MARK SCHEME for SKSS 2024 4E Chemistry Prelim Paper 1 & 2

PAPER 1 [40 marks]

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

PAPER 2
Section A [70 marks]

1 *[This question mainly assesses students' memory work.]*
[accept if correct chemical formula is written each time]

(a) ethanol/water **[1]** **[accept if both are written]**
(b) calcium hydroxide **[1]**
(c) sulfur dioxide **[1]**
(d) aluminium nitrate **[1]**
(e) ammonia **[1]**
(f) methane **[1]**

2 *[This question is similar to the Specimen Paper Q4]*

(a) **[1m for each correct answer; max. of 2m]**
*Any **TWO** of the following answers:*
- forms/gives coloured compounds
- higher density
- higher melting and boiling point

[reject: good catalyst, variable oxidation states as these are not physical properties]

(b) **[1m for all correct number of electrons and protons; 1m for all correct number of neutrons; max. of 2m]**

	$^{52}_{24}Cr$	$^{53}_{24}Cr$
number of electrons	**24**	**24**
number of neutrons	**28**	**29**
number of protons	**24**	**24**

(c) **(i)** $2Cr_2O_3(s) + 3C(s) \rightarrow 4Cr(s) + 3CO_2(g)$ **[1]**
[reject if the coefficients are not in the simplest form]

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[Note to marker: All state symbols must be written correctly to be awarded 1m if students choose to include in the balanced chemical equation.]

(ii) Amphoteric oxide can react with both acids and bases while acidic oxide can only react with bases. **[1]**

*Any **ONE** of the following equations:*

- $Cr_2O_3 + 6HCl \rightarrow 2CrCl_3 + 3H_2O$ ***OR*** with any other acids
- $CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$ ***OR*** with any other bases **[1]**

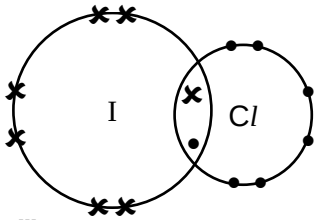
[Note to marker: It is **not** within the syllabus for students to write the chemical equation of chromium(III) oxide with a base as complex ions are formed.]

(d)

- crystal dissolves **[1]**
- *(idea of collision)* particles collide / particles bounce off each other **[1]**
- *(idea of diffusion)* particles move further apart / particles move/diffuse from higher concentration to lower concentration / movement of particles down a concentration gradient **[reject the word 'spread' to describe diffusion as this word is already seen in the question]** **[1]**

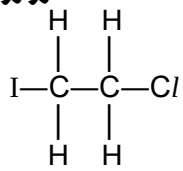
(e) **[1m for every 2 correct order of arrangement; max. of 2m]**
(most reactive) sodium, lanthanum, nickel, mercury (least reactive)

3 **(a)**



[1]

(b) **(i)**

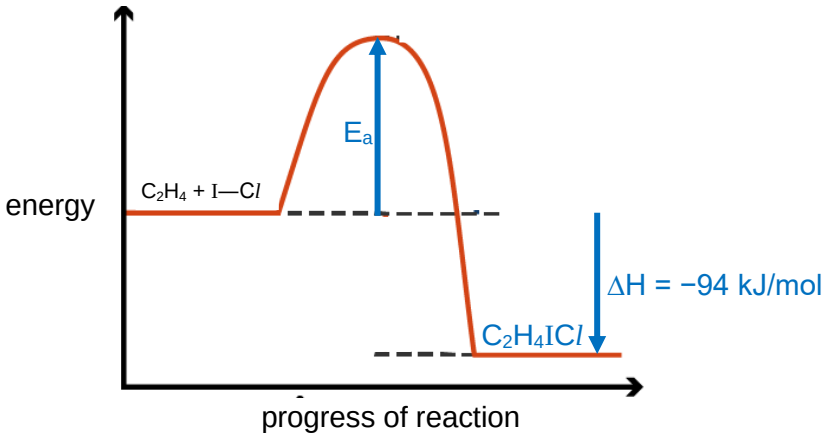


[1]

