VICTORIA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CHEMISTRY   8873/01

Paper 1 Multiple Choice   23 September 2021

1 hour

Additional Materials: Multiple Choice Answer Sheet
                          Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your index number, name and CT group on the Answer Sheet.

There are **thirty** questions. 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.

This document consists of **11** printed pages and **1** blank page.
For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 What is the electronic configuration of Cu^+ ion, with proton number 29?

A $1s^22s^22p^63s^23p^63d^{10}$

C $1s^22s^22p^63s^23p^63d^84s^2$

B $1s^22s^22p^63s^23p^63d^94s^1$

D $1s^22s^22p^63s^23p^63d^84p^2$

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

The ion **X**$^+$ has 54 electrons and 78 neutrons.

Which of the following statements are **incorrect**?

1 The fluoride of **X** formed is expected to have a higher melting point than NaF.
2 The first ionisation energy of element **X** is lower than that of Fr.
3 In an electric field, the ion **X**$^+$ will be deflected at a larger angle than that of Na$^+$.
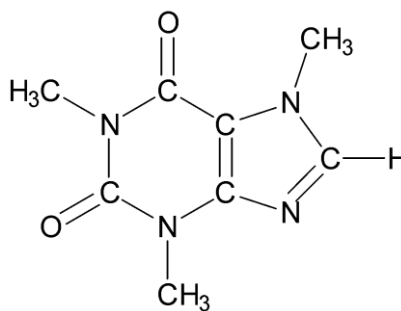
A **1**, **2** and **3**

C **2** and **3** only

B **1** and **2** only

D **3** only

3 To produce decaffeinated coffee, pure liquid CO_2 is sometimes used to extract caffeine from coffee beans.

caffeine

The solubility of caffeine greatly increased when a mixture of ethanol and liquid CO_2 (ethanol−CO_2 mixture) was used.

Which interaction best explains why caffeine is more soluble in the ethanol−CO_2 mixture as compared to liquid CO_2?

A instantaneous dipole–induced dipole interactions

B permanent dipole–permanent dipole interactions
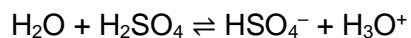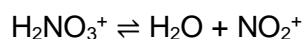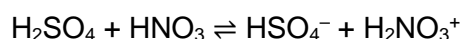
C dative covalent bonding

D hydrogen bonding

4   In which pair does compound **X** have a higher boiling point than compound **Y**?

	compound **X**	compound **Y**
A	$CH_3CO_2NH_4$	$CH_3CH_2NH_2$
B	PH_3	PCl_3
C	CH_3COCH_3	$CH_2=CHCH_2OH$
D	$SiCl_4$	SiO_2

5   The Brønsted–Lowry theory describes acid and base character.

   When concentrated sulfuric acid and concentrated nitric acid are mixed, the following reactions occur.

$$H_2SO_4 + HNO_3 \rightleftharpoons HSO_4^- + H_2NO_3^+$$

$$H_2NO_3^+ \rightleftharpoons H_2O + NO_2^+$$

$$H_2O + H_2SO_4 \rightleftharpoons HSO_4^- + H_3O^+$$

   Which species are Brønsted–Lowry bases in these reactions?

   1 HSO_4^-

   2 $H_2NO_3^+$

   3 H_2O

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

   B   **1** and **3** only   **D**   **2** only

6   10 cm³ of 0.0250 mol dm⁻³ of hydrochloric acid was mixed with 10 cm³ of 0.0500 mol dm⁻³ of sodium hydroxide. What is the pH of the resulting solution?

   A   1.9   **B**   7.0   **C**   12.1   **D**   13.7

7   Which option consists of an acid buffer?

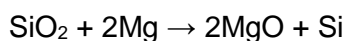   **A**   20 cm³ of 0.100 mol dm⁻³ HCl and 10 cm³ of 0.100 mol dm⁻³ KOH

   B   20 cm³ of 0.100 mol dm⁻³ CH_3COOH and 10 cm³ of 0.100 mol dm⁻³ $Ba(OH)_2$

   C   10 cm³ of 0.100 mol dm⁻³ H_2SO_4 and 40 cm³ of 0.100 mol dm⁻³ NH_3

   D   10 cm³ of 0.100 mol dm⁻³ CH_3COOH and 5 cm³ of 0.100 mol dm⁻³ NaOH

8   In the preparation of silicon, silicon dioxide is heated with magnesium.

$$SiO_2 + 2Mg \rightarrow 2MgO + Si$$

The product mixture contains MgO and Si only.

To separate the silicon from the product mixture, a student proposed the following two possible methods.

