TALLENTEX Chemistry

Sample Paper – 10

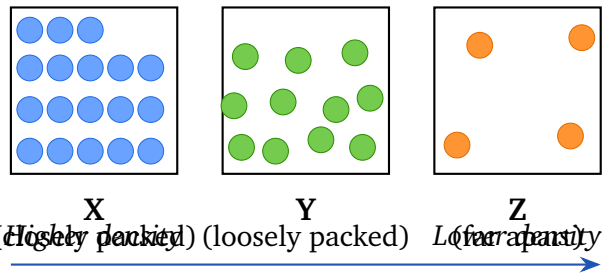
Duration: 23 Minutes **Maximum Marks: 60**

Instructions

- This paper contains **15** Multiple Choice Questions (Single Correct Answer), modelled on the Chemistry portion of **TALLENTEX** entrance.
- Each correct answer carries **+4 marks**. There is **a penalty of** -1 **mark** for incorrect answers. Unattempted questions carry no penalty.
- Only **one** option is correct. Choose carefully.
- Syllabus: **NCERT Class 8 and Class 9 Chemistry**
- Use of mobile phones, calculators, or electronic gadgets is strictly prohibited.

Questions

Q1. The diagram below shows the arrangement of particles in three states of matter (labelled X, Y, and Z). Which option **correctly identifies** X, Y, and Z and states the **correct order of density**?



(A) X = Gas, Y = Liquid, Z = Solid; Density order: X > Y > Z

(B) X = Liquid, Y = Solid, Z = Gas; Density order: Y > X > Z

(C) X = Solid, Y = Gas, Z = Liquid; Density order: X > Z > Y

(D) X = Solid, Y = Liquid, Z = Gas; Density order: X $>$ Y $>$ Z

Q2. An ice skater glides effortlessly on ice because the pressure of the skate blade causes the ice directly beneath it to **melt temporarily**, forming a thin film of water that acts as a lubricant. When the pressure is removed, the water re-freezes. This phenomenon is called:

(A) Sublimation

(B) Evaporation

(C) Regelation

(D) Condensation

Q3. Brass is an alloy of copper (Cu) and zinc (Zn). Which of the following statements about brass is **correct**?

(A) Brass is a compound because it has a definite composition and can only be separated by chemical methods

(B) Brass is a mixture because its composition can vary and it retains some properties of its constituent metals

(C) Brass is a pure substance with a fixed melting point exactly equal to that of copper

(D) Brass is an element because it appears uniform throughout

Q4. Which of the following is an example of a **chemical change**?

(A) Burning of magnesium ribbon in air to form magnesium oxide

(B) Melting of ice to form liquid water

(C) Dissolving sugar in water

(D) Cutting a piece of paper into smaller pieces

Q5. Using the criss-cross method, what is the **correct chemical formula** of aluminium nitrate, given that aluminium has a valency of 3 and the nitrate ion (NO_3^-) has a charge of -1?

(A) $AlNO_3$

(B) $Al_2(NO_3)_3$

(C) Al_3NO_3

(D) $Al(NO_3)_3$

Q6. What is the **formula unit mass** of sodium carbonate (Na_2CO_3)? (Atomic masses: Na = 23, C = 12, O = 16)

(A) 82 u

(B) 98 u

(C) 106 u

(D) 124 u

Q7. Which of the following is a **polyatomic anion** (a negatively charged ion made of more than one atom)?

(A) Na^+ (sodium ion)

(B) CO_3^{2-} (carbonate ion)

(C) Mg^{2+} (magnesium ion)

(D) Fe^{3+} (ferric ion)

Q8. Which pair of species is **isoelectronic** (having the same number of electrons)?

