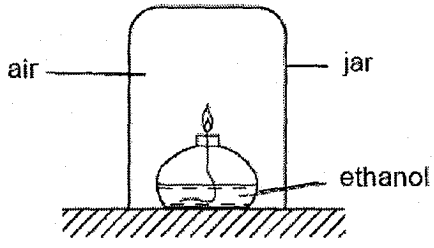
A to decrease the amount of carbon dioxide emitted
B to decrease the amount of nitrogen oxides emitted
C to improve energy conservation
D to reduce global warming

32 Dry air is a mixture of gases of which 99% is nitrogen and oxygen.

What is the main constituent of the remaining 1%?

A argon **C** hydrogen
B helium **D** water vapour

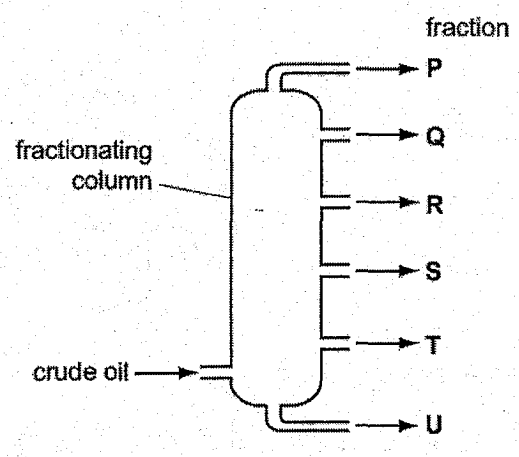
33 The diagram shows ethanol burning in a sealed jar.



The mass of one gas in the jar does not change.

Which gas is this?

34 The diagram shows the fractional distillation of crude oil.



Which statement is correct?

A Each fraction consists of a single compound.

B Fraction P has the highest boiling point.

C The highest temperature is at the top of the column.

D The naphtha fraction is used as feedstock for the chemical industry.

35 Which property of a liquid ester can be used to check its purity before use as a food flavouring?

A boiling point

B colour

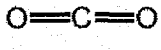
C smell

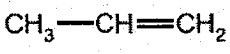
D solubility in water

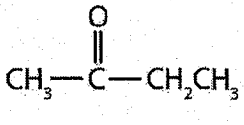
36 Which compound is the most viscous and the least flammable?

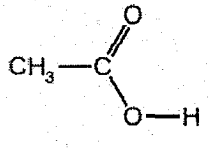
A C_6H_{14} **B** C_8H_{18} **C** $C_{10}H_{22}$ **D** $C_{12}H_{26}$

37 How many of the following structures show an unsaturated hydrocarbon molecule?



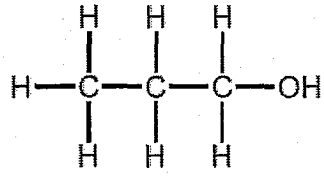






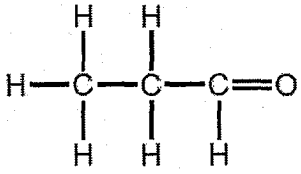
A 1 **B** 2 **C** 3 **D** 4

38 This is the structural of propan-1-ol.



Which of the following is an isomer of propan-1-ol?

A



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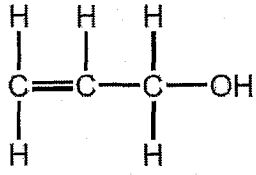

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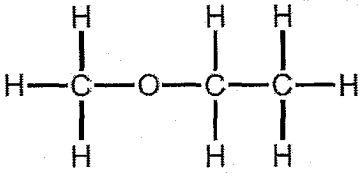
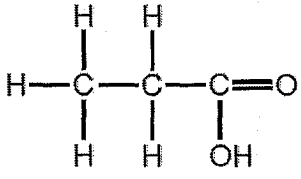
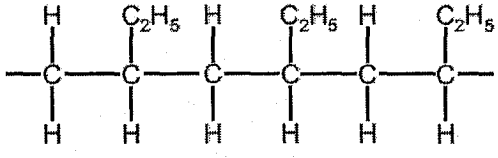


D



39 The diagram shows a section of a polymer.



Which alkene is used to make this polymer?

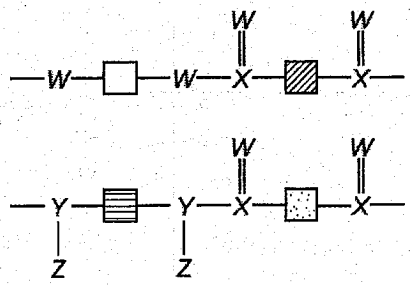
A $CH_3CH{=}CH_2$

B $CH_3CH_2CH{=}CH_2$

C $CH_3CH_2CH{=}CHCH_2$

D $CH_3CH{=}CHCH_3$

40 The diagram shows the partial structures of two different polymers.



Which chemical symbols should replace *W*, *X*, *Y* and *Z*?

	W	*X*	*Y*	*Z*
A	C	N	H	O
B	N	H	O	C
C	O	C	H	N
D	O	C	N	H

END OF PAPER

The Periodic Table of Elements

	Group																
	II										III	IV	V	VI	VII	0
										1 H hydrogen 1						2 He helium 4
	4 Be beryllium 9										5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
	12 Mg magnesium 24										13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The e of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Name and Index Number: ( )	Class:

SENG KANG SECONDARY SCHOOL
PRELIMINARY EXAMINATION

CHEMISTRY (REVISED) 6092/02

Secondary 4 Express

7 August 2018

Paper 2 Theory

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
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.

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 22.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's use	
Section A	**/ 50**
1	/ 5
2	/ 3
3	/ 10
4	/ 7
5	/ 7
6	/ 9
7	/ 9
Section B	**/ 30**
8	/ 13
9	/ 7
10	/ 10
Total	**/ 80**
Total %	**/ 100**

Parent's / Guardian's Signature: .....

Do not turn over the page until you are told to do so.

Section A

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

A1 Fig. 1.1 shows part of the Periodic Table.

										He
					B	C	N	O	F	Ne
					Al	Si	P	S	Cl	Ar
Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
									I	Xe

Fig. 1.1

Answer the following questions using **only** the elements shown in Fig. 1.1.

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

Write the **symbol** for

(a) an element which is used as a gas in balloons, ... [1]

(b) an element which forms an ion of type X^{3-}, ... [1]

(c) an element which is a catalyst for the production of ammonia, ... [1]

(d) two elements which combine to form a compound that causes acid rain, ... and ..... [1]

(e) an element which forms ions in aqueous solution which gives a white precipitate on reaction with acidified silver nitrate. ..... [1]

[Total: 5]

A2 Chlorophyll is a green pigment found in green leaves. 'Old' chlorophyll can decompose into phaeophytin, a grey pigment molecule.

