



CANDIDATE
NAME

CG

H1 GROUP

1 / 2 / 3

CHEMISTRY

8873 /01

Paper 1

13 September 2024

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name and class in the spaces at the top of this page and 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 booklet.

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

- 1 Which of the species in their gaseous state shown below will be deflected by the smallest angle in an electric field?

A ${}^1\text{H}_2$ B ${}^4\text{He}^{2+}$ C ${}^9\text{Be}^{2+}$ D ${}^{11}\text{B}^{3+}$

- 2 What is the electronic configuration of vanadium, ${}_{23}\text{V}$?

A $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4 4s^1$

B $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

C $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^3$

D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$

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

How many atoms of gold, ${}_{79}\text{Au}$, are there in a pure gold coin with a mass of 3.94 g?

A 1.20×10^{21}

B 2.00×10^{21}

C 1.20×10^{22}

D 2.00×10^{22}

- 4 10 cm^3 of gaseous hydrocarbon is burnt completely in 70 cm^3 of oxygen. When cooled to room temperature, the gaseous volume was 50 cm^3 . A further decrease of 40 cm^3 in the gaseous volume was observed when the gaseous mixture is passed through aqueous potassium hydroxide.

What is the molecular formula of the hydrocarbon?

A C_2H_6 B C_3H_8 C C_4H_8 D C_5H_{12}

- 5 A student added 12.5 cm^3 of $0.0500 \text{ mol dm}^{-3}$ sodium hydroxide to 25.0 cm^3 of $0.100 \text{ mol dm}^{-3}$ hydrochloric acid.

What is the concentration of hydrochloric acid remaining in the reaction mixture?

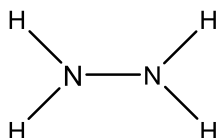
A $0.0333 \text{ mol dm}^{-3}$ B $0.0500 \text{ mol dm}^{-3}$ C $0.066 \text{ mol dm}^{-3}$ D $0.0750 \text{ mol dm}^{-3}$

6 Substance T

- is soluble in polar solvent.
- does not conduct electricity in solid but conducts electricity when molten.
- is a solid at room temperature.

What could be the structure of T?

- A** giant molecular
- B** giant ionic
- C** giant metallic
- D** simple molecular

7 Hydrazine, N_2H_4 , has some properties that are similar to those of ammonia, NH_3 .

Which statement explain why hydrazine molecules are more soluble in water than ammonia molecules?

- A** Hydrazine is more polar than ammonia.
- B** The covalent bonding in hydrazine is stronger than that in water.
- C** There are stronger permanent dipole interactions between hydrazine and water than between ammonia and water.
- D** There are more hydrogen bonds between hydrazine and water than between ammonia and water.

8 Which row correctly describes the change in the properties for Group 1 elements down the group?

	reducing power	ionic radius	first ionisation energy
A	increases	increases	increases
B	decreases	decreases	increases
C	increases	increases	decreases
D	increases	decreases	decreases

- 9 The proton number of the element X is less than 20.

The aqueous chloride of X is acidic and gives a white precipitate when neutralised with NaOH(aq). The precipitate dissolves on reacting either with NaOH(aq) or with H₂SO₄(aq).

In which Group of the Periodic Table is X likely to be found?

- A** 2 **B** 13 **C** 14 **D** 15

- 10 Pure germanium is an important element in the electronic industry and is used in transistors. To manufacture pure germanium, the metal is separated from other metals by the formation of germanium tetrachloride, GeCl₄, followed by fractional distillation.

GeCl₄ is a liquid at room temperature and has similar properties to SiCl₄.

Which statement about germanium tetrachloride is correct?

- A** The bond angle in germanium tetrachloride is 120°.
B Germanium tetrachloride is an ionic compound.
C Germanium tetrachloride will conduct electricity.
D Germanium tetrachloride is hydrolysed by water.

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

The element selenium is immediately below sulfur in the Periodic Table.

Which statements are correct?

- 1** Selenium has a lower first ionisation energy than sulfur.
2 Se²⁻ has a larger ionic radius than S²⁻.
3 Se²⁻ has a smaller ionic radius than Br⁻.

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

12 Each of the following equilibria is subjected to two changes which are carried out separately:

- (i) the pressure is reduced at constant temperature;
- (ii) the temperature is increased at constant pressure.

