Diploma Programme
Programme du diplôme
Programa del Diploma

Chemistry
Higher level
Paper 1A

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]**.

8825 – 6219

15 pages

Section A

1. What is the name of this change of state?

$$CO_2(g) \rightarrow CO_2(s)$$

A. Condensation

B. Deposition

C. Sublimation

D. Freezing

2. What is the best evidence that energy levels are closer together as distance from the nucleus increases?

A. Hydrogen has a line emission spectrum in each of the UV, visible and IR regions.

B. First ionization energies decrease down a group.

C. Lines in an emission spectrum converge at higher energy.

D. First ionization energy generally increases across a period.

3. How many ions are present in 0.20 mol of $(NH_4)_2SO_4$?

A. $0.20 \times 1 \times 6 \times 10^{23}$

B. $0.20 \times 2 \times 6 \times 10^{23}$

C. $0.20 \times 3 \times 6 \times 10^{23}$

D. $0.20 \times 7 \times 6 \times 10^{23}$

4. What is the volume, in dm^3, of ethane gas, $C_2H_6(g)$, produced when $0.25\,dm^3$ of ethyne, $C_2H_2(g)$, reacts with $0.40\,dm^3$ of hydrogen gas, $H_2(g)$?

All volumes are measured under the same conditions.

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

A. 0.20

B. 0.25

C. 0.40

D. 0.45

5. A fixed volume of an ideal gas, initially at 30 °C and with a pressure of **P** Pa, was heated to 60 °C. What is the resulting pressure in Pa?

A. Half of **P**

B. A little less than **P**

C. A little more than **P**

D. Two times **P**

6. What are the electron domain and molecular geometries of thionyl chloride, $SOCl_2$?

	Electron domain geometry	**Molecular geometry**
A.	Tetrahedral	Tetrahedral
B.	Tetrahedral	Trigonal pyramidal
C.	Trigonal planar	Trigonal planar
D.	Trigonal planar	Bent

7. Which molecule is most polar?

A. CF_4

B. CO_2

C. NBr_3

D. NH_3

8. Which allotropes of carbon are electrical conductors?

I. Graphite

II. Diamond

III. Graphene

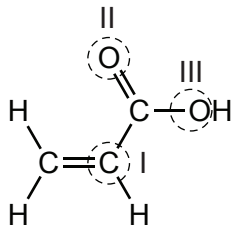
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

9. What is the hybridization of each circled atom I, II and III?



	I	II	III
A.	sp^3	sp	sp^2
B.	sp^3	sp	sp^3
C.	sp^2	sp^2	sp^2
D.	sp^2	sp^2	sp^3

10. Which type of material is a good conductor of heat and electricity in solid and liquid states, is insoluble in water, and typically has a high melting point?

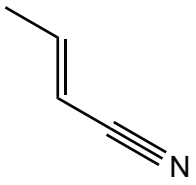
A. Covalent molecular

B. Covalent network

C. Ionic

D. Metallic

11. How many π (pi) and σ (sigma) bonds are there in but-2-enenitrile, $CH_3CHCHCN$?



	π, pi	σ, sigma
A.	5	2
B.	5	7
C.	3	4
D.	3	9

12. Which element is a p-block metal?

A. Sn

B. Te

C. Cd

D. At

13. Which two elements form a compound with the strongest ionic attraction?

A. Li and O

B. Li and Se

C. K and O

D. K and Se

14. Which oxide is the most basic?

A. MgO

B. Al_2O_3

C. SiO_2

D. SO_3

15. Which statements best explain why copper(II) ions, $Cu^{2+}(aq)$, are blue in aqueous solution?

I. Copper(II) ions absorb orange light.

II. Blue light is emitted as electrons move to lower orbitals.

III. Electrons are promoted between d-orbitals.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

16. Which compound has the highest boiling point?

A. $CH_3CH_2CH_2CH_3$

B. $CH_3CH_2CH_2CH_2CH_2CH_3$

C. $(CH_3)_3CCH_2CH_3$

D. $CH_3CH_2CH(CH_3)CH_2CH_3$

17. Which compounds could exist as stereoisomers?

I. CH_2CClBr

II. CHBrICl

III. CHBrCClBr

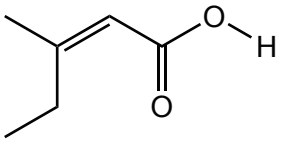
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

18. What is the IUPAC name of this compound?



A. 3-methylpent-2-enoic acid

B. 3-ethylbut-2-enoic acid

C. 2-ethylbut-2-en-4-oic acid

D. 2-methylpent-3-en-5-oic acid

19. What is the sum of the coefficients when 1 mol of propan-1-ol, C_3H_7OH, undergoes complete combustion?

$$\_\_\,C_3H_7OH\,(l) + \_\_\,O_2\,(g) \rightarrow \_\_\,CO_2\,(g) + \_\_\,H_2O\,(l)$$