A student carried out a chromatography to compare the extracts of spinach leaves obtained from two different sources.

Fig. 2.1 shows the results on the chromatogram.

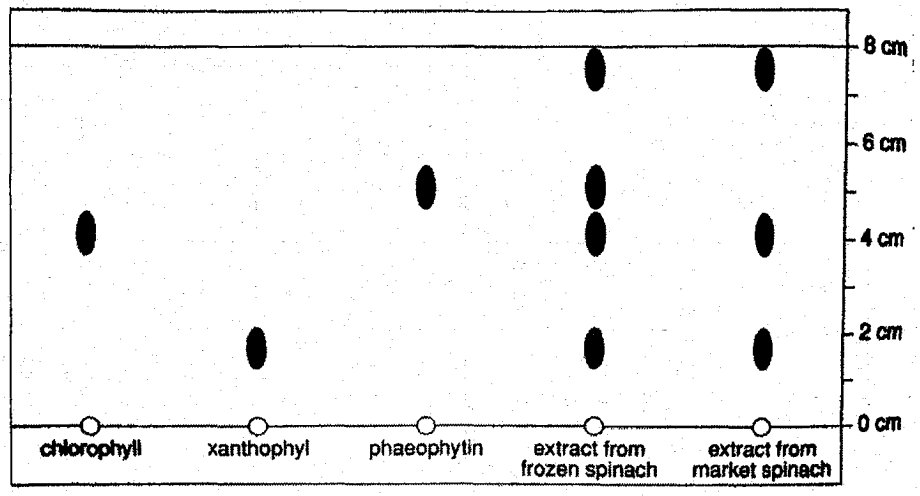


Fig. 2.1

(a) Using the information in Fig. 2.1, describe the result obtained for the extract from frozen spinach.

.....

..... [1]

(b) Calculate the R_f value of chlorophyll in the experiment.

R_f value of chlorophyll ..... [1]

(c) The student concluded that the spinach bought from the market is fresher than the frozen spinach bought from the supermarket.

Using the information in Fig. 2.1, explain his reasoning.

..... [1]

A3 **(a)** Silicon has three naturally occurring isotopes.

Complete Table 3.1 for two of these isotopes.

Table 3.1

isotope	^{28}Si	^{30}Si
atomic number		14
number of neutrons	14	
nucleon number		

[2]

(b) Silicon(IV) chloride is a simple molecular compound and exists as a liquid at room temperature.

(i) Suggest **two** physical properties of silicon(IV) chloride, other than solubility.

.....

..... [2]

(ii) Draw a diagram to show the arrangement of electrons in a molecule of silicon(IV) chloride. You only need to show outer shell electrons.

[2]

(c) Silicon(IV) chloride reacts with water to form silicon(IV) oxide and an acidic product.

Fig. 3.2 shows part of the structure of silicon(IV) oxide.

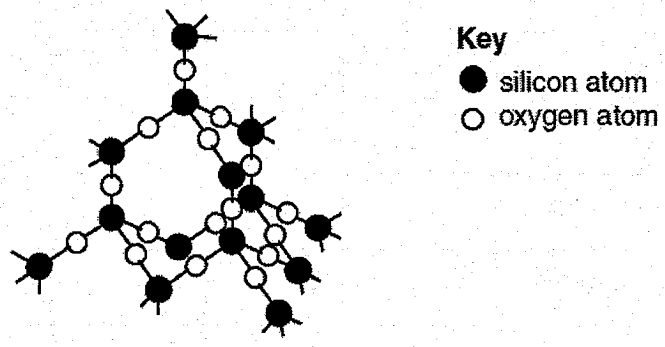


Fig. 3.2

(i) Construct an equation, including state symbols, for the reaction between silicon(IV) chloride with water.

..... [2]

(ii) A student claims that the physical properties of silicon(IV) oxide is similar to that of silicon(IV) chloride.

Explain, in terms of structure and bonding, why the student's claim is wrong.

.....

.....

.....

..... [2]

[Total: 10]

A4 Methane, ethane and propane are all gases at room temperature.

(a) State one possible environmental consequence of the presence of methane in the atmosphere.

..... [1]

(b) Ethane reacts with chlorine in the presence of ultraviolet light to give a number of different compounds.

A 1.00g sample of one of these compounds contains 0.040g of hydrogen, 0.242g of carbon and 0.718g of chlorine.

(i) Calculate the empirical formula of this compound.

empirical formula ..... [2]

(ii) The relative molecular mass of the compound is 99.

Deduce the molecular formula of the compound.

..... [1]

(c) **(i)** Explain why propane diffuses faster at 100°C than at 60°C.

.....

..... [1]

(ii) Explain why diffusion could be used to separate a mixture of methane and propane.

.....

..... [2]

[Total: 7]

A5 Lead is widely used to make lead-acid car batteries.

Lead can be extracted from cerrusite, $PbCO_3$, in a two-stage process.

Stage 1 $PbCO_3 \rightarrow PbO + CO_2$

Stage 2 $PbO + C \rightarrow Pb + CO$

(a) Explain if the reaction from stage 1 is exothermic or endothermic.

.....

..... [2]

(b) Explain why the gas from stage 2 must be removed for the safety of the workers.

..... [1]

(c) In the laboratory, two experiments were set up using lead metal, as shown in Fig. 5.1.

Both experiments were conducted at room temperature of 25°C.

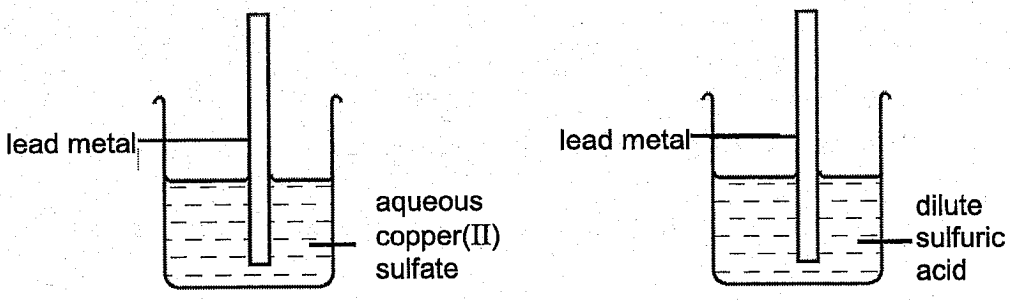


Fig. 5.1

For each experiment, describe what you would observe and how you would test any gas(es) evolved, if any. Write an equation for any **one** of the reactions in Fig. 5.1.

.....