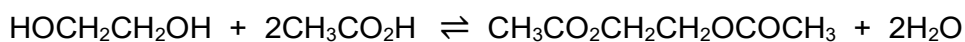
For which equilibrium will **both** of these changes result in an increase in the proportion of reactants?

- A** $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g}); \quad \Delta H = +53 \text{ kJ mol}^{-1}$
- B** $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g}); \quad \Delta H = -950 \text{ kJ mol}^{-1}$
- C** $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}) \quad \Delta H = -92 \text{ kJ mol}^{-1}$
- D** $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) \quad \Delta H = +180 \text{ kJ mol}^{-1}$

13 For a reversible reaction, what is the effect of a catalyst on the rate constant k_1 for the forward reaction, the rate constant k_{-1} for the reverse reaction, and the equilibrium constant K ?

	k_1	k_{-1}	K
A	increases	increases	no effect
B	increases	increases	increases
C	increases	decreases	no effect
D	no effect	no effect	increases

14 When a mixture of 1 mol of ethane-1,2-diol and 2 mol of ethanoic acid is allowed to reach equilibrium at a given temperature, the mixture is found to contain x mol of the diol.



You should assume that these are the only four species present at equilibrium.

What are the amounts of the four species at equilibrium?

	diol / mol	acid / mol	ester / mol	water / mol
A	x	$2x$	$1 - x$	$2(1 - x)$
B	x	$2 - x$	$1 - x$	$2 - x$
C	x	$2x$	x	$2x$
D	x	$2(1 - x)$	x	$2x$

- 15 Which row gives the correct expression for the K_b of methylamine, CH_3NH_2 , and for K_w ?

	$K_b (\text{CH}_3\text{NH}_2)$	K_w
A	$K_b = [\text{OH}^-][\text{CH}_3\text{NH}_3^+]/[\text{CH}_3\text{NH}_2]$	$K_w = [\text{H}^+][\text{OH}^-]/[\text{H}_2\text{O}]$
B	$K_b = [\text{H}^+][\text{CH}_3\text{NH}^-]/[\text{CH}_3\text{NH}_2]$	$K_w = [\text{H}^+][\text{OH}^-]/[\text{H}_2\text{O}]$
C	$K_b = [\text{OH}^-][\text{CH}_3\text{NH}_3^+]/[\text{CH}_3\text{NH}_2]$	$K_w = [\text{H}^+][\text{OH}^-]$
D	$K_b = [\text{H}^+][\text{CH}_3\text{NH}^-]/[\text{CH}_3\text{NH}_2]$	$K_w = [\text{H}^+][\text{OH}^-]$

- 16 A solution was made by mixing 0.020 mol of $\text{Ba}(\text{OH})_2(\text{aq})$ and 0.010 mol of $\text{KOH}(\text{aq})$. Water was added until the volume of the solution was 2 dm^3 .

What is the pH of the solution?

- A** 12.6 **B** 12.4 **C** 12.2 **D** 12.0
- 17 Which aqueous mixture will resist changes in pH on the addition of small amounts of an acid or a base?

- 1 ammonia + ammonium chloride
- 2 hydrochloric acid + potassium chloride
- 3 propanoic acid + sodium propanoate
- 4 sodium chloride + sodium hydroxide

- A** 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4
- 18 When a weak acid is added to a strong base an increase in pH from pH 6.0 to pH 11 occurs at the end-point.

Which indicator would be suitable for use in a weak acid and strong base titration?

	indicator	pH range
A	phenolphthalein	8.2–10.0
B	chlorophenol red	4.8–6.7
C	methyl orange	3.1–4.4
D	alizarin yellow	10.1–13.0

- 19 The reaction between two reagents, X and Y , in aqueous solution follows the general rate equation

$$\text{rate} = k[X]^\alpha[Y]^\beta$$

In a kinetic study the following values were obtained at 298K.

$[X]_0 / \text{mol dm}^{-3}$	$[Y]_0 / 10^{-4} \text{ mol dm}^{-3}$	initial rate / $\text{mol dm}^{-3} \text{ s}^{-1}$
0.040	2.40	2.63×10^{-3}
0.040	4.80	1.05×10^{-2}
0.040	7.20	2.35×10^{-2}
0.080	4.80	2.09×10^{-2}
0.160	2.40	1.05×10^{-2}

$[X]_0$ represents the initial concentration of X .

