



VICTORIA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CHEMISTRY

9729/01

Paper 1 Multiple Choice

19 September 2025

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 name, CT group and VJC index number on the Answer Sheet.

There are **thirty** 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.

This document consists of **12** printed pages

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.

Berkelium, Bk, and Fermium, Fm, are both actinoids. An isotope of Bk^{2+} and an isotope of Fm^{3+} have 249 and 252 nucleons respectively.

Which row of the table is correct?

	ion containing larger number of neutrons	ion containing larger number of electrons
A	Bk^{2+}	Fm^{3+}
B	both the same	Fm^{3+}
C	Fm^{3+}	Bk^{2+}
D	both the same	Bk^{2+}

- 2** Consider the atoms of the Period 3 elements from Na to Ar.

What is the total number of paired electrons in the valence shells of these eight elements?

- A** 26 **B** 28 **C** 30 **D** 32

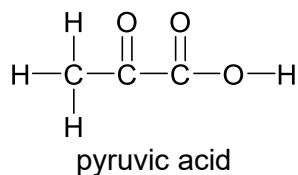
- 3** The boiling points of HF, $\text{HC}\ell$ and HBr are different. $\text{HC}\ell$ has the lowest boiling point.

Which statements are correct?

- 1 $\text{HC}\ell$ has a lower boiling point than HBr because $\text{HC}\ell$ molecules have weaker permanent dipole-permanent dipole forces of attraction.
- 2 HF molecules experience weaker temporary dipole-induced dipole forces of attraction than HBr molecules.
- 3 HF molecules experience stronger permanent dipole-permanent dipole forces of attraction than $\text{HC}\ell$ molecules.

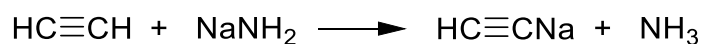
- A** 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 3 only

- 4 The diagram shows the structure of a pyruvic acid.



What set of bond angles are present in pyruvic acid?

- A** 180°, 120°, 90°
- B** 180°, 120°, 109°
- C** 120°, 105°, 90°
- D** 120°, 109°, 105°
- 5 Which statement applies to both ideal and real gases?
- A** Collisions between molecules are elastic.
- B** Molecules are in constant random motion.
- C** Molecules attract each other.
- D** Molecules have zero size.
- 6 Acetylene (C_2H_2) is unable to react with water but is able to react with a strong base like sodium amide (NaNH_2).



Which of the following statements is correct?

- A** Acetylene acts as an Arrhenius acid as it contains a hydrogen atom.
- B** Acetylene does not act as an Arrhenius acid as it is unable to dissociate in water to form H_3O^+ .
- C** The conjugate base of acetylene is $\text{HC}\equiv\text{CNa}$.
- D** Acetylene acts as a Lewis acid in the reaction with sodium amide.

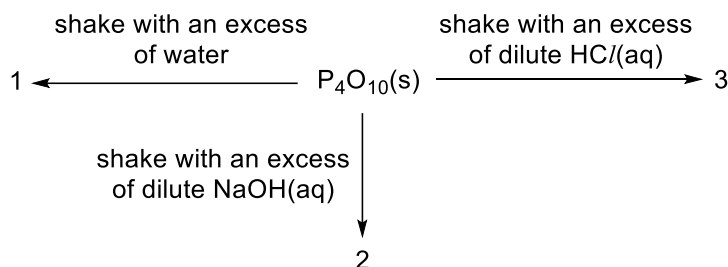
- 7 The three minerals below are known as double carbonates, which are carbonates containing 2 metallic elements. Double carbonates decompose in two steps, with each step involving the decomposition of one of the metallic carbonates that it contains. The decomposition of the carbonates releases carbon dioxide, which helps to smother fire, thus acting as fire retardants.

mineral	chemical formula
dolomite	$\text{CaMg}(\text{CO}_3)_2$
huntite	$\text{Mg}_3\text{Ca}(\text{CO}_3)_4$
norsethite	$\text{BaMg}(\text{CO}_3)_2$

