EUNOIA JUNIOR COLLEGE
JC2 Preliminary Examination 2022
General Certificate of Education Advanced Level
Higher 2

CHEMISTRY

Paper 1 Multiple Choice

9729/01

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, civics group and registration number on the Answer Sheet in the spaces provided unless this has been done for you.

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 question paper.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **12** printed pages.

© EJC

1 The hardness present in a water sample due to dissolved calcium ions can be determined by using an ion-exchange column.

A 50 cm^3 sample of a solution containing calcium sulfate was passed through the ion-exchange resin. The calcium ions in the sample were quantitatively exchanged by hydrogen ions. The sample collected after passing through the resin required 25 cm^3 of 1.0×10^{-2} mol dm^{-3} potassium hydroxide for complete neutralisation.

What was the concentration of the calcium sulfate in the original sample?

A 2.5×10^{-3} mol dm^{-3}

B 5.0×10^{-3} mol dm^{-3}

C 2.0×10^{-2} mol dm^{-3}

D 1.0×10^{-2} mol dm^{-3}

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

The table below shows the fifth, sixth, seventh, eighth and ninth ionisation energies of an element, which is either in the third or fourth period.

	5^{th}	6^{th}	7^{th}	8^{th}	9^{th}
ionisation energy / kJ mol^{-1}	6 500	9 400	11 000	33 600	38 600

Which element has these ionisation energy values?

A As **B** Se **C** C*l* **D** Ar

3 Bromine trifluoride is a liquid which undergoes auto-ionisation at room temperature as represented by the following equation:

$$2BrF_3 \rightleftharpoons BrF_2^+ + BrF_4^-$$

Which of the following is correct regarding BrF_3, BrF_2^+ and BrF_4^-?

A BrF_3 is planar while BrF_4^- is non-planar.

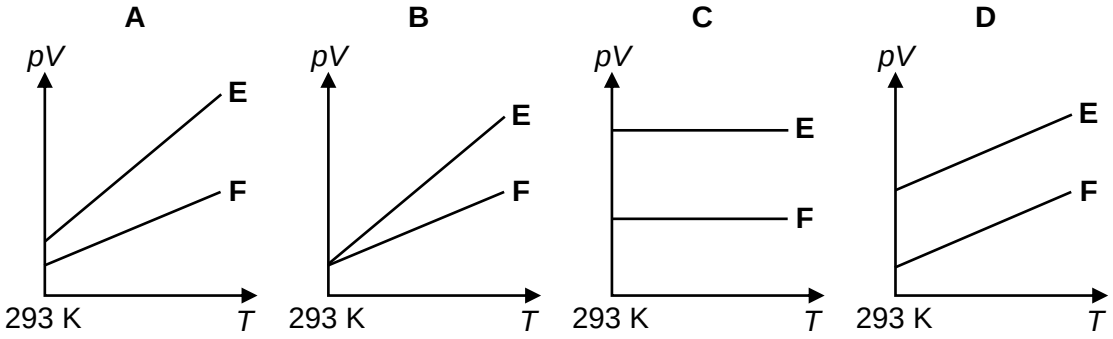
B BrF_2^+ is linear while BrF_4^- is tetrahedral in shape.

C The F–Br–F bond angle in BrF_3 is smaller than that in BrF_4^-.

D There are more lone pairs of electrons around the Br atom in BrF_3 than that in BrF_2^+.

4 **E** and **F** are both ideal gases, and the relative molecular mass of **E** is half that of **F**.

Which graph is obtained when *pV* is plotted against *T* for equal masses of the two gases?



5 Changes in temperature can affect the spontaneity of a reaction.

Which statements are correct?

