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Chemistry

Higher level

Paper 1A

16 May 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]**.

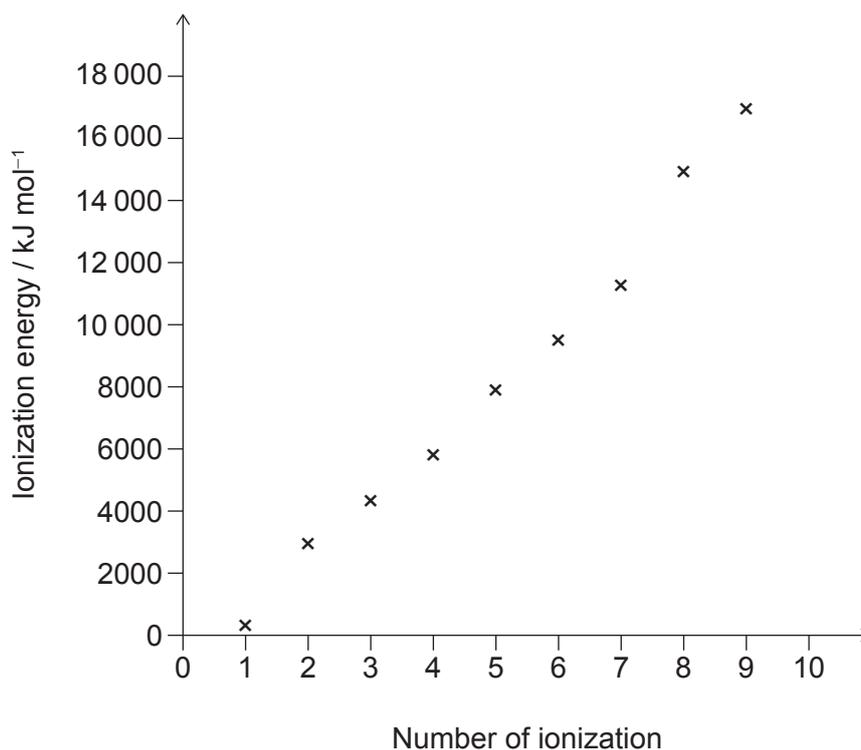
Section A

1. A test tube contains a mixture of liquid hydrocarbons. What is the type of mixture and the best method of separation?

	Type of mixture	Method of separation
A.	homogeneous	distillation
B.	homogeneous	filtration
C.	heterogeneous	distillation
D.	heterogeneous	filtration

2. Which property is the same for water containing tritium (^3H) and water containing hydrogen (^1H)?
- A. Density
 - B. Dipole moment of a molecule
 - C. Boiling point
 - D. Relative molecular mass
3. What is the maximum number of electrons that can occupy the $n = 3$ main energy level?
- A. 3
 - B. 8
 - C. 18
 - D. 28

4. What is the group number of the element whose successive ionization energies are shown?

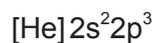


- A. 1
 B. 2
 C. 13
 D. 14
5. What is the empirical formula of a compound with the following composition by mass?

C = 37.5% H = 12.5% O = 50.0%

- A. C₄H₁₂O₅
 B. C₃H₁₂O₃
 C. C₃HO₄
 D. CH₄O

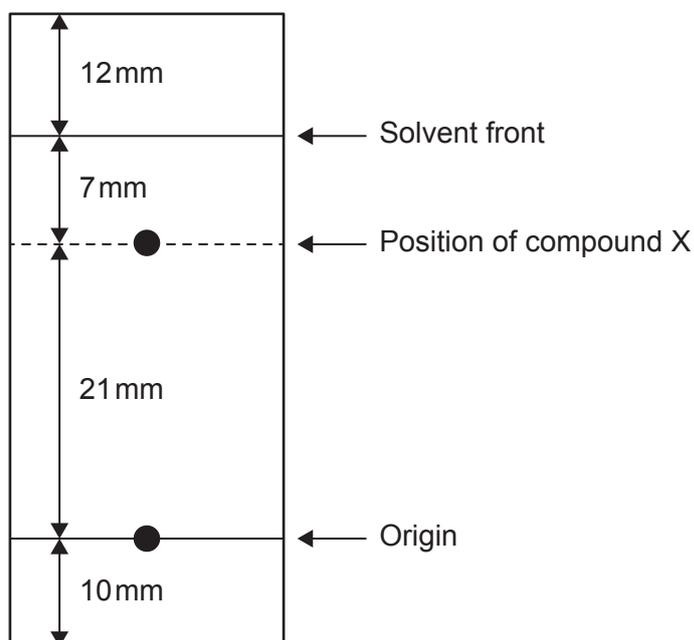
6. What is the charge of the monatomic ion usually formed by the element with the following electron configuration?