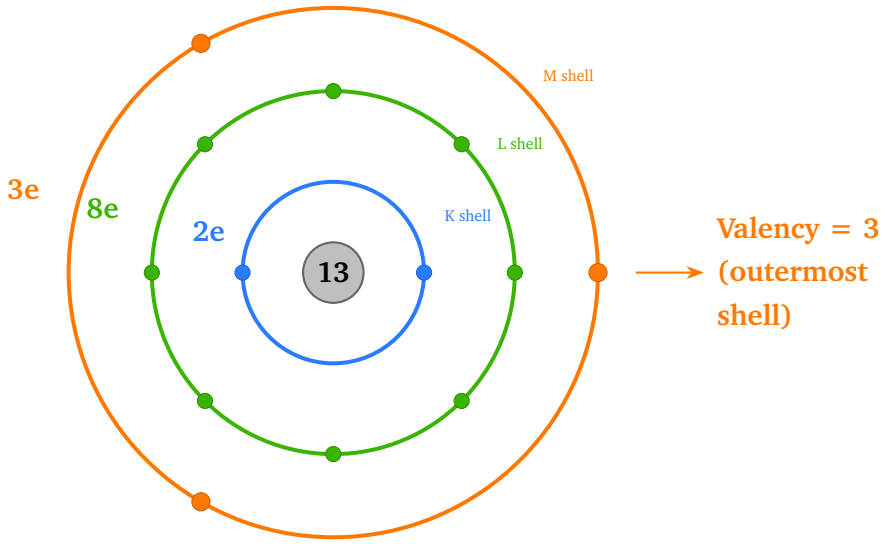
(A) Na^+ and Ne (both have 10 electrons)

(B) Na and Mg (both have 11 electrons)

(C) O^{2-} and S^{2-} (both have 8 electrons)

(D) Ca^{2+} and K^+ (both have 20 electrons)

Q9. The electron shell diagram of aluminium (Al, $Z = 13$) is shown below. What is the **correct electronic configuration** of aluminium, and what is its **valency**?



(A) Configuration: 2, 8; Valency = 8

(B) Configuration: 2, 3, 8; Valency = 3

(C) Configuration: 2, 8, 3; Valency = 8

(D) Configuration: 2, 8, 3; Valency = 3

Q10. Which of the following is a **limitation of Bohr's atomic model**?

(A) It correctly explained the spectrum of the hydrogen atom

(B) It introduced the concept of energy levels (orbits) for electrons

(C) It could not explain the spectra of atoms with more than one electron (multi-electron atoms)

(D) It correctly predicted the number of electrons in each shell

Q11. When calcium oxide (CaO) is added to water, the product formed is **calcium hydroxide** [$Ca(OH)_2$], which turns red litmus **blue**. This reaction illustrates that:

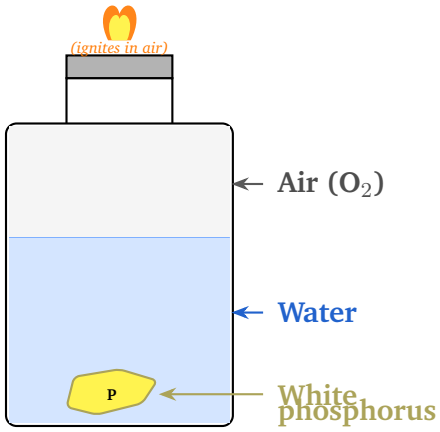
(A) Metal oxides are acidic in nature

(B) Metal oxides are basic in nature and react with water to form alkalis

(C) Metal oxides are neutral and do not change the colour of litmus

(D) Metal oxides react with water to form metal carbonates

Q12. The diagram below shows a bottle with white phosphorus stored **submerged in water**. Why is white phosphorus stored in this way?



(A) White phosphorus ignites spontaneously on contact with air (oxygen) and is stored under water to prevent it from catching fire

(B) White phosphorus reacts violently with water to produce toxic gas

(C) White phosphorus dissolves completely in water and must be kept submerged

(D) White phosphorus is a liquid at room temperature and water prevents it from evaporating

Q13. Which of the following correctly lists three common fuels in **decreasing order** of their approximate calorific values (kJ/kg)?

