Diploma Programme
Programme du diplôme
Programa del Diploma

Chemistry
Higher level
Paper 1A

ANSWERS (?)

31 October 2025

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

2 hours [Paper 1A and Paper 1B]

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A calculator is required for this paper.
- A clean copy of the **chemistry data booklet** is required for this paper.
- The maximum mark for paper 1A is **[40 marks]**.
- The maximum mark for paper 1A and paper 1B is **[75 marks]**.

001

Z001

8825–6207

Section A

1. Which methods for separating the given mixtures into their components are correct?

	Mixture	Method
I.	A mixture of solid in a liquid in which solubility of the solid varies with temperature	Crystallization
II.	A mixture of a solid in a liquid in which the solid is not dissolved	Filtration
III.	A mixture of two miscible liquids with different boiling points	Distillation

A. I and II only

B. I and III only

C. II and III only

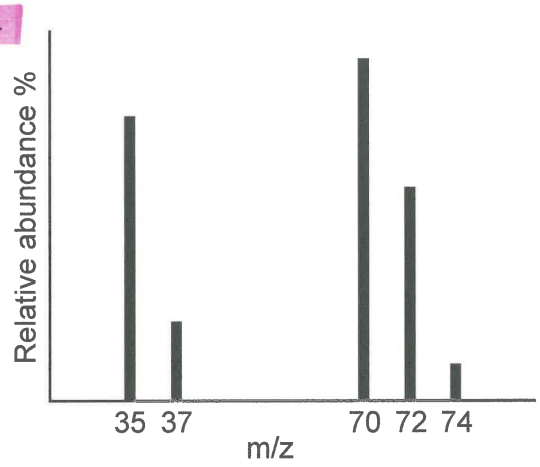
D. I, II and III

001

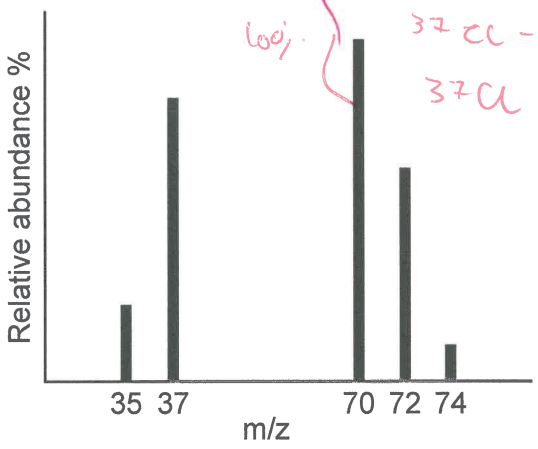
2. Chlorine is a diatomic molecule that contains 75% of ^{35}Cl and 25% of ^{37}Cl.

Which graph shows the full mass spectrum of chlorine?

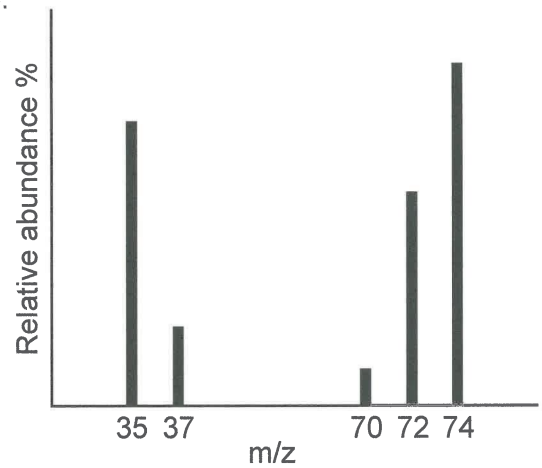
A.



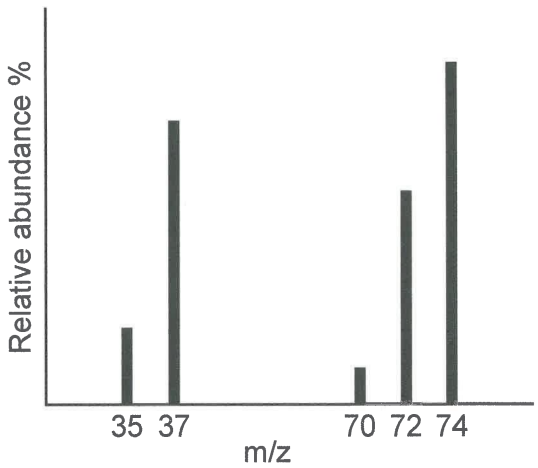
B.



