VICTORIA JUNIOR COLLEGE
JC 1 PROMOTIONAL EXAMINATIONS
Higher 2

CHEMISTRY 9729//01

Paper 1 Multiple Choice **30 September 2022**

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.
A Data Booklet is provided.

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

In 2011, two new elements were added to the Periodic Table. Both elements had been made artificially and were called flerovium (F*l*) and livermorium (Lv).

	F*l*	Lv
proton number	114	116
nucleon number	289	292

Which statements about these elements are correct?

1 A Lv^{+} ion has the same number of electrons as a Fl^{-} ion.

2 A beam of Lv^{3+} ions is deflected by a smaller angle in an electric field as compared to a beam of Fl^{2-} ions.

3 A Lv atom has the same electronic configuration as a Fl^{2-} ion.

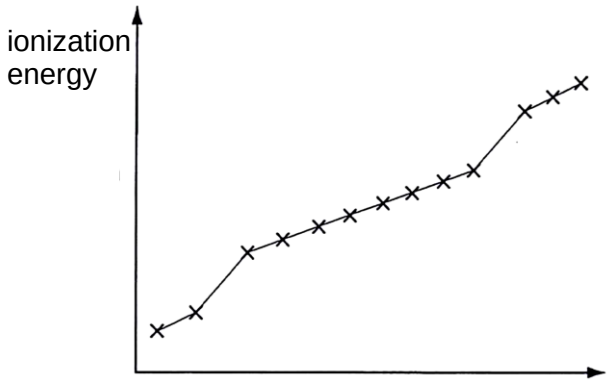
A **1**, **2** and **3** only

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

C **1** and **3** only

D **3** only

2 The graph shows the first thirteen ionisation energies for element **X**.



X reacts with excess oxygen to form a compound, **Y**. **Y** contains the peroxide ion, O_2^{2-}.

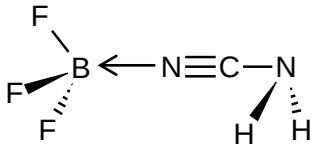
What is the formula of compound **Y**?

A **X**O **B** **X**O_2 **C** $\mathbf{X}_2$O **D** $\mathbf{X}_2O_2$

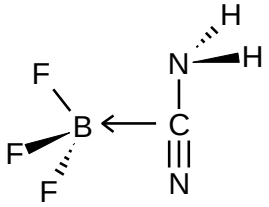
3 Cyanamide, NH_2CN, can form a product with boron trifluoride, BF_3.

What could be a possible structure of the product?

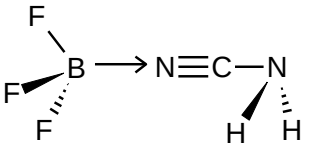
A



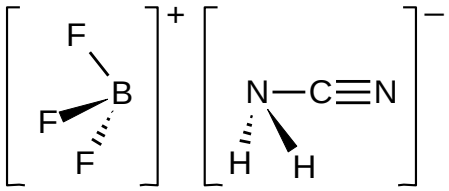
B



C



D



4 Which one of the following pairs of compounds shows the same shape and similar bond angles?

A $POCl_3$ and CCl_4

B $AlCl_3$ and NCl_3

C SO_2 and CO_2

D ClF_3 and SF_4

5 In which of the following pairs does the first substance have a lower boiling point than the second substance?

	first substance	second substance
A	$CH_3CH_2CH_2OH$	$CH_3CH_2CH_2CH_2OH$
B	I_2	HCl
C	$CH_3CH_2NHCH_3$	$CH_3CH_2OCH_3$
D	CH_3CO_2H	CH_3CH_2OH

6 Silicon carbide is a shiny, hard chemically inert material with a very high melting point. It can be used to sharpen knives and make crucibles.

Which type of structure explains these properties?

