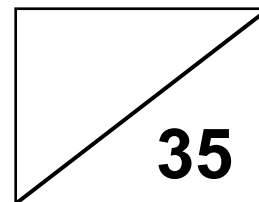




St Andrew's Junior College
JC1 H2 Chemistry 2025
Dec Holidays Assignment



Name : Date :

Class : 25S..... Time : 1 hour

Instructions:

- Complete under timed exam conditions (2 min per MCQ, 1.6 min per mark for structured)
- Self-mark MCQ, Structured Q1 and Q2. Answers on google drive.
- Submit the assignment to your tutor during the first tutorial in 2026.

Section A – Multiple Choice Questions [10 marks]

For each question, there are four possible answers.

Choose the one you consider correct and write your answer in the boxes below.

Question	1	2	3	4	5
Answer					

Question	6	7	8	9	10
Answer					

- 1 10 cm³ of a gaseous hydrocarbon, C_xH_y, was exploded with an excess of oxygen. There was a contraction of 30 cm³. When the resulting gaseous mixture was treated with aqueous sodium hydroxide, there was a further contraction of 40 cm³.

Given that all gas volumes were measured at r.t.p., what is the molecular formula of the hydrocarbon?

A C₃H₈

B C₃H₁₀

C C₄H₈

D C₄H₁₀

2 What is the proton number of an element that has four unpaired electrons in its ground state?

A 16

B 22

C 24

D 26

3 The boiling points of pent-1-ene and 2,2-dimethylpropane are 30 °C and 9 °C respectively.

Which statements help to account for this difference in boiling points?

1 The molecule of pent-1-ene is less compact than that of 2,2-dimethylpropane.

2 The covalent bonds in pent-1-ene are stronger than those in 2,2-dimethylpropane.

3 Pent-1-ene is a polar molecule while 2,2-dimethylpropane is a non-polar molecule.

4 The intermolecular forces of attraction in pent-1-ene are more extensive than those in 2,2-dimethylpropane.

A 1, 2 and 4 only

B 2 and 3 only

C 1 and 4 only

D 3 and 4 only

4 A 5.0 dm³ sample of neon gas at a pressure of 200 kPa and a 2.0 dm³ sample of helium gas at a pressure of 500 kPa are introduced into a 2.5 dm³ vessel at constant temperature.

What is the total pressure in the vessel?

