Name	Reg. No	Class

MAYFLOWER SECONDARY SCHOOL

4EX

CHEMISTRY **6092/02**
Paper 2
[80 Marks]

PRELIMINARY EXAMINATION
August 2024
1 hour 45 minutes

Additional Materials:
Approved calculator

INSTRUCTIONS TO CANDIDATES:

Do not open this booklet until you are told to do so.
Write your name, index number and class in the spaces at the top of this page and on any separate answer paper used.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Paper 2: Section B
Answer **three** questions in the space provided. The last question is in the form of an either/or and only one of the alternatives should be attempted.

FOR EXAMINER'S USE	
Section	**Marks**
Paper 1 MCQ	/ 40
Paper 2: A	/ 70
Paper 2: B	
B Either	/ 10
B Or	/ 10

INFORMATION FOR CANDIDATES:
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.

This question paper consists of **22** printed pages

Setter: Mr Chen Yanhui Timothy Vetter: Miss Jeevana Rani

Name: …….

Section A (70 marks)

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

1 Fig. 1.1 shows part of the Periodic Table.

				He
C	N	O	F	Ne
		S	*Cl*	Ar
			Br	Kr

Fig. 1.1

Select elements from Fig. 1.1 to answer the following questions. You may use each element once, more than once or not at all.

Write down the symbol of an element which:

(a) has five electrons in its outer shell,

.....

(b) exists as monoatomic,

.....

(c) reacts with sodium to form an ionic compound with a relative mass of 62.

.....

(d) is a halogen,

.....

(e) has 4 electron shells,

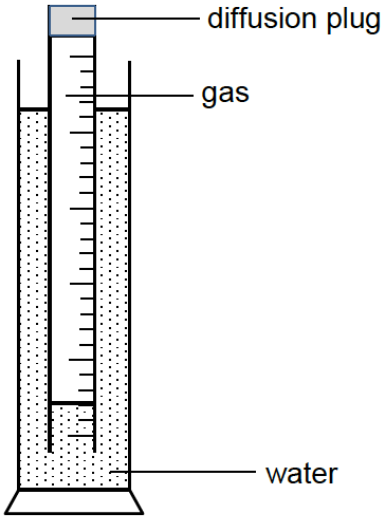
.....

(f) is the most abundant gas in the air.

.....

[Total: 6]

2 An experiment was set up to determine the rate of diffusion of gases in relation to their relative mass



The time taken for 100 cm^3 of some gases at room temperature and pressure to diffuse from this apparatus are recorded in the Table 2.1.

Table 2.1

gas	CO	Cl_2	CH_4	N_2	O_2
time / s	132	211	100	?	141

(a) State and explain, using the examples from Table 2.1, the trend in the experiment.

……...

……...

…… [2]

(b) Hence, predict the time taken for N_2 to diffuse.

…… [1]

(c) Suggest why this apparatus is unsuitable for finding the rate of diffusion of ammonia gas?

……...

…… [1]

[Total: 4]

[Turn over

3 Fig 3.1 shows an article from a textbook about elderberries.

Elderberries are widely used in wine making. Extract of elderberries is a useful pH indicator and it can be separated by chromatography.

As an indicator, the colour of the extract changes to pink at a pH of 2 – 3 and to blue at a pH of 11 – 12.

elderberries

Fig. 3.1

The chromatogram, Fig 3.2**,** was obtained when water was added to a drop of elderberries extract at the centre of a filter paper.

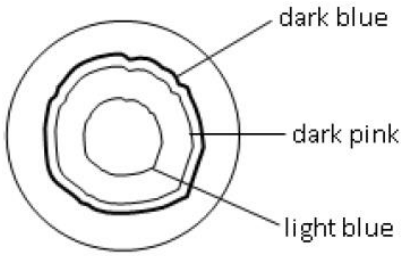


Fig. 3.2

(a) Predict the colour of the elderberries extract at pH 7.

…… [1]

(b) An alternative set-up for the above experiment is shown in Fig 3.3 below.

dye	R_f value	distance travelled (cm)
light blue	0.2	
dark pink	0.4	1.00
dark blue	0.5	