C.



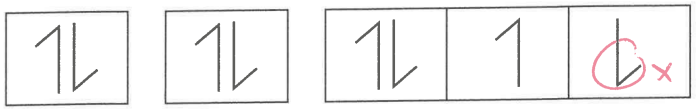
D.



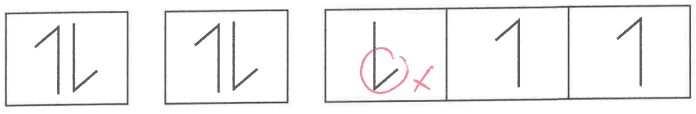
Z001

3. Which orbital diagram represents a correct ground state electron configuration based on the Pauli exclusion principle and Hund's rule?

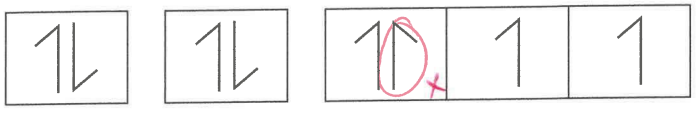
A.



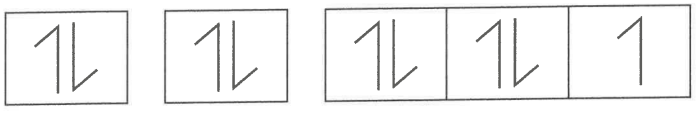
B.



C.



D.



001

4. 5.72 g of $Na_2CO_3 \cdot 10H_2O$ ($M_r = 286\,g\,mol^{-1}$) is dissolved in water to prepare 0.4 dm^3 of aqueous solution.

What is the concentration of sodium ions, in mol dm^{-3}, in the resulting solution?

A. 0.02

B. 0.04

C. 0.05

D. 0.10

$n = \frac{5.72\,g}{286\,g\,mol^{-1}} = 0.02\,mol$

$c = n/V = 0.02\,mol / 0.4\,dm^3$

$= 0.05\,mol/dm^3$

5. In which of the following sets of conditions does the gas exhibit behaviour closest to an ideal gas ?

Z001

	Gas	Pressure / kPa	Temperature / K
A.	H_2	100	273
B.	NH_3	50	473
C.	H_2	50	473
D.	NH_3	100	273

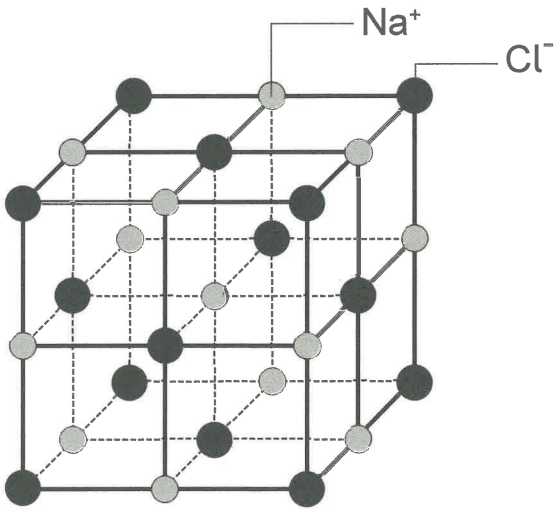
→ high temp.

→ low pressure

→ minimal intermolecular forces.

hydrogen bonds

6. An expanded view of the NaCl lattice is given in the figure.



Which statement is correct for the lattice structure of NaCl?

001

A. The ions are held together in the lattice by covalent bonds. ×

B. The forces of attraction in the lattice are very weak. ×

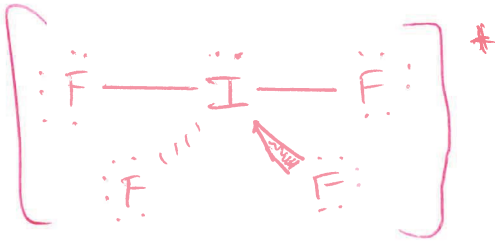
C. Each sodium ion is surrounded by four chloride ions. ✓ -> 6

D. The structure breaks apart when dissolved in water.

7. What are the electron domain and molecular geometries of IF_4^+ ion?

Z001

	Electron domain geometry	Molecular geometry
A.	Trigonal bipyramidal	Seesaw
B.	Tetrahedral	Tetrahedral
C.	Tetrahedral	Seesaw
D.	Trigonal bipyramidal	Tetrahedral