A a giant structure with covalent bonds between silicon and carbon atoms

B a giant structure containing metallic bonding

C a giant layer structure with covalent bonds between atoms and van der Waals' forces between the layers

D a simple molecular structure with covalent bonds between the atoms of silicon and carbon

7 Sodium hydrogen carbonate, $NaHCO_3$, can be prepared from sodium sulfide, Na_2S by the following reactions:

$$Na_2S(s) + CaCO_3(s) \rightarrow CaS(s) + Na_2CO_3(s)$$
$$Na_2CO_3(s) + H_2O(l) + CO_2(g) \rightarrow 2NaHCO_3(s)$$

Assuming that the percentage yield in each step is identical, 20.5 kg of sodium hydrogen carbonate (M_r = 84.0) was formed from 50 kg of sodium sulfide (M_r = 78.1).

What is the percentage yield of each step?

A 13.8% **B** 43.7% **C** 61.8% **D** 70.7%

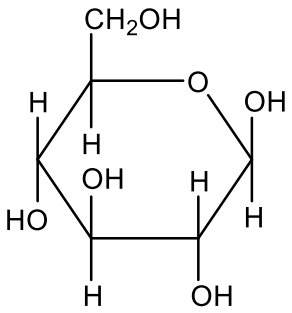
8 Incomplete combustion of w dm^3 of butane, C_4H_{10}, yielded a mixture of carbon dioxide and carbon monoxide in the ratio of 3:1, together with water vapour.

What is the volume of oxygen consumed?

A $5w$ dm^3 **B** $6w$ dm^3 **C** $9w$ dm^3 **D** $12w$ dm^3

9 In the body, cellular respiration produces energy from the oxidation of glucose.

The diagram shows the structure of glucose.



A new artificial sweetener has been produced by replacing all of the alcohol groups attached directly to the ring carbon atoms in glucose with chlorine atoms.

What is the empirical formula of this chlorinated glucose?

A CHC*l*O **B** CH_2Cl **C** $C_3H_4Cl_2O$ **D** $C_6H_7Cl_5O$

10 0.5 g of zinc powder was found to reduce an acidified solution of 10.2 cm^3 of 0.500 mol dm^{-3} VO_2^+.

What is the reduced product of VO_2^+?

A V^{2+} **B** V^{3+} **C** VO^{2+} **D** VO_3^-

11 Some enthalpy changes of combustion are given below.

	ΔH_c / kJ mol^{-1}
$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$	–283
$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$	–286
$CH_3OH(l) + \frac{3}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$	–715

What is the enthalpy change of the following reaction?

$$CO(g) + 2H_2(g) \rightarrow CH_3OH(l)$$

A –146 **B** –140 **C** +140 **D** +146

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

Given the following data:

Lattice energy of magnesium chloride	–2526 kJ mol^{-1}
Standard enthalpy change of hydration of chloride ion	–384 kJ mol^{-1}
Standard enthalpy change of hydration of magnesium ion	–1890 kJ mol^{-1}

What would be the change in temperature measured when 2.00 g of magnesium chloride was dissolved in 50 g of water?
[Molar mass of $MgCl_2$ = 95.3 g mol^{-1}]

A +12.7 °C **B** +13.3 °C **C** +24.3 °C **D** +25.3 °C

13 Some ΔH_f values are given below.

compound	ΔH_f / kJ mol^{-1}
$H_2O(l)$	–286
$CO_2(g)$	–394
$C_6H_{12}O_6(s)$	–1273

The overall reaction in photosynthesis can be represented by the following equation.

$$6CO_2(g) + 6H_2O(l) \rightarrow C_6H_{12}O_6(s) + 6O_2(g)$$

Which of the following statements are correct?

1 The enthalpy change of the reaction is +2807 kJ mol^{-1}.
2 In the formation of products, the system becomes less disordered.
3 The reaction is not spontaneous at all temperatures.

