

Chemistry
Higher level
Paper 1A

Specimen paper

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]**.

Section A

- What is thin-layer chromatography best used for separating?
 - molecules of varying polarity
 - molecules of similar polarity
 - metals in an alloy
 - water of crystallization from hydrated salts
- Ice containing only the isotope ^2H sinks and does not melt when dropped into ordinary distilled water maintained at 3°C .

Which statement is correct?

- The isotope ^2H has a high natural abundance.
 - $^2\text{H}_2\text{O}(\text{s})$ has a higher melting point than normal ice.
 - $^2\text{H}_2\text{O}(\text{s})$ has a lower density than normal ice-cold water.
 - $^2\text{H}_2\text{O}$ has different chemical properties from normal water.
- The table lists successive ionization energies of an element **Z**.

Ionization number	1st	2nd	3rd	4th	5th	6th
Ionization energy / kJ mol^{-1}	577.54	1816.68	2744.78	11 577.5	14 841.9	18 379.0

Which is the formula of the stable oxide of the element **Z**?

- Z_2O
- ZO
- Z_2O_3
- ZO_2

4. A container holds 30 g of argon and 60 g of neon.

What is the ratio of number of atoms of argon to number of atoms of neon in the container?

- A. 0.25
- B. 0.50
- C. 2.0
- D. 4.0

5. A gas storage tank of fixed volume V contains N molecules of an ideal gas at 300 K with a pressure of 40 kPa. $\frac{N}{4}$ molecules are removed, and the temperature is changed to 450 K.

What is the new pressure of the gas in kPa?

- A. 15
- B. 30
- C. 45
- D. 60

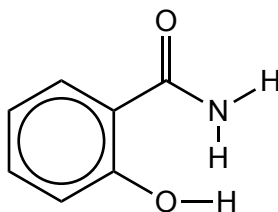
6. What is the formula of the compound formed between magnesium ions and hydrogencarbonate ions?

- A. MgHCO_3
- B. $\text{Mg}(\text{HCO}_3)_2$
- C. $\text{Mg}(\text{HCO}_3)_3$
- D. $\text{Mg}_3(\text{HCO}_3)_2$

7. In which group of ions and molecules are electrons delocalized in all species?

- A. CH_3COOH , O_3 , C_{60}
- B. CH_3COO^- , NO_2^- , C(graphite)
- C. C_2H_2 , $(\text{COOH})_2$, C(diamond)
- D. C_2H_4 , NO_2^+ , SiO_2

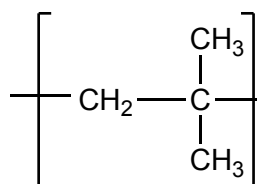
8. What is the molecular geometry of the central atom in SF_4Cl_2 ?
- A. linear
B. tetrahedral
C. hexagonal
D. octahedral
9. Which is the preferred Lewis formula of nitrous oxide, N_2O , as deduced by formal charges?
- A. $\ddot{\text{N}}=\text{N}=\ddot{\text{O}}$
B. $:\text{N}\equiv\text{N}-\ddot{\text{O}}:$
C. $:\ddot{\text{N}}-\text{N}\equiv\text{O}:$
D. $\ddot{\text{N}}=\text{O}=\ddot{\text{N}}$
10. Which pair of statements about electrons in this molecule is correct?



	Number of non-bonding pairs of electrons	Number of electrons in π bonds
A.	3	6
B.	3	8
C.	5	6
D.	5	8

11. What is the explanation for the malleability of metals?
- A. The bonds are strong.
B. The bonds are weak.
C. The bonds involve free electrons.
D. The bonds do not have a specific direction.

12. The structure shows the repeating unit of a polymer found in some plastics.



Which monomer is used to form this plastic?

- A. $\text{H}_2\text{C}=\text{C}(\text{CH}_3)_2$
- B. $\text{CH}_3\text{CH}(\text{CH}_3)_2$
- C. $(\text{H}_3\text{C})_2\text{C}=\text{C}(\text{CH}_3)_2$
- D. $(\text{H}_3\text{C})_2\text{C}=\text{CHCH}(\text{CH}_3)_2$
13. Why is copper(II) sulfate blue?
- A. Red light is absorbed when electrons are promoted between the orbitals in the split d-sublevels.
- B. Blue light is emitted when electrons fall between the orbitals in the split d-sublevels.
- C. Red light is absorbed when electrons fall between the orbitals in the split d-sublevels.
- D. Blue light is emitted when electrons are promoted between the orbitals in the split d-sublevels.
14. Which molecule has a carbonyl functional group?
- A. CH_3OCH_3
- B. CH_3COCH_3
- C. $\text{CH}_3\text{CH}_2\text{OH}$
- D. $\text{CH}_3\text{CH}_2\text{NH}_2$
15. The block structure of the periodic table groups elements according to which characteristic?
- A. atomic number
- B. atomic mass
- C. electron configuration
- D. reactivity