Which row correctly shows the relative effectiveness of the minerals as a fire retardant?

	most effective	—————→	least effective
A	dolomite	huntite	norsethite
B	norsethite	dolomite	huntite
C	norsethite	huntite	dolomite
D	huntite	dolomite	norsethite

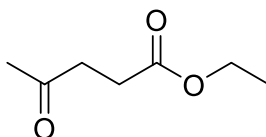
- 8 A student carries out an investigation using phosphorus (V) oxide. All experiments are carried out room temperature.



Which observations would the student make of the results of these experiments?

- A No solid remains in any experiment.
- B A solid remains in one experiment only.
- C A solid remains in two experiments only.
- D Solid remains in all three experiments.

- 9 Compound **G**, $C_7H_{12}O_3$, is a diesel fuel additive which reduces the amount of soot formed when the fuel burns.



compound **G**

How many moles of oxygen gas are needed to completely burn 1 mole of compound **G**?

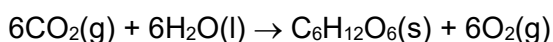
- A** 8.5 **B** 9.0 **C** 9.5 **D** 10.0
- 10 Magnesium(I) chloride, $MgCl$, does not exist as a stable compound but its lattice energy can be estimated.

What is the predicted order of increasing magnitude of lattice energy of $MgCl$, $MgCl_2$ and $SrCl_2$?

- A** $MgCl$, $MgCl_2$, $SrCl_2$
B $MgCl$, $SrCl_2$, $MgCl_2$
C $MgCl_2$, $SrCl_2$, $MgCl$
D $SrCl_2$, $MgCl$, $MgCl_2$
- 11 Some ΔH_f^\ominus values are given below.

compound	$\Delta H_f^\ominus / \text{kJ mol}^{-1}$
$H_2O(l)$	-286
$CO_2(g)$	-394
$C_6H_{12}O_6(s)$	-1273

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



Which of the following statements are correct?

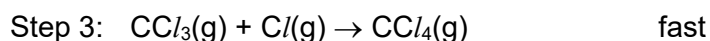
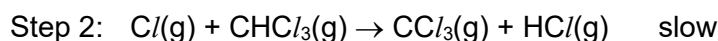
- 1 The enthalpy change of the reaction is $+2807 \text{ kJ mol}^{-1}$
 - 2 In the formation of products, the system becomes less disordered.
 - 3 The reaction is not spontaneous at all temperatures.
- A** 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 1 only

- 12 The hydrolysis of ethyl ethanoate in aqueous solution can be catalysed by hydrogen ions from sulfuric acid.

To determine the order of this reaction with respect to hydrogen ions, which method should be used?

- A Measure the change in pH during the reaction.
- B Measure the rate of the reaction several times, but with a different concentration of ethyl ethanoate each time.
- C Measure the rate of the reaction several times, but with a different concentration of sulfuric acid each time.
- D Remove samples at various time intervals and titrate against a standard solution of aqueous sodium hydroxide.

- 13 The mechanism below has been proposed for the reaction of CHCl_3 with Cl_2 .



Which of the following rate equations is consistent with this mechanism?

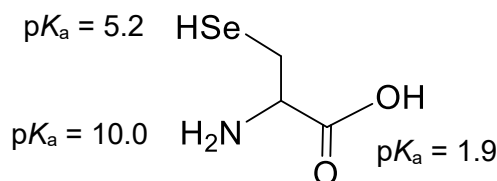
- A $\text{rate} = k[\text{CHCl}_3][\text{Cl}]$
- B $\text{rate} = k[\text{CHCl}_3][\text{Cl}_2]$
- C $\text{rate} = k[\text{CHCl}_3][\text{Cl}_2]^{1/2}$
- D $\text{rate} = \frac{k[\text{CHCl}_3]}{[\text{Cl}_2]}$

- 14 The rates of chemical reaction can be increased by increasing the concentration of reactants, raising the temperature or adding a catalyst.

