RIVER VALLEY HIGH SCHOOL
JC 2 PRELIMINARY EXAMINATION

CANDIDATE NAME

CLASS 2 1 J

CENTRE NUMBER S

INDEX NUMBER

H2 CHEMISTRY
9729/01

Paper 1 Multiple Choice

22 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 name, class, centre number and index number on the Answer Sheet in the spaces provided.

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 **16** printed pages.

1 Which particle has more protons than electrons and more protons than neutrons?
($D = {}^2_1H$)

A NO_2^+ **B** ND_2H **C** NDH^- **D** ND_3H^+

2 Which particle would, on gaining an electron, have a half-filled subshell?

A V^- **B** N **C** Se^+ **D** Ti

3 The first six ionisation energies (I.E.) of a Period 3 element, M, in kJ mol^{-1} are shown.

	1st	2nd	3rd	4th	5th	6th
I.E./ kJ mol^{-1}	1012	1907	2914	4964	6274	21267

Which equations show the formation of the chloride of M?

1 $M + 2Cl_2 \rightarrow MCl_4$

2 $2M + 3Cl_2 \rightarrow 2MCl_3$

3 $2M + 5Cl_2 \rightarrow 2MCl_5$

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

4 The boiling point of water (100 °C) is greater than that of HF (20 °C).

Which statement is a correct explanation of this?

A The H_2O molecule has a larger net dipole moment than the HF molecule.

B Each hydrogen bond formed between H_2O molecules is stronger than that formed between HF molecules.

C There are more electrons in a H_2O molecule than there are in a HF molecule, so the instantaneous dipole-induced dipole interactions are stronger in H_2O.

D On average, there are two hydrogen bonds between H_2O molecules compared to one hydrogen bond between HF molecules.

5   Which molecule contains a dative bond?

   A BF_3

   B   NO

   C   CO

   D SiO_2

6   Which gas shows the greatest deviation from ideality?

   A CH_4 **B** SO_3 **C** C_2H_2 **D** CO_2

7   When a sample of gas is compressed at constant temperature from 20 atm to 80 atm, its volume changes from 67.0 cm^3 to 15.5 cm^3.

   Which of the following is **not** a possible explanation of this behaviour?

   A   Gas is adsorbed onto the vessel walls.

   B   Gas begins to liquefy at 80 atm.

   C   The gas dissociates.

   D   The gas dimerises.

8   The titration curve shows how pH changes when 20.0 cm³ of 0.20 mol dm⁻³ acid is titrated against 0.10 mol dm⁻³ base.

Volume of 0.10 mol dm⁻³ base added / cm³
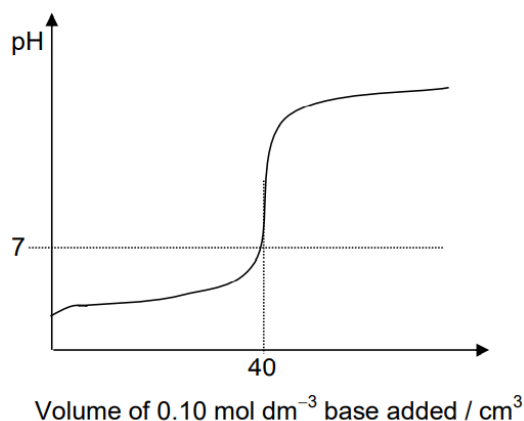
Which of the following statements regarding this titration is **incorrect**?
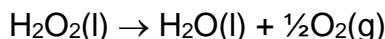
A   The identity of the acid and base could be CH_3COOH and $Ba(OH)_2$ respectively.

B   A buffer solution is formed when 15 cm³ of the base is added.

C   The solution at equivalence point is alkaline.

D   This is a weak acid–strong base titration.

9   Self-heating cans offer benefits to campers without access to a stove or campfire. These soup cans have double walls with an ionic compound such as CaO in a packet and water between the walls. Upon opening the can, the packet breaks, allowing CaO to react with water and warm up the soup.
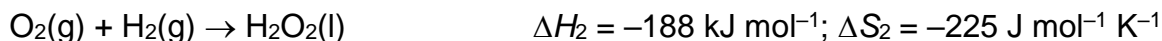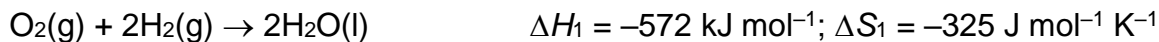
$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$$
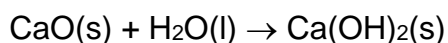
What are the signs of ΔH, ΔS and ΔG for the overall process?