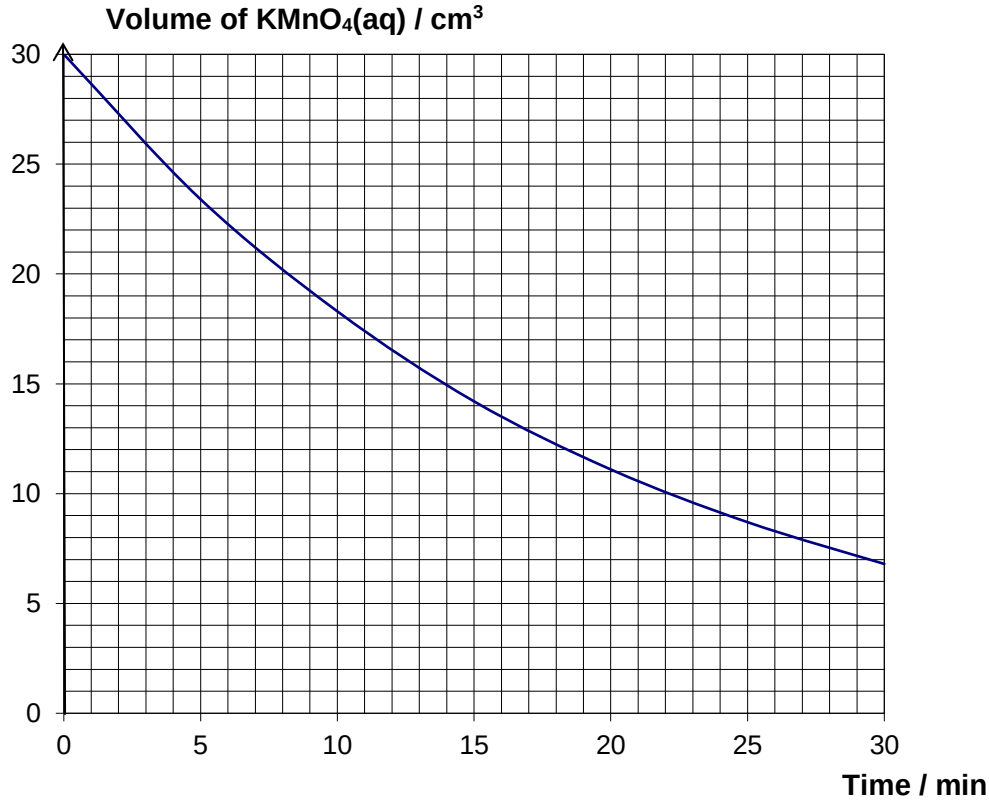
A **1**, **2** and **3**
B **1** and **2** only
C **2** and **3** only
D **3** only

14 A dilute solution of hydrogen peroxide decomposes slowly in aqueous solution according to the following equation:

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

A solution with an original concentration of 3.00 mol dm^{-3} was placed in a bottle contaminated with transition metal ions, which act as catalyst for the decomposition. The rate of decomposition was measured by withdrawing 10.0 cm^3 portion at various times and titrating with acidified 0.05 mol dm^{-3} $KMnO_4(aq)$.

The following results were obtained.



How long has the solution in the bottle been contaminated before the first portion was withdrawn for titration? Assume that 5 mol of H_2O_2 reacts with 2 mol of $KMnO_4$.

A 14 min
B 28 min
C 42 min
D 84 min

15 The rates of chemical reactions can often be increased by increasing the concentration of reactants or raising the temperature.

Which statements are correct?

1 Increasing the concentration increases the rate constant.
2 Increasing the concentration increases the proportion of particles having energy greater than the activation energy.
3 Increasing the temperature increases the rate constant.
4 Increasing the temperature increases the proportion of particles having energy greater than the activation energy.

A **1**, **3** and **4** only
B **1** and **2** only
C **2, 3** and **4** only
D **3** and **4** only

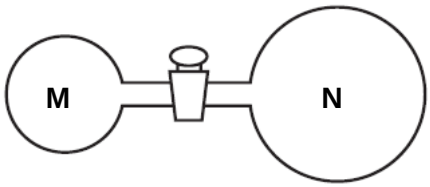
16 A reaction between NO and H_2 has the following suggested mechanism.