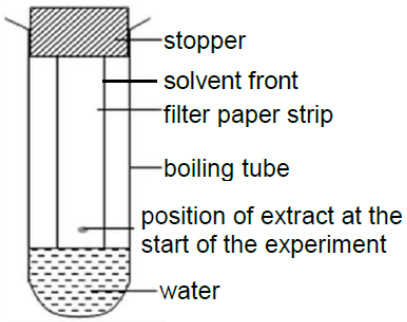
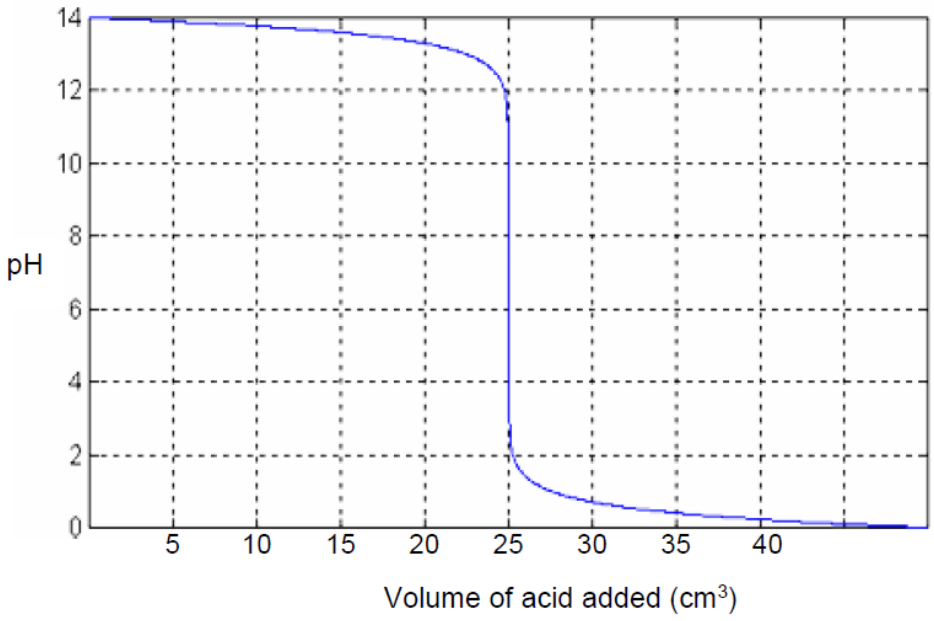


Fig. 3.3

Given that the distance travelled by the dark pink dye is 1.00 cm, complete the table above by stating the distance travelled by the light blue and dark blue dyes. [2]

(c) Graph 3.4 below shows how pH values changed during a titration when an acid was added from a burette into an alkali. A few drops of elderberries extract were added at the start of titration to monitor the pH of the solution.



Graph 3.4

(i) Based on the graph, state and explain whether the alkali used in the reaction is a strong alkali.

……

……

…….. [2]

(ii) State the colour of the elderberries extract when the volume of acid added was;

20 cm^3 ……

30 cm^3 ……

[2]

[Total: 7]

[Turn over

4 Copper(II) sulfate is used as a fungicide to control the growth of fungus in grapes and other kinds of berries.

Mixed with lime, it forms the Bordeaux mixture as shown below. This mixture is then added to plants to control fungus.

$$CuSO_4 + Ca(OH)_2 \rightarrow Cu(OH)_2 + CaSO_4$$

(a) There are three parts in the making of copper(II) sulfate from copper metal.

1. Copper metal is heated in hot air to form a base.
2. The base is then added in excess to an acid to form copper(II) sulfate.
3. A process is then used to separate the excess base from copper(II) sulfate solution.

(i) State the chemical formula of the base and acid used in the making of copper(II) sulfate.

…….. [2]

(ii) What is the process used in separating the excess base from the mixture?

…….. [1]

(iii) Sodium sulfate should not be made using the same method as copper (II) sulfate. Explain why, with reference to the steps listed in **(a)** above.

.....

…….....

…….....

…….. [2]

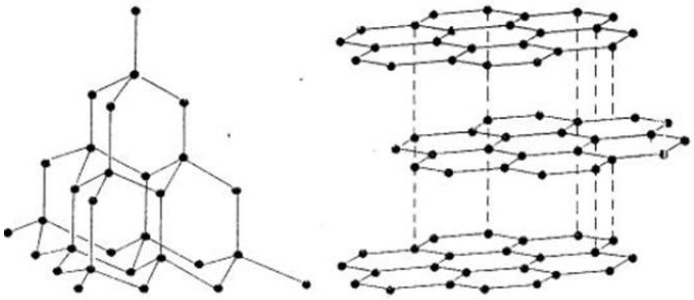
(b) Besides its ability to control fungus, the Bordeaux mixture provides an additional benefit to plants.

Determine, from its composition, what is the additional benefit.

…… [1]

[Total: 6]

5 The figure below shows the structures of diamond and graphite.
Both are giant molecular structure of carbon atoms.



(a) Describe how a simple molecular structure differs from a giant molecular structure.

……...

…… [2]

(b) Diamonds are used as drill tips as they are very hard.
With reference to the bonding and structure of diamond, explain why diamonds are very hard.

……...

……...

……...