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.....

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..... [4]

[Total: 7]

A6 Molten zinc chloride can be electrolysed using the apparatus as shown in Fig. 6.1.

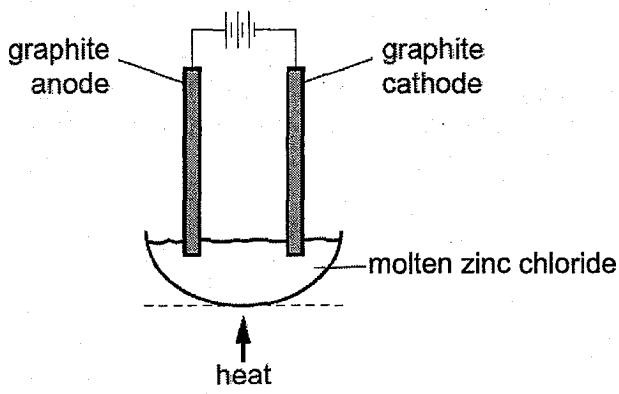


Fig. 6.1

(a) Explain why zinc chloride conducts electricity when molten, but not when solid.

.....

.....

..... [2]

(b) Predict the products of this electrolysis at

the anode, ... [1]

the cathode. ..... [1]

(c) When a dilute aqueous solution of zinc chloride is electrolysed, hydroxide ions are converted to oxygen at the anode.

Write the ionic equation for the reaction that happens at the anode.

..... [1]

(d) Describe a positive test for zinc ions.

test .....

observations .....

(e) Solid zinc chloride absorbs ammonia to form tetra-ammine zinc chloride, $[Zn(NH_3)_4]Cl_2$.

$$ZnCl_2 + 4NH_3 \rightarrow [Zn(NH_3)_4]Cl_2$$

Calculate the maximum yield, in grams, of tetra-ammine zinc chloride formed when 3.4g of zinc chloride reacts with excess ammonia.

[2]

[Total: 9]

A7 This question is about the large scale production of ethanol.

(a) Ethanol can be made by reacting ethene with steam in the presence of a catalyst.

$$C_2H_4\ (g) + H_2O\ (g) \rightleftharpoons C_2H_5OH\ (g)$$

Fig. 7.1 shows how the percentage yield of ethanol changes as the pressure is changed at three different temperatures.

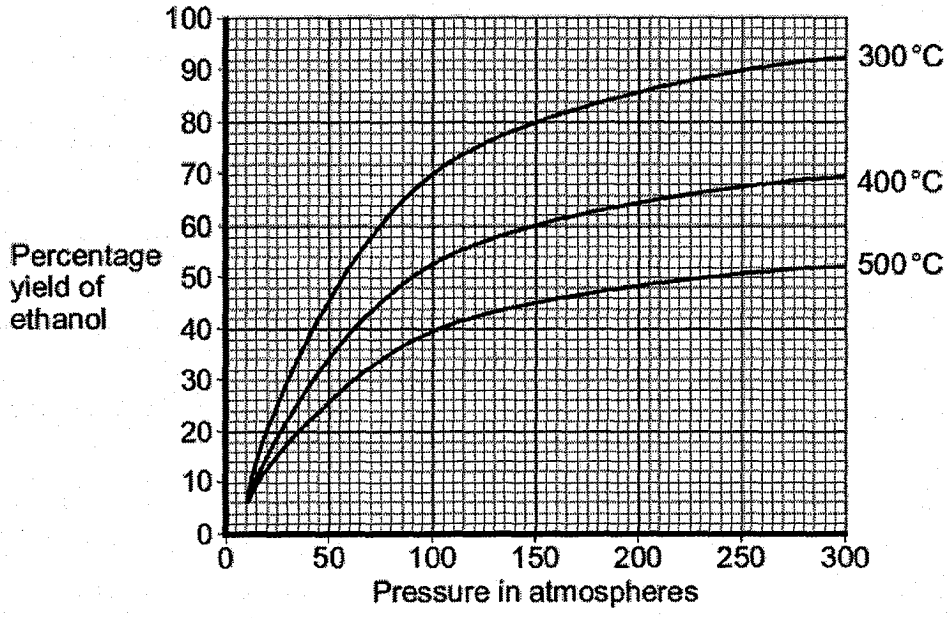
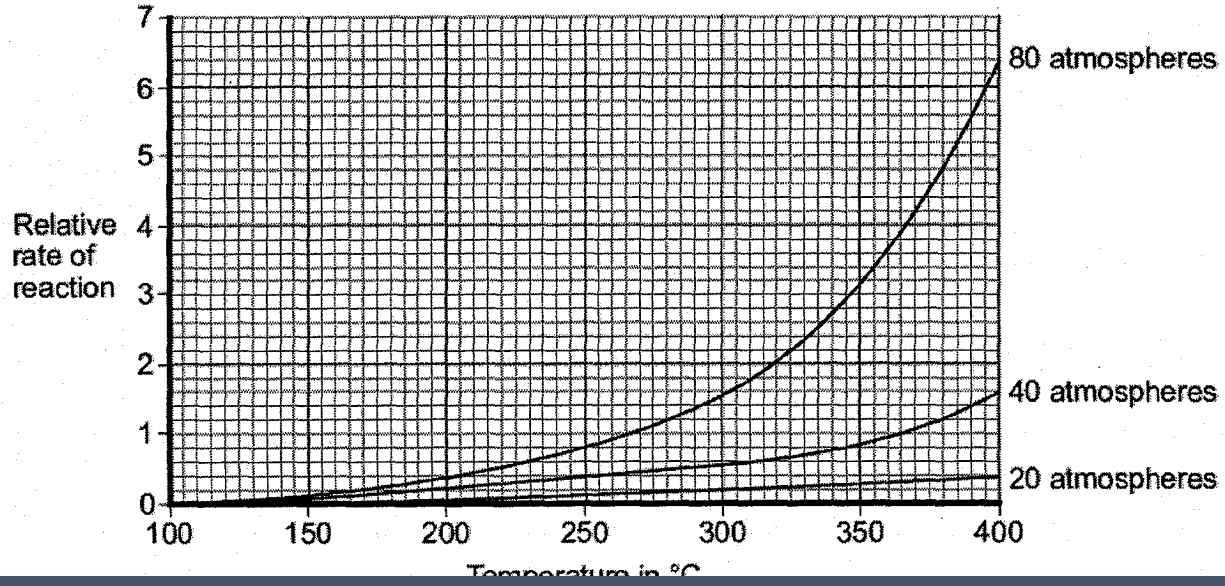


Fig. 7.1

Fig. 7.2 shows how the rate of reaction changes as the temperature changes at three different pressures.