	ΔH	ΔS	ΔG
A	–	–	–
B	–	+	–
C	+	+	–
D	+	+	+

**10** Hydrogen peroxide is thermodynamically unstable and decomposes over time to form water and oxygen gas.

$$H_2O_2(l) \rightarrow H_2O(l) + \tfrac{1}{2}O_2(g)$$

The following data are provided:

$O_2(g) + 2H_2(g) \rightarrow 2H_2O(l)$ $\quad\quad\quad\quad \Delta H_1 = -572$ kJ mol^{-1}; $\Delta S_1 = -325$ J mol^{-1} K^{-1}

$O_2(g) + H_2(g) \rightarrow H_2O_2(l)$ $\quad\quad\quad\quad \Delta H_2 = -188$ kJ mol^{-1}; $\Delta S_2 = -225$ J mol^{-1} K^{-1}

What is the value of ΔG, in kJ mol^{-1}, for the decomposition of hydrogen peroxide at 25 °C?

A −79 **B** −100 **C** −117 **D** −354

11 The enthalpy change of reaction between calcium and water is measured in the laboratory and found to be x kJ mol^{-1}.

$$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g) \quad\quad \Delta H = x \text{ kJ mol}^{-1}$$
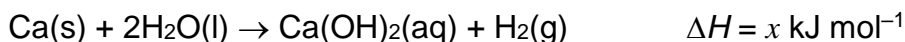
What information is needed to calculate the value of x?

1 enthalpy change of neutralisation of calcium hydroxide

2 enthalpy change of reaction of calcium with acid

3 enthalpy change of formation of water

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

12 When 10 cm^3 of a hydrocarbon was burnt in 100 cm^3 of excess oxygen, the volume of residual gas mixture contracted by 20 cm^3 after passing through a solution of aqueous sodium hydroxide. The remaining volume of gas was just sufficient to completely burn exactly 30 cm^3 of the same hydrocarbon.

All gas volumes were measured at room temperature and pressure.

What is the formula of the hydrocarbon?

**A** C_2H_2 **B** C_2H_3 **C** C_2H_4 **D** C_2H_6

13 50.0 cm^3 of a 0.10 mol dm^{-3} metallic salt solution was found to react exactly with 25.0 cm^3 of 0.10 mol dm^{-3} aqueous sodium sulfite. In this reaction, the sulfite ion is oxidised as follows:

$$SO_3^{2-}(aq) + H_2O(l) \rightarrow SO_4^{2-}(aq) + 2H^+(aq) + 2e^-$$

The oxidation state of metal in the salt solution is +3. What is the oxidation state of metal in the product?

A +1 **B** +2 **C** +4 **D** +5

14 Ethyl ethanoate undergoes acid-catalysed hydrolysis where the concentration of acid in the solution remains constant.

$$CH_3CO_2CH_2CH_3 + H_2O \xrightarrow{H^+} CH_3CO_2H + CH_3CH_2OH$$
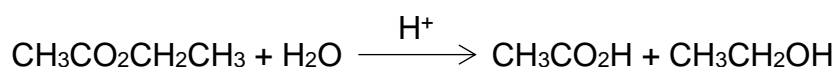
The rate equation is found to be
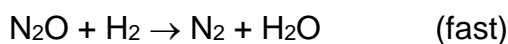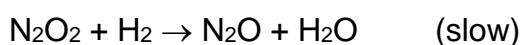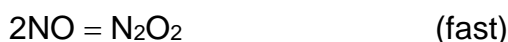
$$rate = k\,[CH_3CO_2CH_2CH_3]\,[H^+]$$

In experiment **1**, the half-life was found to be 31 minutes when 0.2 mol dm^{-3} of HC*l* was reacted with 0.2 mol dm^{-3} of ethyl ethanoate.

In experiment **2**, 0.1 mol dm^{-3} of HC*l* was reacted with 0.2 mol dm^{-3} of ethyl ethanoate.

How long does it take for the concentration of ethyl ethanoate in experiment **2** to fall to 0.05 mol dm^{-3}?

A 31 min **B** 62 min **C** 93 min **D** 124 min

15 The reaction between NO and H$_2$ is thought to involve the following mechanism:

$$2NO = N_2O_2 \qquad \text{(fast)}$$
$$N_2O_2 + H_2 \rightarrow N_2O + H_2O \qquad \text{(slow)}$$
$$N_2O + H_2 \rightarrow N_2 + H_2O \qquad \text{(fast)}$$

Which of the following conclusions can be drawn from this information?

A N$_2$O acts as a catalyst.

B The overall order of reaction is 3.

C The order of reaction with respect to H$_2$ is 2.

D The rate is independent of the concentration of NO.

