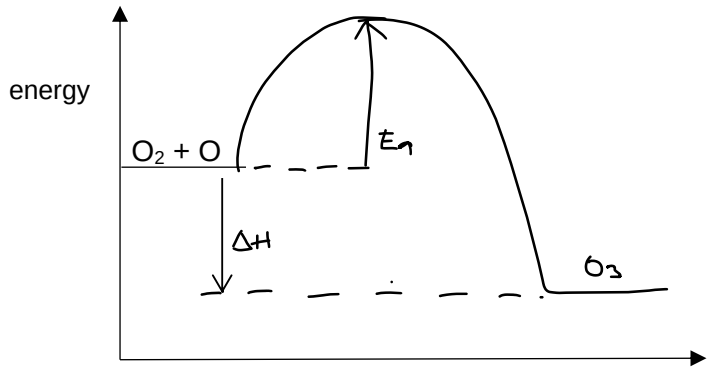
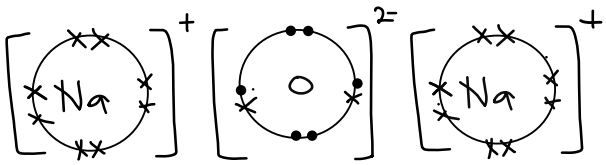
ZHENGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
SECONDARY FOUR EXPRESS
CHEMISTRY

6092/02

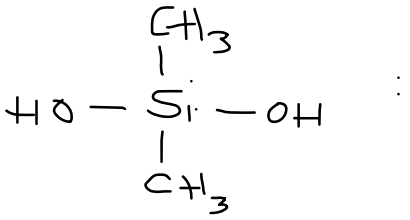
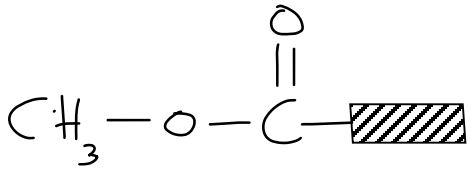
MARKS SCHEME

1	**a** combustion **b** precipitation **c** electrolysis **d** rusting	1 1 1 1
2ai	*in correct order:* methane nitrogen oxygen argon	1
2aii	gases with lowest atomic/molecular mass diffuse fastest. (OR *gases with highest atomic/molecular mass diffuse slowest*) argon will diffuse the slowest since its A_r is the lowest at 40, followed by oxygen (M_r = 32) and nitrogen (M_r = 28) and methane will diffuse the fastest since it has the lowest M_r of 16 (A: *shows trend without stating A_r or M_r)*	1 1
2b	when temperature is constant, particles of all gases have the **same average kinetic energy** (OR *at different temperatures, particles will have different average kinetic energy)* constant temperature ensures results of the experiment is **dependent solely on the molecular mass of the gases**.	1 1
2c	helium / hydrogen	1
2d	ammmonia is **very soluble in water,** hence would dissolve instead of diffuse towards the diffusion plug.	1
3a	carbon can **reduce silicon oxide to silicon**, hence, silicon is less reactive than carbon. **aluminium oxide cannot be reduced to aluminium** by carbon, hence aluminium is more reactive than carbon hence **aluminium is more reactive** than silicon.	1 1
3b	*make references about the (correct) type of bonding & structure present in each molecule* *link to amt of energy needed and hence, the melting point* *make references about presence of (correct) mobile charged particles* *link to ability to conduct electricity*	1 1 1 1

	CO is a covalent compound with simple molecular structure. smaller amount of energy is needed to overcome the weak intermolecular forces of attraction between the molecules, this its low melting point. SiO_2 is a covalent compound with giant molecular / covalent structure. large amount of energy is needed to overcome the strong covalent bonds between silicon atoms and oxygen atoms thus, its very high melting point. Al_2O_3 is an ionic compound with giant ionic / crystal lattice structure. Large amount of energy is needed to overcome strong electrostatic forces of attraction between aluminium cations and oxide anions. Thus, its high melting point. Both CO and SiO_2 cannot conduct electricity as both have no mobile charged particles as all the valence electrons are used up for bonding. In molten state, the giant ionic / crystal lattice structure of Al_2O_3 breaks down, hence there are free moving aluminium cations and oxide anions to conduct electricity.	
4a	*calculate no. of moles of K, Cu and Cl* no. of mole K = 31.5 ÷ 39 no. of mole Cu = 25.6 ÷ 64 no. of mole Cl = 42.9 ÷ 35.5 *calculate simplest ratio by dividing with smallest no. of moles (Cu)* empirical formula: K_2CuCl_3	1 1 1
4b	27; 29; 37	1
4c	$F_2 + CuCl_2 \rightarrow CuF_2 + Cl_2$ fluorine is **more reactive** than chlorine; **displaces** chlorine from copper(II) chloride	1 1
5ai	No. of moles of zinc = 1.65 ÷ 65 mole ratio= 1:1 vol. of H_2 = (1.65 ÷ 65) x 24 = 0.609 dm^3	1 1
5aii	**different atomic mass** of Zn and Fe; **different number of moles** for the same mass	1
5b	add a few drops of aq. sodium hydroxide / aq. ammonia until in excess. white precipitate of zinc(II) hydroxide is observed.	1 1