- A. 3–
 B. 2+
 C. 3+
 D. 5+
7. Which molecule is polar?

- A. CH_4
 B. C_6H_6
 C. SO_2
 D. CO_2

8. What is the retardation factor, R_F , of compound X according to this paper chromatogram?

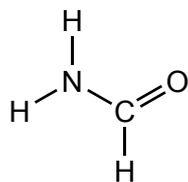


- A. 0.55
 B. 0.75
 C. 0.82
 D. 1.33

9. What are the electron domain and molecular geometries of XeCl_4 ?

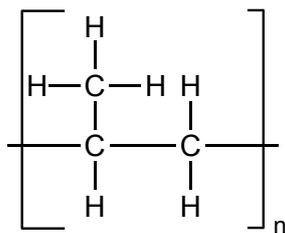
	Electron domain geometry	Molecular geometry
A.	octahedral	tetrahedral
B.	octahedral	square planar
C.	tetrahedral	tetrahedral
D.	tetrahedral	square planar

10. What are the hybridizations of the N, C and O atoms in this molecule?

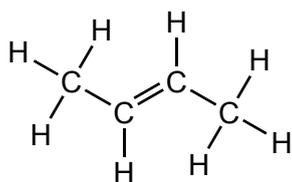


	N	C	O
A.	sp^3	sp^3	sp^2
B.	sp^3	sp^2	sp^2
C.	sp^2	sp^2	sp
D.	sp^2	sp^3	sp

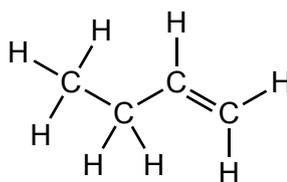
11. Which monomer produces this addition polymer?



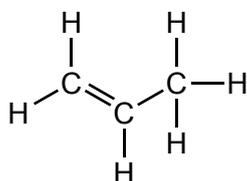
A.



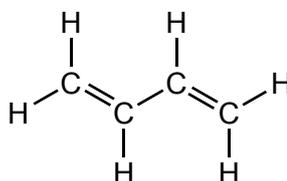
B.



C.



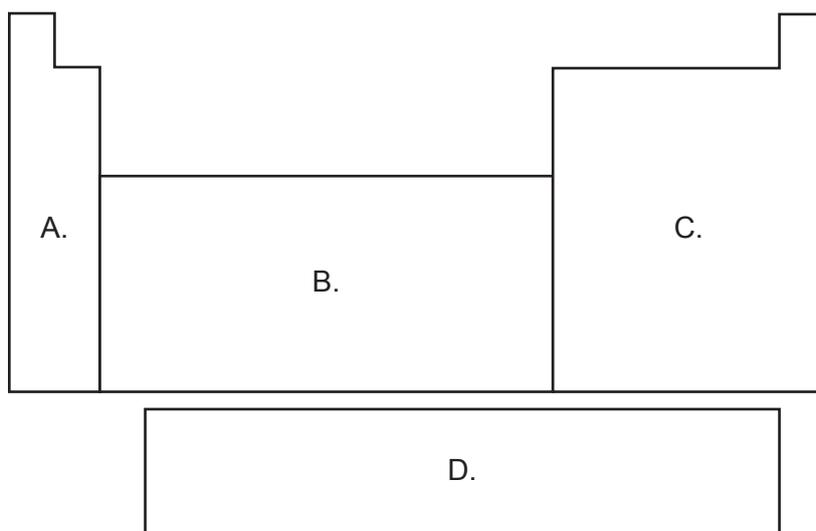
D.



12. Why do group 17 elements have higher first ionization energies than group 1 elements in the same period?

- A. Group 17 elements have more electrons in the valence shell.
- B. Group 17 elements have more filled energy levels.
- C. Group 17 elements have more paired electrons.
- D. Group 17 elements have more protons in the nucleus.