…… [2]

(c) Graphite is used as a lubricant for engines.
With reference to the structure and bonding of graphite, explain why graphite is used as a lubricant.

……...

……...

……...

…… [2]

(d) Other than its exceptional hardness of diamond, state **two** other physical properties of diamond.

……...

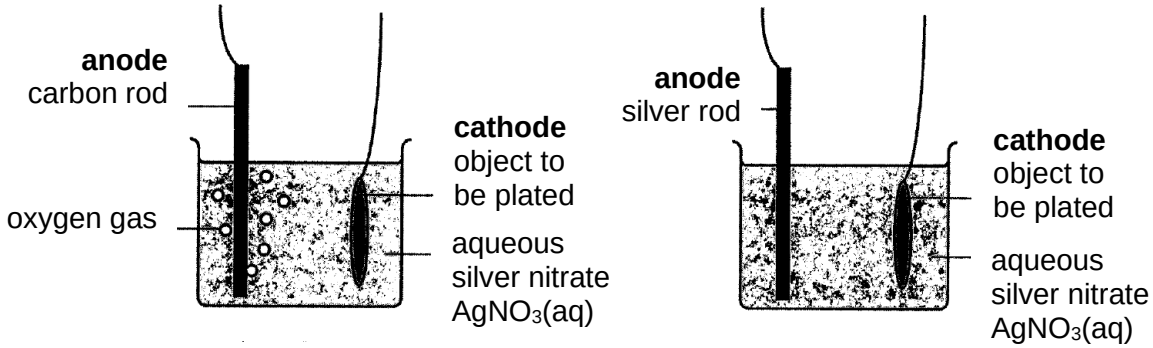
……...

……...

…… [2]

[Total: 8]

6 A student sets up two different experiments for electroplating an object with silver.



Experiment 1 Experiment 2

(a) Write equations, with state symbols, to show the reactions that take place at the anode and cathode during each experiment.

experiment 1

anode: ……

cathode: ……

experiment 2

anode: ……

cathode: ……

[3]

(b) At the beginning of each experiment the student removes a sample of the electrolyte, aqueous silver nitrate, and puts it in a test-tube.

(i) The student then adds a few drops of aqueous sodium chloride to the sample.

Describe and explain what the student sees.

Include an ionic equation in your answer.

…….

……

…….. [2]

(ii) After some time, the student observes that no more silver is being deposited on the object in experiment 1 but more silver is still being deposited on the object in experiment 2.

Suggest a reason for this observation and describe how he could use aqueous sodium chloride to find out if his reasoning is correct.

…….

……

…….

…….

…….. [3]

(c) If an iron object is placed in a beaker of aqueous silver nitrate, a silver coating forms on the iron.

If a gold object is placed in a beaker of aqueous silver nitrate, no reaction takes place.

Explain these two observations.

……..

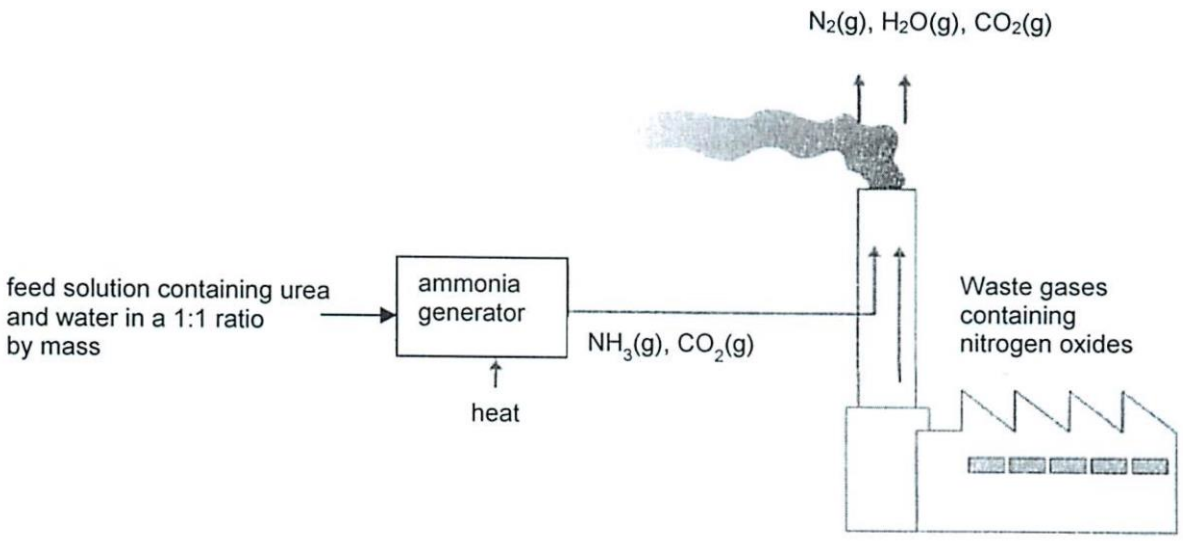
……..