Which statement is **not** correct?

- A Increasing the temperature increases the proportion of particles having energy greater than the activation energy.
- B Adding a catalyst increases the proportion of particles having energy greater than the activation energy.
- C Increasing the temperature increases the rate constant.
- D Increasing the concentration of the reactants increases the rate constant.

- 15 The structure of an amino acid, Selenocysteine, with its three functional groups is shown below. The pK_a of $-\text{SeH}$, $-\text{NH}_2$ and $-\text{COOH}$ are 5.2, 10.0 and 1.9 respectively.



Which statements are correct about Selenocysteine at fixed temperature?

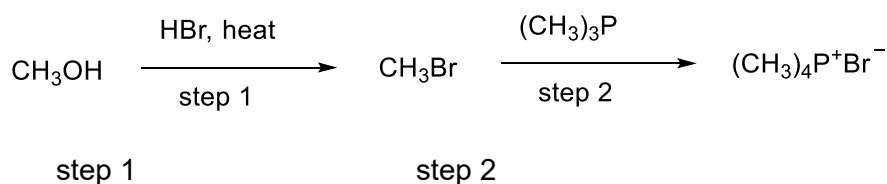
- 1 The carboxylic acid group ($-\text{COOH}$) is the most acidic group.
- 2 At pH 8, Selenocysteine will migrate towards the positive terminal in an electric field.
- 3 When the concentration of H^+ is high, K_a of the three functional groups decreases due to lower extent of dissociation.

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

- 16 Which scenario best demonstrates a common ion effect that reduces the solubility of the underlined salt?

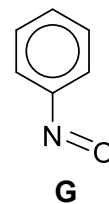
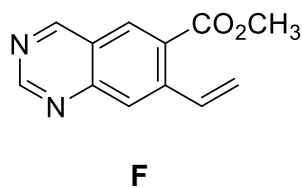
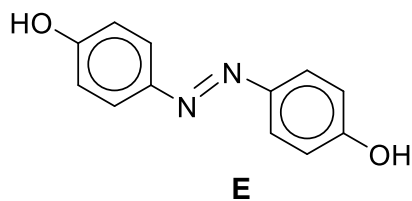
- A** Adding $\text{Pb}(\text{NO}_3)_2$ to a solution of PbCl_2
- B** Adding KNO_3 to a solution of AgCl
- C** Adding Na_2SO_4 to a solution of BaCl_2
- D** Adding AgCl to a solution of NaCl

- 17 In the following sequence of reactions, what is the mechanism of each step?



- A** electrophilic substitution electrophilic addition
- B** electrophilic substitution nucleophilic addition
- C** nucleophilic substitution electrophilic substitution
- D** nucleophilic substitution nucleophilic substitution

- 18 The three compounds **E**, **F** and **G** have the following structures.

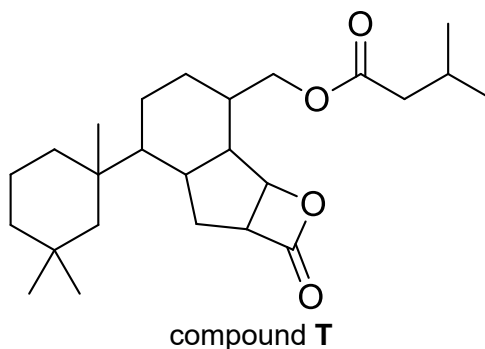


Which statements about **E**, **F** and **G** are correct?

- 1 **E** and **G** have the same empirical formula.
- 2 **E** and **F** are isomers.
- 3 The M_r of **F** is exactly twice that of **G**.

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

- 19 The structure of compound **T** is shown below.



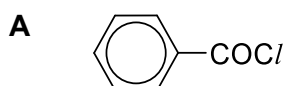
How many chiral centers does 1 molecule of **T** have?