(ii) $\Delta H_{bond\ breaking} = 614 + 4(413) + ? = (2266 + ?)$ kJ
$\Delta H_{bond\ forming} = 240 + 4(413) + 348 + 328 = 2568$ kJ
$\Delta H_{bond\ breaking} - \Delta H_{bond\ forming} = -94$
$2266 + ? - 2568 = -94$ **[1m with correct working]**
$? =$ 208 kJ/mol **[1m with correct unit]**

(iii) *[This part of the question is similar to Specimen Paper, Q9(d)]*
[1m for showing energy of reactants is more than products; 1m for showing E_a and correctly labelled with single-headed arrow pointing in the correct direction (upwards); 1m for indicating correct chemical formula of product (allow ecf from (b)(i)); max. of 3m]

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(c) **(i)** Substituition **[accept minor spelling error]** **[1]**

(ii) $C_2H_6 + ICl \rightarrow C_2H_5Cl + HI$ **[1]**

4 **(a)** Volume of CO_2 present in clean, dry air = $\frac{0.04}{100} \times 480$
= 0.192 dm^3

No. of moles of CO_2 = $\frac{0.192}{24}$ = <u>0.008 mol.</u> **[1]**

No. of molecules of CO_2 = $0.008 \times 6.02 \times 10^{23}$
= 4.816×10^{21} = = <u>4.82×10^{21} (3 s.f.)</u> **[1]**

(b) **(i)**

	C	H
mass / g	85.7	14.3
A_r	12	1
No. of mol	$\frac{85.7}{12} = 7.142$	$\frac{14.3}{1} = 14.3$
ratio	$\frac{7.142}{7.142} = 1$	$\frac{14.3}{7.142} = 2.00$

[1]

∴ empirical formula = CH_2

(ii) Relative molecular mass of CH_2 = 12 + 1 + 1 = 14

n × 14 = 128.25

n = 9.16 ≈ 9

∴ molecular formula = $(CH_2)_9 = C_9H_{18}$ **[1]**

(iii) Equation: $2C_9H_{18} + 27O_2 \rightarrow 18CO_2 + 18H_2O$ **[1]**

Note to marker: There are two solutions to this part of the question.

<u>Solution 1</u>

No. of moles of C_9H_{18} present
= $\frac{1000}{(12\times9)+(1\times18)}$ = 7.9365

Mole ratio = C_9H_{18} : CO_2
= 2 : 18
=7.9365: 71.42857

Vol. of CO_2 = 71.42857 × 24
= 1710 dm^3 (3 s.f.)

<u>Solution 2</u>

No. of moles of C_9H_{18} present
= $\frac{1000}{128.25}$ = 7.79727 **[1]**

Mole ratio = C_9H_{18} : CO_2
= 2 : 18
=7.79727: 70.175

Vol. of CO_2 = 70.175 × 24
= 1680 dm^3 (3 s.f.) **[1]**

(c) **(i)** *Any **ONE** of the following answers:*

- Desertification of fertile land would lead to the amount of food that can be produced globally to decrease. **[1]**

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- High temperatures from more frequent and severe heat waves can be fatal.
- Ocean warming can cause commercially-important fish population to be depleted.
- Melting of polar ice caps can cause sea levels to rise and permanently flood coastal areas.