I: $2NO \rightleftharpoons N_2O_2$ (fast)
II: $N_2O_2 + H_2 \rightleftharpoons N_2O + H_2O$ (slow)
III: $N_2O + H_2 \rightarrow H_2O + N_2$ (fast)

Which of the following correctly describes the rate equation?

A rate = k $[NO]^2$
B rate = k $[NO]^2[H_2]$
C rate = k $[NO]^2[N_2O_2][H_2]$
D rate = k $[N_2O_2][H_2]$

17 Two glass vessels **M** and **N** are connected by a closed valve.



M contains helium at 25 °C at a pressure of 1 x 10^5 Pa. **N** has been evacuated, and has three times the volume of **M**. In an experiment, the valve is opened and the whole set–up placed in boiling water at 100 °C.

What is the final pressure in the system?

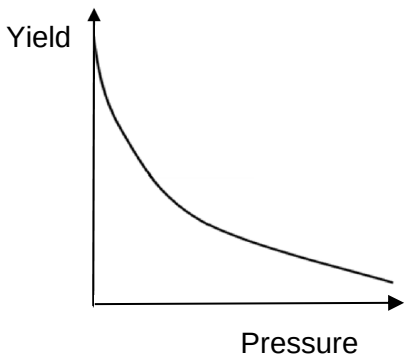
A 3.13 × 10^4 Pa
B 3.76 × 10^4 Pa
C 4.17 × 10^4 Pa
D 1.00 × 10^5 Pa

18 Ammonia can be synthesised directly using a mixture of hydrogen gas and nitrogen gas in a reversible reaction as shown:

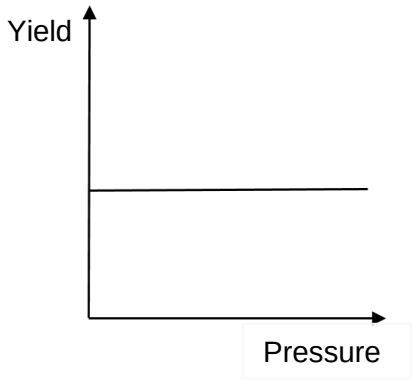
$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

Which one of the following describes how the yield of ammonia at equilibrium changes as pressure increases?

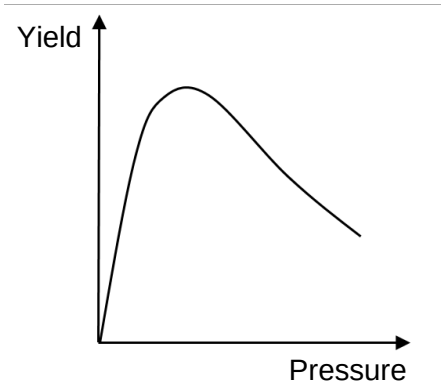
A



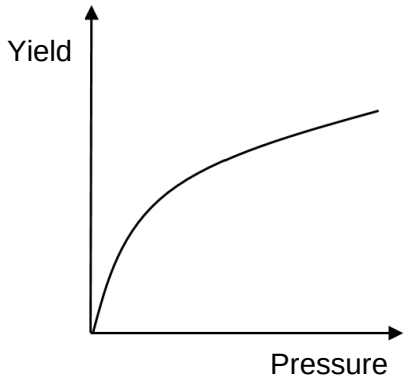
C



B



D



19 In an experiment carried out at 298 K, 1 mol of N_2O_4 and 0.2 mol of NO_2 were added to a sealed vessel with a fixed volume of 4 dm^3. When the system reached equilibrium, 0.68 mol of NO_2 was present in the vessel.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

What is the numerical value of the equilibrium constant, K_c, at 298 K?