- A** 5 **B** 6 **C** 7 **D** 8

- 20 When a substance, **Z**, is shaken with aqueous silver nitrate at room temperature, there is no immediate precipitate.

In a second experiment, **Z** is boiled under reflux for some time with aqueous sodium hydroxide. The resulting solution is cooled and acidified with dilute nitric acid. When aqueous silver nitrate is now added, a white precipitate readily forms.

What could **Z** be?



- 21 Alcohols can be dehydrated by passing their vapour over heated aluminium oxide.

Which compound is **not** produced when hexan-3-ol is treated in this way?

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CHCH}_3$
- B $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_3$
- C $\text{CH}_2=\text{CHCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- D H_2O

- 22 Which reaction will form $(\text{CH}_3)_2\text{CHCH}_2\text{CO}_2\text{H}$?

- A 2-methylpropanenitrile with dilute sodium hydroxide
- B ethyl 2-methylbutanoate with dilute sulfuric acid
- C 3-methylbutan-1-ol with acidified $\text{Cr}_2\text{O}_7^{2-}$
- D 3-methylbutan-2-ol with acidified MnO_4^-

- 23 Which statements are correct about the reaction between ethylamine and ethanoyl chloride?

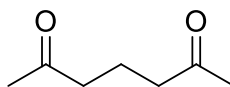
- 1 During the reaction, a carbon-chlorine bond is broken and a carbon-nitrogen bond is formed.
- 2 The same reaction will take place if ethanoyl chloride is replaced by ethanoic acid.
- 3 The organic product formed, when dissolved in water will give a solution that has a pH greater than 7.

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

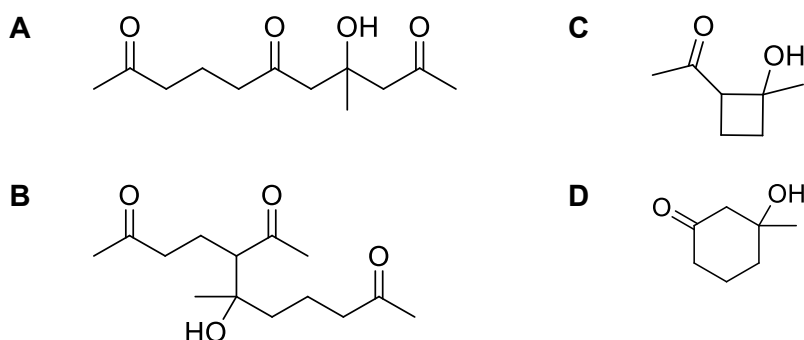
- 24 The aldol reaction between two carbonyl compounds involves the removal of a H^+ from a carbon atom adjacent to the carbonyl group by NaOH , and subsequent formation of the product. An example is shown below.



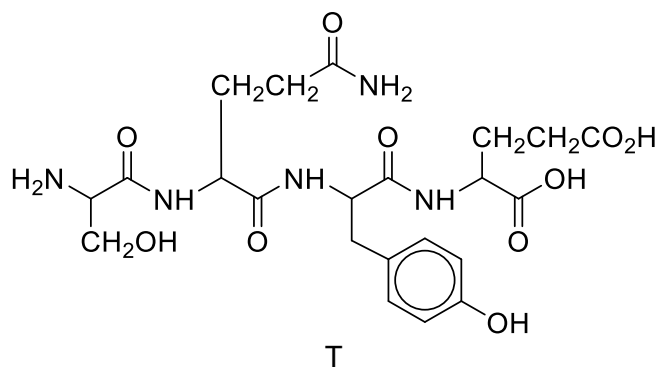
The following compound is a diketone.



Which one of the following products **cannot** possibly be formed from the above diketone via the aldol reaction?



- 25 The diagram shows the structure of the tetrapeptide T.



When 0.1 mol of T is heated under reflux with NaOH(aq) until no further reaction occurs, how many mol of NaOH will react?