1 If a reaction is endothermic and has a negative entropy change, the reaction is spontaneous at all temperatures.

2 If a reaction is exothermic and has a negative entropy change, the reaction is non-spontaneous at all temperatures.

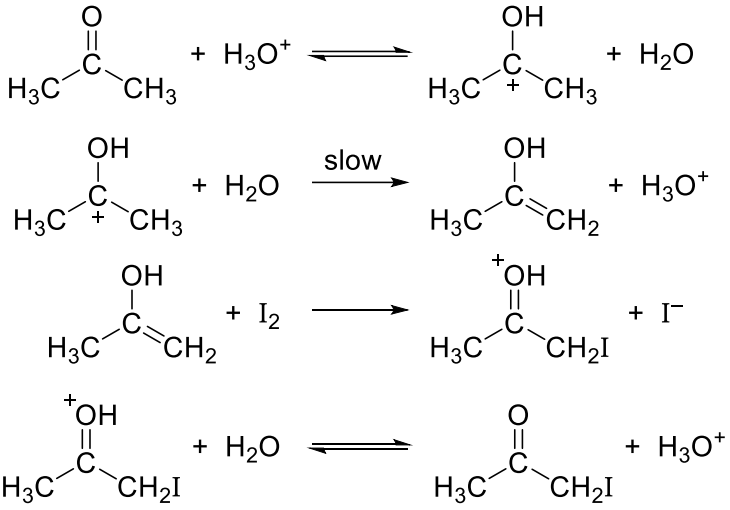
3 If a reaction is exothermic and has a positive entropy change, the reaction is spontaneous at all temperatures.

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

6 Which equation does **not** correspond to the enthalpy change stated?

A	$CH_3CO_2H(aq) + KOH(aq) \rightarrow CH_3CO_2K(aq) + H_2O(l)$	$\Delta H^{\ominus}_{\text{neutralisation}}$
B	$Na^+(g) + H^+(g) + CO_3^{2-}(g) \rightarrow NaHCO_3(s)$	$\Delta H^{\ominus}_{\text{lattice energy}}\left(NaHCO_3\left(s\right)\right)$
C	$NaHSO_4(s) + aq \rightarrow Na^+(aq) + H^+(aq) + SO_4^{2-}(aq)$	$\Delta H^{\ominus}_{\text{solution}}\left(NaHSO_4\left(s\right)\right)$
D	$S(s) + 4H_2(g) + N_2(g) + 2O_2(g) \rightarrow (NH_4)_2SO_4(s)$	$\Delta H^{\ominus}_{\text{formation}}\left((NH_4)_2SO_4\left(s\right)\right)$

7 The mechanism for the acid-catalysed reaction between CH_3COCH_3 and I_2 is given.



Which statements are correct for the reaction?

1 At low pH, the reaction is observed to be pseudo-first order.

2 The rate constant increases as pH decreases.

3 The rate of reaction is independent of $[I_2]$.

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

8 Known amount of hydrogen and iodine are allowed to come to equilibrium at 500 ^oC in a vessel of known volume.

$$H_2 + I_2 \rightleftharpoons 2HI$$

From which experimental method can K_c be found?

A Measuring the total pressure in the vessel.

B Slow cooling to 20 ^oC, breaking open the vessel under aqueous potassium iodide, and titrating the iodine present with aqueous sodium thiosulfate.

C Rapid cooling to 20 ^oC, breaking open the vessel under aqueous potassium iodide, and titrating the iodine present with aqueous sodium thiosulfate.

D Withdrawal of a measured sample of the equilibrium mixture, followed by complete decomposition of the hydrogen iodide present, and then titrating the total amount of iodine with aqueous sodium thiosulfate.

9 Consider the following equilibrium for the adsorption of gas **G** on the active sites of a metal catalyst, **M**:

$$\mathbf{G}(g) + \mathbf{M}(s) \underset{k_2}{\overset{k_1}{\rightleftharpoons}} \mathbf{GM}(s) \qquad \Delta H < 0$$

where k_1 is the rate constant for the adsorption, and
k_2 is the rate constant for the desorption.

The percentage occupancy, θ, of metal surface by gas **G** can be represented as:

$$\theta = \frac{\frac{k_1}{k_2} p_{\mathbf{G}}}{1 + \frac{k_1}{k_2} p_{\mathbf{G}}}$$

where $p_{\mathbf{G}}$ is the partial pressure of gas **G**.

Which of the following statements is correct regarding the above system?

A K_p of the system increases with increasing temperature.