1. Heat the mixture gently and collect the silicon vapour.
2. Shake the mixture with aqueous hydrochloric acid and filter.

Which of the methods will **not** work?

A 1 only   **B** 2 only   **C** 1 and 2   **D** none

9 The information relates to element **Z**.

- **Z** is a Period 3 element.
- A **Z** atom has a half-filled subshell in its ground state.
- The chloride of **Z** forms an acidic solution in water.

What could **Z** be?

A Na   **B** Si   **C** P   **D** Cl

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

Which of the following statements about iodine and its compounds are correct?

1 Hydrogen iodide is a stronger acid than hydrogen bromide as the H–I bond is weaker.

2 When aqueous chlorine is added to potassium iodide and the aqueous mixture is shaken with tetrachloromethane, a purple organic layer is obtained.

3 Hydrogen iodide has a higher boiling point than hydrogen chloride due to stronger instantaneous dipole-induced dipole interactions.

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

B **1** and **3** only   **D** **1** only

11 10 cm^3 of a hydrocarbon C$_x$H$_y$ was exploded in 100 cm^3 of oxygen gas and cooled to room temperature. There was a contraction of 30 cm^3. When the resulting gas was passed through a solution of sodium hydroxide, there was a further contraction of 40 cm^3. All volumes measured are under room conditions.

What is the molecular formula of the hydrocarbon?

A C$_4$H$_8$ **B** C$_4$H$_{10}$ **C** C$_5$H$_{10}$ **D** C$_5$H$_{12}$

12 10 cm^3 of 0.2 mol dm^{-3} **X**O$_4^{2-}$ reacts completely with 40 cm^3 of 0.1 mol dm^{-3} iron(II) sulfate solution. If Fe^{2+} is oxidised to Fe^{3+} in the above reaction, what is the final oxidation state of **X**?

A +2   **B** +3   **C** +4   **D** +5

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

Butane is used as a fuel for cooking.

When 0.025 mol of butane was burnt under a vessel containing 250 g of water, it was found that the temperature of the water rose by 50 ºC.

Given that the heat transfer was 75% efficient, what is the enthalpy change of combustion of butane?

A -18000 kJ mol^{-1} **C** -2090 kJ mol^{-1}

B -2790 kJ mol^{-1} **D** -697 kJ mol^{-1}

14 The following energy cycle and enthalpy changes are provided.

	ΔH / kJ mol^{-1}
$K(s) \rightarrow K^+(aq) + e^-$	-251
$P(s) + 2O_2(g) + 3e^- \rightarrow PO_4^{3-}$ (aq)	-1284
$K_3PO_4(s) \rightarrow 3K^+(aq) + PO_4^{3-}(aq)$	-2

What is the enthalpy change of formation of solid potassium phosphate, $\Delta H_f(K_3PO_4(s))$?

A -1533 kJ mol^{-1} **C** -2035 kJ mol^{-1}

B -1537 kJ mol^{-1} **D** -2039 kJ mol^{-1}

15 Compound **M**, $CH_3CH=CHCHClCH_3$, reacts readily with alcoholic KCN.

$$CH_3CH=CHCHClCH_3 + CN^- \rightarrow CH_3CH=CHCH(CN)CH_3 + Cl^-$$
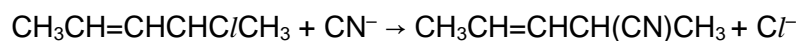
The initial rate of this reaction was measured using different concentrations of compound **M** and CN$^-$ and the following results were obtained.

experiment	**[M]**	[CN$^-$]	relative rate

	/ mol dm^{-3}	/ mol dm^{-3}	
1	0.1	0.1	1
2	0.2	0.1	2
3	0.3	0.3	3

Which conclusion could be drawn from the information?

A   The overall order of reaction is 2.

B   It is an addition reaction involving two reactant particles combining to form products.

C   The rate of reaction will increase when concentration of CN$^-$ increases.

D   The rate of reaction will change when chlorine atom in **M** is replaced with bromine.

16   The age of rock samples can be calculated using Uranium-Lead dating. ^{235}U is an unstable isotope which decays into ^{207}Pb. This nuclear reaction obeys first-order kinetics with a half-life of 710 million years.

The decay can be summarised by the following equation:

$$^{235}U \rightarrow \, ^{207}Pb + \text{other decay products}$$

A rock sample has a ^{235}U : ^{207}Pb ratio of 1 : 15.

Assuming that all the ^{207}Pb detected is formed from the decay of ^{235}U, what is the age of the rock sample?

