Answers (1–25)

1. **B**
2. **C**
3. **B**
4. **C**
5. **B**
6. **B**
7. **C**
8. **C**
9. **C**
10. **C**
11. **B**
12. **C**
13. **A**
14. **A**
15. **A**
16. **A**
17. **B**
18. **C**
19. **B**
20. **C**
21. **B**
22. **B**
23. **A**
24. **B**
25. **D**
26. –B
27. -C,
28. -B,
29. -B,
30. –C

Answers (26-50)

26. B
27. C
28. B
29. B
30. C
31. C
32. A
33. C
34. A
35. B
36. B
37. B
38. B
39. B
40. C
41. B
42. C
43. A
44. A
45. A
46. A
47. B
48. A
49. C
50. C

COMPREHENSIVE MARKING SCHEME

SECTION A (Compulsory – Answer All)

[Total: 70 Marks]

1. Acid, Base, and Salt

(a)(i) Define a base according to the Bronsted-Lowry theory.

- **Answer:** A base is a proton (H^+ ion) acceptor.
- **Marking:**
  - Correct definition (**2 marks**).

(a)(ii) Give two examples of amphoteric substances.

- **Answer:**

1. Water (H_2O)
2. Aluminum hydroxide ($Al(OH)_3$) / Amino acids / HCO_3^-

- **Marking:**
  - Each correct example (**1.5 marks × 2 = 3 marks**).

(b)(i) Prepare dry NaCl crystals from NaCl + sand mixture.

- **Answer:**

1. Dissolve mixture in water (sand is insoluble).
2. Filter to remove sand.
3. Evaporate filtrate to dryness.

- **Marking:**
  - Each correct step (**1 mark × 3 = 3 marks**).

(b)(ii) Balanced equation for HCl + NaOH.

- **Answer:**

$$HCl+NaOH\rightarrow NaCl+H2OHCl+NaOH\rightarrow NaCl+H_2O$$

- **Marking:**
  - Correct reactants/products (**1 mark**), balancing (**1 mark**).

---

2. Chemical Bonding

(a)(i) Define covalent bond.

- **Answer:** A bond formed by sharing electron pairs between atoms.
- **Marking:**
  - Correct definition (**2 marks**).

(a)(ii) Diamond vs. Graphite hardness.

- **Answer:**
  - Diamond: **Tetrahedral covalent network** (rigid 3D structure).
  - Graphite: **Layered structure** with weak van der Waals forces between layers.
- **Marking:**
  - Diamond explanation (**1.5 marks**), Graphite explanation (**1.5 marks**).

(b)(i) Electron dot structure for NH_3.