…… [2]

[Total: 10]

[Turn over

7 Ammonia generated in a small-scale ammonia generator is used to treat waste gases containing nitrogen oxides. This treatment converts nitrogen monoxide to nitrogen and water.



(a) **(i)** Construct a chemical equation for the reaction between nitrogen monoxide and ammonia.

…….... [1]

(ii) Based on the reactants and products in **(a)(i)**, discuss the advantages and disadvantages of using the ammonia generator on the environment.

…….

…….

…….

…….

…….

……. [3]

(b) Decomposition of ammonia occurs at a high temperature

Explain, in terms of collisions between particles, why increasing the temperature of the ammonia generator is necessary.

……....

……....

……....

……....

……....

…….. [3]

(c) Draw the 'dot-and-cross' diagram of ammonia gas. Include only the valence electrons.

[2]

[Total: 9]

- - - - End of Section A - - - -

8 Covalent bonds are a result of the sharing of an electron pair between two atoms. The two atoms are bonded due to the electrostatic forces of attraction between the nuclei of the atoms and the shared electrons.

Table 8.1 lists the bond energy and bond length of some covalently-bonded atoms.

Table 8.1

bond	bond energy / kJ/mol	bond length / pm
H – H	435	74
H – C*l*	431	127
H – Br	366	141
H – I	299	161
C*l* – C*l*	243	198
Br – Br	193	228
I – I	149	267
C – C	331	154
C = C	590	134
C ≡ C	812	120

Bond energy is a measure of the strength of the bond and the amount of energy required to break one mole of a particular covalent bond. Bond length is the distance between the nuclei of two atoms that are covalently bonded to each other.

Bond length is also affected by the atomic size of atoms. Table 8.2 shows the atomic size of some atoms.

Table 8.2

element	H	F	C*l*	Br	I
atomic radius /pm	53	147	175	185	198

Bond energy is a factor affecting reactivity of a molecule. Reactivity of Group VII halogens changes down the group. Hydrogen halides are formed when halogens react with hydrogen.

Table 8.3 shows some information about the reactions of halogens with hydrogen to form hydrogen halides.

Table 8.3

reaction	observation	enthalpy change/ KJ/mol	percentage of hydrogen halide that decompose at 1000°C / %
$H_2 + Cl_2 \rightarrow 2HCl$	reacts explosively in sunlight but reacts slowly in the dark	–185	negligible
$H_2 + Br_2 \rightarrow 2HBr$	reacts in sunlight and on heating with platinum		0.5
$H_2 + I_2 \rightleftharpoons 2HI$	reacts very slowly on heating with platinum	26	33

(a) Using information from Table 8.1, describe two factors, other than atomic size of atoms, that affect bond length.

Explain how one of the factors stated affects bond length.

……...

……...

……...

……...

……...

……...

……...

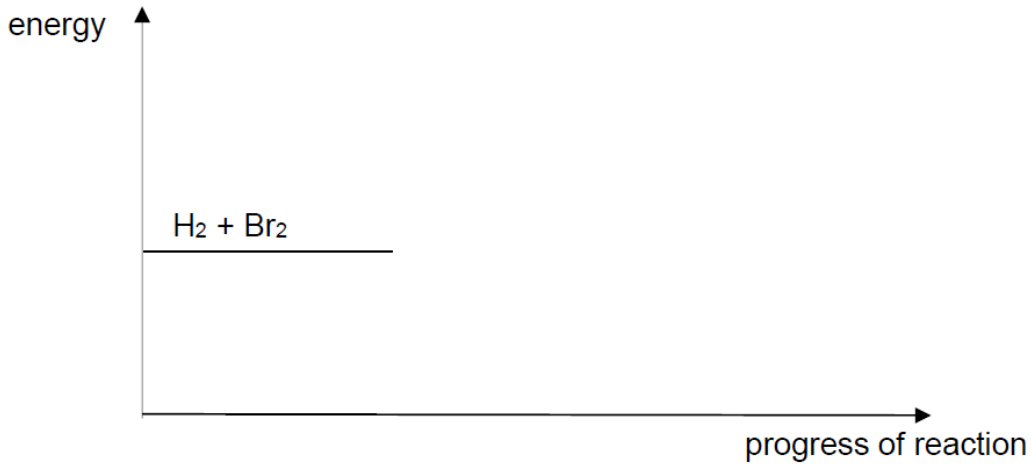
…….. [4]

(b) **(i)** Using information provided, calculate the enthalpy change of the reaction between bromine and hydrogen.