In one process for the reaction of ethene with steam, the conditions are:

- 300°C
- 65 atmospheres
- a catalyst

Use the information in Fig. 7.1 and 7.2, and relevant chemistry knowledge, justify why the above three conditions are used.

.....

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.....

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.....

.....

..... [6]

(b) Other than the reaction of ethene with steam, ethanol can also be manufactured on a large scale by the fermentation of sugar.

Compare these two processes of making ethanol, in terms of

- the rate of reaction,
- concentration of the ethanol produced,
- the use of finite resources.

.....

.....

.....

.....

..... [3]

Section B

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

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

B8 Fats and oils are triglycerides formed from the condensation reaction of propane-1,2,3-triol with long chain carboxylic acids (fatty acids). Each triglyceride is formed from three fatty acids.

Fig. 8.1 shows the structural formula of a triglyceride likely to be found in peanut oil.

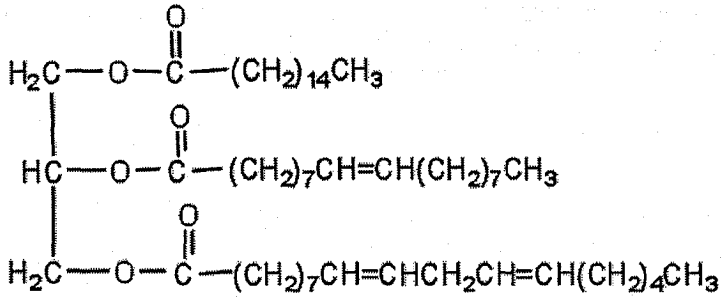


Fig. 8.1

A triglyceride is considered a fat if it is a solid at 25°C, whereas it is considered an oil if it is a liquid at 25°C. These differences in melting points reflect the differences in the degree of unsaturation and molar mass of the constituent fatty acids.

One method for checking the unsaturation level in fatty acids is to determine the iodine number. *Iodine number* is the number of grams of iodine consumed by 100 g of fat or oil. A higher iodine value indicates a higher degree of unsaturation.

Table 8.2 shows average figures for the percentage fatty acid composition of some common fats and oils.

Table 8.2

source of fat or oil	% saturated fatty acids (total)	% monounsaturated fatty acid, oleic acid ($C_{17}H_{33}COOH$)	% polyunsaturated fatty acids	
			linoleic acid ($C_{17}H_{31}COOH$)	linolenic acid ($C_{17}H_{29}COOH$)
beef fat	59	38	3	—
coconut oil	90	8	2	—
corn oil	25	26	47	2
cotton seed oil	22	35	43	—
soybean oil	14	28	50	8

The *polyunsaturated/saturated (P/S) index* of a fat or oil is the ratio of polyunsaturated fat to saturated fat. It is sometimes used to compare the relative health benefits of different fats and oils in the diet.

The above passage is modified from https://2012books.lardbucket.org/books/introduction-to-chemistry-general-organic-and-biological/s20-lipids.html.

(a) **(i)** State the chemical linkage which is observed in Fig. 8.1.

..... [1]

(ii) Identify the by-product formed for the reaction of propane-1,2,3-triol with three long chain carboxylic acids (fatty acids).

..... [1]

(iii) Draw the structural formulae of **two** reactants that are used to produce the triglyceride, as seen in Fig. 8.1.

- reactant 1: propane-1,2,3-triol

- reactant 2: one of the carboxylic acids

[2]

(b) Using the information in Table 8.2, deduce and explain which fat or oil has the lowest iodine number.

.....

(c) Although cotton seed oil and corn oil have similar iodine numbers, the melting point of cotton seed oil is higher than that of corn oil.

Suggest an explanation, in terms of the structure and bonding, in these two oils.

.....

.....

.....

.....

..... [2]

(d) Linoleic acid is a polyunsaturated fatty acid with molecular formula of $C_{17}H_{31}COOH$.

How many double bonds between carbon atoms are present in one molecule of linoleic acid? Explain your reasoning.

.....

.....

.....

.....

..... [2]

(e) A P/S value of greater than 1 is considered beneficial for health.

Calculate the P/S index of coconut oil and soybean oil, giving your answers to 3 significant figures.

Hence, determine which oil, coconut oil or soybean oil, is more beneficial for health.

..... [3]

B9 **(a)** A series of experiments was carried out to compare the rate of reaction of acid with magnesium under different conditions.

Excess magnesium and 25.0 cm^3 of acid were used. The conditions for each experiment are shown in Table 9.1.

Table 9.1

experiment	particle size of magnesium	concentration and type of acid used
A	lumps	0.1 mol/dm^3 HC*l*
B	lumps	0.2 mol/dm^3 HC*l*
C	lumps	0.1 mol/dm^3 CH_3COOH
D	powder	0.2 mol/dm^3 HC*l*

The gas evolved was collected and its total volume was measured every 30 seconds for 10 minutes. The results obtained for experiment **A** and **B** were plotted in Fig. 9.2.