16 In a closed system, the reaction between steam and hot iron to form ferroso-ferric oxide is an example of an equilibrium. The reaction is investigated by mixing 3.0 mol of Fe with 2.0 mol of H_2O and allowing the equilibrium to establish.

$$3Fe \quad + \quad 4H_2O \quad \rightleftharpoons \quad Fe_3O_4 \quad + \quad H_2$$

initial moles   3.0   2.0   0   0
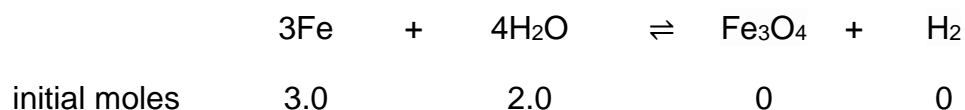
At equilibrium, x mol of H_2O has reacted with Fe.

What are the amounts, in moles, of each of the components of the equilibrium mixture?

	Fe	H_2O	Fe_3O_4	H_2
A	$3.0 - \frac{3x}{4}$	$2.0 - \frac{x}{4}$	$4x$	$4x$
B	$3.0 - \frac{4x}{3}$	$2.0 - x$	$4x$	$4x$
C	$3.0 - \frac{3x}{4}$	$2.0 - x$	$\frac{x}{4}$	$\frac{x}{4}$
D	$3.0 - \frac{4x}{3}$	$2.0 - x$	$\frac{x}{4}$	$\frac{x}{4}$

17 0.1 mol solid sodium sulfide was added to a 1 dm^3 sample containing Ag^+, Cu^{2+} and Sn^{4+} to obtain saturated solutions for all 3 sulfides.

Relevant K_{sp} values are given in the table.

salt	K_{sp}
Ag_2S	6.8×10^{-50}
CuS	6.3×10^{-36}
SnS_2	1.0×10^{-70}

What are the concentrations, in mol dm^{-3}, for each of the cations?

	$[Ag^+(aq)]$	$[Cu^{2+}(aq)]$	$[Sn^{4+}(aq)]$
A	8.25×10^{-49}	6.3×10^{-35}	1.0×10^{-68}
B	8.25×10^{-25}	6.3×10^{-35}	1.0×10^{-68}
C	8.25×10^{-25}	6.3×10^{-37}	1.0×10^{-69}
D	8.25×10^{-49}	6.3×10^{-37}	1.0×10^{-69}

18 The pK_a values of ethanoic, bromoethanoic and fluoroethanoic acids are given in the table.

	CH_3COOH	$CH_2BrCOOH$	CH_2FCOOH
pK_a	4.76	2.86	2.57

Which statements explain these data?

1 Bromine and fluorine are both electronegative and draw electrons away from the O#H bond in the carboxyl group.

2 Bromine and fluorine are both electronegative and stabilise the carboxylate anion.

3 Methyl groups are electron donating and destabilise the carboxylate anion.

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

19 Which conditions are necessary when an electrode potential is measured using a standard hydrogen electrode as the reference electrode?

    1   the use of hydrogen gas at 1 bar

    2   measurement of e.m.f when the current delivered by the cell is effectively zero

    3   a pH of 1.0 for the solution at the hydrogen electrode

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

20 β-carotene is a red-orange pigment found in carrots.
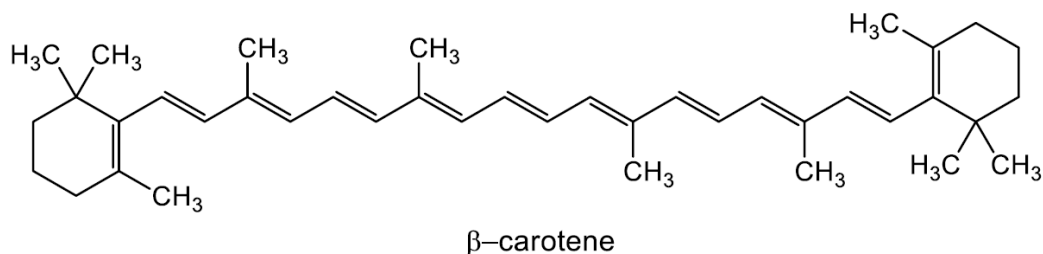
β–carotene

β-carotene reacts with hot, acidified $KMnO_4$.

Which statements are correct?

    1   Two organic products are obtained.

    2   All organic products react with warm aqueous alkaline iodine.

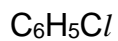   3   Some of the products are isomeric.

