NATIONAL JUNIOR COLLEGE

SH1 Promotional Examination

Higher 1

CANDIDATE NAME			
SUBJECT CLASS		REGISTRATION NUMBER	

CHEMISTRY **8873/01**

Paper 1 Multiple Choice **29 September 2022**

40 mins

Additional Materials: Optical Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, subject class and registration number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **twenty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate 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 booklet.
The use of an approved scientific calculator is expected, where appropriate.

Instructions on how to fill in the Optical Mark Sheet

Shade the index number in a 5 digit format on the optical mark sheet:
2nd digit and the last 4 digits of the Registration Number.

Example:

Student	Examples of Registration No.	Shade:
	2205648	**25648**

This document consists of **8** printed pages.

Answer key for 2022 SH1 H1 Chemistry Promo Paper 1

1	C
2	B
3	D
4	B
5	A

11	D
12	B
13	A
14	D
15	A

6	B
7	D
8	C
9	D
10	C

16	C
17	A
18	C
19	C
20	A

1 How many hydrogen atoms are present in 4.0 g of methane? (*L* = Avogadro constant)

A $\frac{L}{16}$ **B** $\frac{L}{4}$ **C** L **D** $4L$

Ans: C

Amount of methane, $CH_4 = \frac{4.0}{16.0} = 0.25$ mol

Amount of H atoms in $CH_4 = 4 \times 0.25 = 1$ mol

No. of H atoms = 1 × L = L

2 The table shows the relative abundance of a sample of naturally occurring isotopes of zinc.

isotope	relative abundance
$^{64}_{30}Zn$	10
$^{65}_{30}Zn$	8
$^{67}_{30}Zn$	2
$^{68}_{30}Zn$	1

What is the relative atomic mass of this sample of zinc?

A 64.0 **B** 64.9 **C** 68.1 **D** 72.2

Ans: B

$A_r = \frac{64\times10 + 65\times8 + 67\times2 + 68\times1}{21} = 64.9$

3 Analysis of a mixture of two sulfur-containing gases show that H_2S and CS_2 are present in a 3 : 1 mole ratio.

This mixture is burned in excess oxygen to give CO_2 and SO_2 gas.

What is the mole ratio of the gases CO_2 : SO_2 obtained after complete combustion?

A 1 : 2 **B** 1 : 3 **C** 1 : 4 **D** 1 : 5

Ans: D

Let amount of H_2S be $3x$ mol and CS_2 be x mol,

$H_2S + \frac{3}{2}O_2 \rightarrow SO_2 + H_2O$

$3x$ $3x$

Amount of SO_2 produced by H_2S = $3x$ mol

$CS_2 + 3O_2 \rightarrow 2SO_2 + CO_2$

x $2x$ x

Amount of SO_2 produced by CS_2 = $2x$ mol, Amount of CO_2 produced = x mol

Hence, mole ratio of CO_2 : SO_2 obtained after complete combustion is

$x : (3x + 2x)$

1 : 5

4 2 moles of an oxidising agent, $\mathbf{X}O_4^-$, in the presence of excess acid, oxidised 96.0 dm^3 of nitrogen dioxide gas to NO_3^- at room temperature and pressure.

What is the number of moles of electrons accepted by one mole of $\mathbf{X}O_4^-$?

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

Ans: B

Amount of NO_2 at r.t.p = $\frac{96.0}{24.0}$ = 4 mol

[O]: $NO_2 + H_2O \rightarrow NO_3^- + 2H^+ + e^-$ (from Data Booklet)

4 mol of NO_2 donates 4 mol of e^- to 2 mol of XO_4^-

Hence, 1 mol of XO_4^- gains 2 mol of e^-

5 The first six ionisation energies of an element, **Y**, in kJ mol^{-1} are shown.

	1st	2nd	3rd	4th	5th	6th
Ionisation Energy / kJ mol^{-1}	738	1451	7733	10543	13630	18020

Y forms an oxide by heating **Y** with oxygen gas.
What is the molecular formula of the oxide of **Y** formed?