A 0.15 **B** 0.22 **C** 0.46 **D** 0.61

20 Which of the following mixtures represent a Bronsted–Lowry acid and its conjugate base?

1 H_2O and OH^-

2 $H_2PO_4^-$ and HPO_4^{2-}

3 NaH and Na

A **1**, **2** and **3**

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

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

D **1** only

21 20 cm^3 of sodium hydroxide with concentration at 0.500 mol dm^{-3} is mixed with 20 cm^3 of ethanoic acid with concentration of 1.00 mol dm^{-3}.

What is the pH of the resultant solution?
(K_a of ethanoic acid = 1.8×10^{-5} mol dm^{-3})

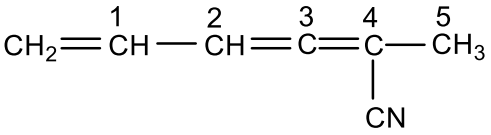
A 2.37 **B** 2.61 **C** 4.74 **D** 9.13

22 An aqueous solution of compound **G** ($pK_a = 4.70$) is titrated against an aqueous solution of NaOH.

Which of the following is the most suitable indicator for the titration?

	Indicator	pH range
A	Methyl yellow	2.9 – 4.0
B	Bromocresol purple	5.2 – 6.8
C	Cresolphthalein	8.2 – 9.8
D	Indigo carmine	11.4 – 13.0

23 Consider the molecule below:



Which statements about the molecule above are true?

1 There are four sp^2 hybridised carbon atoms in the molecule.

2 The π bond between C3–C4 is formed by 2p–2p overlap.

3 The σ bond between C1–C2 is longer than that between C4–C5.

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

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

24 A non–cyclic organic compound has the molecular formula $C_5H_8O_2$.

Which combination of functional groups **cannot** be present in this molecule?

1 one alkene and one carboxylic acid group

2 one ketone and one alcohol group

3 one aldehyde and one ketone group

4 one alkene and two alcohol groups

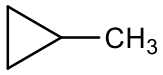
A **1** and **3** only **C** **2** and **3** only

B **1** and **4** only **D** **2** and **4** only

25 How many possible non-cyclic isomers, including stereoisomers, are there with the molecular formula C_3H_5Br?

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

26 Compound **U** undergoes substitution with chlorine gas to form monosubstituted compounds.

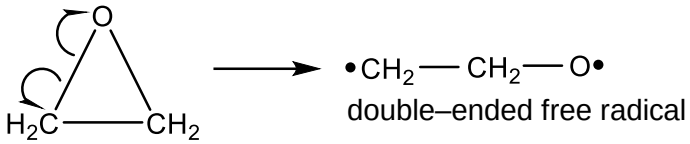


U

Considering only monosubstituted products, how many possible isomers, including stereoisomers, can be formed in the reaction?

A 4 **B** 5 **C** 6 **D** 7

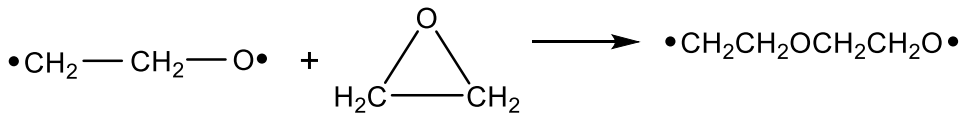
27 Non–ionic detergents can be made by the reaction of excess epoxyethane with an alcohol. A possible mechanism involves homolytic fission of a C–O bond in epoxyethane, giving rise to a 'double–ended' free radical with unpaired electrons on two atoms:

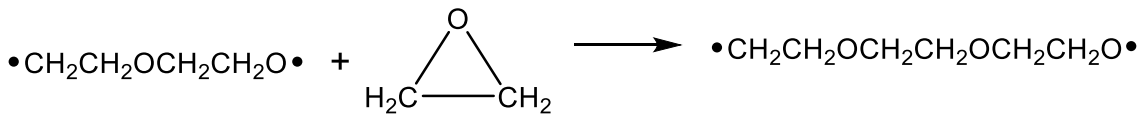


epoxyethane

double–ended free radical

The double–ended free radical then initiates a chain reaction in the propagation stage, where the double–ended radical formed in one step goes on to react in the next. The first two steps of the propagation stage are represented as follows:





Subsequent propagation steps occur in a similar way. Termination of the chain reaction occurs when a particular double–ended free radical reacts with an alcohol to form a non–ionic detergent.

