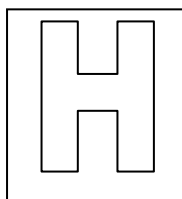


Candidate Name: _____

Class Adm No

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2023 Preliminary Examination Pre-University 3

H2 CHEMISTRY

9729/01

Paper 1 Multiple Choice

20 September 2023

1 hour

Additional materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Do not turn over this question paper until you are told to do so

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, class and admission number in the spaces provided at the top of this page and on the Multiple Choice Answer Sheet 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 Multiple Choice Answer Sheet provided.

Read the instructions on the Multiple Choice 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.

FOR EXAMINER'S USE	
TOTAL (30 marks)	

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

1 Which of the following contain the same number of hydrogen atoms?

- 1 0.10 mol of pentane
- 2 0.15 mol of but-2-ene
- 3 0.60 mol of hydrogen gas
- 4 0.50 mol of steam

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

2 Ascorbic acid found in fruits and vegetables is believed to help prevent colds.

Analysis of ascorbic acid shows that it contains only carbon, hydrogen and oxygen with 40.91% carbon and 4.55% hydrogen by mass. Ascorbic acid has a molar mass of 176 g mol^{-1} .

What is the molecular formula of ascorbic acid?

- A** $\text{C}_2\text{H}_3\text{O}_2$
- B** $\text{C}_3\text{H}_4\text{O}_3$
- C** $\text{C}_6\text{H}_8\text{O}_6$
- D** $\text{C}_6\text{H}_9\text{O}_6$

3 Which of the following species is **unable** to act as a Lewis acid?

- A** AlCl_3
- B** FeCl_3
- C** BeCl_2
- D** CCl_4

- 4 In 2020, a massive explosion took place in Beirut at a warehouse which stocked ammonium nitrate. Ammonium nitrate, $\underline{\text{N}}\text{H}_4\text{NO}_3$ decomposes explosively when heated to form nitrous oxide, N_2O and water, H_2O .

What is the change in the oxidation number of the nitrogen atom that is underlined when this reaction happens?

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

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

What do the ions $^{31}\text{P}^{3-}$ and $^{32}\text{S}^{2-}$ have in common?

- A Both ions have more neutrons than protons.
- B Both ions have more electrons than neutrons.
- C Both ions have more protons than electrons.
- D Both ions have an outer electronic configuration of $2s^2 2p^6$.

- 6 The table below shows the ionisation energy (in kJ mol^{-1}) of four elements labelled **A**, **B**, **C** and **D**.

Element	1 st I.E.	2 nd I.E.	3 rd I.E.	4 th I.E.	5 th I.E.	6 th I.E.
A	1012	1907	2914	4964	6274	21 267
B	787	1577	3232	4356	16 091	19 805
C	1521	2666	3931	5771	7238	8781
D	738	1451	7733	10 543	13 630	18 020

Which element above has no electrons in the valence p subshell?

- A element **A**
- B element **B**
- C element **C**
- D element **D**

7 Which molecules contain at least one bond angle of 120° ?

- 1 C_2H_4
- 2 PCl_5
- 3 NF_3

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

8 Elements **E**, **F** and **G** are all in the first two periods of the Periodic Table. Their Pauling electronegativity values, E_N , are given in the table.

element	E_N
E	1.0
F	2.5
G	3.0

Compounds exist with formulae **EG**, **FG** and **G₂**.

What is the correct order of increasing boiling point of the three compounds?