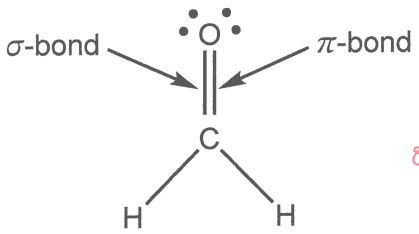


5 electron domains

4 bonding domains

+ 1 lone pair

8. Which orbitals overlap to form σ-bond and π-bond between carbon and oxygen in methanal?



	σ-bond	π-bond
A.	sp^2 and sp^3	p and p
B.	sp^2 and sp^2	p and sp^2
C.	sp^2 and sp^2	p and p
D.	sp^2 and sp^3	p and sp^2

9. Which species contain a coordination bond?

I. O_3

II. CO_2

III. NO_3^-

A. I and II only

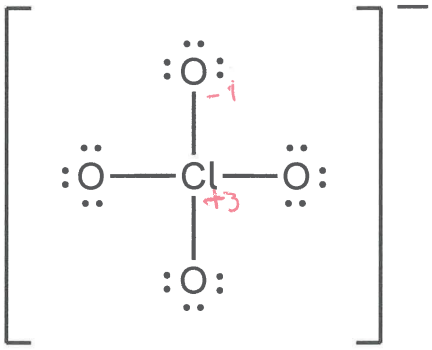
B. I and III only

C. II and III only

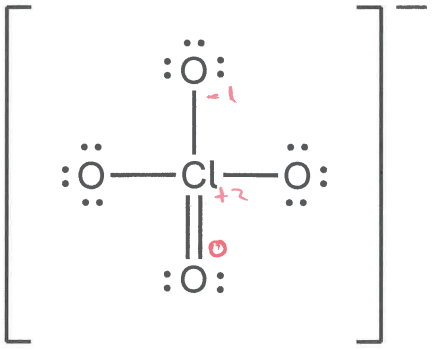
D. I, II and III

10. What is the preferred Lewis formula for chlorate(VII), ClO_4^-, ion based on formal charges?

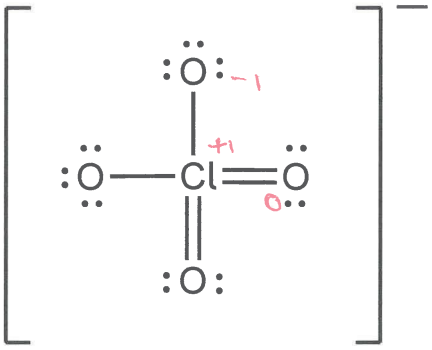
A.



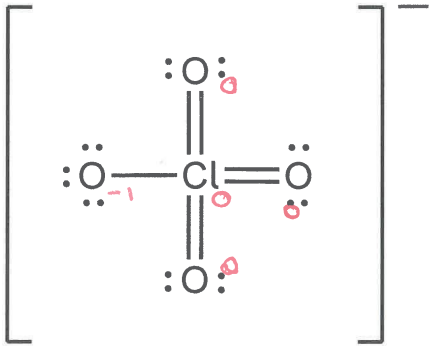
B.



C.



D.



next F.C of 'O'