What is a possible formula of such a non–ionic detergent?

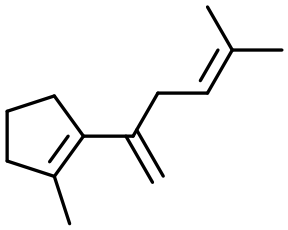
A $[CH_3(CH_2)_{10}O]_{10}CH_2CH_2OH$

B $CH_3(CH_2)_{10}O(OCH_2CH_2)_{10}OH$

C $CH_3(CH_2)_{10}O(CH_2CH_2O)_{10}OH$

D $CH_3(CH_2)_{10}O(CH_2CH_2O)_{10}H$

28 Consider the structure of Compound **V** given below:



Compound **V**

What are the organic products formed when Compound **V** is heated with an excess of hot acidified $KMnO_4(aq)$?

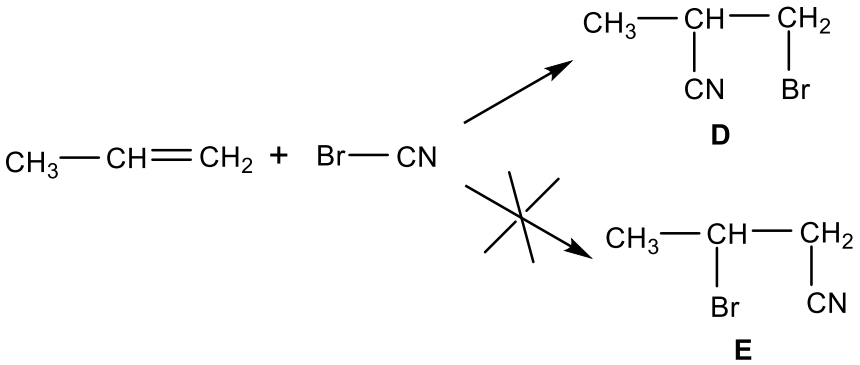
A $CH_3COCH_2CH_2CH_2COCOCH_2CO_2H$ and CH_3CO_2H

B $CH_3COCH_2CH_2CH_2CO_2H$ and $HO_2CCH_2COCOCH_2CH_3$

C $CH_3COCH_2CH_2COCH_2COCH_2CHO$ and $(CH_3)_2CO$

D $CH_3COCH_2CH_2CH_2COCOCH_2CO_2H$ and $(CH_3)_2CO$

29 Cyanogen bromide, BrCN, undergoes addition reactions with alkenes. With propene, isomer **D** is produced rather than isomer **E**.



What is the intermediate formed when BrCN undergoes a similar reaction with $CH_3CH{=}CHCH_3$?

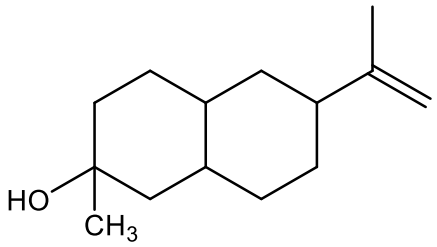
A $CH_3CHBr-\overset{+}{C}HCH_3$

B $CH_3\overset{+}{C}H-CH(CN)CH_3$

C $CH_3CH_2-CH(CN)\overset{+}{C}H_2$

D $\overset{+}{C}H_2CHBr-CH_2CH_3$

30 Compound **X** has the following structure.



X

X undergoes a reaction to form **Y**. **Y** has the same number of chiral centres as **X**.

What could be the appropriate set of reagents and conditions for the conversion of **X** to **Y**?

A cold alkaline $KMnO_4$

B Al_2O_3, heat

C Br_2 dissolved in CCl_4, room temperature

D H_2 and Ni, heat