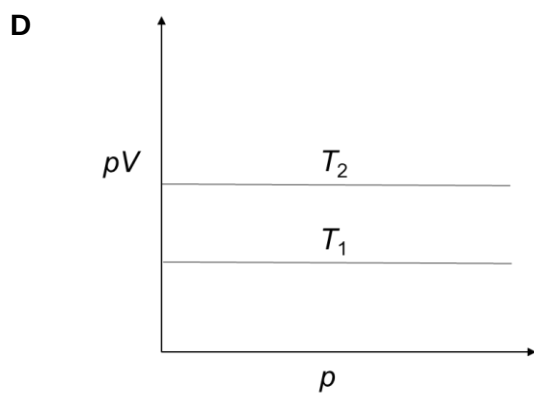
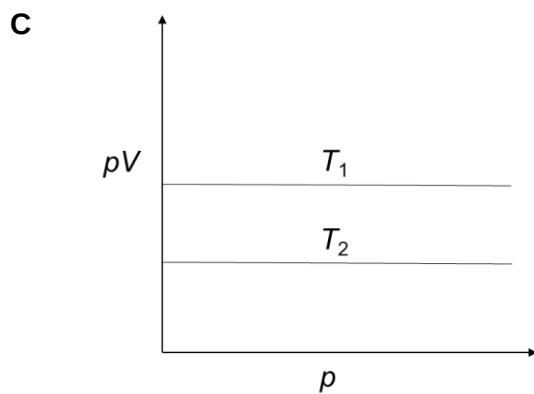
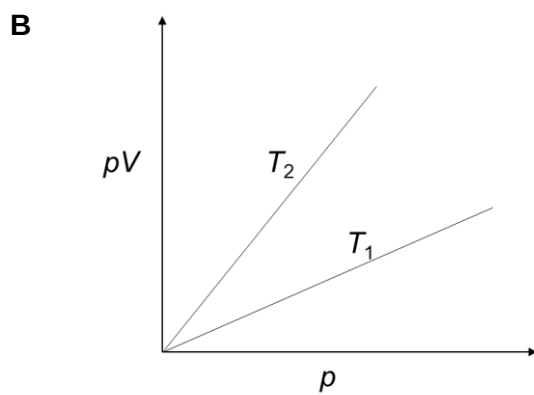
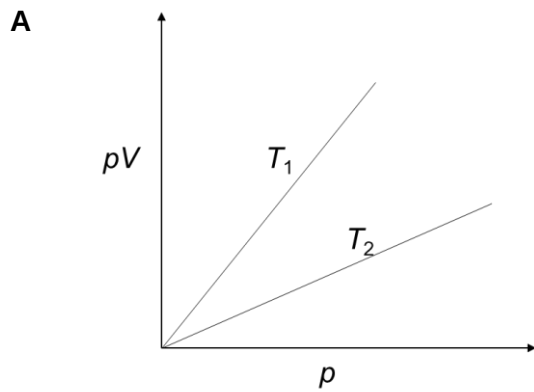
- A **EG** → **FG** → **G₂**
- B **EG** → **G₂** → **FG**
- C **G₂** → **FG** → **EG**
- D **G₂** → **EG** → **FG**

9 When an evacuated glass bulb of volume 300 cm^3 is filled with a gas at 450 K and 101 kPa , the mass of the bulb increases by 0.679 g . The gas obeys the ideal gas equation.

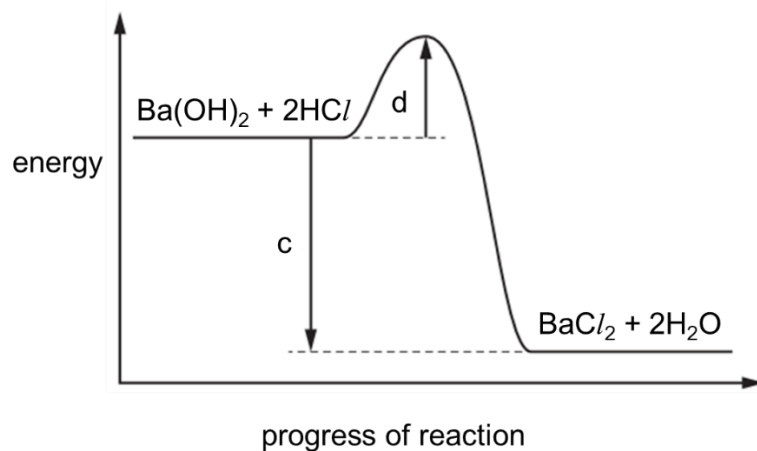
What is the identity of the gas?

- A argon
- B krypton
- C neon
- D nitrogen

- 10 Which graph shows the correct plot of pV against p for a fixed mass of ideal gas at two temperatures, T_1 and T_2 , in which $T_1 > T_2$?

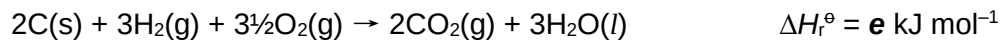


- 11** A reaction pathway diagram for the reaction of aqueous barium hydroxide and dilute hydrochloric acid is shown.