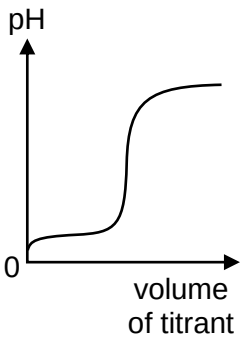
B K_p of the system is equal to its K_c.

C The greater the total surface area of the metal catalyst, the greater the percentage occupancy, θ, of the metal surface by gas **G**.

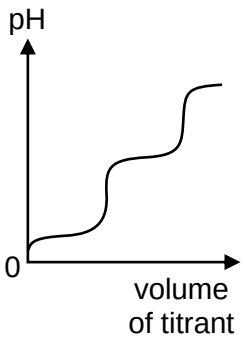
D At high pressures of gas **G**, increasing the temperature does not increase the percentage occupancy, θ, of the metal surface by gas **G**.

10 Which of the following titration curves is obtained when HC*l*(aq) is titrated against standard Na_2CO_3(aq)?

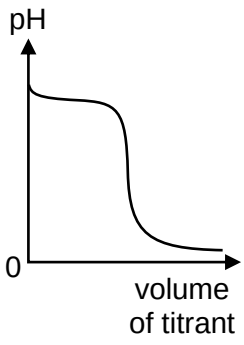
A



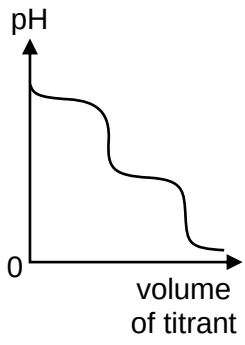
B



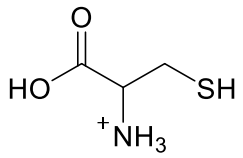
C



D



11 A solution of cysteine in its *fully protonated* form is titrated against a standard solution of potassium hydroxide. The structure of *fully protonated* cysteine is shown below and its three pK_a values are 10.3 (for –SH), 8.1 and 1.9.



The isoelectric point is the pH value at which the net electric charge of a molecule is zero, and in the case of cysteine, can be estimated by taking the average of two appropriate pK_a values.

Which of the following indicators can be used to detect the isoelectric point of cysteine?

	indicator	working range
A	methyl orange	3.2 – 4.4
B	methyl red	4.1 – 6.1
C	bromothymol blue	6.0 – 8.0
D	phenol red	6.9 – 8.9

12 Silver ions can be used as an alternative disinfecting agent for public swimming pools. The Ag^+ concentration needs to be between 1.0×10^{-7} mol dm^{-3} and 1.0×10^{-6} mol dm^{-3} for effective disinfection.

Saturated solutions of four different compounds were prepared by stirring an excess of each compound in pure water. Which of the following compounds would provide the necessary silver ion concentration required for disinfection?

	compound	K_{sp}
A	Ag_2CO_3	8.1×10^{-12}
B	AgC*l*	1.8×10^{-10}
C	AgBr	5.4×10^{-13}
D	$AgIO_3$	3.2×10^{-8}

13 **L** is a substance made from two Period 3 elements. When **L** is added to cold water, a vigorous reaction occurs and a suspension consisting of a white solid in a colourless solution is formed. Upon filtration of this suspension, the residue is found to be insoluble in water and sulfuric acid. When zinc metal is added to the filtrate, effervescence is observed.

Which two Period 3 elements could **L** be made of?

A Mg and C*l*

B Si and C*l*

C Mg and Si

D A*l* and Si

14 The metals of Group 2, magnesium to barium, show increasing chemical reactivity down the group.

Which of the following statements helps to explain this trend?

A Electron affinity increases down the group.

B Electronegativity increases down the group.

C Nuclear charge increases down the group.

D Number of electron shells increases down the group.

15 Which property generally **increases** down Group 17?

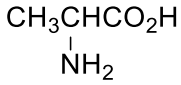
A electronegativity

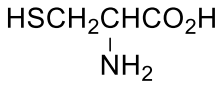
B oxidising power of the halogen

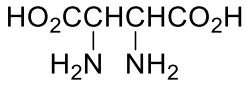
C polarisability of the halide ion

D reduction potential of the halogen

16 Which of the following amino acids can exhibit enantiomerism?

1 

2 

3 

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

17 When dichlorodifluoromethane, CCl_2F_2, is released into the atmosphere, it accumulates in the upper part of the atmosphere where it reacts to form free radicals due to the action of ultraviolet light.