A **YO** **B** YO_2 **C** Y_2O **D** Y_2O_3
Ans: A

The sharp increase from the second to the third ionisation energy indicates that the third most loosely held electron is removed from an inner principal quantum shell, hence there are 2 valence electrons, **Y** is in Group 2. Therefore, the formula of its oxide is **Y**O.

6 The radioactive isotope $^{223}_{88}Ra$ decays to give **Q** and emits a high energy α-particle, $^{4}_{2}He$. No other particle is produced.

$$^{223}_{88}Ra \longrightarrow {}^{4}_{2}He + \mathbf{Q}$$

How many neutrons are present in **Q**?

A 86 **B** 133 **C** 135 **D** 219
Ans: B

$^{223}_{88}Ra \longrightarrow {}^{219}_{86}\mathbf{Q} + {}^{4}_{2}He$

Number of neutrons in Q = 219 – 86 = 133

7 Why is the second ionisation energy of fluorine lower than that of oxygen?

A There are more paired electrons in the 2p orbitals of fluorine than in oxygen.

B The ionic radius of O^+ is greater than F^+.

C Fluorine has a lower nuclear charge compared to oxygen.

D All 2p orbitals of O^+ are singly filled but one of the 2p orbitals of F^+ is doubly filled.

Ans: **D**

The second I.E. involves the removal of the most loosely held electron in F^+ and O^+.
$F^+(g)$: $1s^2 2s^2 2p^4$
$O^+(g)$: $1s^2 2s^2 2p^3$
With electronic configuration of $2p^4$, the paired electrons in the 2p subshell of F^+ experiences inter-electron repulsion and hence it is easier to be removed despite the increase in nuclear charge.

Option A refers to the electronic configuration of F and O atoms, it does not explain the 2nd I.E.

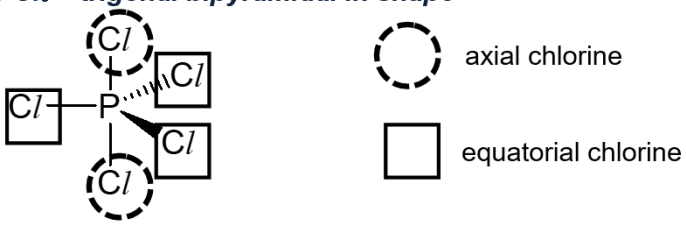
8 Chlorine atoms in the PCl_5 molecule can be successively replaced by fluorine atoms, with the axial chlorine atoms replaced before the equatorial ones.

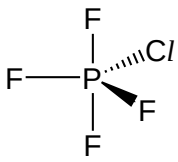
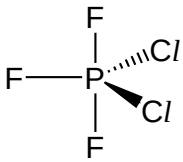
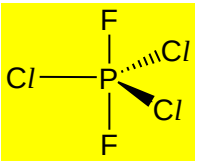
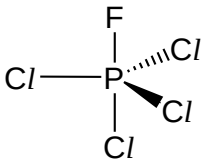
Which of the possible molecules formed in the above reaction does **not** have a net dipole moment?

A $PClF_4$ **B** PCl_2F_3 **C** PCl_3F_2 **D** PCl_4F

Ans: C

PCl_5 – trigonal bipyramidal in shape



 *dipole moments do not cancel out*	 *dipole moments do not cancel out*	 *dipole moments cancel out*	 *dipole moments do not cancel out*

9 **Q** has the following physical properties.

- It is non-volatile.
- It does not conduct electricity in its standard state.
- It dissolves in water.

What is the identity of **Q**?

A Magnesium

B Carbon dioxide

C Silicon dioxide

D Sodium chloride

Ans: **D**

Q is non-volatile (does not vapourise easily) eliminates carbon dioxide which has a simple covalent structure with weak instantaneous dipole-induced dipole interactions and is a gas at rtp.
Q does not conduct electricity in its standard state eliminates magnesium as metals can conduct electricity.

Q dissolves in water eliminates silicon dioxide as it is insoluble in water due to its giant covalent structure with extensive covalent bonds.

Sodium chloride is the only option that

- is non-volatile (due to strong ionic bonds holding the giant ionic lattice),
- does not conduct electricity in its standard state (no mobile ions as charge carriers in the solid state), and
- dissolves in water (by forming ion-dipole interactions with H_2O molecules).