A   710 million years   **C**   2130 million years

B   1420 million years   **D**   2840 million years

17   Why does a reaction between two gases take place faster in the presence of a catalyst?

1   The gas molecules move more quickly in the presence of a catalyst.

2   A higher proportion of collisions is successful in the presence of a catalyst.

3   The activation energy of the reaction is lowered in the presence of a catalyst.

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

B   **1** and **3** only   **D**   **2** only

18   Aqueous sodium chromate(VI) contains yellow chromate(VI) ions, CrO_4^{2-}. These CrO_4^{2-}ions exist in equilibrium with orange dichromate(VI) ions, $Cr_2O_7^{2-}$.

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(l)$$
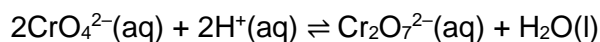
A solution was prepared in which the initial concentration of CrO_4^{2-} ions and H^+ ions was each 1.00 mol dm^{-3}. When the equilibrium was reached, it was observed that 30% of the CrO_4^{2-} ions had reacted.

What is the numerical value of K_c for this equilibrium?

A	0.0937	**C**	15.1
B	0.625	**D**	43.2

19 Which statement about a condition used in the Haber process is correct?

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92 \text{ kJ mol}^{-1}$$

A An iron catalyst is used in order to get a higher percentage of ammonia in the equilibrium.

B A pressure of 200 atmospheres is used because a high pressure will favour the side of the equilibrium with a greater number of gaseous molecules.

C A temperature of 400 °C to 500 °C is used because a high temperature will increase the rate of reaction.

D A temperature of 400 °C to 500 °C is used because a high temperature will increase the equilibrium yield of ammonia.

20 A straight chain organic compound has a molecular formula of C_4H_5NO. It contains a nitrile, $-C\equiv N$, functional group.
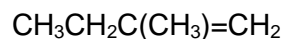
Which other functional groups could be present in this molecule?

1 aldehyde

2 alkene

3 amide

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

21 There are five possible constitutional (structural) isomers for an alkene with molecular formula C_5H_{10}.
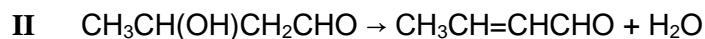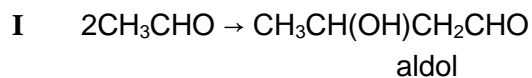
Four of these isomers are shown below.

$CH_3CH_2CH_2CH=CH_2$

$CH_3CH_2CH=CHCH_3$

$CH_3CH_2C(CH_3)=CH_2$

$(CH_3)_2CHCH=CH_2$

What is the name of the fifth isomer?

A pent-3-ene

B   3-methylbut-2-ene

C   2-methylbut-2-ene

D   2,2-dimethylpropene

22   Reaction **I** shows two ethanal molecules combining to form an aldol. Reaction **II** shows reaction of the aldol when heated.

I $2CH_3CHO \rightarrow CH_3CH(OH)CH_2CHO$
                                         aldol

II $CH_3CH(OH)CH_2CHO \rightarrow CH_3CH=CHCHO + H_2O$

Which option correctly describes reactions **I** and **II**?

	I	**II**
A	elimination	reduction
B	substitution	elimination
C	addition	reduction
D	addition	elimination

23   The compound 1,2-dichloroethene, $C_2H_2Cl_2$, has been used as an industrial solvent for a number of compounds including fats, camphor and caffeine.

Which statement about this compound is **incorrect**?

A   The compound is a planar molecule.

B   The compound shows cis-trans isomerism.

C   The compound can be catalytically hydrogenated.

D   The compound undergoes substitution with Br_2 in CCl_4 to form $C_2Cl_2Br_2$

24 How many different mono-chlorinated organic products can be formed when 2-methylbutane is reacted with limited chlorine gas in the presence of UV light?

A   3   **B**   4   **C**   5   **D**   6

**25** The structure of 2-methylbutane-1,2,3,4-tetrol of molecular formula $C_5H_{12}O_4$ is shown below.

2-methylbutane-1,2,3,4-tetrol
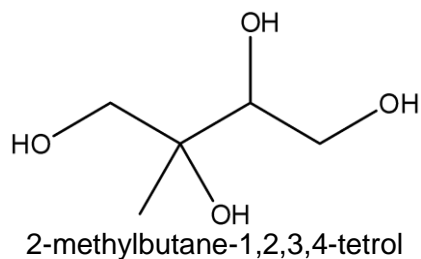
After prolonged heating under reflux with an excess of acidified dichromate(VII), it forms a compound **X** which also has five carbon atoms.