What is the value of the enthalpy change of neutralisation, ΔH_{neut} ?

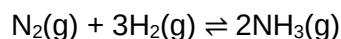
- A** c **B** $c - d$ **C** $\frac{c}{2}$ **D** $\frac{(c - d)}{2}$
- 12** The enthalpy change of reaction, $\Delta H_r^\ominus$, for the following reaction is $e \text{ kJ mol}^{-1}$.



What is the correct expression to calculate the value of e ?

- A** $2 \times \Delta H_c^\ominus [\text{CO}_2\text{(g)}] - 3 \times \Delta H_f^\ominus [\text{H}_2\text{(g)}]$
B $2 \times \Delta H_c^\ominus [\text{CO}_2\text{(g)}] + 3 \times \Delta H_f^\ominus [\text{H}_2\text{O(g)}]$
C $2 \times \Delta H_f^\ominus [\text{CO}_2\text{(g)}] - 3 \times \Delta H_f^\ominus [\text{H}_2\text{(g)}]$
D $2 \times \Delta H_f^\ominus [\text{CO}_2\text{(g)}] + 3 \times \Delta H_f^\ominus [\text{H}_2\text{O(l)}]$

- 13** Nitrogen reacts with hydrogen to form ammonia.



A mixture of 2.00 mol of nitrogen, 6.00 mol of hydrogen and 2.40 mol of ammonia was allowed to reach equilibrium in a sealed vessel of volume 2 dm³. When equilibrium was established, 2.32 mol of nitrogen were present in the equilibrium mixture.

Which expression will give the value of K_c ?

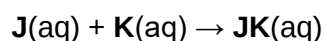
A $\frac{(0.88)^2}{(1.16)(3.48)^3}$

B $\frac{(1.76)^2}{(2.32)(6.96)^3}$

C $\frac{(1.20)^2}{(1.16)(3.00)^3}$

D $\frac{(1.04)^2}{(1.16)(3.16)^3}$

- 14** In the reaction below, the concentrations of both **J** and **K** are reduced to half their original values whilst keeping the total volume of the solution constant.

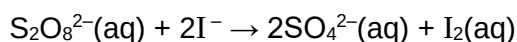


Simultaneously, the temperature was raised from 298 K to 348 K.

Which prediction is definitely true?

- A** A smaller proportion of collisions between particles of **J** and particles of **K** will be effective.
- B** The average kinetic energy of particles of **J** and particles of **K** will increase.
- C** The rate of the reaction will be unaffected.
- D** The frequency of collisions between particles **J** and particles of **K** will halve.

- 15 The rate equation for the reaction



is $\text{rate} = k[\text{S}_2\text{O}_8^{2-}][\text{I}^-]$, where k was found to be $0.2 \text{ mol}^{-1} \text{ dm}^3 \text{ s}^{-1}$ at temperature T .

What is the half-life of the reaction when $\text{S}_2\text{O}_8^{2-}$ is present in a large excess at concentration of 0.4 mol dm^{-3} at the same temperature?

- A 0.35 s
- B 1.39 s
- C 3.76 s
- D 8.66 s

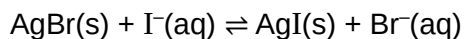
- 16 The value of $\text{p}K_w$ at 40°C is 13.54.

What is the pH of an aqueous solution of $0.05 \text{ mol dm}^{-3} \text{ Ba}(\text{OH})_2$ at 40°C ?

- A 12.23
- B 12.54
- C 12.70
- D 13.00

- 17 The numerical values of the solubility products at 25°C for AgBr and AgI are 7.7×10^{-13} and 8.0×10^{-17} respectively.

What is the value of the equilibrium constant for the reaction below?



- A 6.2×10^{-29}
- B 1.0×10^{-4}
- C 9.8×10^1
- D 9.6×10^3

- 18** The table gives the concentrations and pH values of the aqueous solutions of three compounds, **H**, **I** and **L** at 25 °C. Each compound could be an acid or a base.

	H	I	L
concentration /mol dm ⁻³	1.00	1.00	1.00×10^{-4}
pH	3	14	4

Which statements are correct?

- H** is a strong acid and **I** is a strong base.
- The extent of dissociation of **H**(aq) is greater than **L**(aq).
- When equal volumes of **H** and **I** are mixed, a solution of pH > 7 is obtained.