16. Which d block element has the highest number of different oxidation states?

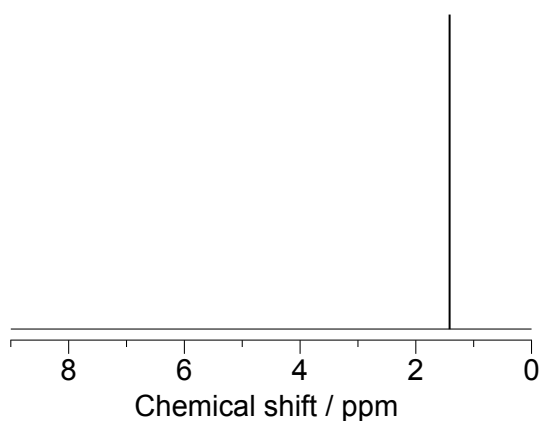
- A. Ti
- B. Mn
- C. Cu
- D. Zn

17. What do all greenhouse gases have in common?

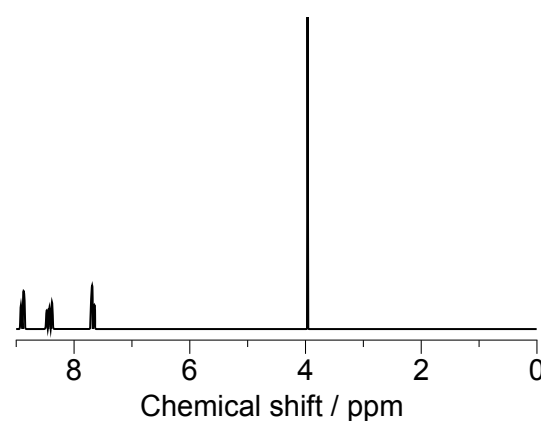
- A. They are emitted by the burning of fossil fuels.
- B. They absorb ultraviolet radiation.
- C. They are symmetrical molecules with no polar bonds.
- D. They absorb infrared radiation.

18. Which is the ^1H NMR spectrum of cyclohexane?

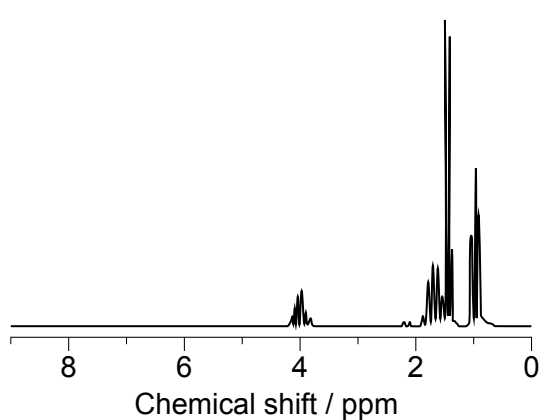
A.



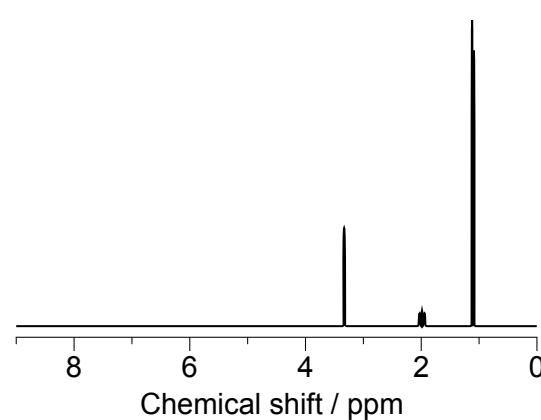
C.