001

11. Which statement best explains the malleability of magnesium metal?

A. The metal lattice is held together by the attraction between magnesium ions.

B. The outer shell electrons of magnesium are free to move.

C. The layers of magnesium ions can slide relative to each other.

D. There are strong attractions between the magnesium ions and the free moving electrons.

Z001

12. Which material is a good electrical conductor?

A. Diamond

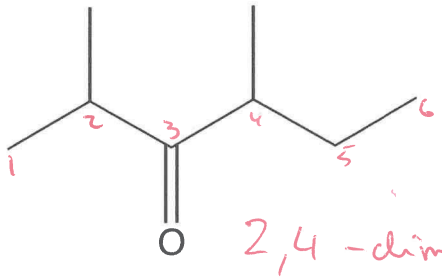
B. Graphite

contains delocalised e^-

C. Fullerene

D. Silicon

13. What is the IUPAC name of the molecule below?



2,4-dimethylhex-3-one

A. 2-ethyl-4-methylpentan-3-one

B. 4-ethyl-2-methylpentan-3-one

C. 2,4-dimethylhexan-3-one

D. 3,5-dimethylhexan-4-one

$2(+1) + x + 4(-2) = 0$

$\therefore x = 8 - 2$

$= +6$

14. What are the oxidation states of the elements in Na_2CrO_4?

	Sodium	Chromium	Oxygen
A.	+1	+6	–1
B.	+2	+3	–1
C.	+1	+6	–2
D.	+2	+3	–2

15. Which statement is correct for the group 17 elements from fluorine to iodine?

A. The elements become more volatile. ✗ F (g) Br (l) I (s)

B. The hydrides of the elements become more acidic. ✓ bond gets weaker easier for H^+ to come off

C. The elements become more reactive. ✗ Fmost reactive

D. The bond between the halogen atoms becomes less polar. ✗ all non-polar

16. Which aqueous solution of an ion is likely to be coloured based on the electron configuration of that ion?

A. Ni^{2+}

B. Sc^{3+}

C. Cu^{+}

D. Zn^{2+}

17. Which molecule contains a chiral centre?

A. $CH_3CH(CH_3)CHO$

B. $CH_3CHClCH_2CH_3$

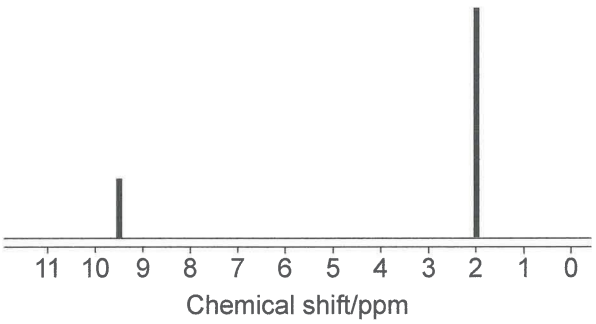
C. $CH_3C(CH_3)_2OH$

D. $ClCH_2CH_2COOH$

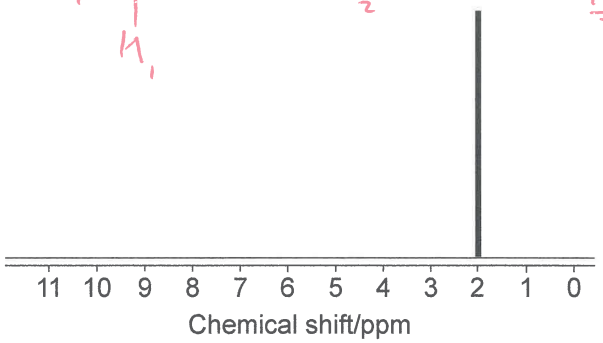
001

18. What is the low-resolution ^1H NMR spectrum of ethanal?

A.

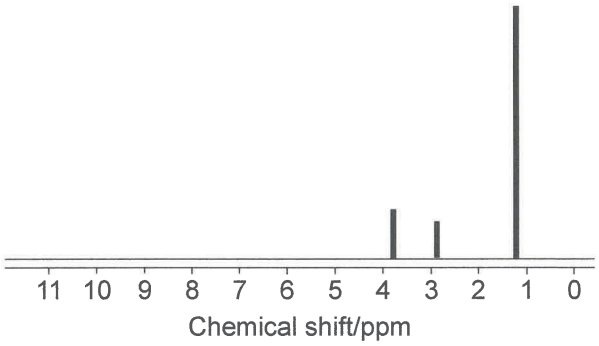


B.