10 Which statement best explains why the boiling point of butanone (80 °C) is higher than that of pentane (36 °C)?

A The covalent bonds in the butanone molecule are stronger than those in the pentane molecule.

B The relative molecular mass of butanone is higher than that of pentane.

C There are permanent dipole-permanent dipole forces between butanone molecules, but not between pentane molecules.

D There are hydrogen bonds between butanone molecules, but not between pentane molecules.

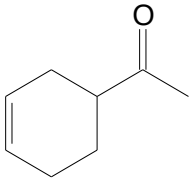
Ans: **C**

Butanone, $CH_3COCH_2CH_3$ (M_r = 72.0), is polar molecule with permanent dipole – permanent dipole interaction between molecules while pentane, $CH_3CH_2CH_2CH_2CH_3$ (M_r = 72.0), is a non-polar molecule with instantaneous dipole-induced dipole interaction between molecules.

During boiling, more energy is required to overcome the stronger pd-pd between butanone molecules as compared to the weaker id-id between pentane molecules.

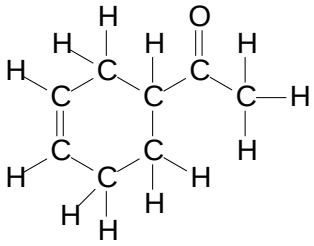
Note: covalent bonds are NOT broken during melting and boiling of simple molecular structures. $CH_3COCH_2CH_3$ (l) $\longrightarrow$ $CH_3COCH_2CH_3$ (g)

11 Which option is correct for the following organic molecule?



	No. of σ bond	No. of π bond
A	9	2
B	18	2
C	19	4
D	21	2

Ans: **D**



In a double bond (C=C and C=O), there is 1σ + 1π bond.

12 *Use of the Data Booklet is relevant to this question.*

Hexamine has an enthalpy change of combustion of −4288 kJ mol^{-1}.

12.4 g of hexamine tablets were burnt to heat up 850 cm^3 of water. Given that the process was 75 % efficient and temperature of the water increased from 10 °C to 90 °C, what is the molar mass of hexamine?

A 105.2 g mol^{-1} **B** 140.3 g mol^{-1} **C** 187.1 g mol^{-1} **D** 249.4 g mol^{-1}

Ans: B

$$\Delta H_c = -\frac{mc\Delta T}{n_{hexamine}} \div \text{efficiency}$$

$$-4288000 = -\frac{(850)(4.18)(90-10)}{n_{hexamine}} \div \frac{75}{100}$$

$$n_{hexamine} = 0.08838 \text{ mol}$$

$$\text{molar mass} = \frac{12.4}{0.08838} = 140.3 \text{ g mol}^{-1}$$

13 *Use of the Data Booklet is relevant to this question.*

A reaction which causes the presence of oxides of nitrogen in car exhausts is the formation of NO.

$$N_2(g) + O_2(g) \longrightarrow 2NO(g) \qquad \Delta H = +180 \text{ kJ mol}^{-1}$$

What is the bond energy in NO, in kJ mol^{-1}?

A 630 **B** 810 **C** 1260 **D** 1440

Ans: A

$\Delta H = \Sigma BE(\text{reactants}) - \Sigma BE(\text{products})$

$+180 = 944 + 496 - 2\ BE(NO)$

$2BE(NO) = 1260$

$BE(NO) = 630$

14 The reaction of a compound **XY** is shown below.

$$\mathbf{XY}(g) \longrightarrow \mathbf{X}(g) + \mathbf{Y}(g)$$

The rate equation for the reaction is rate = k[**XY**] and the half-life is 193s. If the initial concentration of **XY** is 2.0×10^{-2} mol dm^{-3}, what will be the concentration of **XY** after 770 seconds?