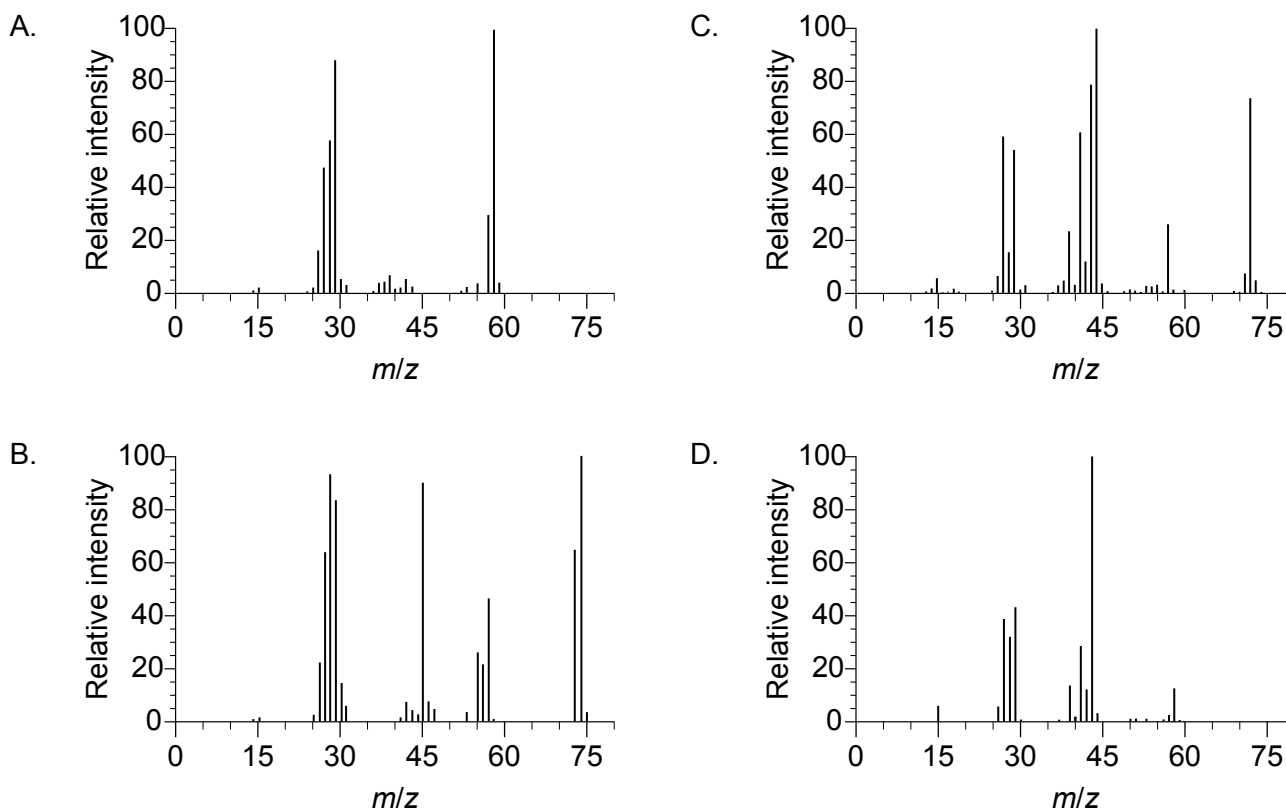
B.



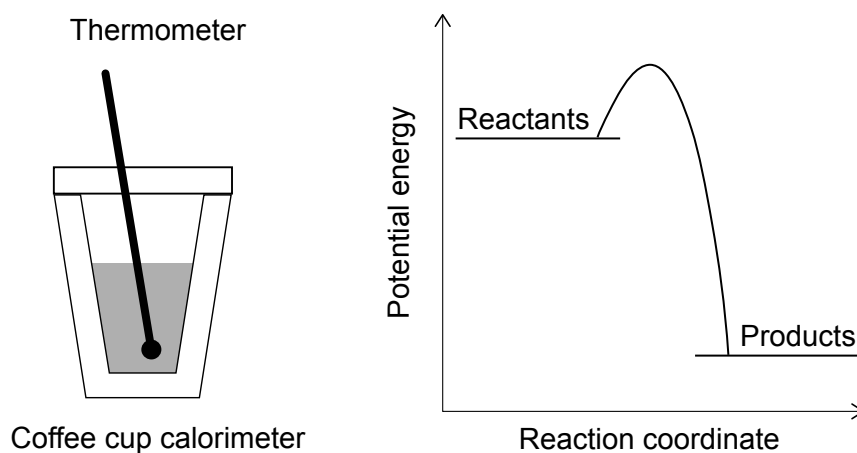
D.



19. Which is the mass spectrum of butanal?



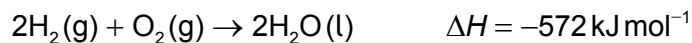
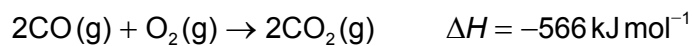
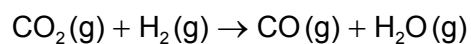
20. The potential energy profile for a “coffee cup” calorimetry experiment is shown.