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

21 Equal amounts of compound **W**, **X**, **Y** and **Z** are heated separately with excess ethanolic silver nitrate for the same duration. Any precipitate formed is filtered, dried and weighed.
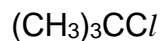
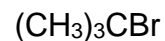What are the possible masses of the precipitates obtained for each halogen-containing compound?
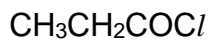
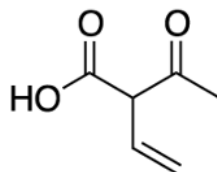|	CH_3CH_2COCl	C_6H_5Cl	$(CH_3)_3CCl$	$(CH_3)_3CBr$
	W	**X**	**Y**	**Z**

	mass of precipitate/ g			
	W	**X**	**Y**	**Z**
A	1.434	0	1.256	1.388
B	1.434	0	1.256	1.723
C	1.723	0	1.434	1.256
D	1.434	1.434	1.434	1.878

**22** Which are the products formed when compound **P** reacts with the following reducing agents?


compound **P**

	H$_2$, Ni, heat	LiAlH$_4$ in dry ether
A		
B		
C		
D		

23 Which statement is true about the reaction between propanone and hydrogen cyanide?

A The sp^2 hybridised carbon is electrophilic and accepts a pair of electrons.

B The π bond in the carbon-oxygen bond is weak and undergoes homolytic fission.

C All carbon atoms in the product are sp^3 hybridised.

D Nucleophilic attack on the trigonal planar carbon centre forms a racemic mixture.

24 Estradiol is an estrogen steroid hormone and daidzein is a natural isoflavone with estrogen-like activity.
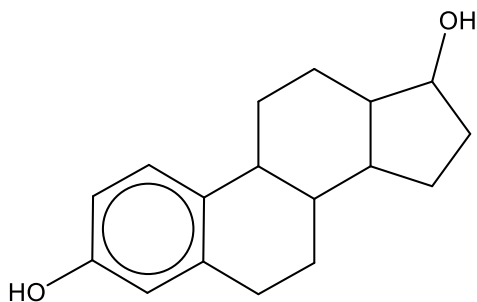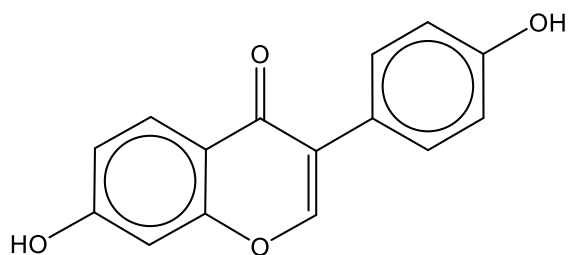

estradiol   daidzein

You may assume that the C#O#C bond in daidzein is unreactive.

Which reagent **cannot** be used as a distinguishing test?

A   acidified potassium dichromate(VI), heat

B   phosphorous pentachloride

C   2,4-dinitrophenylhydrazine

D   aqueous bromine

25 Which statements best describe the reaction mechanism involved in the conversion of chloroethane to ethanol?

1   The reaction mechanism involves a carbocation.

2   The rate determining step involves both the chloroethane and the nucleophile.

3   The reaction mechanism involves heterolytic fission of the C#Cl bond.

4   The activation energy of the first step of the mechanism is greater than that of the second step.

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

26 Compound **Y** is formed from the partial hydrolysis of a biomolecule.

$$OH$$

$$CH(CH_3)OH \qquad\qquad CH_2$$
$$H_2NCHCONHCHCONHCHCONHCHCOOH$$
$$CH_2COOH \qquad\qquad CH_2CONH_2$$
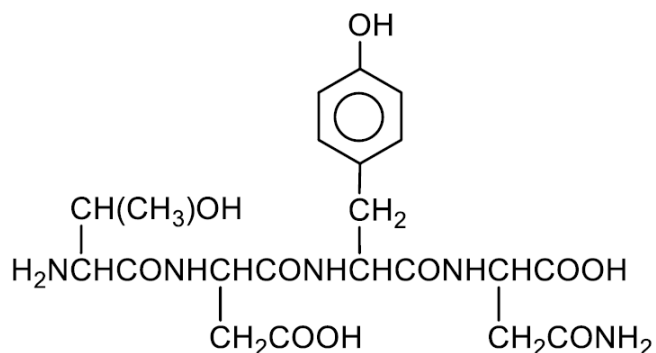
Compound **Y**

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

A Two moles of Br_2 are needed for complete reaction with one mole of compound **Y**.

B Two moles of Na_2CO_3 are needed for complete reaction with one mole of compound **Y**.

C Prolonged heating of compound **Y** with dilute NaOH liberates an alkaline gas.