A 1.0×10^{-2} mol dm^{-3}

B 5.0×10^{-3} mol dm^{-3}

C 2.5×10^{-3} mol dm^{-3}

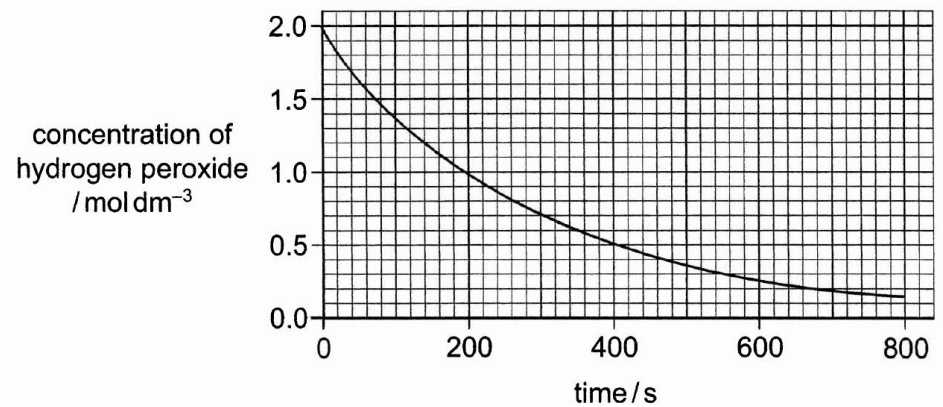
D 1.25×10^{-3} mol dm^{-3}

Ans: **D**

After 770 seconds, $\frac{770}{193}$ = 4 half-life had passed;

concentration of XY after 4 half-life = $2.0 \times 10^{-2} \times (\frac{1}{2})^4 = 1.25 \times 10^{-3}$ mol dm^{-3}

15 The graph represents the decomposition of a sample of hydrogen peroxide in the presence of manganese(IV) oxide.



Which conclusions can be drawn from the graph?

1 The rate of decomposition of hydrogen peroxide depends on its concentration in the sample.

2 The half-life of the hydrogen peroxide in the sample is 200s.

3 The reaction is first order with respect to hydrogen peroxide.

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

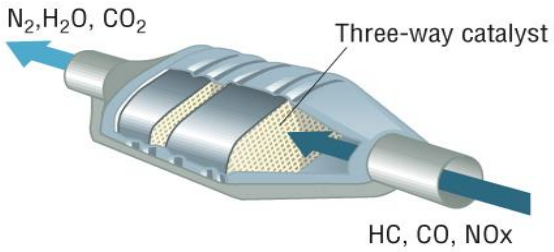
Ans: **A**

Option 1 is correct. The instantaneous rate (gradient of the tangent of conc vs time graph), is affected by the concentration of H_2O_2 as shown in the graph.

Option 2 is correct. The time taken for $[H_2O_2]$ to decrease from 2.0 to 1.0 and 1.0 to 0.5 is constant at 200s.

Option 3 is correct. As seen from the graph, as $[H_2O_2]$ decreases, the rate of reaction decreases with a constant half-life of 200s, hence it is first order w.r.t H_2O_2.

16 The diagram shows the structure of a catalytic converter fitted in the exhaust system of a car where harmful gases are converted into carbon dioxide, nitrogen and water vapour.



catalytic converter

Which reactions would occur on the surface of the catalyst in the catalytic converter?

1 hydrocarbons + oxides of nitrogen ⟶ carbon dioxide + water + nitrogen

2 carbon monoxide + oxides of nitrogen ⟶ carbon dioxide + nitrogen

3 carbon monoxide + hydrocarbon ⟶ carbon dioxide + water

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

In the catalytic converter, the harmful gases undergo reduction and oxidation to give less harmful products.

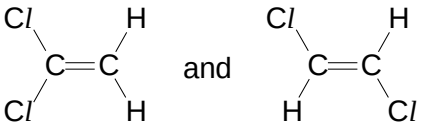
Options 1 & 2 are correct. Oxides of nitrogen undergo reduction while hydrocarbons/CO undergo oxidation.

Option 3 is wrong. The equation shows that both CO and hydrocarbon undergo oxidation, which is not possible.