[1]

(ii) Complete the energy profile diagram for the reaction between bromine and hydrogen. Your diagram should include:

- the calculated enthalpy change of reaction from (c)(i)
- the activation energy



[2]

(c) State and explain three differences in the reaction of iodine with hydrogen and reaction of chlorine with hydrogen.

……...

……...

……...

……...

……...

…… [4]

(d) Estimate the value for bond length in HF.

…… [1]

[Total: 12]

9 The extract below was found from a brochure about the extraction of gold from Waihi Gold Mine, New Zealand.

Gold ore is first loaded into a S.A.G. (semi-autonomous grinding) mill with hardened steel balls, lime and water. The tumbling action grinds the ore into fine powder.

The resulting slurry is fed into large leach tanks where a weak sodium cyanide (NaCN) solution is added to dissolve the gold into gold(I) ions. The slurry then passes through tanks containing activated carbon granules where the gold(I) ions are adsorbed onto the carbon.

The loaded carbon is screened out of the adsorption tanks and sent to an elution column where the carbon is washed with super-heated water to remove the previous metals. The washed solution, called pregnant electrolyte, is passed through a series of electrowinning where gold is deposited onto stainless steel cathodes. The cathodes are rinsed to yield a muddy sludge which is dried to a powder, mixed with fluxes and put into the furnace. The fluxes help to form a slag of impurities, leaving behind 99% pure gold.

(a) Explain why the ore is grinded to fine powder.

…… [1]

(b) The chemical equation between sodium cyanide solution and the gold present in the ore is shown below.

$$4Au + 8NaCN + O_2 + 2H_2O \rightarrow 4Na[Au(CN)_2] + 4NaOH$$

(i) State the oxidation state of gold in $Na[Au(CN)_2]$.

…… [1]

(ii) Explain, in terms of oxidation states, why the reaction is a redox reaction.

……..

……..

……..

……..

…… [2]

(c) Electrowinning, also called electroextraction, is the electrodeposition of metals from their ores that have been put in solution or liquefied using an inert anode.

Based on your understanding of electroplating, state one difference between electroplating and electrowinning.

……...

…… [1]

(d) Table 9.1 shows some examples of gold alloys and their respective alloy compositions.

Table 9.1

type of gold alloy	alloy composition
rose gold	75% gold; 20% copper; 5% silver
white gold	75% gold; 25% platinum
purple gold	80% gold; 20% aluminium

Explain, in terms of arrangement of particles, why gold alloys are used to make jewelry instead of pure gold.

Include a labelled diagram to support your answer.

……...

……...

……...

……...

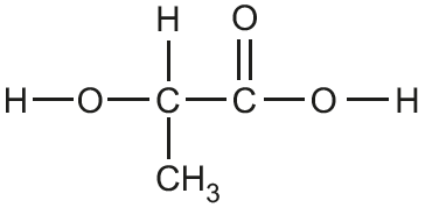
…… [3]

[Total: 8]

Section B (10 marks)

Answer **one** question from this section.

10 Lactic acid has a pH of 3.5. It can be used to make poly(lactic acid), a biodegradable polymer. The structure of lactic acid is shown below.



(a) **(i)** Suggest what is meant by the term biodegradable.

……

…….. [1]

(ii) Draw the full structural formula of poly(lactic acid).

[2]

(iii) A factory uses 500 tonnes of lactic acid to make poly(lactic acid). Explain why the mass of poly(lactic acid) made is less than 500 tonnes even when the percentage yield is 100%.

……

…….. [1]

(iv) Calculate the mass of poly(lactic acid) produced from 500 tonnes of lactic acid.

[2]

(b) Lactic acid reacts with ethanol to form an ester.

(i) State the conditions needed to form an ester.

…….. [1]

(ii) Draw the structural formula of the ester produced by the reaction of lactic acid with ethanol.

[1]

(c) When equal mass of potassium carbonate is added to same concentration and volume of lactic acid and hydrochloric acid, the rate of reaction differs.

Explain why.

……...

……...

……...

……. [2]

[Total: 10]

11 One of the components in crude oil is undecane, $C_{11}H_{24}$.

This molecule may be broken down to give 2 molecules of butene and one other product.
The reaction is carried out in the oil refinery.

(a) What is the name of this type of reaction?

…… [1]

(b) Construct a balanced chemical equation for this reaction.

Hence, name the other product formed in this reaction besides butene.

……...

…… [2]

(c) When the reaction is carried out, 1.00 mol of undecane produces 50.4 g of butene.

Calculate the percentage yield of butene.