13. Which part of the periodic table contains elements which are likely to form acidic oxides only?



14. What is the oxidation state of nitrogen in N_2O_4 ?

- A. -4
- B. -2
- C. +2
- D. +4

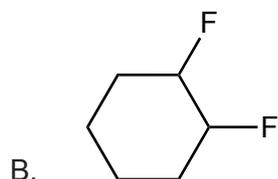
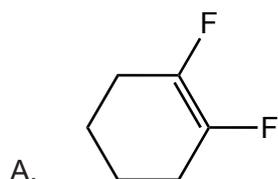
15. Which properties are typical of transition elements?

- I. Low melting points
 - II. Formation of coloured compounds
 - III. Variable oxidation states
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

16. What is the electron configuration of the Cr^{2+} ion?

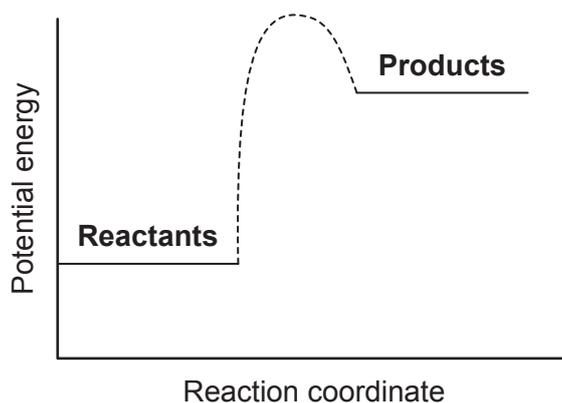
- A. $[\text{Ar}]4s^23d^2$
- B. $[\text{Ar}]4s^13d^5$
- C. $[\text{Ar}]3d^4$
- D. $[\text{Ar}]3d^5$

17. Which compound shows *cis-trans* isomerism?



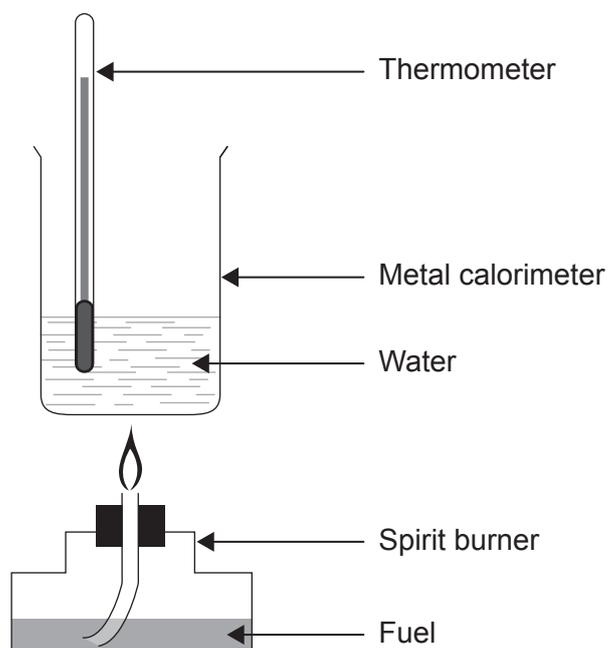
- C. $\text{H}_2\text{C}=\text{CF}_2$
- D. $\text{HFC}=\text{CF}_2$

18. What is the correct interpretation of this energy profile?



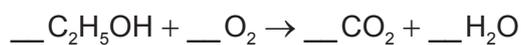
	Relative stability	Temperature of surroundings
A.	reactants more stable than products	decreases
B.	reactants more stable than products	increases
C.	reactants less stable than products	decreases
D.	reactants less stable than products	increases

19. What is the standard enthalpy change, $\Delta H_{\text{combustion}}^{\ominus}$, according to the data?



Amount of fuel burned = 0.110 mol
 Mass of water = 200 g
 Initial temperature of water = 21.0 °C
 Final temperature of water = 25.0 °C
 Specific heat capacity of water, $c_w = 4.18 \text{ J g}^{-1} \text{ K}^{-1}$
 $Q = mc\Delta T$

- A. $-2110 \text{ kJ mol}^{-1}$
 B. $-30.4 \text{ kJ mol}^{-1}$
 C. $+30.4 \text{ kJ mol}^{-1}$
 D. $+2110 \text{ kJ mol}^{-1}$
20. What is the coefficient of oxygen when the equation for the complete combustion of ethanol is balanced using the smallest whole numbers?