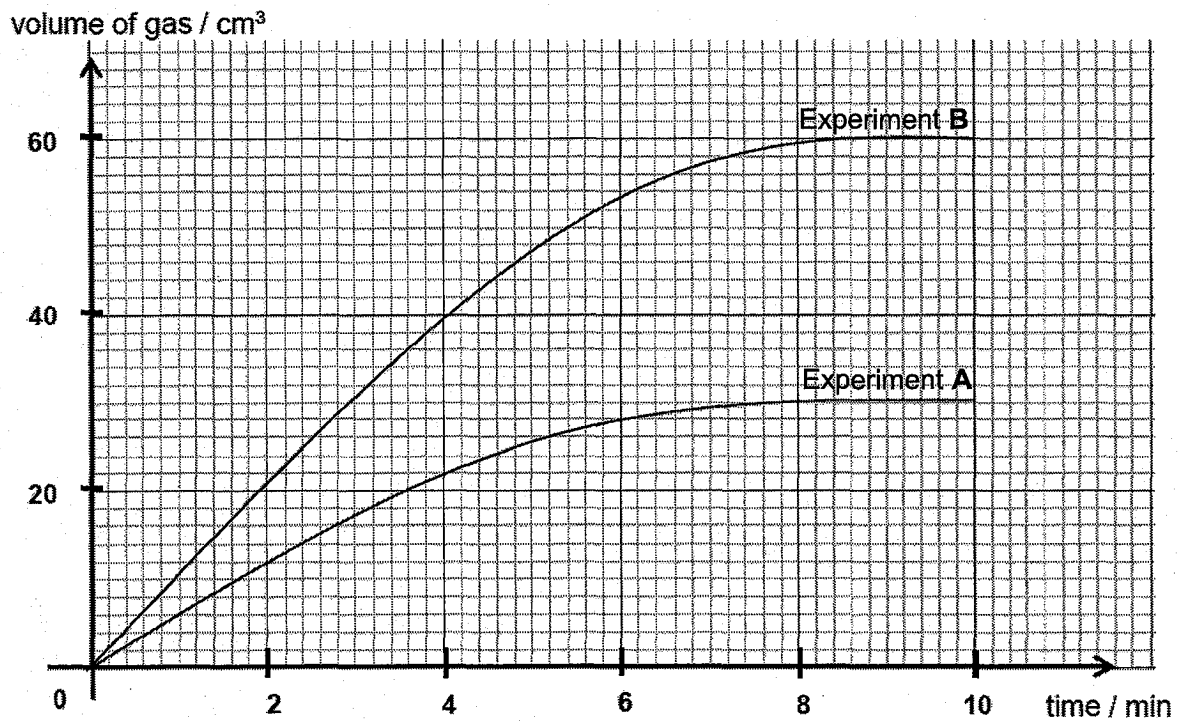


Fig. 9.2

(i) Sketch on Fig. 9.2 the curve that you would expect for experiment **C**, assuming that the reaction ended at the tenth minute. Label this curve as 'Experiment **C**'.

[1]

(ii) Explain, in terms of collisions between reacting particles, why there is a difference in the initial rate of reaction between experiments **B** and **D**.

.....

.....

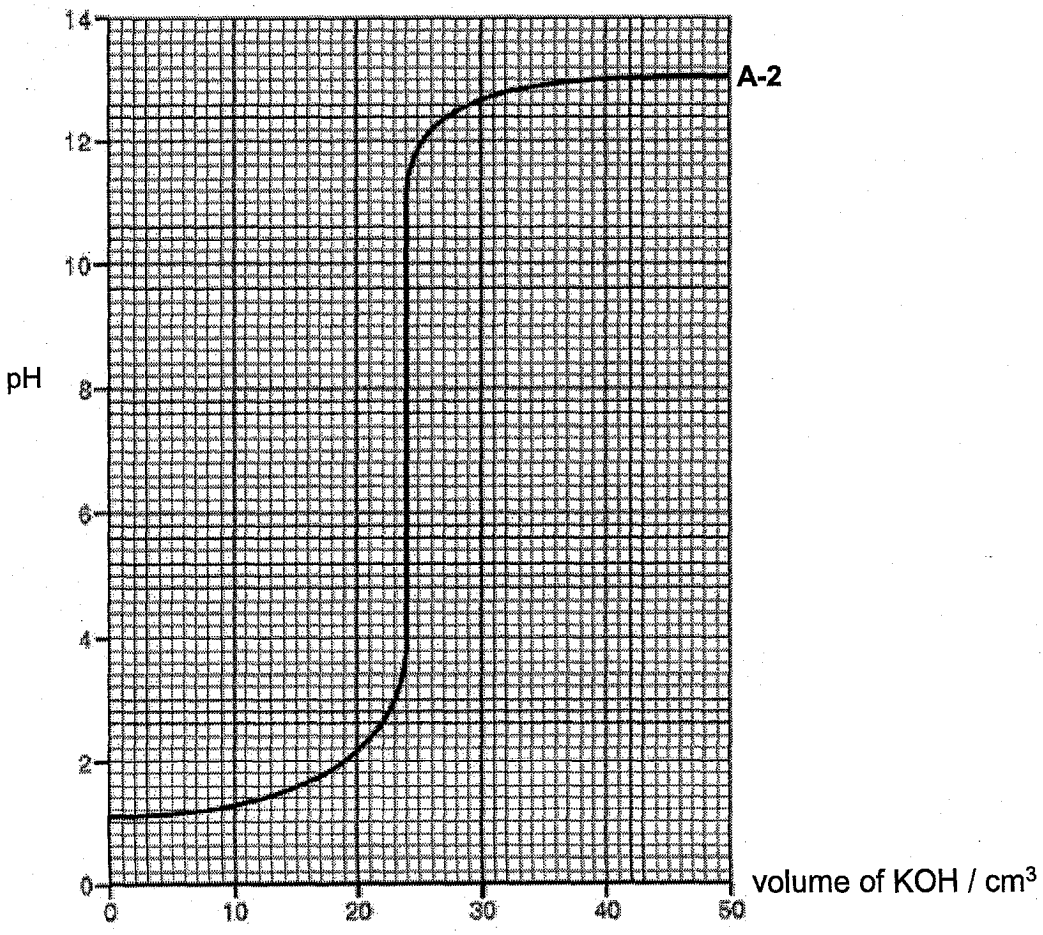
.....

..... [2]

(b) The acids from experiments **A** and **C** are used in titration experiments with potassium hydroxide.

In experiment **A-2**, 0.1 mol/dm^3 of potassium hydroxide was added from a burette to 24.0 cm^3 of dilute hydrochloric acid. A pH probe attached to a computer measured the pH during the titration experiment.

Fig. 9.3 shows the results.



In experiment **C-2**, 0.1 mol/dm^3 of potassium hydroxide was added from a burette to 24.0 cm^3 of dilute ethanoic acid.

(i) Using the graph in Fig. 9.3, state the pH value of hydrochloric acid used in experiment **A-2**.

..... [1]

(ii) The pH value of the ethanoic acid used in experiment **C-2** is 4. On the same axes on Fig. 9.3, sketch the curve you would expect for this experiment. Label this curve as '**C-2**'. [1]

(iii) The acids used in experiment **A-2** and **C-2** have the same concentration.

Explain why they have different pH values.

.....

.....

.....

..... [2]

[Total: 7]

EITHER

B10 This question is about the chemistry of chlorine and some of its compounds.

(a) Describe, with the aid of an ionic equation, the reaction of chlorine with aqueous potassium bromide. Explain why this reaction involves the reduction of chlorine.

.....

.....

.....

.....

..... [3]

(b) Describe a way to prepare a dry, pure sample of silver chloride, AgC*l*, from silver metal.

Use the following information to help you

- silver does not react with dilute hydrochloric acid,
- silver reacts with hot concentrated nitric acid to form silver nitrate,
- all nitrates are soluble in water,
- silver chloride is insoluble in water.

.....

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.....

(c) The ozone layer in the atmosphere contains ozone, O_3.

The ozone absorbs ultraviolet light and breaks down to form oxygen.

$$2O_3 \xrightarrow{\text{ultraviolet light}} 3O_2$$

The ultraviolet light provides the activation energy for the reaction.

Fig. 10.1 shows the energy profile diagram for the above reaction.