[reject: cause climate change / melt ice caps / cause death]

(ii) Carbon dioxide, a greenhouse gas, traps heat within the Earth's atmosphere. **[1]**

This leads to the increase in the average temperature of the Earth's surface. **[1]**

(d) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

5 (a) (i) Peroxodisulfate ions act as an oxidising agent. **[No mark is awarded unless explanation is correct.]**

It causes iodide ions to be oxidised to iodine due to an increase in oxidation state of iodine from −1 to 0. **[1]**

(ii) *[data analysis: inference]*

Peroxodisulfate ions: Comparing experiment 1 and 2 / 2 and 3, rate of reaction increases by twice/doubles when concentration of peroxodisulfate ions doubles with the same concentration of iodide ions at 0.02 mol/dm^3. **[1]**

Iodide ions: Comparing experiment 1 and 4 / 4 and 5, rate of reaction increases by twice/doubles when concentration of iodide ions doubles with the same concentration of peroxodisulfate ions at 0.008 mol/dm^3. **[1]**

[reject if the experiment numbers and concentrations are not quoted]

(iii) The presence of a catalyst provides an alternative pathway of lowering/decreasing activation energy, allowing more colliding particles to have energy greater than or equal to activation energy. **[1]**

This increases the frequency/rate of effective collisions and the rate of reaction. **[1]**

(b) (i) *[data analysis: inference and deduction, supported by scientific explanation]*

There are only 4 drops of halogenoalkanes used in experiment 1 as compared to 8 drops of halogenoalkanes used in experiment 2. **[1]**

[reject if number of drops is not quoted]

Lesser amount of reacting particles present per unit volume/in the same volume, resulting in lower frequency/rate of effective collisions hence slower rate of reaction. **[1]**

(ii) *[data analysis: describing trend]*

The more reactive the halogen, the slower the rate of reaction between a halogenoalkane and water. **[1]**

OR The less reactive the halogen, the faster the rate of reaction between a halogenoalkane and water.

(iii) At lower temperature, reactant particles have less kinetic energy and move slower. **[1]**

There are less reactant particles possessing energy that is greater than or equal to activation energy. **[1]**

This decreases the frequency/rate of effective collisions and the rate of reaction. **[1]**

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6 **(a)** Different forms of the same element of phosphorus with different structural arrangements of atoms. **[1]**
[reject if phosphorus is not stated]

(b) P_4 **[1]**

(c) **(i)** White phosphorus: simple molecular structure
Black phosphorus: giant (three dimensional) molecular structure

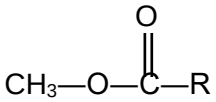
(ii) *[This part of the question requires students to memorise the correct scientific phrases to score.]*
[Marking point: 1m for stating the comparison of the melting points, that is low/lower VS high/higher m.p; 1m for stating the correct energy and type of force in white phosphorus; 1m for stating the correct energy and bond in black phosphorus; max. of 3m]
Little/Small amount of (thermal) energy is needed to overcome the weak intermolecular forces of attraction between the molecules of white phosphorus (in the simple molecular structure), hence has a low/lower melting point (of 44 °C).
Large/A lot of (thermal) energy is needed to break/overcome the strong, extensive covalent bonds between the phosphorus atoms (in the giant molecular structure), hence has a high/higher melting point (of 610 °C).

(d) *[Note: Students are to relate that the concept is similar to why graphite is soft.]*
Little/Small amount of energy is needed to overcome the weak forces of attraction between each layer **[1]**. Hence, the layers can be easily peeled off with the scotch tape delamination.

7 *[data-based question, reference from GCE O Level Chemistry 2018 P2B Q9]*

(a) **(i)** three ester linkages in one molecule / per molecule **[1]**

(ii)



[1]

(iii) Presence of acid in the waste vegetable oil will inactivate / make the catalyst ineffective / neutralise / remove KOH. **[1]**
This slows down / reduces / decreases the rate of reaction. **[1]**
Therefore, longer time is required for its conversion.