- A. 1
 B. 2
 C. 3
 D. 7

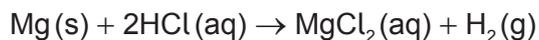
21. Which change results in a decrease in entropy?

- A. $\text{N}_2\text{H}_4(\text{l}) \rightarrow \text{N}_2(\text{g}) + 2\text{H}_2(\text{g})$
- B. $\text{K}_2\text{Cr}_2\text{O}_7(\text{s}) \rightarrow \text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$
- C. $\text{MgCO}_3(\text{s}) \rightarrow \text{MgO}(\text{s}) + \text{CO}_2(\text{g})$
- D. $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$

22. Which value indicates an equilibrium reaction?

- A. $\Delta S = 0 \text{ JK}^{-1} \text{ mol}^{-1}$
- B. $\Delta G = 0 \text{ kJ mol}^{-1}$
- C. $\Delta H = 0 \text{ kJ mol}^{-1}$
- D. $\Delta T = 0 \text{ K}$

23. What are the limiting reactant and theoretical yield of hydrogen when 0.20 mol of magnesium reacts with 0.20 mol of hydrochloric acid?

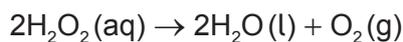


	Limiting reactant	Theoretical yield of H_2 / mol
A.	Mg	0.10
B.	Mg	0.20
C.	HCl	0.05
D.	HCl	0.10

24. Which are units for rate of reaction?

- A. mols
- B. $\text{dm}^{-3} \text{ h}^{-1}$
- C. $\text{mol dm}^{-3} \text{ h}^{-1}$
- D. $\text{mol dm}^{-3} \text{ s}$

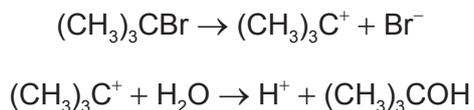
25. Which changes increase the rate of the reaction?



- I. Introducing a catalyst
- II. Increasing concentration of $\text{H}_2\text{O}_2(\text{aq})$
- III. Increasing pressure

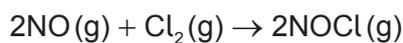
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

26. Which species is an intermediate in the following reaction mechanism?



- A. $(\text{CH}_3)_3\text{C}^+$
- B. Br^-
- C. H_2O
- D. H^+

27. What is the overall reaction order?



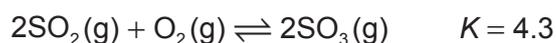
[NO] / mol dm ⁻³	[Cl ₂] / mol dm ⁻³	Rate
0.10	0.10	2.5 × 10 ⁻⁶
0.10	0.20	5.0 × 10 ⁻⁶
0.20	0.10	10.0 × 10 ⁻⁶

- A. Zero order
- B. First order
- C. Second order
- D. Third order

28. What is true of rate constants of elementary reactions?

- A. Always increase with temperature
- B. Only increase with temperature for endothermic reactions
- C. Never vary with temperature
- D. Only decrease with temperature for endothermic reactions

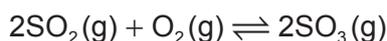
29. The following system is at equilibrium.



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

- A. $\sqrt{\frac{1}{4.3}}$
- B. 4.3
- C. $\frac{1}{4.3}$
- D. $\sqrt{4.3}$

30. What is the effect of doubling the pressure on the equilibrium? All other conditions remain unchanged.



	Effect on equilibrium position	Effect on equilibrium constant, K
A.	shifts right	no change
B.	shifts left	no change
C.	shifts right	increases
D.	shifts left	decreases