One of the chain reactions which can occur is shown, where X• represents the halogen radical.

$$X\bullet + O_3 \rightarrow XO\bullet + O_2$$
$$2XO\bullet + O_2 \rightarrow 2X\bullet + 2O_2$$

Which of the following statements is correct?

A Homolytic fission occurs in the initiation step only.

B The halogen radical is formed during the termination step.

C The breakdown of ozone occurs faster in the presence of halogen radicals.

D F• and •CCl_2F are the major free radical products made during the initiation step.

18 2-methylbuta-1,3-diene, $CH_2=C(CH_3)CH=CH_2$, can be polymerised to make synthetic rubbers.

Which of the following statements about 2-methylbuta-1,3-diene are correct?

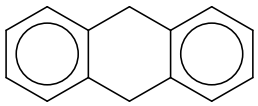
1 It decolourises aqueous bromine.

2 It is chiral.

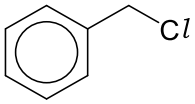
3 It undergoes nucleophilic addition reactions.

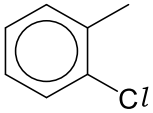
A 1 only **B** 1 and 2 only **C** 2 and 3 only **D** 1, 2 and 3

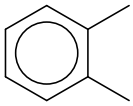
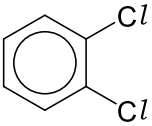
19 Which of the following compounds, when mixed with a trace amount of anhydrous $FeCl_3$ in the dark, can be used to make compound **H**?



compound **H**

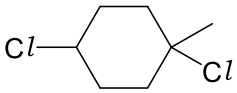
1 

2 

3  and 

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

20 How many different products are formed when compound **J** is heated with excess ethanolic potassium hydroxide?

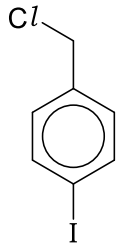


compound **J**

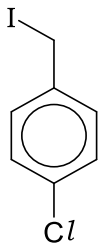
A 2 **B** 3 **C** 4 **D** 6

21 Which of the following will give the largest mass of precipitate when 1 mole of each compound is heated with excess ethanolic silver nitrate?

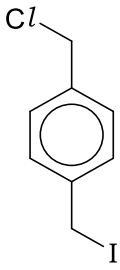
A



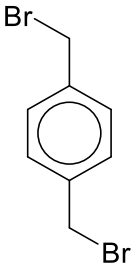
B



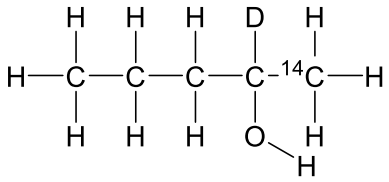
C



D



22 The diagram below shows the displayed formula of pentan-2-ol. This molecule of pentan-2-ol has one carbon atom and one hydrogen atom replaced with their corresponding heavy isotopes, ^{14}C and D (= ^{2}H), respectively.



Which of the following compounds is one of the products formed when this molecule of pentan-2-ol is heated with NaOH(aq) and I_2(aq)?

A CHI_3

B CDI_3

C $CH_3CH_2CH_2CO_2^-Na^+$

D $CH_3CH_2CH_2{}^{14}CO_2^-Na^+$

23 A compound **Q**, $C_4H_{10}O$, gives the compound **R**, C_4H_8O, on oxidation. **R** gives a red precipitate on warming with Fehling's solution.

Which of the following could be **Q**?