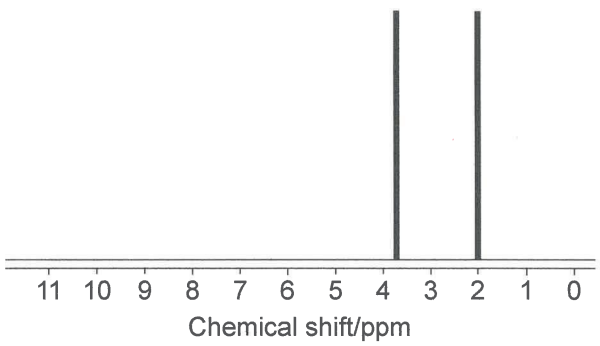


Z001

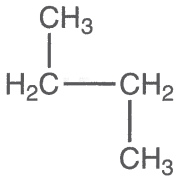
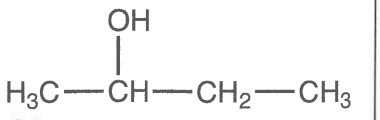
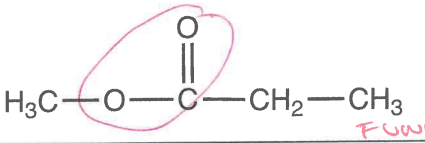
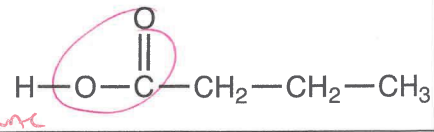
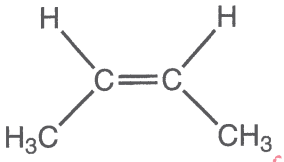
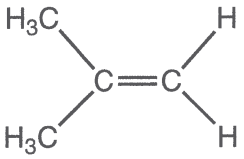
C.



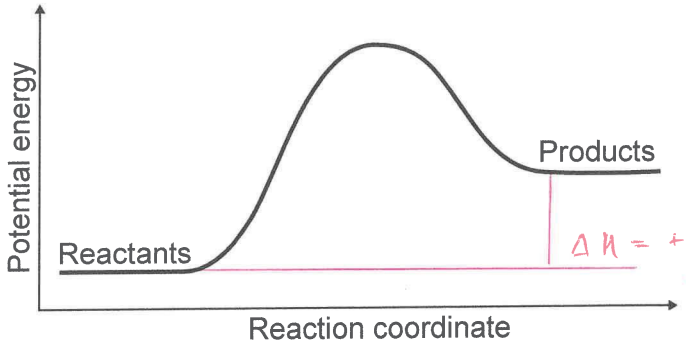
D.



19. Which pair of compounds represents the correct type of isomerism?

	Type of isomerism	Pair of compounds
A.	Chain	$H_3C—CH_2—CH_2—CH_3$ and 
B.	Functional group	$H_3C—O—CH_2—CH_2—CH_3$ and 
C.	Positional	 and 
D.	*Cis-trans*	 and 

20. The potential energy profile of a reaction is shown.



Which reaction has this energy profile?

A. $N_2(g) + O_2(g) \rightarrow 2NO(g)$

B. $2H(g) \rightarrow H_2(g)$

C. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

D. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

21. What is the enthalpy change for the reaction in $kJ\,mol^{-1}$?

$$C_2H_2(g) + 2H_2(g) \rightarrow C_2H_6(g)$$

	ΔH^{θ}_c / $kJ\,mol^{-1}$
$C_2H_2(g)$	–1301
$H_2(g)$	–286
$C_2H_6(g)$	–1561

A. $-1561 - 2(-286) - 1301$

B. $-1561 + 2(-286) - 1301$

C. $-1301 + 2(-286) + 1561$

D. $-1301 - 2(-286) + 1561$

001

22. Which equation represents the enthalpy change of atomisation, ΔH^{θ}_{at}, of bromine?

A. $Br_2(l) \rightarrow Br_2(g)$

B. $1/2Br_2(g) \rightarrow Br(g)$

C. $1/2Br_2(l) \rightarrow Br(g)$

D. $Br_2(g) \rightarrow 2Br(g)$

23. Which of the following statements best describes an environmental implication associated with the use of fossil fuels?

A. Increased biodiversity due to the establishment of habitats through mining

B. Decreased emission of greenhouse gases leading to global cooling

C. Enhanced soil fertility due to the deposition of coal dust

D. Acid rain formation from the release of sulfur dioxide and nitrogen oxides

Z001

24. Which reaction is predicted to occur with the largest decrease in entropy?

A. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ 4(g) → 2(g)

B. $N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$ 3(g) → 2(g)

C. $6CO_2(g) + 6H_2O(g) \rightarrow C_6H_{12}O_6(s) + 6O_2(g)$ 12(g) → 1(s) + 6(g)

D. $CO(g) + 2H_2(g) \rightarrow CH_3OH(l)$ 3(g) → 1(l)

25. Equal volumes of X_2 and Y_2 gases are allowed to react in a sealed container to form XY_3 gas. After completion of the reaction, the volume of XY_3 is measured to be 40 cm^3.