(b) **(i)** Amount of biodiesel present in 1kg of fuel = $\frac{20}{100} \times 1000 = 200g$
Amount of petroleum diesel present in 1kg of fuel = 800g **[1]**
Total estimated amount of energy produced = (43 × 800) + (37.8 × 200)
= 34400 + 7560
= 41960 kJ **[1]**

(ii) Biodiesel is biodegradable when released into the environment (e.g. oil spill) and produces less carbon monoxide as it is less likely to be involved in incomplete combustion compared to petroleum diesel. **[1]**
Biodiesel requires crops (e.g. corn) to be grown for fuel which is an alternative renewable energy source while petroleum diesel requires fossil fuel to be refined, which is a non-renewable energy source. **[1]**

(c) **(i)** **[1m for stating all three pollutants; 1m for stating the % reduction]**
Usage of biodiesel reduces the emissions of unburnt hydrocarbon, particulate matter and carbon monoxide **[1]**
by about 46% in total compared to using petroleum diesel. **[1]**

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OR reduces emissions of unburnt hydrocarbon by 20%, carbon monoxide & PM by about 26% - 28%.
[reject if data is not quoted]

(ii) As more biodiesel is burnt, more nitrogen oxides are produced / increases production of NO_x by 10%. **[1]**
Nitrogen oxides is a cause of acid rain, which will damage metallic and limestone structures / nitrogen oxides react with sunlight and other pollutants to produce ozone which damage crops. **[1]**

Section B [10 marks]
[Note to marker: Only mark Q8 if student attempts both questions in this section.]

8 (a) **[1m for 2 correct answers; 2m for 3 correct answers]**

element	oxidation state in $NaAu(CN)_2$
carbon	**+2**
gold	**+1**
nitrogen	−3
sodium	**+1**

(b) **(i)** Na^+, Au^+ and H^+ **[reject: sodium ions, gold ions and hydrogen ions]** **[1]**

(ii) $Au^+(aq) + e^- \rightarrow Au(s)$ **[reject if correct state symbols are not included]** **[1]**
[allow ecf based on the oxidation state of Au in 8(a)]

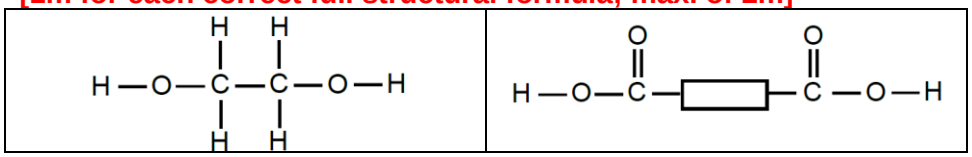
(iii) Gold is the least reactive among the three cations attracted to the cathode ***OR*** Gold is less reactive than hydrogen and sodium. **[1]**
Hence, gold ions gain electrons more readily than sodium ions and hydrogen ions. **[1]**

(c) No ***OR*** The concentration remains constant. **[No mark is awarded unless explanation is correct.]**
The gold ions that are discharged at the cathode came mainly from the gold anode. **[1]**
There is no net loss of gold ions from the electrolyte/ sodium dicyanoaurate. **[1]**

(d) Gold would be deposited at the cathode initially. Hydrogen gas would be evolved after a long time. **[1]**
Initially, the concentration of gold ions in the electrolyte decreases as they are preferentially discharged over sodium and hydrogen ions at the cathode. After a long time, hydrogen ions would then be discharged preferentially over sodium ions, forming hydrogen gas. **[1]**

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9 (a) (i) **[1m for each correct full structural formula; max. of 2m]**



ethylene glycol | terephthalic acid

(ii) Acts as catalyst ***OR*** A catalyst in the enzyme ***OR*** To increase the rate of reaction **[1]**

(b) (i) Butanal **[1]**; C_3H_7CHO **[1]**

(ii) $C_nH_{2n+1}CHO$ ***OR*** $C_{n-1}H_{2n-1}CHO$ **[1]**

(iii) **[1m for every correct factor; max. of 2m]**

- presence of oxygen in the organic compound
- length of carbon chain / number of carbon atoms / percentage by mass of carbon / relative molecular mass / molecular size

(c) (i) Oxidation **[accept minor spelling error]** **[1]**

(ii) Waxworms can remove <u>non-biodegradable plastic</u> from the environment, <u>reducing pollution</u>. **[1]**

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