A. 11.5

B. 12

C. 12.5

D. 13

20. Consider these equations:

$$S\,(s) + O_2\,(g) \rightarrow SO_2\,(g) \qquad \Delta H^{\ominus} = x\ \text{kJ mol}^{-1}$$

$$2SO_2\,(g) + O_2\,(g) \rightarrow 2SO_3\,(g) \qquad \Delta H^{\ominus} = y\ \text{kJ mol}^{-1}$$

What is the value of $\Delta H^{\ominus}$, in kJ mol^{-1}, for this reaction?

$$S\,(s) + \frac{3}{2}\,O_2\,(g) \rightarrow SO_3\,(g)$$

A. $x + y$

B. $x + \frac{1}{2}\,y$

C. $x - \frac{1}{2}\,y$

D. $x - y$

21. Which statement is a disadvantage of using biofuels instead of fossil fuels?

A. Land is used that could be used to grow food.

B. Combustion releases more energy per mol of fuel.

C. Emissions of CO_2 to the atmosphere are lower overall.

D. Crop waste can be used as a fuel.

22. Which products may form when propane undergoes incomplete combustion?

A. CO_2 and H_2 only

B. CO, C and H_2

C. CO_2, H_2O and H_2

D. CO_2, CO and C

23. A crystal of copper(II) sulfate is in equilibrium with a copper(II) sulfate solution in a stoppered flask at constant temperature.

Which observation is possible?

A. The colour of the solution becomes darker.

B. The volume of the liquid decreases.

C. The shape of the crystal changes slowly over time.

D. The size of the crystal decreases.

24. What is the theoretical yield, in g, of ethanamide, CH_3CONH_2, that can be produced from the reaction of 4.00 g of ammonium carbonate, $(NH_4)_2CO_3$, with excess ethanoic acid, CH_3COOH?

$$2CH_3COOH(l) + (NH_4)_2CO_3(s) \rightarrow 2CH_3COONH_4(aq) + H_2O(l) + CO_2(g)$$

$$CH_3COONH_4(aq) \rightarrow CH_3CONH_2(s) + H_2O(l)$$

$$M_r(NH_4)_2CO_3 = 96.11$$

$$M_r CH_3CONH_2 = 59.08$$

A. 1.23

B. 2.46

C. 4.92

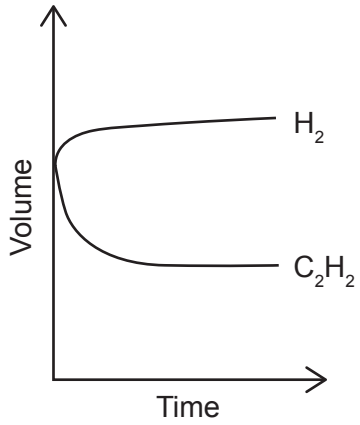
D. 6.51

25. The volume of ethyne as it reacts with hydrogen is shown in the graphs.

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

Which graph shows how the volume of hydrogen changes with time?

A.



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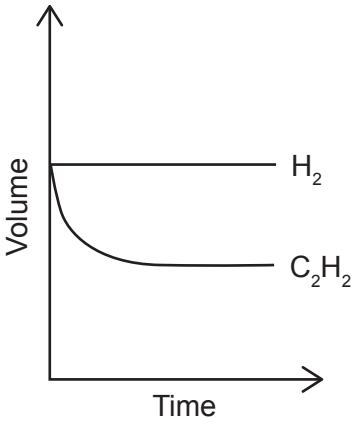

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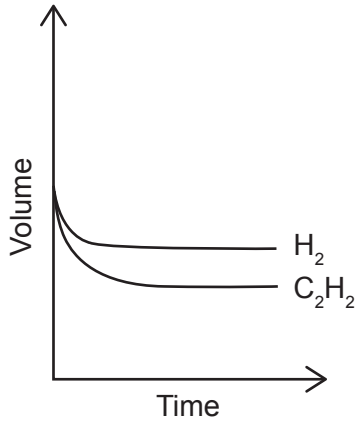
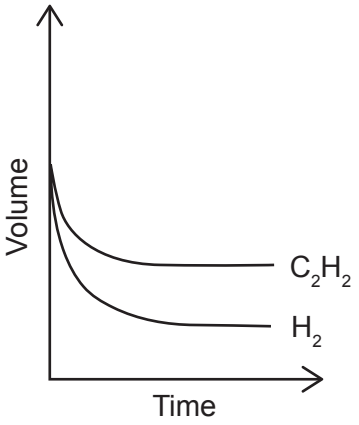


D.



26. The reaction between bromine and nitrogen(II) oxide follows a two-step mechanism.

$$Br_2(g) + NO(g) \rightleftharpoons NOBr_2(g) \qquad \text{fast}$$

$$NOBr_2(g) + NO(g) \rightarrow 2NOBr(g) \qquad \text{slow}$$

What is the rate equation?

A. Rate $= k[Br_2][NO]$

B. Rate $= k[Br_2][NO]^2$

C. Rate $= k[Br_2][NO]^2[NOBr_2]$

D. Rate $= k[NOBr]^2$

27. Which statement about catalysts is correct?

A. Catalysts increase the kinetic energy of reacting particles.

B. Catalysts affect endothermic reactions more than exothermic reactions.

C. Catalysts increase reaction rate and are used up in a reaction.

D. Catalysts alter the mechanism of a reaction.

28. What is the value of the Gibbs energy change, ΔG, in $kJ\,mol^{-1}$, for the reaction between hydrogen and iodine gases at 30 °C?