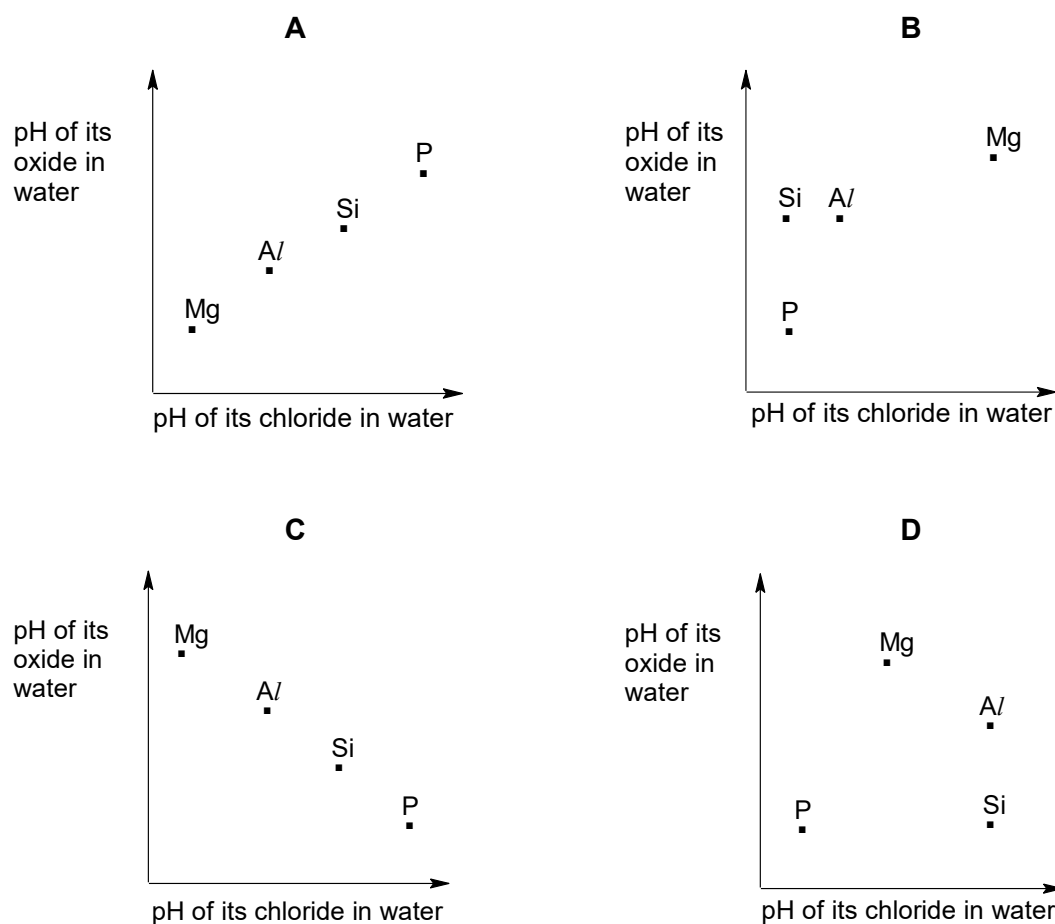
A 500 kPa

B 700 kPa

C 800 kPa

D 1000 kPa

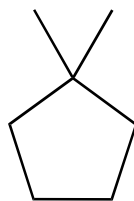
- 5 The oxides and chlorides of Mg, Al, Si and P are added separately to excess water. Which of the following shows the correct trends of the pH of the resultant solutions?



- 6 Which of the following enthalpy changes is exothermic?

- A** $\text{Mg}^{2+}(\text{g}) + 2\text{Cl}^{-}(\text{g}) \rightarrow \text{MgCl}_2(\text{aq})$
- B** $\text{Al}_2\text{O}_3(\text{s}) \rightarrow 2\text{Al}^{3+}(\text{g}) + 3\text{O}^{2-}(\text{g})$
- C** $\text{O}^{-}(\text{g}) + \text{e}^{-} \rightarrow \text{O}^{2-}(\text{g})$
- D** $\text{Br}_2(\text{g}) \rightarrow 2\text{Br}\cdot(\text{g})$

- 9** 1,1-dimethylcyclopentane undergoes free radical substitution with limited bromine in the presence of ultraviolet light. A mixture of mono-brominated products is obtained.

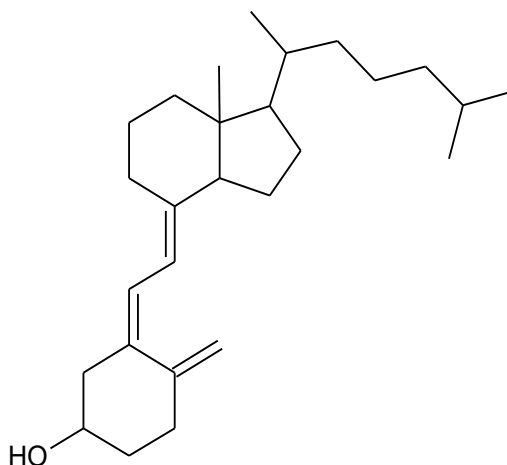


1,1-dimethylcyclopentane

What is the total number of mono-brominated products (ignore stereoisomers) obtained?

- | | | | |
|----------|---|----------|---|
| A | 2 | B | 3 |
| C | 4 | D | 6 |

- 10** Cholecalciferol is a type of vitamin D that is made by the skin when exposed to sunlight. It can also be found in the flesh of fatty fish and fish liver oils.



cholecalciferol

Which statements about cholecalciferol are correct?