6ai	energy **absorbed** in **bond breaking** of O_2 is **less** than the energy **released** in the **bond forming** of O_3.	1
6aii	no of moles of oxygen = 48 x 16 × 2 = 1.5 mol energy released = 1.5 x 392 = 588 kJ	1 1
6aiii	 correct shape of graph 1 products shown 1 Ea and ΔH labelled 1	
7a	 draw 2 ions with correct charges 1 correct number of electrons 1	
7b	universal indicator turns blue as sodium oxide is an alkali / basic oxide	1 1
7c	$4Na + O_2 \rightarrow 2Na_2O$	1
7di	no. of moles of Na = 0.8 ÷ 23 no. of moles of Na_2O = = (0.8 ÷ 23) ÷ 2 Mass of Na_2O = 0.4 g	1 1
7dii	actual mass of Na_2O = 10.55 – 10.2 = **0.35g** percentage yield = (0.35 – 0.4) x 100 % = **87.5%**	1 1

8a	**partial dissociation** of **weak acid**, ethanoic as compared to **full dissociation** of **strong acid**, hydrochloric higher concentration of **H^+ ions per unit volume** in hydrochloric than in ethanoic acid leading **to increased frequency of effective collisions**, **higher speed of reaction** in experiment 1 than in experiment 3	1 1 1

8b	experiment 1, time taken for experiment 4 will be **less than 3 minutes.** at higher temperature, reacting particles in experiment 4 has **higher kinetic energy and move at higher speeds**. leading to **increased frequency of effective collisions, higher speed** in reaction experiment 4 than experiment 1.	1 1 1
9a	A reaction in which monomers react with each other and in the process, release a small molecule like water or alcohol	1
9b		1
9c	saturated as it does **not** have any **carbon – carbon double** bond. add a few drops of **aq. bromine**; bromine **remains reddish-brown** in a sample of siloxanes	1 1
10a	One molecule contains **three ester linkages.**	1
10bi		1
10bii	carbon dioxide released by combustion of biodiesel is **offset** by the **carbon dioxide absorbed by the plants** in which **the cooking oil** is made from.	1

10c	average vol. of KOH used = 21.55 cm^3 Mass of KOH used for 10.0 g of oil = 1 x (21.55 / 1000) = 0.02155 g Mass of KOH needed for 1 kg of oil = 0.02155 x 100 = 2.155 g	1 1 1
11a	Helium is a **noble gas** with a **stable electronic configuration** of 2. *OR* Helium has a **fully filled valence** electron **shell**. Hence, helium **does not need to gain, lose or share electrons** and will not react with other substances. (r: answers w/o explaining electrons)	1 1
11b	*Any two of the following:* • **Heating** is involved in both separation methods. • Both separation methods **separate miscible liquids**. • The substances with the **lower boiling point will be separated out / collected first** for both methods. *OR* Both separation methods are based on **difference** in **boiling points of the substances**.	1 1
11ci	Signal A – **toluene** Signal B – **mesitylene**	1
11cii	amount of toluene : amount of mesitylene = Signal A height : Signal B height = 3 : 5 Percentage amount of toluene = $^3/_8$ x 100% = 37.5 % Percentage amount of mesitylene = $^5/_8$ x 100% = 62.5 %	 1 1
11di	A **higher flow rate** will result in **shorter retention time.** For example, with hexane when the flow rate increases from **20 cm/min to 35 cm/min**, the retention time decreases from **5.54 min to 3.99 min**. *a: other relevant data from question*	1 1
11dii	The temperature is **above the boiling points** of both substances, hence **both substances evaporated** and are carried by the carrier gas together.	1

Section B

12a	• *describe reactions at both cathode and anode, includes correct half-equations and products* at cathode, hydrogen formed. $2H^+ (aq) + 2e^- \rightarrow H_2 (g)$ at anode, chlorine formed. $2Cl^- (aq) \rightarrow Cl_2 (g) + 2e^-$ • *explained changes to pH of the solution during electrolysis* pH of the solution **increases.** **sodium ions and hydroxide ions remain** in the solution resulting in an **alkaline** solution. • *explained change in the difference in vol. of gases* initially, less chlorine than hydrogen as **chlorine is more soluble in wate**r as compared to hydrogen, hence chlorine gas dissolved over time, **chlorine stops dissolving** as the solution is already **saturated** with it.	 1 1 1 1 1 1
12bi	The voltmeter reading will **decrease** as **the difference in the reactivity between iron and copper is lower than the difference in reactivity between zinc and copper.**	1 1
12bii	The **direction of the flow of electron** is **reversed** as the **electrons flowed from copper metal to silver metal** instead.	1 1

<table>
<tr><td>13a</td><td>

- *describe any physical changes that occurred to each electrode*
- *explain, with the use of half-equations, why the changes at each electrode occurred*

anode (pure gold electrode) **decreased in** size (became smaller)

oxidation occurred at the anode in which the **gold metal oxidised** to form **gold ions** which entered the solution. Au(s) → Au^{+}(aq) + e-

the cathode (spoon) **increased** in size (became bigger)

reduction occurred at the cathode in which the **gold ions is discharged and reduced to form gold metal** around the spoon. Au^{+}(aq) + e- → Au(g)

- *explain how the concentration of the solution changed during electrolysis*

initially, less chlorine than hydrogen as **chlorine is more soluble in wate**r as compared to hydrogen, hence chlorine gas dissolved

over time, **chlorine stops dissolving** as the solution is already **saturated** with it.

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<tr><td>13b</td><td>

Gold would be deposited at the cathode initially,
as **gold is less reactive than hydrogen and sodium**, hence gold ions were **preferentially discharged.**

Over time, **hydrogen gas** would be produced,
as when the **concentration of gold ions in the electrolyte decreases to zero**, hydrogen ions would then be **discharged preferentially over sodium ions**.

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<tr><td>13c</td><td>

element	oxidation state in $NaAu(CN)_2$
carbon	+2
gold	+1
nitrogen	
sodium	+1

[2] for 3 correct, [1] for 1 – 2 correct

</td><td>2</td></tr>
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