What was the volume, in cm^3, of X_2 gas at the beginning?

$$X_2(g) + 3Y_2(g) \rightarrow 2XY_3(g)$$

Vol. of gas ∝ mol of gas

X_2 = V cm^3

Y_2 = V cm^3

A. 20

B. 40

C. 60

D. 120

V cm^3 of X_2 requires 3V cm^3 of Y_2

∴ Y_2 is limiting

3 vol. Y_2 → 2 vol. XY_3 ∴ $\frac{2}{3}V = 40\ cm^3$

∴ $V = \frac{3}{2} \times 40\ cm^3 = 60\ cm^3$

001

26. What is the volume of nitrogen dioxide, in cm^3, produced at STP when 1.28 g of copper reacts with excess nitric acid?

$$Cu(s) + 4HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$$

Molar volume of an ideal gas at STP is 22.7 $dm^3\,mol^{-1}$

A. 227

B. 456

C. 684

D. 914

$n_{Cu} = \frac{1.28\ g}{63.5\ g\,mol^{-1}} = 0.0201...$ mol Cu

$n_{NO_2} = 2 \times n_{Cu}$

$= 2 \times 0.0201$

$= 0.0403...$

$n = V/V_m$

$\therefore V = n \times V_m$

$= 0.0434 \times 22.7$

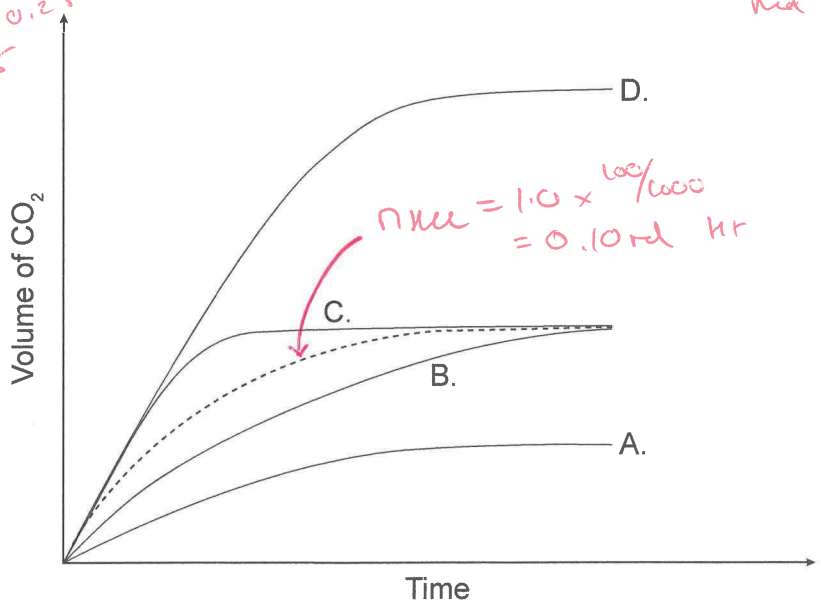
$= 0.915\ dm^3$

$= 915$

Z001

27. The dotted line represents the volume of carbon dioxide evolved when excess calcium carbonate is added into 100 cm^3 of 1.0 mol dm^{-3} of hydrochloric acid.

Which graph represents the production of carbon dioxide when excess calcium carbonate is added to the 200 cm^3 of 0.25 mol dm^{-3} of hydrochloric acid?



001

28. Which reaction has the lowest activation energy?

A. $Cl_2(g) \rightarrow 2Cl(g)$

B. $HCl(g) \rightarrow H(g) + Cl(g)$

C. $HCl(g) \rightarrow H^+(g) + Cl^-(g)$

D. $2H(g) \rightarrow H_2(g)$

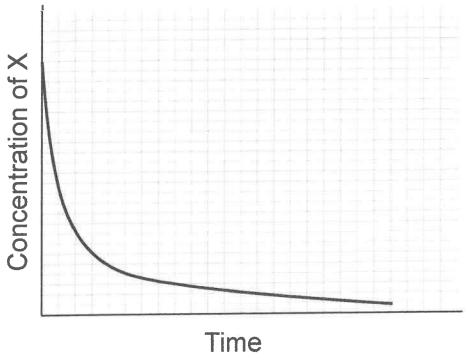
Z001

29. Consider the following equation:

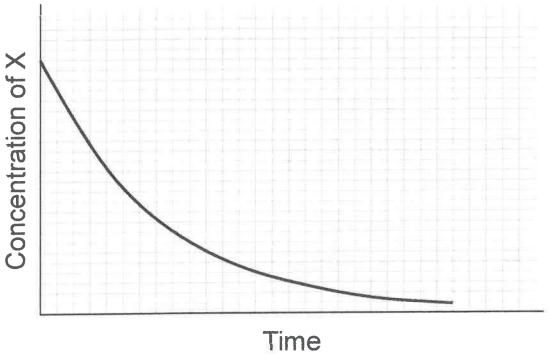
$$2X \rightarrow Y + Z$$

Which graph shows that the reaction is first order with respect to X?