[2]

(d) Butene can exist as 3 isomers. One isomer of butene is shown in Figure 11.1.

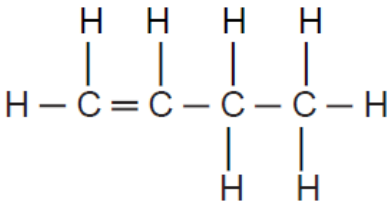


Figure 11.1

Draw the structures of the other **two** isomers of butene.

[1]

[1]

(e) The isomers of butene can undergo addition polymerisation.

Draw the structure of the polymer formed by any **one** of the isomers in **part (d)**, showing three repeating units.

[2]

(f) Butanol is manufactured by the reaction between steam and butene.

Two isomers of butanol which are miscible are formed at the same time.

State and explain the separation technique suitable for separating the components of the mixture.

……...

……...

…….. [2]

[Total: 10]

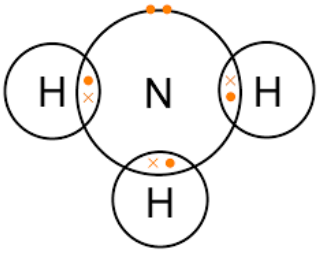
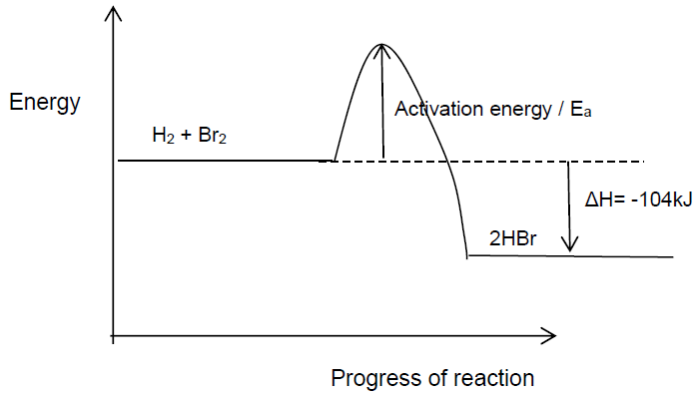
- - - - End of Section B - - - -
- - - - End of paper - - - -

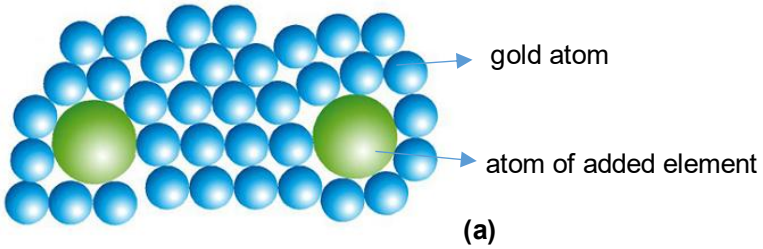
Monfort 6092 Prelim 2024

P2 Section A

	Suggested answers		marks
1	(a)	N	[1]
	(b)	He/ Ne/ Ar/ Kr	[1]
	(c)	O	[1]
	(d)	F/Cl/Br	[1]
	(e)	Br/Kr	[1]
	(f)	N	[1]
2	(a)	The lower the relative mass, the shorter the time for diffusion of $100cm^3$ of the gas. Example: Chlorine, having a higher relative mass of 71, than carbon monoxide, which has a lower relative mass of 28, has a longer diffusion time.	[1] [1]
	(b)	132s	[1]
	(c)	Ammonia is very soluble in water and will dissolve in water.	[1]
3	(a)	pink	[1]
	(b)	0.5 1.25	[1] [1]
	(c)	It has a high pH of 14, therefore It is a strong alkali as this indicates a high concentration of hydroxide ions.	[1] [1]
	(d)	Blue Pink	
4	(a)(i)	CuO H_2SO_4	[1] [1]
	(ii)	Filtration	[1]
	(iii)	sodium metal will be too explosive in oxygen to be heated up in hot air to form sodium oxide. In addition, sodium oxide is soluble in water and will not be filtered off in step 3.	[1] [1]
	(b)	It can reduce acidity in soils.	[1]
	(e)		[2]
5	(a)	A simple molecular structure consists of small discrete molecules held together by weak intermolecular forces of attraction. A giant molecular structure consist of atoms joined together by strong covalent bonds throughout the structure.	[1] [1]