- **Answer:**

text

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```
  H
  ..
N · · H
  ..
  H
```

(Lone pair on N, 3 single N-H bonds).

- **Marking:**
  - Correct structure (**3 marks**).

(b)(ii) Two properties of ionic compounds.

- **Answer:**

1. High melting/boiling points.
2. Conduct electricity when molten/dissolved.

- **Marking:**
  - Each property (**1 mark × 2 = 2 marks**).

---

3. States of Matter

(a)(i) Define sublimation with example.

- **Answer:**
  - Direct solid → gas phase change.
  - Example: Iodine / Dry ice (CO_2).
- **Marking:**
  - Definition (**1 mark**), Example (**1 mark**).

(a)(ii) Gases vs. liquids compressibility.

- **Answer:**
  - Gases have **large intermolecular spaces**; liquids have tightly packed particles.
- **Marking:**
  - Correct explanation (**3 marks**).

(b)(i) Define Brownian motion.

- **Answer:** Random movement of particles in a fluid due to collisions.
- **Marking:**
  - Correct definition (**2 marks**).

(b)(ii) Evaporation vs. boiling differences.

- **Answer:**

1. Evaporation: **Surface-only**, any temperature.
2. Boiling: **Throughout liquid**, fixed temperature.

- **Marking:**
  - Each difference (**1.5 marks × 2 = 3 marks**).

---

4. Atomic Structure

(a)(i) Define isotopes.

- **Answer:** Atoms of the same element with **same protons but different neutrons**.
- **Marking:**
  - Correct definition (**2 marks**).

(a)(ii) Uses of radioactive isotopes.

- **Answer:**

1. Carbon-14 dating.
2. Cancer treatment (e.g., Cobalt-60).

- **Marking:**
  - Each use (**1.5 marks × 2 = 3 marks**).

(b)(i) Electronic configuration & group (Z=12, A=24).

- **Answer:**
  - Configuration: **2,8,2**.
  - Group: **2 (alkaline earth metals)**.
- **Marking:**
  - Configuration (**2 marks**), Group (**1 mark**).

(b)(ii) Charge of ion.

- **Answer: 2+** (loses 2 electrons).
- **Marking:**
  - Correct charge (**2 marks**).

---

5. Practical Applications

(a)(i) Why conc. H_2SO_4 is not used to dry NH_3.

- **Answer:** NH_3 (base) reacts with H_2SO_4 (acid):

$$2NH3+H2SO4→(NH4)2SO42NH_3+H_2SO_4→(NH_4)_2SO_4$$

- **Marking:**
  - Correct explanation (**3 marks**).

(a)(ii) Gas dried by conc. H_2SO_4.

- **Answer: Hydrogen (H_2)** / Chlorine (Cl_2).
- **Marking:**
  - Correct example (**2 marks**).

(b)(i) Observations when Mg burns in air.

- **Answer:**

1. Bright white flame.
2. White ash (MgO) forms.

- **Marking:**
  - Each observation (**1.5 marks × 2 = 3 marks**).

(b)(ii) Balanced equation for Mg + O_2.

- **Answer:**

$$2Mg+O2\rightarrow 2MgO2Mg+O_2\rightarrow 2MgO$$

- **Marking:**
  - Correct equation (**2 marks**).

---

6. Acid-Base Titration Calculations

(a) Balanced equation for HCl + NaOH.

- **Answer:**

$$HCl+NaOH\rightarrow NaCl+H2OHCl+NaOH\rightarrow NaCl+H_2O$$

- **Marking:**
  - Correct equation (**2 marks**).

(b)(i) Moles of HCl (0.5 mol/dm^3, 25 cm^3).

- **Answer:**

  Moles=0.5×0.025=0.0125 molMoles=0.5×0.025=0.0125mol

- **Marking:**
  - Correct calculation (**2 marks**).

(b)(ii) Concentration of NaOH (20 cm^3 used).

- **Answer:**

  Concentration=0.01250.02=0.625 mol/dm3Concentration=0.020.0125 =0.625mol/dm3

- **Marking:**
  - Correct steps (**4 marks**).

(b)(iii) Concentration of NaCl solution.

- **Answer:**

  Total volume=45 cm3Total volume=45cm3Concentration=0.01250.045≈0.278 mol/dm3Concentration=0.0450.0125≈0.278mol/dm3

- **Marking:**
  - Correct calculation (**2 marks**).

(b)(iv) pH of resulting solution.

- **Answer: 7** (neutral salt solution).
- **Marking:**
  - Correct pH (**2 marks**).

(c) Suitable indicator.

- **Answer:** Phenolphthalein / Methyl orange.
- **Marking:**
  - Correct indicator (**2 marks**).

SECTION B (Optional – Answer Any 3)

[Total: 40 Marks]

SECTION B (Optional – Answer Any 3)

[Total: 40 Marks]

7. Acid, Base, and Salt

(a)(i) Why ethanoic acid is a weak acid.

- **Answer:**
  Ethanoic acid (CH_3COOH) **partially dissociates** in water, releasing few H^+ ions.

  $$CH3COOH⇌CH3COO−+H+CH3COOH⇌CH3COO−+H+$$

- **Marking:**
  - Partial dissociation (**2 marks**).
  - Equilibrium sign (⇌) (**1 mark**).
  - Example equation (**1 mark**).

(a)(ii) Two differences: Strong vs. Weak acids.

- **Answer:**