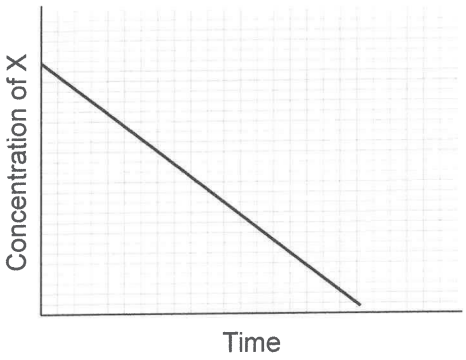
A.



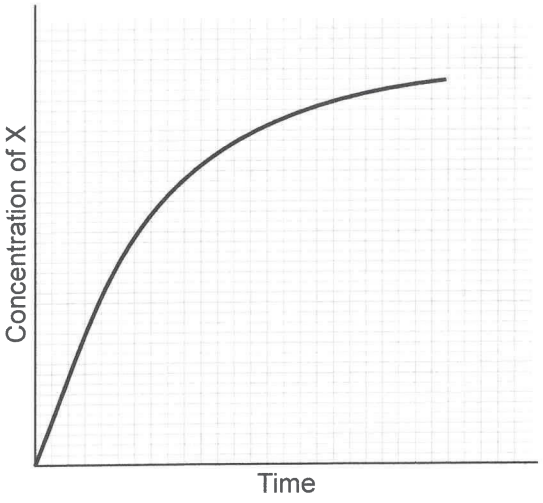
B.



C.



D.



001

30. Which statement regarding the chemical equilibrium explains why it is described as dynamic?

A. There is a continuous shift in the equilibrium position.

B. The reactants and products continue to react.

C. The concentrations of reactants and products continue to change.

D. The rates of forward and reverse reactions continue to change.

Z001

31. SO_2 reacts with O_2 to produce SO_3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

A mixture of 1.10 mol of $SO_2(g)$ and 1.95 mol of $O_2(g)$ was placed into a 1 dm^3 container at a certain temperature. When the equilibrium was reached, the mixture contained 0.18 mol of $SO_2(g)$.

What is the value of the equilibrium constant, K, for this reaction?