What are the values of α and β respectively for the above rate equation?

- A $\alpha = 0$ and $\beta = 2$
 - B $\alpha = 1$ and $\beta = 1$
 - C $\alpha = 1$ and $\beta = 2$
 - D $\alpha = 2$ and $\beta = 1$
- 20 The rate equation for the reaction between P and Q is

$$\text{rate} = k[P]^2[Q]$$

If the concentration of P is halved, what must be done to the concentration of Q to make the reaction proceed at 50% of its former rate?

- A halve $[Q]$
- B increase $[Q]$ by a factor of two
- C increase $[Q]$ by a factor of four
- D keep $[Q]$ constant

21 Use of Data Booklet is relevant to this question.

Butane is used as a fuel for cooking.

When 0.025 mol of butane was burnt under a vessel containing 500 g of water, it was found that the temperature of the water rose by 25°C.

Which value for the enthalpy change of combustion of butane is given by these results?

- A** -338 kJ mol^{-1} **B** -500 kJ mol^{-1} **C** $-1306 \text{ kJ mol}^{-1}$ **D** $-2090 \text{ kJ mol}^{-1}$

22 In 1947 a ship full of ammonium nitrate fertiliser exploded, devastating Texas City.

Two reactions took place.



followed by



compound	$\Delta H_f^\ominus / \text{kJ mol}^{-1}$
NH_4NO_3	-366
N_2O	+82
H_2O	-286

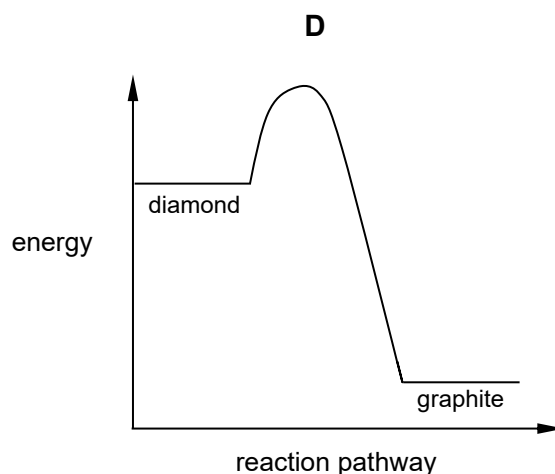
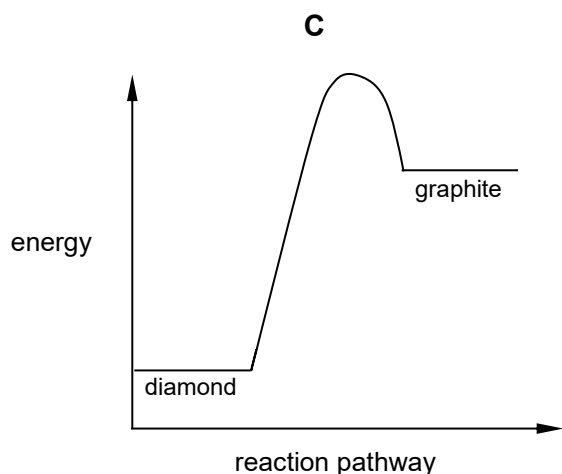
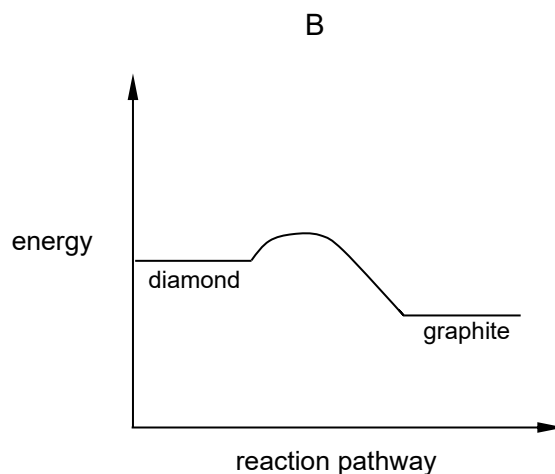
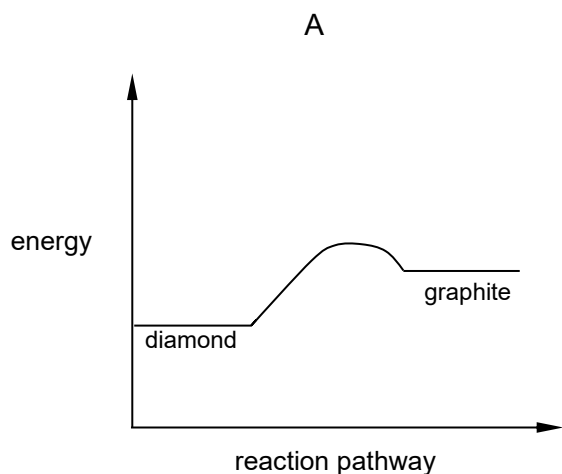
Using the standard enthalpy change data in the table, which statements are correct?

