

VICTORIA JUNIOR COLLEGE JC 2 PRELIMINARY EXAMINATION Higher 2

CHEMISTRY

9729/01

Paper 1 Multiple Choice

19 September 2024

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.

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Which arrangement of the four electrons of highest energy corresponds to the electronic configuration of a Group 14 element at its ground state?

A $2s^22p^2$ **B** $1s^22s^2$ **C** $2s^12p^3$ **D** $2s^22p^3$

2 The table below shows the sixth ionisation energies of four consecutive elements in the Periodic Table.

element	W	Х	Y	Z
sixth ionisation energy / kJ mol ⁻¹	19800	21300	8500	9360

What is the formula of the fluoride of W?

Α	WF ₃	в	WF₄	С	WF ₅	D	WF ₆
	•••• 5		**1 4	•	•••• 5		

Boron trifluoride, BF₃, is very difficult to handle due to its high reactivity at room temperature.
1 mole of BF₃ can react with 1 mole of dimethyl ether, CH₃OCH₃ to form compound J.

Which statements are correct?

- 1 Lone pair electrons on oxygen in CH₃OCH₃ is donated to the vacant orbital of boron in BF₃.
- 2 The bond angle around boron changes from 120° in BF_3 to 109.5° in compound J.
- 3 The molecular shape around oxygen changes from bent in CH₃OCH₃ to trigonal planar in compound J.
- **A** 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 only
- 4 The boiling point of water (100°C) is greater than that of NH_3 (–33.3°C).

Which statement does **not** explain the relative boiling points of H₂O and NH₃?

- **A** The water molecule has a greater permanent dipole than the NH₃ molecule.
- **B** Each hydrogen bond formed between water molecules is stronger than that formed between NH₃ molecules.
- ${f C}$ There are, on average, more hydrogen bonds between water molecules than there are between NH₃ molecules.
- **D** The O–H bonds in water are stronger than the N–H bonds in NH₃.

5 Deuterium, ²H, is an isotope of hydrogen.

In an experiment, 18.0 g of gas A at 40°C is found to occupy the same volume as 0.6 g of a deuterium gas, ${}^{2}H_{2}$, at 20°C.

The pressure of gas A is twice of that of the deuterium gas.

What is the relative molecular mass of gas A?

- **A** 32.0 **B** 60.0 **C** 64.1 **D** 120
- **6** V and Z are both elements in Period 3 of the Periodic Table. Each element forms one stable ion that does not contain another element.

The atomic radius and the ionic radius of each element described above is shown.

element	atomic radius / nm	ionic radius / nm
V	0.186	0.095
Z	0.099	0.181

Which statement is correct?

- A lons of V and Z have the same number of full electronic shells.
- **B** Z has a greater electronegativity than V.
- **C** lons of Z are positively charged.
- **D** V has more valence electrons than Z.
- 7 Which statements about the behaviour of the Group 2 elements, magnesium to barium, or their compounds are correct?
 - 1 The thermal stability of their carbonates increases.
 - 2 The reaction between elements with water becomes less vigorous.
 - 3 The electronegativity of elements decreases.
 - **A** 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 3 only

8 X, Y and Z are three elements in Group 17.

 X_2 has weaker covalent bonds than Y_2 .

 X_2 has stronger instantaneous dipole–induced dipole interactions between its molecules than Z_2 .

 Y_2 is a stronger oxidising agent than Z_2 .

What could be X, Y and Z?

	Х	Y	Z
Α	Ι	Cl	Br
В	Ι	Br	Cl
С	Cl	Br	Ι
D	Br	Cl	Ι

9 Use of the Data Booklet is relevant to this question.

KCN is used to extract gold, Au, from its ore. Gold dissolves in an aqueous cyanide solution in the presence of air to form $Au(CN)_2^-$, which is stable in aqueous solution.

 $4Au(s) + 8CN^{-}(aq) + O_2(g) + 2H_2O(I) \rightarrow 4Au(CN)_2^{-}(aq) + 4OH^{-}(aq)$

What is the minimum volume of air, measured at room temperature and pressure, needed to extract 10 kg of gold from its ore?

[You may assume the oxygen content in air to be 20%.]