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

- 19** The formula $[\text{CH}_3]^x$ (where x can be 1–, 0 or 1+) can represent an anion, a cation or a free radical. Species with the formula CH_3 can act as an electrophile, a free radical or a nucleophile depending on the number of outer shell electrons present on the central carbon atom.

How many outer shell electrons must be present for $[\text{CH}_3]^x$ to act in these different ways?

	$[\text{CH}_3]^x$ as an electrophile	$[\text{CH}_3]^x$ as a free radical	$[\text{CH}_3]^x$ as a nucleophile
A	6	7	8
B	6	8	7
C	7	6	8
D	8	7	6

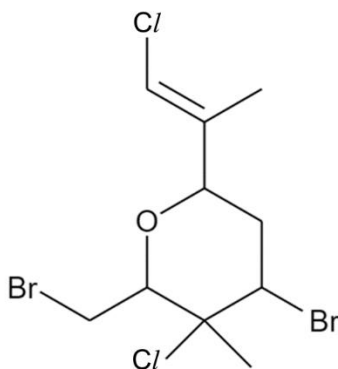
- 20** Ethene reacts with aqueous bromine to form a mixture of two products.

Which statements are correct?

- 1 Both products can be hydrolysed to form the same diol.
- 2 Both products can form hydrogen bonds with water.
- 3 Both products are obtained in this reaction by electrophilic substitution.
- 4 Both products are obtained in this reaction by nucleophilic addition.

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

- 21** Red algae found in marine habitats have been found to be a source of natural products which show antibacterial bioactivity. One such compound is costatone C.

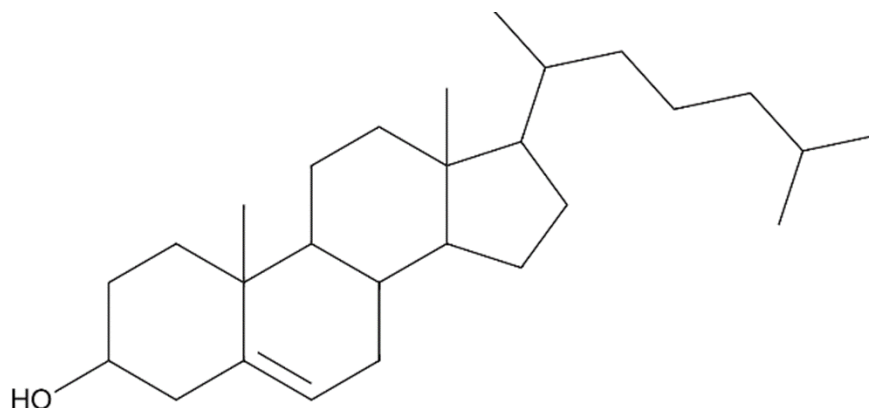


costatone C

How many moles of halides (Cl^- and Br^-) can be obtained when one mole of costatone C is heated under reflux with an excess of NaOH(aq) ?

- A** 1
B 2
C 3
D 4

- 22** Cholesterol is a natural occurring molecule that is essential for many metabolic processes in the human body.



cholesterol

Cholesterol is separately treated with

- cold dilute, acidified KMnO_4 ,
- hot concentrated acidified KMnO_4 .

What is the change in the number of chiral carbon atoms in the molecule during each reaction?

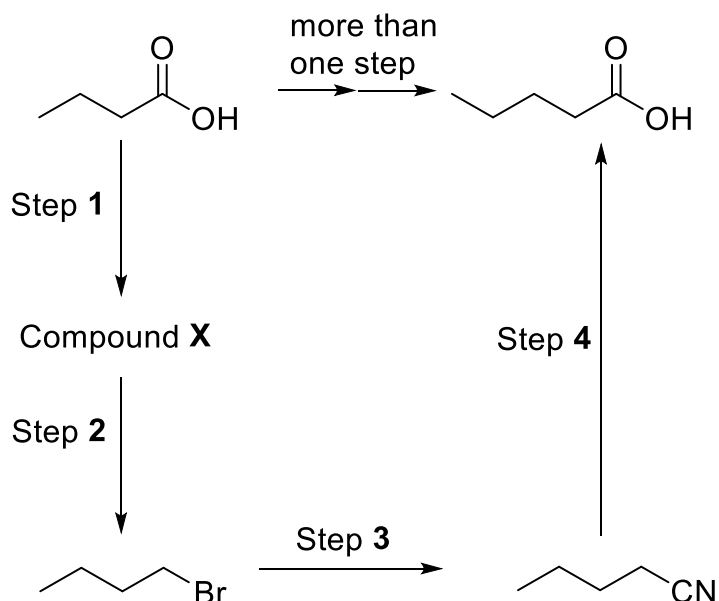
	cold, dilute acidified KMnO_4	hot, concentrated acidified KMnO_4
A	+1	0
B	+1	-1
C	+2	0
D	+2	-1