17 Which pairs of molecules are constitutional isomers?

1 $CH_3CH_2CH(CH_3)_2$ and $(CH_3)_4C$

2 butanone and 2−methylpropanal

3 

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

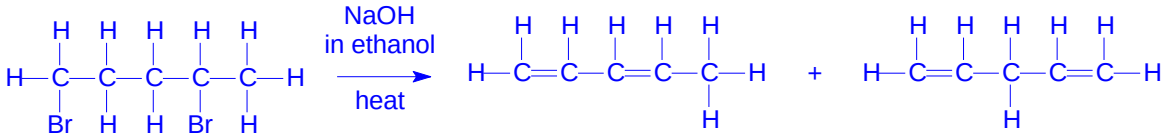
Constitutional isomers have the same molecular formula but atoms are connected differently. Constitutional isomers include chain isomers, positional isomers and functional group isomers.

1	The molecules are chain isomers. $CH_3CH_2CH(CH_3)_2$ is straight chain while $(CH_3)_4C$ is branched.
2	The molecules are functional group isomers. Butanone, $CH_3CH_2COCH_3$, has a ketone functional group while 2−methylpropanal, $CH_3CH(CH_3)CHO$, has an aldehyde functional group.
3	The two molecules are positional isomers since the chloro groups are in different carbon positions. 1,1-dichloroethene and 1,2-dichloroethene

18 How many isomeric alkenes with formula C_5H_8 are present in the mixture produced when 1,4-dibromopentane is heated with NaOH in ethanol?

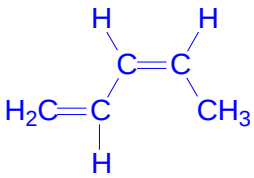
A 1 **B** 2 **C** 3 **D** 4
Ans : **C**

1,4-dibromopentane undergoes elimination when heated with NaOH in ethanol to give C=C.

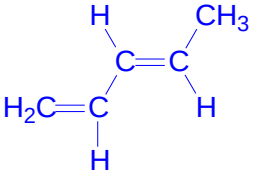


penta-1,3-diene penta-1,4-diene

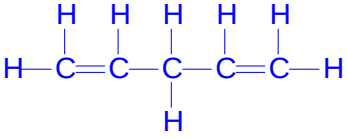
Penta-1,3-diene can exist as cis and trans isomer.
Hence, there are a total of 3 isomers:



cis penta-1,3-diene



trans penta-1,3-diene



penta-1,4-diene

19 Which compound is a product of the hydrolysis of $CH_3CO_2CH_2CH_2CH_3$ by boiling aqueous sodium hydroxide?

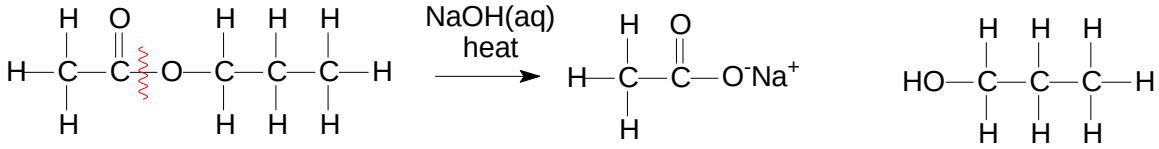
A CH_3OH

B CH_3COOH

C $CH_3CH_2CH_2OH$

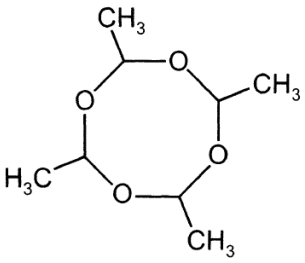
D $CH_3CH_2CH_2COO^-Na^+$

Ans: **C**



This is alkaline hydrolysis. carboxylic acid, CH_3COOH, undergoes a further acid-base reaction to give $CH_3COO^-Na^+$

20 'Slug-bait' is used for killing slugs and contains the compound shown.



This compound is prepared by a sequence of addition reactions of a simple carbonyl compound, **X**, using concentrated sulfuric acid as a catalyst at 0 °C.

What is **X**?

A ethanal

B methanal

C propanal

D propanone

Ans: **A**

The molecular formula of the product is $C_8H_{16}O_4$. We can observe a repeating unit of CH_3CHO (C_2H_4O) in the structure of the product. Hence it is likely due to addition reactions of ethanal.