What is the correct interpretation of this reaction?

	Temperature	Type of reaction
A.	increases	exothermic
B.	increases	endothermic
C.	decreases	exothermic
D.	decreases	endothermic

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



- A. –1182
- B. –899
- C. –41
- D. +41
22. Which is a renewable energy source?
- A. natural gas
- B. uranium
- C. coal
- D. wood
23. Which are endothermic processes in a Born–Haber cycle for the formation of an ionic compound?
- I. Enthalpy of atomization
- II. First electron affinity
- III. First ionization energy
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

24. What is correct as a system approaches equilibrium?

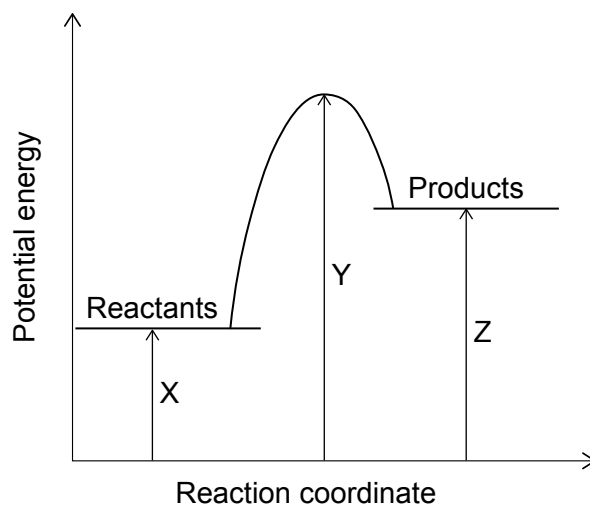
- A. Q remains constant.
- B. K_c increases.
- C. $\Delta G^\ominus$ becomes more negative.
- D. ΔG approaches zero.

25. The complete combustion of 20.0 cm^3 of a gaseous hydrocarbon, C_xH_y , produces 80.0 cm^3 of gaseous products. This volume reduces to 40.0 cm^3 when the water vapour present condenses. All volumes are measured at the same temperature and pressure.

What is the molecular formula of the hydrocarbon?

- A. CH_4
- B. C_2H_2
- C. C_2H_4
- D. C_3H_6

26. The diagram shows the energy profile of a reaction.



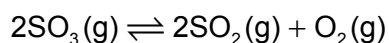
Which combination is correct?

	Activation energy of forward reaction	Activation energy of reverse reaction
A.	X	Z
B.	$Y - X$	$Y - Z$
C.	Y	Y
D.	$Y - X$	$Z - X$

27. What is the main reason for an increase in rate of reaction when the temperature is raised?

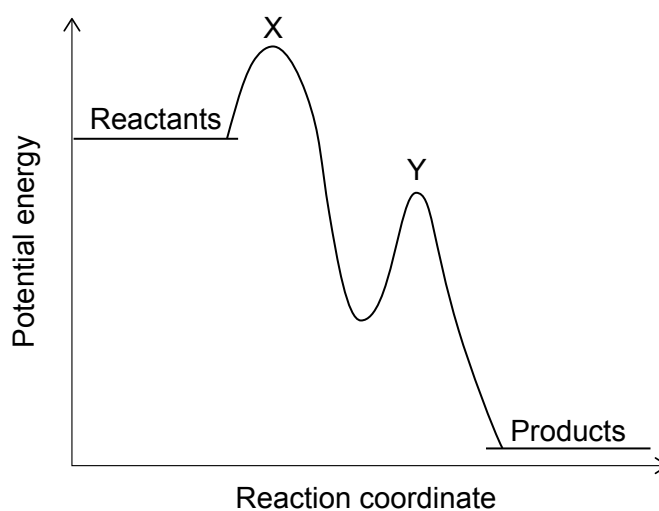
- A. A greater proportion of collisions are successful.
- B. Particles collide more frequently.
- C. The bonds in the reactants are weakened.
- D. The activation energy of the reaction decreases.

28. What is the equilibrium constant expression for the following reaction?



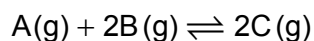
- A. $\frac{[\text{SO}_2]^2[\text{O}_2]}{[\text{SO}_3]^2}$
- B. $\frac{[\text{SO}_2]^2 + [\text{O}_2]}{[\text{SO}_3]^2}$
- C. $\frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]}$
- D. $\frac{2[\text{SO}_2][\text{O}_2]}{2[\text{SO}_3]}$

29. Which statement is correct about points X and Y on the energy profile diagram?



- A. X is a transition state and Y is an intermediate.
- B. X is an intermediate and Y is a transition state.
- C. X and Y are transition states.
- D. X and Y are intermediates.