- 23** Compound **N**, $\text{C}_4\text{H}_8\text{O}$, produces an orange precipitate when it is reacted with 2,4-dinitrophenylhydrazine. Compound **N** produces a carboxylic acid when heated under reflux with an acidified solution of potassium dichromate(VI).

What could be the identity of compound **N**?

- A** butanal
- B** butanone
- C** 2-methylbutanal
- D** 4-hydroxybut-1-ene

- 24 The following reaction scheme shows a suggested route for the conversion of butanoic acid to pentanoic acid.



Which of the following deductions about the reaction scheme are correct?

- 1 Step 1 can be achieved using ethanolic NaBH_4 .
- 2 Step 2 is a nucleophilic substitution reaction.
- 3 Step 3 can be achieved by using cold HCN with trace amounts of NaCN .

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

- 25 **Q** is a mixture of a Group 2 oxide and a Group 2 sulfate.

When **Q** is shaken with water and the resulting mixture is filtered, a solid residue and a colourless filtrate is obtained. There is no reaction when the solid residue is shaken with HCl(aq) . Shaking the filtrate with $\text{H}_2\text{SO}_4\text{(aq)}$ produced a white precipitate.

What could be the identity of **Q**?

- A** $\text{BaO} + \text{BaSO}_4$
B $\text{BaO} + \text{MgSO}_4$
C $\text{MgO} + \text{BaSO}_4$
D $\text{MgO} + \text{MgSO}_4$

- 26** **R** and **S** are in the third period of the Periodic Table.

The chloride of **R** gives an aqueous solution of $\text{pH} = 7$.

The oxide of **S** gives an aqueous solution which is weakly alkaline.

Which of the following statements is true?

- A** The atomic radius of **R** is smaller than **S**.
B The first ionisation energy of **R** is smaller than **S**.
C The electronegativity of **R** is greater than **S**.
D The atomic number of **R** is greater than **S**.
- 27** A student set up 4 standard half-cells each containing one of the metals, **T**, **U**, **V**, **W**, immersed in a solution of its metallic salts. These were then used to make different electrochemical cells. The table below shows the standard electrode cell potential, $E^\ominus_{\text{cell}}$ and the positive terminal of each electrochemical cell.

Cell	Metals used	$E^\ominus_{\text{cell}} / \text{V}$	Positive terminal
1	T and U	+1.10	U
2	U and V	+0.46	V
3	U and W	+0.47	U

Which of the following statements are true?

- 1 **T** can reduce all the cations of **U**, **V** and **W**.
 2 **W** has a stronger reducing power than **V**.
 3 **V** is produced in Cell 2.
- A** 1 only
B 2 and 3 only
C 1, 2 and 3
D 2 only

- 28 A student used an acidified solution of $\text{Cr}_2\text{O}_7^{2-}$ to electroplate a steel box with chromium metal. How long would it take for a current of 0.125 A to deposit 0.0312 g of chromium to plate the entire box?

A 463 s
B 1390 s
C 2780 s
D 5560 s

- 29 The unbalanced equation below involves manganese in different oxidation states.



Which of the statements is **incorrect**?

- A This is a disproportionation reaction.
B MnO_4^- solutions are purple due to d–d electronic transition.
C The amounts of Mn^{2+} and MnO_4^- formed are unequal.
D The 3d electrons in Mn^{2+} are all unpaired.
- 30 Rhodium and its compounds are often used as catalysts in many important reactions. Which of the following properties make rhodium a suitable heterogeneous catalyst?
- A Rhodium has vacant d orbitals that are energetically accessible.
B Rhodium exhibits various oxidation states.
C Rhodium is able to form stable complexes.
D Rhodium is able to form coloured compounds.

END OF PAPER 1

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