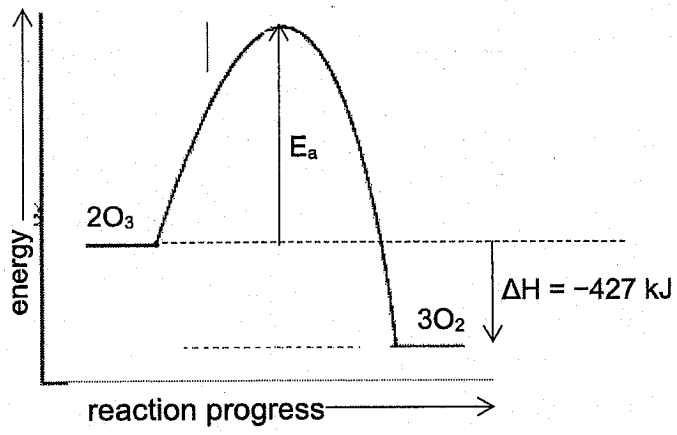


Fig. 10.1

(i) Chlorine atoms, pollutants in the ozone layer, catalyse the reaction that breaks down ozone and increase its rate.

Sketch the energy profile of the catalysed reaction in Fig. 10.1. [1]

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

.....

.....

..... [2]

[Total: 10]

OR

B10 (a) Some metal carbonates, when heated, decompose to produce carbon dioxide.

Fig. 10.2 shows the results from an investigation on the rate of decomposition of four metal carbonates.

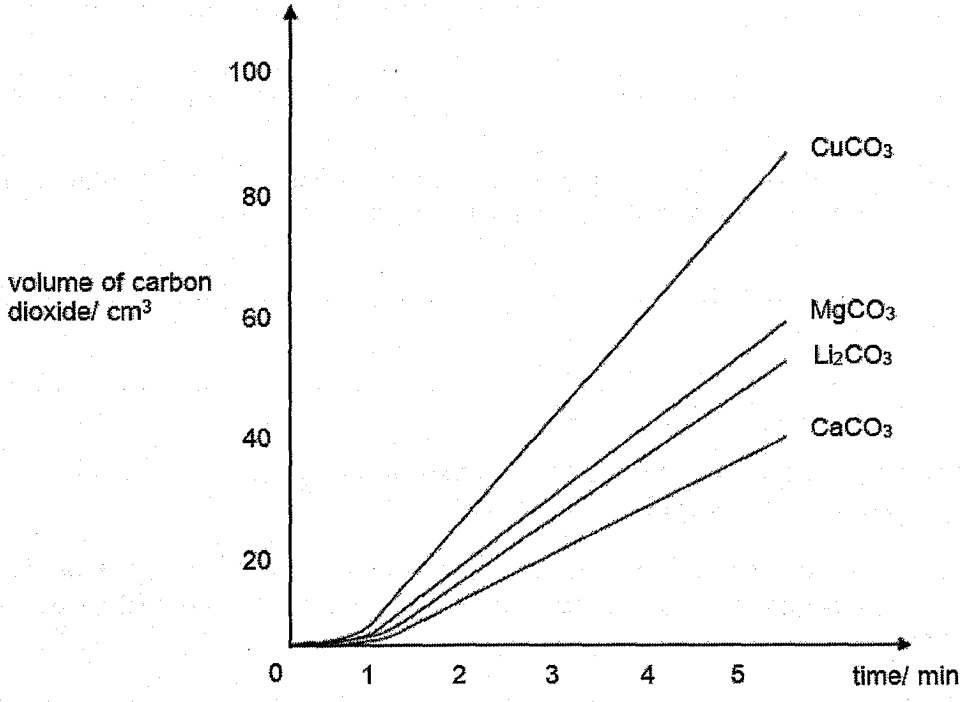


Fig. 10.2

In each experiment, 1.00 g of metal carbonate was heated to the same temperature using flame of the same intensity. The volume of carbon dioxide produced was measured at every minute interval.

(i) Suggest why very little carbon dioxide was collected at the start of each experiment.

.....

..... [1]

(ii) Using the information in Fig. 10.2, explain why the decomposition of metal carbonates were **not** completed at the end of the investigation.

.....

..... [1]

(iii) Using **only** the information in Fig. 10.2, state and explain which metal carbonate decomposed at the fastest rate.

.....

.....

..... [2]

(iv) Describe and explain how the volume of carbon dioxide will change with time if sodium carbonate was used for the experiment.

.....

..... [2]

(b) Two samples of a copper ore have been discovered. They contain different amounts of copper(II) carbonate but no other carbonate.

When excess dilute acid is mixed with the powdered ore, a gas is produced. The volume of gas evolved is a measure of the amount of copper(II) carbonate in the ore.

Outline an experiment that compares the amounts of copper(II) carbonate in the two different ores. You may include a diagram if it helps you to answer the question.

.....

.....

.....

.....

.....

.....

.....

..... [4]

END OF PAPER

The Periodic Table of Elements

Group																
I	II										III	IV	V	VI	VII	0
						1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9										5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24										13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

thanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
ctinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The e of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

SECONDARY FOUR CHEMISTRY PRELIM EXAM MARKING SCHEME

PAPER 1 [40 marks]

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

PAPER 2 [80 marks]

Section A [50 marks]

A1 (a) He [1] (b) N/P/As [1] (c) Fe [1] (d) S and O/N and O/ C and O [1]

(e) *Cl* [1]

[Overall of 1 m will be deducted if candidates never follow the instruction to write chemical symbol.]

A2 (a) The extract from frozen spinach contains xanthophyll, chlorophyll, phaeophytin and a / one unknown spot / substance. [1]

(b) $R_f = \frac{4}{8} = 0.500$ (3 sig. fig.) [1]

(c) The frozen spinach contains the 'old' chlorophyll, phaeophytin, [1] indicating that it is no longer fresh. or The spinach bought from the market does not contain the 'old' chlorophyll, phaeophytin.