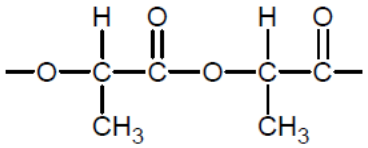
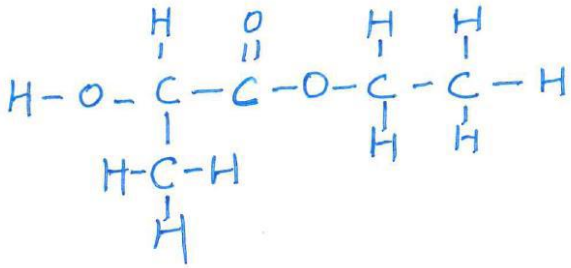
	(b)	Diamond consists of carbon atoms covalently bonded throughout its giant molecular structure. a large amount of energy/force to is needed to break the strong bonds. Hence diamond is very hard.	[1] [1]
	(c)	graphite is made up of flat hexagonal layers of carbon held together by weak intermolecular forces of attraction. the layers of carbon can easily slide over one another when a force is applied. hence graphite is used as a lubricant.	[1] [1]
	(d)	Very high melting and boiling points Does not conduct electricity	[1] [1]
6	(a)	experiment 1 anode: $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$ cathode: $Ag^+(aq) + e^- \rightarrow Ag(s)$ experiment 2 anode: $Ag(s) \rightarrow Ag^+(aq) + e^-$ cathode: $Ag^+(aq) + e^- \rightarrow Ag(s)$	 [1] [1] [1]
	(b)(i)	A **white precipitate** is observed as silver chloride is insoluble in water $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$	[1] [1]
	(ii)	Silver ions in experiment 1 has all be **reduced/discharged** to form silver metal while in experiment 2, the silver anode **oxidises to form silver ions** which increases the **supply** of silver ions in the solution compared to experiment 1 A white precipitate of silver chloride would be observed in experiment 2 only when sodium chloride is added to test for silver ions.	[1] [1] [1]
	(c)	Iron is **more reactive** than silver in the reactivity series of metals, thus it is able to **displace** silver from aqueous silver nitrate/ Gold is less reactive than silver in the reactivity series of metals, thus is it unable to displace silver from aqueous silver nitrate	[1] [1]
7	(a)(i)	$6NO + 4NH_3 \rightarrow 5N_2 + 6H_2O$	[1]
	(ii)	Advantage: NO is removed which can react with moisture and air (or water and oxygen) to form nitric acid which dissolves in water; to form acid rain which corrodes limestone buildings/kills aquatic life; Disadvantage: CO_2 is released which is a greenhouse gas which leads to climate change that leads to melting ice caps that could result in rising sea levels / (any effects of climate change)	[1] [1]
	(b)	Increasing the temperature increases kinetic energy of particles and move faster. In addition, particles collide with energy equal or more than the activation energy required for the reaction.	[1] [1]

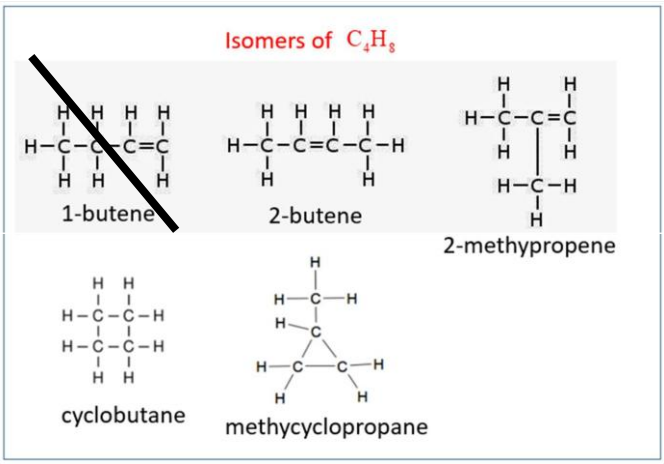
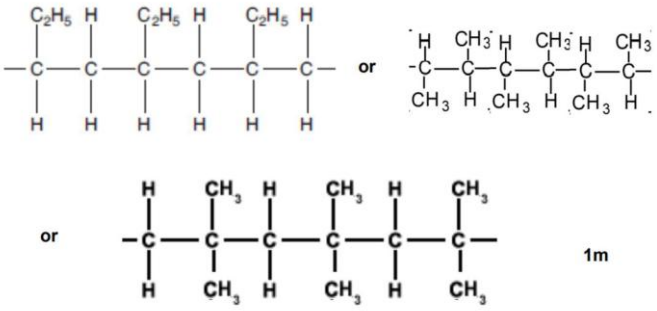
		This increases the frequency of effective collision which increases rate of reaction;	[1]
	(c)		[2]
8	(a)	**(a)** The greater the number of bonds between two atoms, the smaller the bond length. (Can be substituted with Group 17 trend/Can use data on Grp 17 for answering/relative mass as alternative) The bond length decreases from 154pm to 120pm when the number of bonds increase from C-C to C≡C. **(b)** As the bond energy decreases, the bond length increases. As bond energy decreases from 431kJ/mol to 299kJ/mol from H–Cl to H–I, bond length increases from 127pm to 161pm. **(c)** As the number of bonds increase, more energy is absorbed to break the bonds. **(d)** This increases the bond energy of the atoms. OR **(c)** increase in atomic radius down Group 17 results in the decrease of the strength of the electrostatic attraction of attraction. **(d)** This lowers the bond energy. *ΔH* = Energy absorbed during bond breaking – Energy released during bond forming = (435 + 193) – 2 x 366 = -104 kJ	[1] [1] [1] [1] / [1] [1]
	(b)(i)		
	(b)(ii)		[2]
	(c)	**(a1)** Reaction of iodine with hydrogen is slower/requires catalyst]than the reaction of hydrogen with chlorine	[1]