31. What is required to convert a base into its conjugate acid?

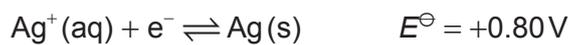
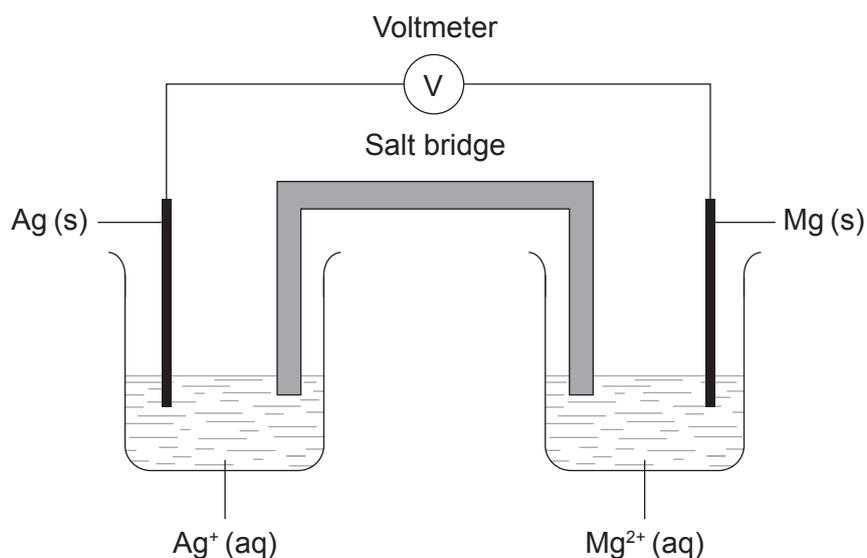
- A. A negative charge
- B. A hydrogen atom
- C. An electron pair
- D. A proton

32. Which solution has a pH of 9.0?
- A. $10^{-9} \text{ mol dm}^{-3} \text{ NH}_3(\text{aq})$
 - B. $10^{-9} \text{ mol dm}^{-3} \text{ NaOH}(\text{aq})$
 - C. $10^{-5} \text{ mol dm}^{-3} \text{ NH}_3(\text{aq})$
 - D. $10^{-5} \text{ mol dm}^{-3} \text{ NaOH}(\text{aq})$
33. What is the main reason why sulfuric acid has a lower pH than methanoic acid of the same concentration?
- A. Sulfuric acid is diprotic, whereas methanoic acid is monoprotic.
 - B. Sulfuric acid ionizes more than methanoic acid.
 - C. Sulfuric acid has a stronger conjugate base than methanoic acid.
 - D. Sulfuric acid is more soluble in water than methanoic acid.
34. Which salt is basic?
- A. HCOONa
 - B. HCOONH_4
 - C. NaNO_3
 - D. NH_4Cl
35. What is the best indicator to use in the titration of phenylamine with nitric acid?
- A. Bromophenol blue, $\text{p}K_{\text{a}} = 4.2$
 - B. Bromothymol blue, $\text{p}K_{\text{a}} = 7.0$
 - C. Phenol red, $\text{p}K_{\text{a}} = 7.9$
 - D. Phenolphthalein, $\text{p}K_{\text{a}} = 9.6$

36. In which compound does sulfur have an oxidation state of +4?

- A. H_2S
- B. SO_3
- C. H_2SO_3
- D. H_2SO_4

37. What is the standard cell potential, E_{cell}^\ominus , of the following cell?



- A. -3.17V
 - B. -1.57V
 - C. $+1.57\text{V}$
 - D. $+3.17\text{V}$
38. Which change represents oxidation of the functional group?
- A. $\text{CH}_3\text{COOH} \rightarrow \text{CH}_3\text{CHO}$
 - B. $\text{H}_2\text{CO} \rightarrow \text{HCOOH}$
 - C. $\text{HCCH} \rightarrow \text{H}_2\text{CCH}_2$
 - D. $\text{H}_2\text{CO} \rightarrow \text{CH}_3\text{OH}$

39. What are the products of the electrolysis of dilute aqueous copper(II) sulfate when using inert electrodes?

	Product at anode	Product at cathode
A.	oxygen gas	hydrogen gas
B.	oxygen gas	copper metal
C.	copper metal	oxygen gas
D.	hydrogen gas	copper metal

40. Which equation represents propagation in a radical substitution mechanism?

- A. $\text{CH}_4 + \text{Cl}\cdot \rightarrow \cdot\text{CH}_3 + \text{HCl}$
- B. $\cdot\text{CH}_3 + \text{Cl}\cdot \rightarrow \text{CH}_3\text{Cl}$
- C. $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$
- D. $\text{CH}_3\text{Cl} + \text{Cl}\cdot \rightarrow \text{CH}_2\text{Cl}_2 + \text{H}\cdot$