- A** 0.4 **B** 0.5 **C** 0.6 **D** 0.7

- 26** **J** is a synthetic nonapeptide that is found in honeybee venom.

To investigate the sequence of amino acids in **J**, the nonapeptide was first hydrolysed by two enzymes. The protein fragments were then separated and their sequence determined.

The first enzyme, which hydrolysed the polypeptide chain at the carboxylic end of the amino acid lysine, Lys, yielded the following fragments.

Trp-Ile-Lys
Leu-Arg
Arg-Ile-Ser-Lys

The following protein fragments were obtained from the second enzyme which hydrolysed the polypeptide chain at the carboxylic end of the amino acid isoleucine, Ile.

Ser-Lys-Trp-Ile
Arg-Ile
Lys-Leu-Arg

Which is the correct primary structure of the nonapeptide **J**?

- A** Lys-Leu-Arg-Ile-Ser-Lys-Trp-Ile-Lys
B Arg-Ile-Ser-Lys-Trp-Ile-Lys-Leu-Arg
C Ser-Lys-Trp-Ile-Lys-Leu-Arg-Ile-Ser
D Trp-Ile-Lys-Leu-Arg-Ile-Ser-Lys-Trp
- 27** A current was passed through two cells connected in series. The first cell contained molten magnesium chloride, MgCl_2 , while the other contained molten chromium(III) chloride, CrCl_3 .

4.8 g of magnesium was liberated from the first cell. What is the mass of chromium liberated from the other cell?

- A** 2.4 g **B** 3.2 g **C** 6.8 g **D** 15.6 g

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

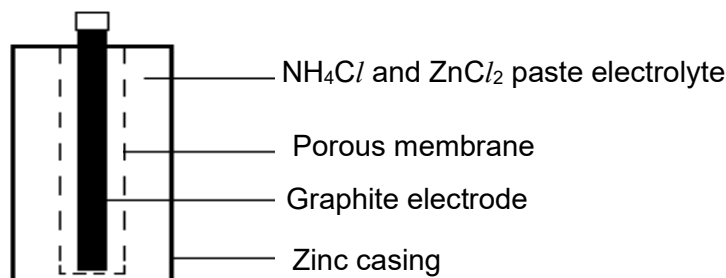
An excess of sulfur dioxide, SO_2 , is bubbled into a warm solution containing VO_2^+ ions in acid conditions.

What will be the final oxidation state of vanadium?

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

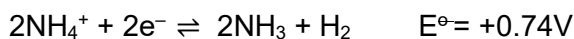
29 Use of the Data Booklet is relevant to this question.

A dry cell is a type of electrochemical cell that serves as a portable source of electrical energy. The diagram below shows the setup for a dry cell.



The NH_4Cl and ZnCl_2 paste electrolyte are sufficiently mobile to travel to the electrodes.

The half-cell equation for NH_4^+ is shown below.



Which row correctly shows the direction of flow of electrons and the E^\ominus_{cell} of the dry cell?

	direction of electron flow in external circuit	$E^\ominus_{\text{cell}} / \text{V}$
A	zinc casing to graphite electrode	+1.50
B	zinc casing to graphite electrode	+2.12
C	graphite electrode to zinc casing	+1.50
D	graphite electrode to zinc casing	+2.12

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

A student noted the relevant standard electrode potentials and correctly deduced that bubbling $\text{O}_2(\text{g})$ through an acidic solution of $\text{HBr}(\text{aq})$ should oxidise it to $\text{Br}_2(\text{aq})$.

On bubbling air through an acidic solution of $\text{HBr}(\text{aq})$ in a test tube, the student observed no effect.

What could be reasons for this?

- 1 The oxygen pressure was smaller than 1.0 atmosphere.
- 2 The activation energy for the reaction is high.
- 3 The $\text{Br}^-(\text{aq})$ concentration is much smaller than 1.0 mol dm^{-3} .

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