10 Which reaction represents standard enthalpy change of formation of a substance?

$$\mathbf{A} \qquad \mathsf{Li}^+(g) + \mathsf{C}l^-(g) \to \mathsf{Li}\mathsf{C}l(s)$$

- $\mathbf{B} \qquad 2H_2(g) + O_2(g) \rightarrow 2H_2O(\mathsf{I})$
- $\label{eq:constraint} \textbf{C} \qquad 2C(g) + 3H_2(g) \rightarrow C_2H_6(g)$

D Na(s) +
$$\frac{1}{2}Cl_2(g) \rightarrow NaCl(s)$$

11 When SOC*l*₂ is added to Ba(OH)₂, a vigorous reaction occurs and the temperature of the solution falls from 25°C to 0°C.

What are the correct signs of ΔG and ΔS for this reaction?

	ΔG	ΔS
Α	—	+
В	_	-
С	+	-
D	+	+

12 Hydrogen peroxide can be decomposed in the presence of a fixed amount of MnO₂ catalyst as follows.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

The rate of the decomposition of hydrogen peroxide can be followed by measuring the time taken for the same volume of oxygen to be produced from a range of hydrogen peroxide concentrations.

To find the order of the reaction with respect to hydrogen peroxide, which would be the most suitable graph to plot using the data?

B [H₂O₂] against
$$\frac{1}{\text{time}}$$

C volume of O₂ against time

.

D volume of O_2 against $\frac{1}{\text{time}}$

13 The Boltzmann distribution for a gas at a constant temperature of T_1 is shown.



If the temperature of the gas is reduced to T_2 , the graph changes shape.

Which row best describes how the value of *n* changes at the molecular energies, X and Y respectively?

	Х	Y
Α	higher	higher
В	higher	lower
С	lower	higher
D lower		lower

14 SO₃ is manufactured from SO₂ and O₂ in the Contact process.

The reaction is exothermic.

Which row shows the effect on the equilibrium yield obtained in the Contact process by increasing the temperature and adding a vanadium(V) oxide catalyst?

	increasing the temperature	adding vanadium(V) oxide as catalyst
Α	equilibrium yield decreases	equilibrium yield unchanged
В	equilibrium yield decreases	equilibrium yield increases
С	equilibrium yield increases	equilibrium yield unchanged
D	equilibrium yield increases	equilibrium yield increases

15 At a constant total pressure of 1.0 atm, 50% of dinitrogen tetraoxide is dissociated at a temperature of 60°C according to the following equation.

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

What is the value of the equilibrium constant, K_p , for this reaction at 60°C?

A
$$\frac{1}{3}$$
 B $\frac{2}{3}$ **C** $\frac{4}{3}$ **D** 2

16 Soft drinks often have sodium citrate added to them to act as a buffer.

Which statement about buffer solutions is correct?

- A The pH of a buffer solution remains unchanged when small amounts of acid or base are added.
- **B** The pH of a buffer solution changes slightly when very large amounts of acid or base are added.
- **C** The pH of a buffer solution increases very slightly when small amounts of acid are added.
- **D** The pH of a buffer solution increases very slightly when small amounts of base are added.
- 17 Which of the following statements explain why silver chloride is soluble in aqueous ammonia, but silver iodide is not?
 - 1 The solubility product of silver chloride is numerically larger than that of silver iodide.
 - 2 Ammonium ions and chloride ions have great affinity for each other.
 - 3 The lattice energy of silver chloride is numerically greater than that of silver iodide.
 - A 1, 2 and 3 B 1 and 2 only C 2 and 3 only D 1 only
- **18** Clavulanic acid is a β-lactam drug that is used in combination with penicillin-type antibiotics to reduce antibiotic resistance.



clavulanic acid

How many stereoisomers does clavulanic acid have?

A 4 **B** 8 **C** 16 **D** 32

- **19** Which reaction is a termination step in the chain reaction between chlorine and methane, in the presence of ultraviolet light?
 - $A \qquad CH_3 \bullet + CH_3 \bullet \rightarrow CH_3 CH_3$
 - **B** $CH_3 \bullet + Cl_2 \rightarrow CH_3Cl + Cl \bullet$
 - $\mathbf{C} \qquad CH_{3}\bullet + H\bullet \rightarrow CH_{4}$
 - **D** $H \bullet + Cl \bullet \rightarrow HCl$
- **20** A key molecule in the chemistry of vision is the highly conjugated rhodopsin, which is synthesised in the rod cells of the eye from 11-*cis*-retinal and R–NH₂, where R is an unreactive alkyl group.



Which statement is correct?