- 1 There is a maximum of 128 stereoisomers.
- 2 The carbon bonded to oxygen atom is an electrophilic site.
- 3 1 mol of cholecalciferol produces 3 mol of carbon dioxide when heated with acidified KMnO_4 .

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

Section B – Structured Questions [25 marks]

1 (a) Silicon is the 14th element in the Periodic Table.

(i) State the full electronic configuration of a silicon atom.

[1]

(ii) On the axes provided in Fig. 1.1, sketch the first six successive ionisation energies of silicon against the number of electrons removed.

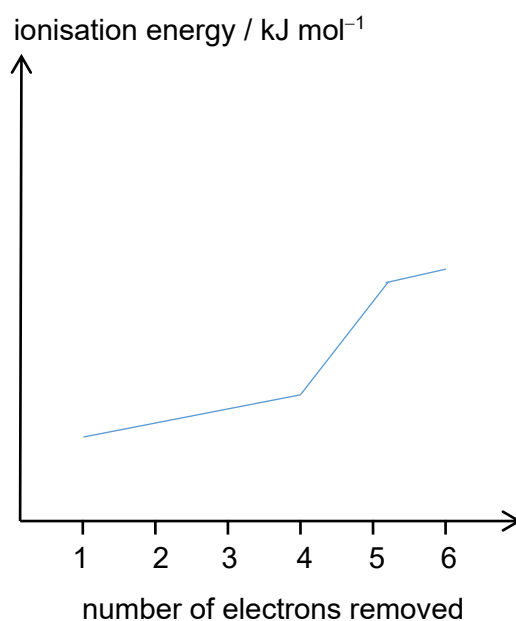


Fig. 1.1

Explain the general shape and significant change (if any) in your sketch.

[3]

(iii) Sketch and label clearly all the **occupied** orbitals of a Si^{4+} ion.

[2]

(c) *Use of the Data Booklet is relevant to this question.*

In an experiment, KMnO_4 oxidises $\text{X}^{2+}(\text{aq})$ in acidic medium, while itself is reduced to Mn^{2+} .

25.0 cm^3 of $0.300 \text{ mol dm}^{-3} \text{ X}^{2+}(\text{aq})$ was found to require 26.30 cm^3 of $0.0570 \text{ mol dm}^{-3} \text{ KMnO}_4$ for complete oxidation.

Determine the final oxidation state of **X**.

[2]

[Total: 8 – complete within 13 min]

- 2 (a) Data concerning CaCl_2 , at 298 K, are given in Table 5.1 below.

Table 5.1

Standard enthalpy change of formation, CaCl_2 / kJ mol^{-1}	–796
Standard enthalpy change of hydration of Ca^{2+} / kJ mol^{-1}	–1650
Standard enthalpy change of hydration of Cl^- / kJ mol^{-1}	–363
Lattice energy of CaCl_2 / kJ mol^{-1}	–2258

- (i) Write an equation for the *standard enthalpy change of formation of CaCl_2* . [1]
- (ii) Calculate the standard enthalpy change of solution of CaCl_2 at 298 K. [1]
- (iii) The theoretical enthalpy change of solution of CaCl_2 is -81 kJ mol^{-1} .
Using this theoretical value, calculate the final temperature of the solution when 5.50 g of CaCl_2 is dissolved in 60.0 cm^3 of water at 25.0°C . [3]

[Total: 5 – complete within 8 min]

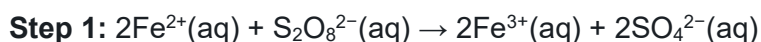
- 3 Many chemical reactions such as the reaction between peroxodisulfate, $\text{S}_2\text{O}_8^{2-}$, and iodide ions occur very slowly at room temperature.