- 1** Reaction 2 gives off 80 kJ mol^{-1} more energy than Reaction 1 under standard conditions.
- 2** The enthalpy change for Reaction 2 is -206 kJ mol^{-1} under standard conditions.
- 3** Reaction 1 is exothermic.

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

- 23** The conversion of diamond into graphite is exothermic by 2 kJ mol^{-1} . Diamond does not readily change into graphite.

Which reaction pathway diagram correctly represents this conversion?



- 24** How many constitutional (structural) isomers with the molecular formula $\text{C}_4\text{H}_8\text{O}_2$ are esters?

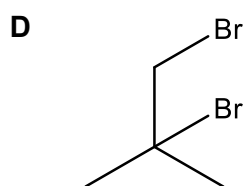
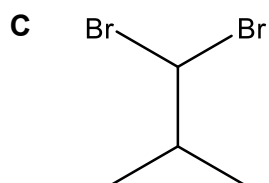
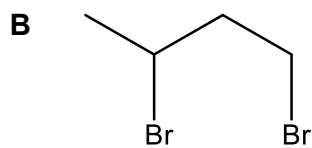
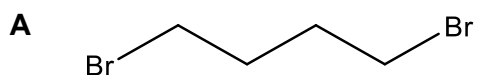
A 3

B 4

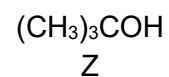
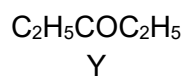
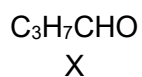
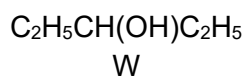
C 5

D 6

25 Which compound could be formed by reacting bromine with an alkene of formula C_4H_8 ?



26 In which pair of compounds can one compound be oxidised and the other can be reduced?



	oxidised	reduced
A	W	X
B	X	Z
C	Y	W
D	Z	Y

27 Which statements about poly(propene) are correct?

- 1 On combustion, poly(propene) produces carbon dioxide and water
- 2 When poly(propene) is buried in a landfill site, it will not significantly biodegrade
- 3 The empirical formula of poly(propene) is the same as its monomer

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

28 High density polyethylene (HDPE) is commonly used as medicine bottle, juice container and shampoo bottles while low density polyethylene (LDPE) is used in squeezable bottles, lids, toys, and plastic bags.

Which statement regarding HDPE and LDPE is correct?

- A** HDPE is more flexible than LDPE
- B** HDPE has more branching than LDPE
- C** HDPE is less dense than LDPE
- D** HDPE is harder than LDPE

29 Which statement best explains that geckos are able to stick on walls?

- A** The millions of tiny setae on its feet can be attached on the rough surface of the wall.
- B** The spatula-tipped setae are nanostructures which possess high surface area to volume ratio thus causes surface area of contact to increase.
- C** Its body weight on the wall causes a reactive force from the wall to itself which is sufficient to support its own body weight.
- D** The millions of tiny setae on the wall have a large surface area to volume ratio to generate extensive hydrogen bonds to support its own body weight.

30 Which statements about nanoparticles are true?

- 1 They can enter the human body through ingestion only.
- 2 They have a high surface area to volume ratio.
- 3 They cannot be used as a catalyst.

A 2 only

B 1 and 2 only

C 2 and 3 only

D 1, 2 and 3