- A 1 mol of 11-*cis*-retinal reacts with 5 mol of hydrogen gas.
- **B** The reaction between 11-*cis*-retinal and R-NH₂ is a condensation reaction.
- **C** The reaction of 11-*cis*-retinal with LiA/H₄ produces a product that is optically active.
- **D** The reaction between 11-*cis*-retinal and excess hot acidified potassium manganate(VII) produces a total of five different organic products.
- 21 Which of the following transformation has a set of conditions that is correct?



22 Chlorofluoroalkanes are commonly used as aerosol propellants. However, they cause depletion to the ozone layer when they rise into the stratosphere. It has thus been suggested that fluoroalkanes should be used instead.

Which of the following could be a possible reason for the suggestion?

- A Fluoroalkanes are less volatile than chlorofluoroalkanes and reach the stratosphere less easily.
- **B** Fluorine radicals may be produced, but unlike chlorine radicals, do not react with ozone.
- **C** Fluorine radicals are not produced as the C–F bonds are stronger than the C–C*l* bonds.
- **D** Fluorine radicals may be produced, but unlike chlorine radicals, are not regenerated after reaction with ozone.
- 23 Catechin is an antioxidant found in green tea, chocolate and peaches.



In the following reactions, R–O–R remains unaltered.

Which statement about catechin is correct?

- **A** 1 mol of catechin reacts with 5 mol of aqueous bromine.
- **B** 1 mol of catechin reacts with sodium to produce 5 mol of hydrogen gas.
- **C** 1 mol of catechin reacts with sodium carbonate to give 4 mol of carbon dioxide gas.
- **D** 1 mol of catechin reacts with 5 mol of aqueous sodium hydroxide.
- 24 Compound Z has the molecular formula $C_4H_8O_2$ and it undergoes the following reactions.
 - It forms an orange precipitate with 2,4-dinitrophenylhydrazine.
 - It does not form a precipitate with alkaline aqueous iodine.
 - It produces hydrogen gas with sodium metal.

How many non-cyclic constitutional isomers does compound Z have?

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

25 Use of the Data Booklet is relevant to this question.

A sample of propyl ethanoate is hydrolysed by heating under reflux with aqueous sodium hydroxide. The two organic products of the hydrolysis are separated, purified and weighed.

Out of the total mass of products obtained, what is the percentage by mass of each product?

- A 32.4 % and 67.6 %
- **B** 38.3 % and 61.7 %
- **C** 41.5 % and 58.5 %
- **D** 42.3 % and 57.7 %
- **26** Esters can also be reduced by LiA/H₄ in dry ether to give two alcohols as shown below.



What are the possible products formed when the compound Q is reacted with an excess of LiA/H_4 in dry ether?



compound Q



27 Methotrexate is an immunosuppressant used to treat some forms of cancer.



You may assume that the R group is unreactive.

Which statements about methotrexate are correct?

- 1 N_a and N_b can react with ethanoyl chloride to give an amide.
- 2 When 1 mole of H^+ is added to 1 mol of methotrexate at room temperature, N_a is protonated preferentially.
- 3 The treatment of methotrexate with an excess of LiA*l*H₄ will result in the removal of two oxygen atoms from methotrexate.
- **A** 1, 2 and 3 **B** 1 and 3 only **C** 2 and 3 only **D** 2 only
- **28** Two separate electrolyses were performed as follows, under the same conditions of temperature and pressure.
 - Electrolysis 1 When molten copper(II) chloride was electrolysed for five minutes, 100 cm^3 of chlorine were collected from the anode.
 - Electrolysis 2 When aqueous sulfuric acid was electrolysed for five minutes, 200 cm³ of oxygen were collected from the anode.

If the current used in electrolysis 1 was I, what was the current used in electrolysis 2?

A 0.5*I* **B** *I* **C** 2*I* **D** 4*I*

12

29 Use of the Data Booklet is relevant to this question.

Which of the following are chemically stable when left to stand in the atmosphere?

- 1 An aqueous solution of potassium hexacyanoferrate(III), K₃[Fe(CN)₆]
- 2 An aqueous solution of chromium(II) chloride, CrCl₂
- 3 A mixture of aqueous sodium hydroxide, NaOH and iron(II) sulfate, FeSO₄

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

- 30 Which one of the following cannot act as a ligand to form complexes?
 - A SCN⁻
 - **B** H₂NCH₂CH₂NH₂
 - $C A l H_4^-$
 - **D** C*l*⁻