One way to speed up the rate of reaction is to use a homogeneous catalyst.

- (a) (i) Explain why the reaction between $\text{S}_2\text{O}_8^{2-}$ and I^- has a high activation energy. [1]

A solution of iron(II) ions can be used to catalyse the reaction between $\text{S}_2\text{O}_8^{2-}$ and I^- . A two-step reaction mechanism is proposed. The first step is shown below.



- (ii) Write a balanced equation, including state symbols, for the second step of the reaction mechanism. [1]

- (b) A kinetics study was conducted on the reaction between $\text{S}_2\text{O}_8^{2-}$ and I^- to determine the rate equation.

Varying volumes of water, 2.50 mol dm^{-3} sodium peroxodisulfate, $\text{Na}_2\text{S}_2\text{O}_8$, and 0.05 mol dm^{-3} potassium iodide, KI , were added to a mixture containing sodium thiosulfate and starch indicator.

As the reaction of $\text{S}_2\text{O}_8^{2-}$ and I^- proceeds, the iodine produced will be consumed by the thiosulfate. When all the thiosulfate has reacted, the remaining iodine will react with the starch indicator, forming a blue-black complex. The rate of reaction is determined by the time taken for the blue-black colouration to appear.

The results for experiments 1 to 3 are shown in Table 3.1.

Table 3.1

experiment	volume of KI / cm ³	volume of Na ₂ S ₂ O ₈ / cm ³	volume of Na ₂ S ₂ O ₃ / cm ³	volume of water / cm ³	time for blue-black colouration to appear / s
1	10	20	10	10	50
2	5	20	10	15	100
3	30	10	10	0	33

Hint: What is the relationship between rate and time taken for the blue-black colouration to appear?

- (i) Determine the order of reaction with respect to I⁻ and S₂O₈²⁻.

[2]

- (ii) Hence, write the rate equation and state the units of rate constant.

[1]

rate equation:

Units of k :

- (iii) Calculate the initial concentration of I⁻ in experiment 1.

[1]

(iv) The first half-life of I^- for experiment 1 was observed to be 120 s.

Using your answers in (b)(i) and (b)(iii), sketch a graph of concentration of I^- against time for experiment 1 in Fig. 3.2.

[1]

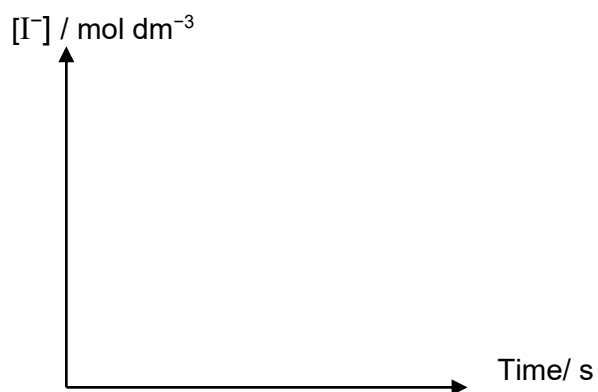
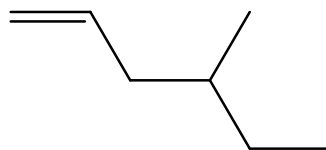


Fig. 3.2

[Total: 7 – complete in 12 min]

- 4 Compound **A** exists as a colourless liquid and is a crucial building block in the synthesis of innovative drug candidates.



Compound **A**

- (a) When aqueous bromine is added to Compound **A**, the major product formed has a molecular formula of $C_7H_{15}OBr$.

(i) Give the IUPAC name of Compound **A**.

[1]

(ii) Draw the structures of the two carbocation intermediates that are formed when Compound **A** reacts with bromine.

[1]

carbocation 1	carbocation 2

(ii) Using your answers in (a)(i), state and explain which carbocation is formed preferentially.

[2]

(iii) Hence, draw the structural formula of the major product.

[1]

[Total: 5 – complete in 8 min]