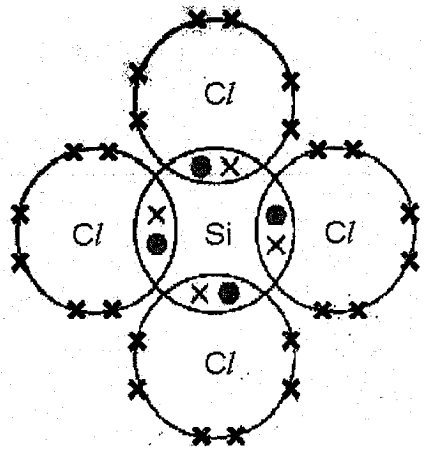
A3 (a) **[1 m for every 2 correct answers; max. of 2 m]**

isotope	^{28}Si	^{30}Si
atomic number	**14**	14
number of neutrons	14	**16**
nucleon number	**28**	**30**

(b) (i) **1 m for any correct answer; max. of 2 m:**

- low melting point and boiling point
- poor electrical conductor / cannot conduct electricity / good insulator

(ii)



**[1 m for showing 1 Si atom with 4 Cl atoms;
1 m for showing correct number of electrons, including the sharing of electrons]**

(c) (i) $SiCl_4\ (l) + 2H_2O\ (l) \rightarrow SiO_2\ (s) + 4HCl\ (aq)$

[1 m for all correct chemical formulae and balanced equation; 1 m for all correct state symbols]

(ii) 1 m for mentioning SiO_2 having a three-dimensional giant molecular structure (whereas $SiCl_4$ has a simple molecular structure)

1 m for any following description related to bonding:

- each silicon atom is covalently bonded to 4 oxygen atoms and each oxygen atom is covalently bonded to 2 silicon atoms
- the strong covalent bonds in silicon(IV) oxide are difficult to overcome and hence, has a high melting point, unlike silicon(IV) chloride which has weak van der Waals forces of attraction / weak intermolecular forces of attraction between the molecules that is easy to overcome and hence, has a low melting point

A4 (a) Methane traps heat, causing global warming. **[1]**

(b) (i)

	C	H	Cl	
Mass / g	0.242	0.04	0.718	
A_r	12	1	35.5	
No. of moles	$\frac{0.242}{12} = 0.02016$	$\frac{0.04}{1} = 0.04$	$\frac{0.718}{35.5} = 0.02022$	**[1] or**
Ratio	$\frac{0.02016}{0.02016} = 1$	$\frac{0.04}{0.2016} \approx 2$	$\frac{0.02022}{0.02016} \approx 1$	**[1]**

Empirical formula = CH_2Cl **[1]**

(ii) M_r of $CH_2Cl = 12 + 1 + 1 + 35.5 = 49.5$

$n = \frac{99}{49.5} = 2$

Hence, molecular formula = $(CH_2Cl)_2 = C_2H_4Cl_2$ **[1]**

(c) (i) At higher temperature of 100°C, the propane molecules have more kinetic energy **[1]** and hence move faster, as compared to a lower temperature of 60°C.

(ii) Molecules/particles have different (relative molecular) masses such that Methane (molecules) move or diffuse faster / propane (molecules) move or diffuse slowest **[1]**

A5 (a) Endothermic [1], because heat is taken in during decomposition [1] to break down the lead(II) carbonate into smaller compounds.

(b) Carbon monoxide is a toxic (poisonous) gas/pollutant.

or carbon monoxide combines with haemoglobin in our red blood cells to form a stable carboxyhaemoglobin, which deprives our body of oxygen.

Reject: CO is an air pollutant / causes death / breathing difficulty as no scientific explanation was given.

(c) Reaction of lead metal with aqueous copper(II) sulfate:

Observation: blue copper(II) sulfate fades (turns colourless) / Reddish-brown (pink) deposits seen. [1]

Equation: $Pb + CuSO_4 \rightarrow PbSO_4 + Cu$ [2]

Reaction of lead metal with dilute sulfuric acid

Observation: no visible (observable) change white deposits on lead metal [1]

Reject : Efferevescence (bubbles) seen. / Hydrogen gas evolved, which extinguishes the lighted splint with a 'pop' sound.

Equation: $Pb + H_2SO_4 \rightarrow PbSO_4 + H_2$ [2] (but reaction will NOT go to completion)

A6 (a) When molten, the strong electrostatic forces of attraction between the oppositely charged ions, Zn^{2+} and Cl^-, are overcome. In solid state, the oppositely-charged ions are held together by the strong electrostatic forces of attraction and can only vibrate about in fixed position. [1]

In molten state, the ions can slide around / move / are mobile to carry the charges across to conduct electricity. [1] There are free moving (mobile) ions in molten state.

(b) at anode: Chlorine gas evolved. ($2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$) [1]

at cathode: Zinc metal deposited on the cathode. ($Zn^{2+}(l) + 2e^- \rightarrow Zn(s)$) [1]

(c) $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$ [1]

(d) Test: add aqeuous sodium hydroxide (aqueous ammonia) dropwise, followed by in excess [1]

Observations: White precipitate, soluble in excess giving a colourless solution [1]

(e) M_r of $ZnCl_2 = 65 + 35.5 + 35.5 = 136$

No. of moles of $ZnCl_2 = \frac{3.4}{136} =$ 0.025 mol. [1]

M_r of $[Zn(NH_3)_4]Cl_2 = 65 + 4(14 + 3) + (35.5 \times 2) = 204$

Mass of $[Zn(NH_3)_4]Cl_2 = 0.025 \times 204 = 5.10$ g (3 sig. fig.) [1]

A7 (a) *Temperature:*

A lower (higher) temperature gives a higher (lower) yield

or A higher (lower) temperature gives a higher (lower) rate **[1]**

Pressure:

A higher pressure gives a higher yield (increase in yield gets less as pressure increases)

or A higher pressure gives a higher rate (increase in rate increases as pressure increases) **[1]**

Catalyst: using a catalyst speeds up the reaction **[1]**

Compromised conditions:

A higher pressure gives a higher rate and thereby a higher yield but increases costs and/or risk **[1]**

A lower temperature gives a higher yield but a lowe rate resulting in lower economical production of ethanol. **[1]**

Catalyst makes reaction faster so a lower temperature can be used. **[1]**

(b) Formation of ethanol is faster for reaction of ethene with steam / faster reaction between ethene and steam (slower for fermentation)

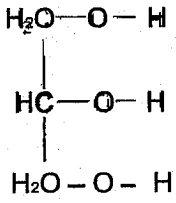
Concentration of ethanol is higher for reaction of ethene with steam (lower for fermentation) **[1]**

Non-renewable resource such as crude oil is used to produce ethene needed for the reaction of ethene with steam while renewable resources such as sugar cane plants are used to extract sugar for fermentation **[1]**

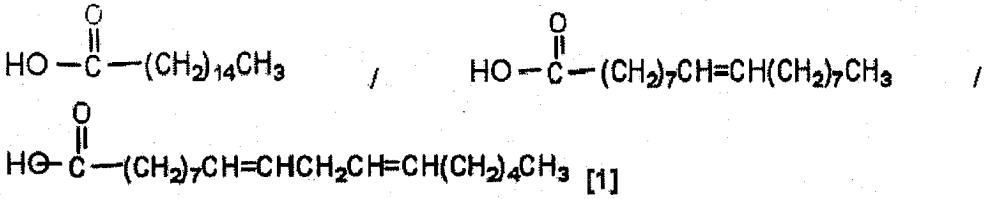
Section B [30 marks]

B8 (a) (i) Ester linkage **[1]** **(ii)** Water / H_2O **[1]**

(iii) Structural formula of propane-1,2,3-triol:



Structural formula of one of the carboxylic acids:



[1]

(b) Coconut oil **[1]**, as the percentage of unsaturation adds up to (8% + 2% =) 10% **[1]**, which is the lowest.