		(a2) because chlorine is more reactive than iodine. **(b1)** Reaction of iodine with hydrogen is **exothermic** and the reaction of hydrogen with chlorine is **endothermic** **(b2)** because the **energy absorbed for bond breaking of the chlorine and hydrogen is less than the energy released from bond forming of the hydrogen chloride while the opposite is true for iodine.** **(c1)** Reaction of iodine with hydrogen is **reversible** and the reaction of hydrogen with chlorine is not/ Reaction of iodine with hydrogen produced a halide which decomposes at high temperature while reaction of chlorine produced a halide that does not decompose at high temperature. **(c2)** because **hydrogen iodide is thermally less stable** as compared to hydrogen chloride hence it breaks down easily to form hydrogen and iodine.	[1] [1] [1]
	(d)	91 pm (accept 87 to 107pm)	[1]
9	(a)	To increase the **total surface area (to volume ratio)** of the gold particles so as to increase the **rate** at which the gold dissolves in the cyanide solution.	[1]
	(b)(i)	+1	[1]
	(ii)	**(a)** Gold is oxidised as the oxidation state of gold increased from 0 in Au to +1 in gold ion / Na[Au(CN)2]. (e.c.f. allowed **(b)** Oxygen is reduced as the oxidation state of oxygen decreased from 0 in O_2 to –2 in NaOH. Since oxidation and reduction occurred simultaneously, the reaction is redox.	[1] [1]
	(c)	Any one of the following: • The anode in electroplating is made of gold while the anode in electrowinning is made of an inert material. • The concentration of gold(I) ions in the electrolyte decreases in electrowinning but the concentration of gold(I) ions in the electrolyte remains the same in electroplating.	[1]
	(d)	 **(a)** Atoms of the added element have a different atomic size compared to the gold atoms. **(b)** This disrupts the orderly arrangement of atoms in the gold metal.	[1]

		(c) The atoms of different sizes cannot slide over one another easily, making the gold alloy harder/stronger.	[1] [1]

Section B

10	Either		
	(a)(i)	can be decomposed naturally / can be broken down by bacterial action.	[1]
	(ii)		[2]
	(iii)	Poly(lactic acid) is make by condensation polymerisation, besides the polymer, small molecules (water) is also formed.	[1]
	(iv)	No of mol of lactic acid = 500 x 10^6/ 90 = 5.555 x 10^6 mol During condensation polymerisation, there is a remove of a mole of water molecules from 1 mole of acid. Therefore mass of water formed from 500 tonnes = 5.555 x10^6 mol x18g/mol = 99.99 x 110^6 g Mass of poly(lactic acid) = 500 tonnes – 99.99 tonnes = 400 tonnes	[1] [1]
	(b)(i)	concentrated sulfuric acid as a catalyst.	[1]
	(ii)		[1]
	(c)	The rate of reaction in hydrochloric acid is faster. Hydrochloric acid is a **strong acid** and lactic acid is a **weak** acid, so for equal concentration and volume of hydrochloric acid give a **higher number /concentration of hydrogen ions** in hydrochloric acid than lactic acid This leads to a faster rate of reaction.	[1] [1]

10	Or		
	(a)	Cracking	[1]
	(b)	Propane $C_{11}H_{24} \rightarrow 2C_4H_8 + C_3H_8$	[1] [1]
	(c)	Moles of $C_{11}H_{24}$ = Mole of butene = 1 x 2 = 2 mol Mass of butene = 2 x (12 x 4 + 8) = 112 g % yield of butene = (50.4 ÷ 112) x 100% = 45% [Allow ecf]	[1] [1]
	(d)		
	(e)	 or or 1m	[2]
	(f)	Method : fractional distillation [Reject : distillation] Reason : Isomers have different boiling points.	[1] [1]