A $CH_3CH_2OCH_2CH_3$

B $(CH_3)_2CHCH_2OH$

C $CH_3CH_2CH(OH)CH_3$

D $(CH_3)_3COH$

24 Which of the following reagents reacts only with the acid group of the amino acid $H_2NCH_2CO_2H$?

A CH_3CHO **B** C_6H_5OH **C** C_2H_5OH **D** C_6H_5COCl

25 Which of the following will **not** give 2-methylpropanoic acid as one of the products?

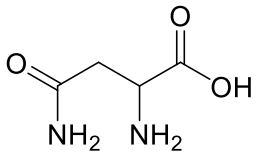
A Heating 2-cyanopropane with dilute sulfuric acid

B Heating 2-methylpropyl propanoate with dilute sulfuric acid

C Heating 2-methylpropan-1-ol with aqueous acidified potassium dichromate(VI)

D Heating 4-methylpent-2-ene with aqueous acidified potassium manganate(VII)

26 Asparagine is required for the development and function of the brain.



asparagine

Which of the following statements about asparagine is correct?

A Asparagine exists in aqueous solution as a zwitterion.

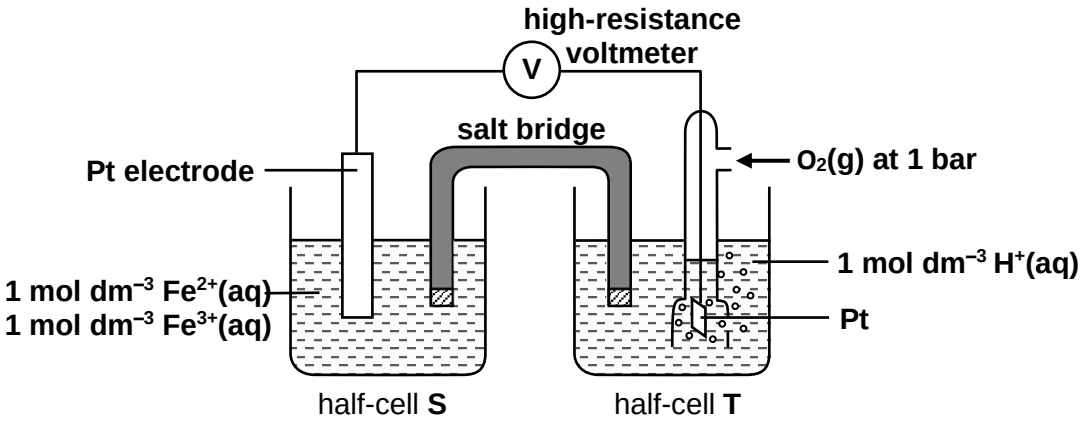
B The side chain ($-CH_2CONH_2$) of asparagine is neutral.

C When hot dilute H_2SO_4 is added to asparagine, a gas which turns damp red litmus paper blue is evolved.

D Asparagine is a liquid at room temperature.

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

Which of the following changes will result in an increase in the cell potential for the following setup?



1 Adding water to half-cell **S**.

2 Adding solid NaCN to half-cell **S**.

3 Adding water to half-cell **T**.

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

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

A current of 15.0 A flows through a dilute solution of sodium chloride for 5.00 minutes.

How many moles of gas are released in total during this time?

A 0.0117 mol **B** 0.0233 mol **C** 0.0350 mol **D** 0.0466 mol

29 Which statements explain the general increase in density across the Period 4 transition elements?

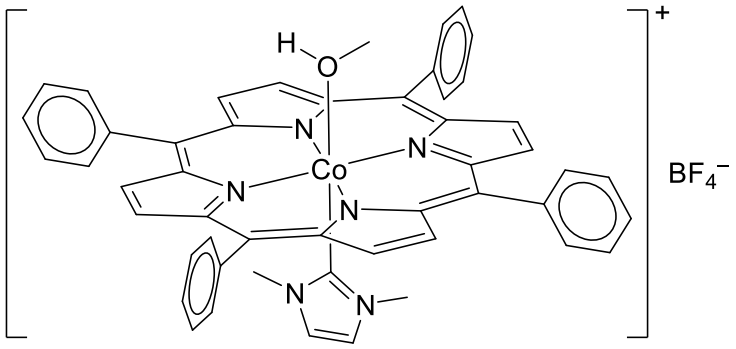
1 The atomic radii remain relatively constant from Sc to Cu.

2 The number of nucleons increases from Sc to Cu.

3 The number of outer shell electrons increases from Sc to Cu.

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

30 What is the oxidation state of cobalt in the following salt?



A +1 **B** +2 **C** +3 **D** +4