Cotton seed oil (molecules) have higher molar mass / relative molecular mass than

corn oil (molecules) **[1]**. More energy is needed to overcome the stronger intermolecular forces / Van der Waals' forces of attraction between the molecules. **[1]** *or* Corn oil (molecules) have lower molar mass / relative molecular mass than cotton seed oil (molecules). Lesser energy is needed to overcome the lesser intermolecular forces / Van der Waals' forces of attraction between the molecules.

Reject: the phrase 'bonds' in replacement of 'forces', 'break' in replacement of 'overcome', and 'atoms' in replacement of 'molecules'

(d) Since general formula of carboxylic acid is $C_nH_{2n+1}COOH$, a saturated fatty acid with 18 carbon atoms should have a molecular formula of $C_{17}H_{35}COOH$. **[1]**

Since a decrease in 2 hydrogen atoms indicates the present of one carbon-carbon double bond in each molecule, each molecule of linoleic acid ($C_{17}H_{31}COOH$) will contain two carbon-carbon double bonds. **[1]**

(e) P/S of coconut oil = $\frac{2}{90}$ = 0.0222 (3 sig. fig.) **[1]**

P/S of soybean oil = $\frac{50+8}{14}$ = 4.14 (3 sig. fig.) **[1]**

Soybean oil **[1]** is more beneficial for health than coconut oil.

B9 (a) (i) [1m for correct curve drawn, such than shallower gradient and same volume of gas collected as compared to Experiment A]

(ii) Powdered magnesium was used in Experiment **D**, indicating that more surface area is exposed for more collisions [1] to occur. Hence, initial rate of reaction is higher [1] than that of Experiment **B**.

or Magesium lumps was used in Experiment **B**, indicating that lesser surface area is exposed for lesser collisions to occur. Hence, initial rate of reaction is lower than that of Experiment **D**.

(b) (i) pH 1.1 [1]

(ii) **[1 m for similar curve to A-2, except for an initial pH value of 4 (same volume of KOH used & same height at the end of the reaction)]**

(iii) In experiment **A**, hydrochloric acid, a strong acid, ionises/dissociates completely to produce a lot of hydrogen ions, while in experiment **C**, ethanoic acid, a weak acid, ionises/dissociates partially to produce little hydrogen ions. **[1]**

1 m for linking pH value to concentration of hydrogen ions, with any one of the following:

- Ethanoic acid has a lower concentration of hydrogen ions and therefore has a higher pH value.
- Hydrochloric acid has a higher concentration of hydrogen ions and therefore has a lower pH value.

EITHER

B10 (a) Chlorine is more reactive than bromine, and hence displaces bromine from potassium bromide (its salt solution). **[1]**

Cl_2 (g) + $2Br^-$ (aq) → $2Cl^-$ (aq) + Br_2 (aq) **[1]**

Reject: chemical equation

Chlorine is reduced due to a decrease in its oxidation state from 0 to -1 .

or chlorine is reduced due to a gain in electrons.

(b) Step:

1) Add excess silver metal to the hot concentrated nitric acid to form aqueous silver nitrate. **[1]**
2) Filter to collect the aqueous silver nitrate as filtrate / to remove the unreacted silver as residue.
3) Add aqueous silver nitrate to sodium chloride (or any soluble chloride salt) to produce the white precipitate of silver chloride. **[1]**
4) Filter to collect the silver chloride as the residue. **[1]**
5) *(optional)* Wash the residue with deionised water and dry between filter papers.

(c) (i) **[1 m for showing a lower E_a but with same height for energy level of reactants and products]**

(ii) The catalyst provides a lower activation energy, whereby more colliding particles possess energy equal to or greater than the activation energy. **[1]**

The number of effective collisions increases, leading to higher rate of formation of product particles. **[1]**

OR

B10 (a) (i) Energy was still being absorbed to overcome the activation energy / most reactant particles have insufficient activation energy to undergo decomposition. **[1]**

Accept: little or not enough energy for decomposition

Reject: 'break' in replacement of 'overcome'

(ii) Volume of carbon dioxide has not reached a constant / is still increasing at the end of 5 minutes. **[1]**

Accept: CO_2 was still being produced

(iii) Copper(II) carbonate/ $CuCO_3$ **[1]**

Highest volume of carbon dioxide produced per unit time / most carbon dioxide produced throughout the experiment. **[1]**

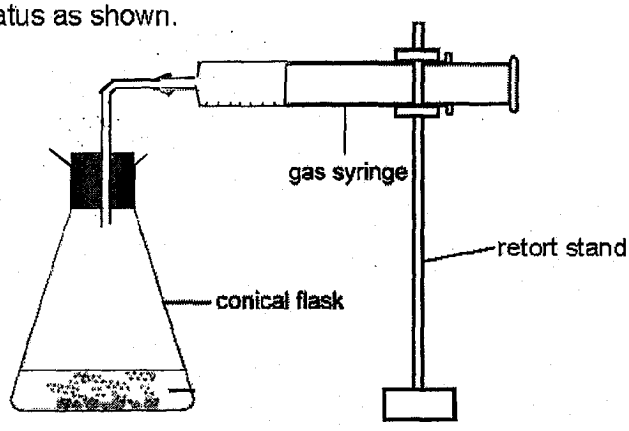
(iv) No carbon dioxide will be collected as time pass / volume of carbon dioxide remains zero / volume of carbon dioxide collected will be a horizontal / straight line. **[1]**

Sodium carbonate is stable to heat / does not decompose upon heating / very hard / hard to decompose sodium carbonate / sodium carbonate is thermally stable. **[1]**

(b)

Step:

1) Measure 5.0g ***(or any reasonable mass)*** of one of the copper ore using an electronic balance and transfer into a conical flask. **[1]**
2) Measure 25.0cm3 of 0.1 mol/ dm3 dilute hydrochloric acid (or any appropriate acid) using a pipette (or use a measuring cylinder/burette to measure volume of any other acid). **[1]**
3) Set up the apparatus as shown.



4) Record the final volume of carbon dioxide gas produced.
5) Repeat step 1 to 4 for the other copper ore. **[1]**

Conclusion: The ore that gives out more gas contains more copper(II) carbonate. **[1]**