D Prolonged heating of compound **Y** with dilute NaOH produces three carbon-containing products.
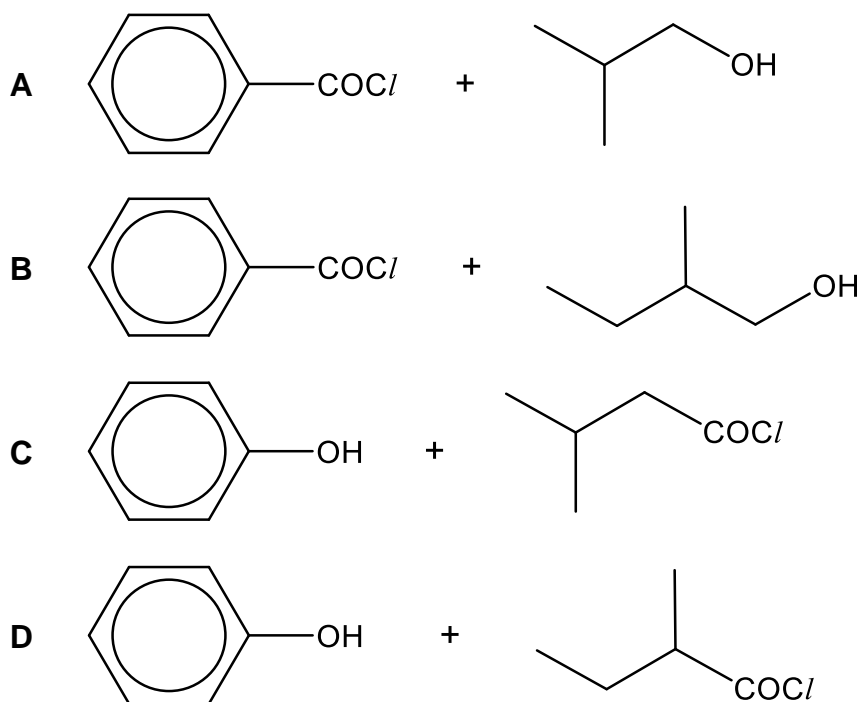
27 The set-up below is commonly used in the synthesis of organic compounds in the laboratory.
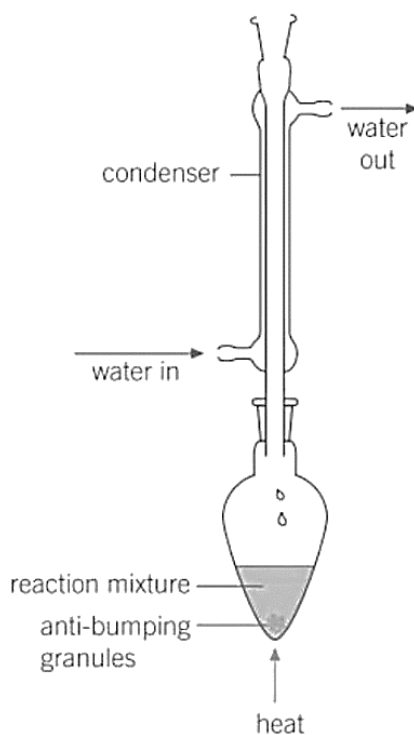
Which reaction requires the above set-up for synthesis?

A $CH_3CH_2NH_2 + CH_3COCl \rightarrow CH_3CONHCH_2CH_3 + HCl$

B $CH_3COCl + H_2O \rightarrow CH_3COOH + HCl$

C $CH_3CH_2OH + [O] \rightarrow CH_3CHO + H_2O$

D $CH_3CONH_2 + NaOH \rightarrow CH_3COONa + NH_3$

28 Which reaction will produce phenyl 2-methylbutanoate under suitable conditions?

A

B

C

D

29 When drops of NH_3(aq) are added to $Cu(NO_3)_2$(aq), a pale blue precipitate is formed. This precipitate dissolves when an excess of NH_3(aq) is added, giving a dark blue solution.

Which of the following process does **not** occur?

A ligand exchange

B acid-base reaction

C reduction of Cu^{2+} ions

D formation of a complex ion

30 Iron, a transition metal, is used in the Haber process. Which of the following statements best explains the role of iron in this application?

A Iron has partially filled 3d orbitals for adsorption of reactant molecules.

B Iron exhibits variable oxidation states in its compounds as 3d and 4s electrons have similar energies.

C Iron has a very high melting point as both 3d and 4s electrons contribute to forming strong metallic bonds.

D Iron forms coloured ions due to absorption of energy in the visible light region to promote an electron from a lower energy to a higher energy 3d orbital.

- End of paper -