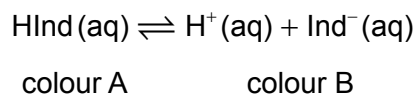
30. The equation for the reaction between two gases, A and B, is:



When the reaction is at equilibrium at 600 K, the concentrations of A, B, and C are 2, 1, and 2 mol dm^{-3} respectively. What is the value of the equilibrium constant at 600 K?

- A. 0.25
- B. 1
- C. 2
- D. 4
31. Which reaction would be expected to have the largest Arrhenius (pre-exponential) factor, A , at constant temperature?
- A. $\text{H(g)} + \text{I(g)} \rightarrow \text{HI(g)}$
- B. $\text{H}_2\text{(g)} + \text{I}_2\text{(g)} \rightarrow 2\text{HI(g)}$
- C. $2\text{HCl(g)} \rightarrow \text{H}_2\text{(g)} + \text{Cl}_2\text{(g)}$
- D. $\text{H}_2 + \text{C}_2\text{H}_4 \rightarrow \text{C}_2\text{H}_6$
32. Which reactions involve the transfer of a proton?
- I. $2\text{HCl(aq)} + \text{Mg(s)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$
- II. $2\text{HCl(aq)} + \text{MgO(s)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{O(l)}$
- III. $2\text{HCl(aq)} + \text{MgCO}_3\text{(s)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{O(l)} + \text{CO}_2\text{(g)}$
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

33. The indicator, HInd, is used in an acid–base titration.

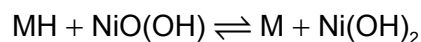


Which statements are correct?

- I. In a strongly alkaline solution, colour B is observed.
- II. Colour A is observed when $[\text{HInd}] < [\text{Ind}^-]$.
- III. $[\text{Ind}^-]$ approximately equals $[\text{HInd}]$ at the end point.

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

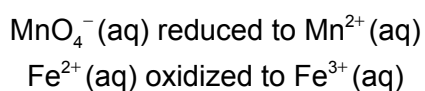
34. The overall reaction occurring at the electrodes of a rechargeable metal hydride battery can be summarized as:



Which statement is correct?

- A. The oxidation state of Ni does not change.
- B. M is oxidized by loss of hydrogen.
- C. The oxidation state of one H atom changes from -1 to $+1$.
- D. The oxidation state of one O atom changes from -1 to -2 .

35. In a redox titration, manganate(VII) ions are reduced to manganese(II) ions and iron(II) ions are oxidized to iron(III) ions.



What volume, in cm^3 , of $0.1 \text{ mol dm}^{-3} \text{ MnO}_4^-(\text{aq})$ is required to reach the equivalence point in the titration of 20.00 cm^3 of $0.1 \text{ mol dm}^{-3} \text{ Fe}^{2+}(\text{aq})$?

- A. 2.00
- B. 4.00
- C. 20.00
- D. 100.00

36. Which statements explain the following reactions occurring in the upper atmosphere?

	Chlorofluorocarbon (CFC) compounds break down to produce chlorine radicals but usually not fluorine radicals.	A single chlorine radical breaks down many ozone, O₃, molecules.
A.	C–Cl bond is stronger than C–F bond	chain propagation steps produce more radicals
B.	C–F bond is stronger than C–Cl bond	chain termination steps cause chlorine radicals to reform chlorine molecules
C.	C–Cl bond is stronger than C–F bond	chain termination steps cause chlorine radicals to reform chlorine molecules
D.	C–F bond is stronger than C–Cl bond	chain propagation steps produce more radicals

37. Which term cannot characterize ammonia, NH₃?

- A. Lewis acid
- B. Brønsted–Lowry acid
- C. ligand
- D. nucleophile

38. Which ion is a better leaving group in nucleophilic substitutions?

- A. bromide ion
- B. chloride ion
- C. fluoride ion
- D. iodide ion

39. Which statement is correct when 2-chloro-2-methylpentane reacts with water to form 2-methylpentan-2-ol?

- A. Water acts as a nucleophile and attacks the chlorine atom.
- B. The reaction occurs in a single step.
- C. A carbocation intermediate is formed.
- D. Homolytic bond fission occurs.

40. Which illustrates the correct intermediate formed in the nitration of benzene by NO_2^+ ?