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad K = 40.2$$

$$\Delta G = -RT \ln K \qquad R = 8.31\,J\,K^{-1}\,mol^{-1}$$

A. –9300

B. –921

C. –9.30

D. –0.921

29. 2 mol of NO (g) and 1 mol of Cl_2 (g) were mixed together, and the system was allowed to reach equilibrium at 35 °C:

$$2NO(g) + Cl_2(g) \rightleftharpoons 2NOCl(g) \qquad K = 6.5 \times 10^4 \text{ at } 35\,°C$$

Which relationship is correct for this equilibrium at 35 °C?

A. [NOCl] = [NO]

B. [NOCl] = 2[Cl_2]

C. [NOCl] >> [NO]

D. [NOCl] << [NO]

30. Consider the equilibrium reaction:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

Under certain conditions, $K = 2.5$.

At the same temperature and pressure, a mixture has the following concentrations, in mol dm^{-3}

$$[CO] = 0.2 \qquad [H_2] = 0.4 \qquad [CH_3OH] = 0.32$$

Which statement is correct?

A. Mixture is at equilibrium and no reactions are occurring.

B. Forward and reverse reactions are occurring at the same rate.

C. Forward reaction rate is favoured to establish equilibrium.

D. Reverse reaction rate is favoured to establish equilibrium.

31. What is the concentration of OH^- (aq), in mol dm^{-3}, in a solution at 298.15 K with a pH of 4.50?

$$pH = -\log_{10}[H^+] \qquad [H^+] = 10^{-pH} \qquad pOH = -\log_{10}[OH^-] \qquad [OH^-] = 10^{-pOH} \qquad K_w = [H^+][OH^-]$$

A. 3.16×10^{-10}

B. 3.16×10^{-9}

C. 3.16×10^{-5}

D. 3.16×10^{-4}

32. Which aqueous solution has the lowest pH?

A. $1.0\,mol\,dm^{-3}\ HNO_3$

B. $2.0\,mol\,dm^{-3}\ HCl$

C. $1.0\,mol\,dm^{-3}\ CH_3COOH$

D. $2.0\,mol\,dm^{-3}\ NaOH$

33. What are the oxidizing and reducing agents in this reaction?

$$ClO^-(aq) + SO_2(g) + H_2O(l) \rightarrow Cl^-(aq) + SO_4^{2-}(aq) + 2H^+(aq)$$

	Oxidizing agent	Reducing agent
A.	ClO^-	H_2O
B.	SO_2	SO_4^{2-}
C.	SO_2	ClO^-
D.	ClO^-	SO_2

34. Which statement about electrochemical cells is correct?

A. Primary (voltaic) cells use electrical energy to produce a redox reaction.

B. Electrolytic cells are rechargeable.

C. Secondary cells can use electrical energy to produce a redox reaction.

D. Primary (voltaic) cells are rechargeable.

35. Consider two half-cells: $Al(s)/Al^{3+}(aq)$ and $Ni(s)/Ni^{2+}(aq)$.

What will be the cell potential, in V, when the two half-cells are connected?

$$Al^{3+}(aq) + 3e^- \rightleftharpoons Al(s) \qquad E^{\ominus} = -1.66\,V$$

$$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s) \qquad E^{\ominus} = -0.26\,V$$

A. -2.54

B. -1.40

C. $+1.40$

D. $+2.54$

36. Which statement about the standard hydrogen electrode, SHE, is correct?

A. The SHE must be the anode when measuring $E^{\ominus}$ values of another half-cell.

B. SHE has a standard reduction potential of 0 V at any temperature.

C. Cell potential is unaffected by the pressure of the hydrogen gas.

D. Any acid with a concentration of $1.0\,mol\,dm^{-3}$ would give the same cell potential.

37. What are the main products when concentrated $NaCl(aq)$ is electrolysed using inert electrodes?

	Anode	Cathode
A.	$Cl_2(g)$	$H_2(g)$
B.	$O_2(g)$	$H_2(g)$
C.	$H_2(g)$	$Cl_2(g)$
D.	$H_2(g)$	$O_2(g)$

38. Which product may be obtained by the reduction of CH_3CH_2COOH?

A. $CH_3CH(OH)CH_3$

B. $CH_3CH_2CH_2OH$

C. $CH_3CH_2OCH_3$

D. CH_3COOCH_3

39. What is the oxidation state of Pt in $[Pt(NH_3)_5Cl]Cl_3$?

A. +1

B. +2

C. +3

D. +4

40. What is the main product of the reaction between but-1-ene, $CH_2CHCH_2CH_3$, and hydrogen bromide, HBr?

A. $CH_3CHBrCH_2CH_3$

B. $CH_2BrCH_2CH_2CH_3$

C. $CH_2BrCHBrCH_2CH_3$

D. $CH_2BrCH(CH_3)_2$