1. **Strong acids** fully dissociate (e.g., HCl), while **weak acids** partially dissociate (e.g., CH_3COOH).
2. **Strong acids** have higher electrical conductivity than weak acids at same concentration.

- **Marking:**
  - Each correct difference (**1.5 marks × 2 = 3 marks**).

(b)(i) Test for carbonate ion (CO_3^{2-}).

- **Answer:**

1. Add dilute acid (e.g., HCl) to the sample.
2. Observe **effervescence** (bubbles of CO_2 gas).
3. Pass gas through limewater → turns **milky** (confirms CO_2).

- **Marking:**
  - Procedure steps (**3 marks**).
  - Limewater test (**1 mark**).

(b)(ii) Equation for carbonate test.

- **Answer:**

$$CO32−+2H+→CO2↑+H2OCO32−+2H+→CO2↑+H2$$
$$OCO2+Ca(OH)2→CaCO3↓+H2OCO2+Ca(OH)2→CaCO3↓+H2O$$

- **Marking:**
  - First equation (**1 mark**).
  - Limewater equation (**1 mark**).

---

8. Chemical Bonding

(a)(i) Metallic bonding definition.

- **Answer:**
  A lattice of **positive metal ions** surrounded by a "sea" of **delocalized electrons**.
- **Marking:**

- Positive ions + delocalized electrons (**3 marks**).

(a)(ii) Why metals conduct electricity.

- **Answer:**
  Delocalized electrons are **mobile** and carry charge when a voltage is applied.
- **Marking:**
- Electron mobility (**2 marks**).
- Applied voltage context (**2 marks**).

(b)(i) Bonding in NaCl vs. HCl.

- **Answer:**
- **NaCl:** Ionic bond (Na^+ and Cl^- ions).
- **HCl:** Polar covalent bond (shared electrons closer to Cl).
- **Marking:**
- NaCl description (**2 marks**).
- HCl description (**2 marks**).

(b)(ii) Which conducts electricity in solution?

- **Answer:**
  NaCl conducts because it **ionizes fully** into Na^+ and Cl^- ions in water. HCl (gaseous) forms ions only when dissolved.
- **Marking:**
- NaCl explanation (**1 mark**).
- HCl clarification (**1 mark**).

---

9. States of Matter

(a)(i) Diffusion & Graham's law.

- **Answer:**
  - **Diffusion:** Movement of particles from high → low concentration.
  - **Graham's Law:** Rate of diffusion ∝ 1Molar MassMolar Mass1.
- **Marking:**
  - Diffusion definition (**2 marks**).
  - Graham's law formula (**2 marks**).

(a)(ii) Order of diffusion rates (slowest → fastest).

- **Answer:**

  $CO2<O2<N2<H2$$CO_2<O_2<N_2<H_2$

  (Molar masses: CO_2=44, O_2=32, N_2=28, H_2=2).

- **Marking:**
  - Correct order (**3 marks**).

(b)(i) Critical temperature definition.

- **Answer:**
  The highest temperature at which a gas can be liquefied by pressure alone.
- **Marking:**
  - Correct definition (**3 marks**).

(b)(ii) Real gases deviate at high pressure.

- **Answer:**

1. Intermolecular forces become significant.
2. Gas particles occupy volume (non-negligible).

- **Marking:**

- Forces explanation (**1.5 marks**).
- Volume explanation (**1.5 marks**).

---

10. Atomic Structure

(a)(i) Three principles of hybridization.

- **Answer:**

1. Mixing of atomic orbitals.
2. Hybrid orbitals have **equal energy**.
3. Number of hybrid orbitals = number of mixed orbitals.

- **Marking:**
  - Each principle (**1.33 marks × 3 ≈ 4 marks**).

(a)(ii) Maximum electrons in 3rd energy level.

- **Answer:**

$$2n2=2(3)2=18 \text{ electrons}2n2=2(3)2=18\text{electrons}$$

- **Marking:**
  - Correct calculation (**3 marks**).

(b)(i) Orbit vs. Orbital.

- **Answer:**
  - **Orbit:** Fixed circular path (Bohr model).
  - **Orbital:** Probability region for electrons (quantum model).
- **Marking:**
  - Orbit definition (**1.5 marks**).
  - Orbital definition (**1.5 marks**).

(b)(ii) Electron configuration of iron (Fe, Z=26).

- **Answer:**

  $1s22s22p63s23p64s23d61s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$

  or $[Ar]4s23d6[Ar]4s^2 3d^6$.

- **Marking:**
  - Correct configuration (**3 marks**).

Key Notes for Marking Section B:

1. **Partial credit** is awarded for:
   - Correct concepts with minor errors (e.g., incomplete equations).
   - Logical steps in calculations.
2. **Deduct 0.5–1 mark** for:
   - Missing units (e.g., mol/dm^3).
   - Incorrect subscripts/superscripts (e.g., writing CO3 instead of CO_3^{2-}).

SUMMARY

- **Section A:** 70 marks allocated across **definitions, explanations, equations, and calculations**.
- **Partial credit** awarded for logical steps (e.g., in calculations).
- **Section B:** Focus on **conceptual depth** and **application**.