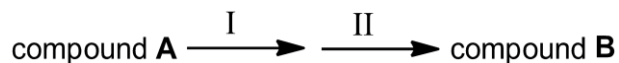What is the molecular formula of compound **X**?

A $C_5H_{10}O_5$ **B** $C_5H_{18}O_5$ **C** $C_5H_8O_6$ **D** $C_5H_6O_6$
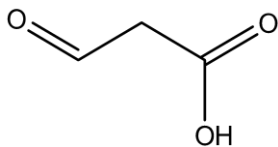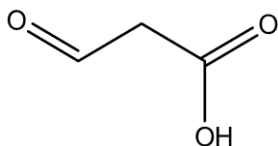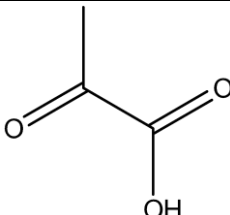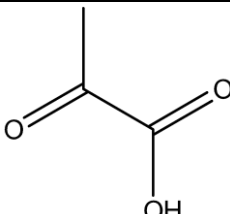
26 Which set of reagents and conditions **cannot** be used for the interconversion of compounds shown in the reaction scheme below?
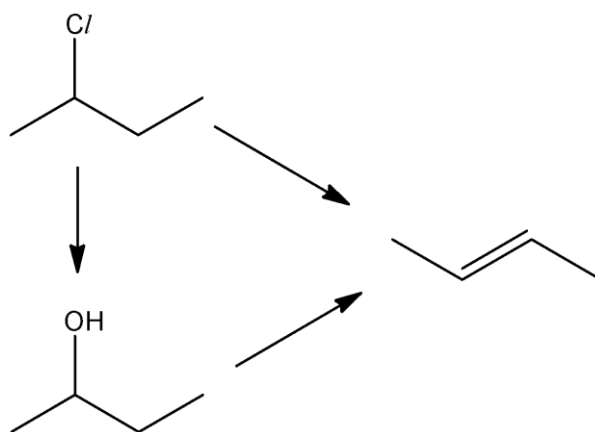
A   Heat with excess concentrated H_2SO_4

B   Add cold concentrated H_2SO_4, followed by water with heating

C   Heat with aqueous NaOH

D   Heat with alcoholic KOH

27 Which synthetic route converts compound **A** to **B** containing two amide functional groups?

$$\text{compound A} \xrightarrow{\quad I \quad} \xrightarrow{\quad II \quad} \text{compound B}$$

	compound **A**	**I**	**II**
A		NH$_3$ in DCC solvent at room temperature	Heat with K$_2$Cr$_2$O$_7$ in H$_2$SO$_4$(aq)
B		Heat with K$_2$Cr$_2$O$_7$ in H$_2$SO$_4$(aq)	NH$_3$ in DCC solvent at room temperature
C		NH$_3$ in DCC solvent at room temperature	Heat with K$_2$Cr$_2$O$_7$ in H$_2$SO$_4$(aq)
D		Heat with K$_2$Cr$_2$O$_7$ in H$_2$SO$_4$(aq)	NH$_3$ in DCC solvent at room temperature

28 Dishwasher pouches are small convenient packets that contain the detergent needed to be used in dishwashers. Such pouches are sturdy enough to be easily transported and safely handled by hand, yet dissolve easily when it is time to wash dishes with water.

What could be the polymer that is used for the pouches?

A poly(vinyl alcohol)

B poly(ethylene terephthalate)

C poly(diallyl phthalate)

D poly(vinyl chloride)

29 Which of the following statements are true regarding polyester fabrics in comparison to polyamide fabrics?

1 Polyester fabrics tend to crease less easily than polyamide fabrics.

2 Polyester fabrics tend to be stained by oil more easily than polyamide fabrics.

3 Polyester fabrics tend to absorb more sweat than polyamide fabrics.

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

B **1** and **2** only   **D** **3** only

30 Part of the structure of a polymer is shown below.

$$-\overset{O}{\overset{\|}{C}}-CH_2CH_2-\overset{O}{\overset{\|}{C}}-O-CH_2CH_2-O-\overset{O}{\overset{\|}{C}}-CH_2CH_2-\overset{O}{\overset{\|}{C}}-$$

Which monomers could be used to make the polymer?

A $HO_2C-CH_2CH_2-CO_2H$ and $HO-CH_2CH_2-OH$

B $HO_2C-CH_2-CO_2H$ and $HO_2C-CH_2CH_2-CO_2H$

C $HO_2C-CH_2-CO_2H$ and $HO-CH_2-OH$

D $HO_2C-CH_2CH_2-CO_2H$ and $HO-CH_2-OH$

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