A. $\dfrac{0.92^2}{0.92^2 \times 0.46}$

B. $\dfrac{0.46}{0.18 \times 1.03}$

C. $\dfrac{0.92}{0.18 \times 1.49}$

D. $\dfrac{0.92^2}{0.18^2 \times 1.49}$

$2SO_2 + O_2 \rightleftharpoons 2SO_3$

i 1.10 1.95 0

Δ −0.92 −½(0.92) +0.92

⇌ 0.18 1.49 0.92

$\therefore K = \dfrac{[0.92]^2}{[0.18]^2[1.49]} = D$

001

32. In which of the following reactions does ammonia behave as a Brønsted–Lowry base?

accept H^+ to form NH_4^+

A. $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ ✗

B. $NH_3 + H_2O + CO_2 \rightarrow (NH_4)HCO_3$ NH_4^+

C. $NH_3 + CH_3CH_2Cl \rightarrow CH_3CH_2NH_2 + HCl$ ✗

D. $2NH_3 + 2K \rightarrow 2KNH_2 + H_2$ ✗

33. Which aqueous solution has the lowest pH?

A. 0.01 mol dm^{-3} NH_4Cl acidic salt

B. 0.01 mol dm^{-3} NaCl neutral

C. 0.01 mol dm^{-3} NH_4HCO_3 NH_4^+ = acidic HCO_3^- = amphiprotic

D. 0.01 mol dm^{-3} $NaHCO_3$ Not neutral HCO_3^- = amphiprotic

Z001

34. What is the half equation for the reduction of nitric acid to nitrogen(II) oxide in acidic medium?

A. $HNO_3 + 3H^+ + 3e^- \rightarrow NO + 2H_2O$

B. $HNO_3 + 4H^+ + 4e^- \rightarrow NO + 2H_2O$

C. $HNO_3 + 2H_2O \rightarrow NO + 4H^+ + 4e^-$

D. $HNO_3 + 2H_2O \rightarrow NO + 3H^+ + 3e^-$

35. Which compound undergoes oxidation when heated with acidified potassium dichromate?

I. $CH_3CH_2CH_2CH_2OH$

II. $CH_3C(CH_3)_2OH$

III. $CH_3CH(OH)CH_2CH_3$

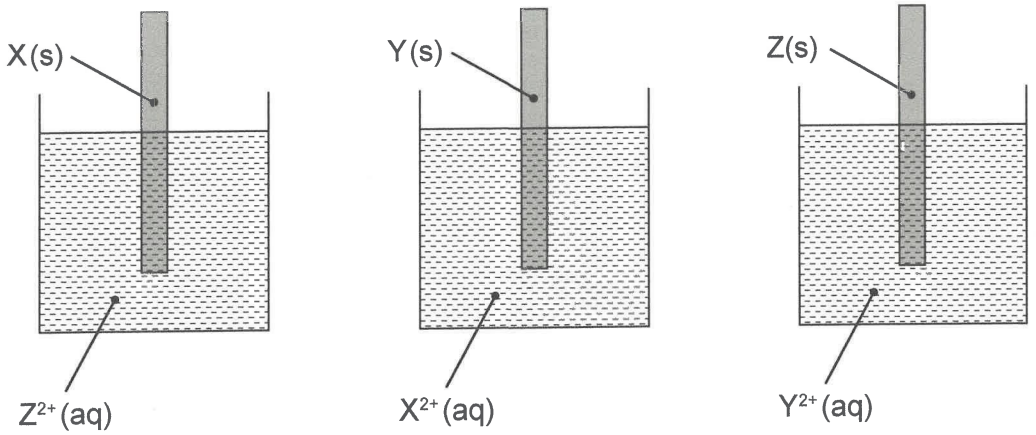
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

36. A student performed displacement reactions using metals X, Y, Z and solutions of their ions, X^{2+}, Y^{2+}, Z^{2+}. The results are shown.



Results:	No reaction	No reaction	Reaction occurs

What is the increasing order of the reactivity of X, Y and Z metals?

A. X, Y, Z

B. Y, X, Z

C. Z, X, Y

D. Y, Z, X

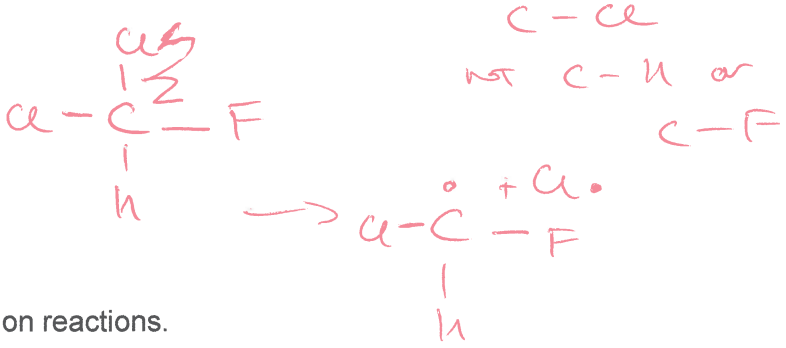
37. Which radical is most likely to form during the breakdown of one covalent bond of dichlorofluoromethane, $CHCl_2F$, in the upper atmosphere?

A. $\bullet CHClF$

B. $\bullet CCl_2F$

C. $\bullet CHCl_2$

D. $\bullet CHCl_2F$



38. But-2-ene undergoes a variety of addition reactions.

Which of the following is correct?

	Reagent added	Product
A.	H_2	But-1-ene
B.	H_2O	Butan-1-ol
C.	HBr	2-bromobutane
D.	Br_2	2,2-dibromobutane

001

39. Which statements are correct for the complex ion $[FeCl_4]^{2-}$?

I. Chloride ions are behaving as ligands.

II. The oxidation state of iron is +3.

III. Iron ion forms coordination bonds with chloride ions.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Z001

40. Which statement is correct about an S_N2 mechanism?

A. Two molecules are involved in the rate-determining step of the mechanism.

B. Two steps are involved in the mechanism.

C. A nucleophile is substituted by an electrophile.

D. The mechanism involves formation of an intermediate carbocation.