(A) Wood ($\approx 17\,000$) $>$ Coal ($\approx 25\,000$) $>$ LPG ($\approx 55\,000$)

(B) Coal ($\approx 25\,000$) $>$ LPG ($\approx 55\,000$) $>$ Wood ($\approx 17\,000$)

(C) LPG ($\approx 55\,000$) $>$ Wood ($\approx 17\,000$) $>$ Coal ($\approx 25\,000$)

(D) LPG ($\approx 55\,000$) $>$ Coal ($\approx 25\,000$) $>$ Wood ($\approx 17\,000$)

Q14. A student tests two solutions — one of hydrochloric acid (HCl) and one of acetic acid (CH_3COOH) — using an electric bulb conductivity tester. The bulb glows **brightly** with HCl but only **dimly** with acetic acid of the same concentration. The reason is:

(A) HCl is not an electrolyte; acetic acid is a good electrolyte

(B) HCl has a lower molar mass than acetic acid, so it conducts better

(C) HCl is a strong electrolyte that ionises almost completely in water; acetic acid is a weak electrolyte that ionises only partially

(D) Acetic acid is denser than HCl, so ions move more slowly through it

Q15. Bakelite is used in making **electric switches** and **handles of cooking utensils**. Which of the following correctly describes the property of Bakelite that makes it suitable for these uses?

(A) Bakelite is a thermoplastic that softens on heating and can be re-moulded easily

(B) Bakelite is a thermosetting plastic: once moulded, it cannot be softened by heating, and it is a poor conductor of heat and electricity

(C) Bakelite is a natural fibre extracted from cellulose

(D) Bakelite melts at low temperatures (below 100°C) and is used only in cold environments

Detailed Solutions

1.

Solution

Concept: The three states of matter differ in how closely their particles are packed.

In box **X**, the particles (blue circles) are arranged in a tight, orderly grid — this represents a **solid**. Solids have the highest density because particles are packed closest together.

In box **Y**, the particles (green circles) are close but randomly arranged and can flow — this represents a **liquid**. Liquids have intermediate density.

In box **Z**, only 4 particles (orange circles) are scattered across a large space — this represents a **gas**. Gases have the lowest density because particles are far apart.

Density order: Solid $>$ **Liquid** $>$ **Gas**, i.e., X $>$ Y $>$ Z.

Options A, B, and C all misidentify one or more states or give an incorrect density order. Only option **D** is correct.

Answer: (D) Go Back to Q 1

2.

Solution

Concept: Ice has an unusual property — increased pressure *lowers* its melting point (because water is denser than ice, so pressure favours the liquid phase).

When a skate blade exerts enormous pressure on ice, the melting point of ice just beneath the blade drops below 0°C, causing it to melt and form a thin lubricating film of water. When the skate moves on and pressure is removed, the water immediately re-freezes. This pressure-induced melting and refreezing cycle is called **regelation**.

- **Sublimation:** Solid converts directly to gas (e.g., dry ice, camphor). Not applicable here.
- **Evaporation:** Surface molecules escape into gas phase; does not involve pressure.
- **Condensation:** Gas converts to liquid. Opposite of what happens here.
- **Regelation (C):** Correct — pressure melting followed by refreezing.

Answer: (C) Go Back to Q 2

3.

Solution

Concept: A **mixture** has variable composition, retains properties of its components, and can be separated by physical methods. A **compound** has fixed composition and is formed by chemical combination.

Brass is an alloy of copper (Cu) and zinc (Zn). Key facts:

- Its composition can vary (e.g., 70% Cu + 30% Zn for cartridge brass, or 60% Cu + 40% Zn for Muntz metal).
- It retains metallic properties of both Cu and Zn (luster, conductivity).
- It does not have a sharp, fixed melting point; it melts over a range.
- Components can be separated by physical/metallurgical methods.

Therefore, brass is a **homogeneous mixture** (specifically an alloy), not a compound or element. Option **B** is correct.

Answer: (B) Go Back to Q 3

4.

Solution

Concept: A **chemical change** involves formation of new substances with different chemical properties; the change is generally irreversible.

Analysis of each option:

- **(A) Burning of magnesium:** Mg reacts with O_2 to form MgO (a new substance). This is a **chemical change**. $2Mg + O_2 \rightarrow 2MgO$
- **(B) Melting of ice:** Only the state changes (solid $\rightarrow$ liquid); H_2O remains H_2O. Physical change.
- **(C) Dissolving sugar:** Sugar molecules disperse in water but are unchanged chemically. Physical change (reversible by evaporation).
- **(D) Cutting paper:** Only shape and size change; no new substance is formed. Physical change.

Only option **A** involves a chemical change with formation of a new substance (magnesium oxide).

Answer: (A) Go Back to Q 4

5.

Solution

Concept: In the criss-cross method, the valency (charge) of each ion is exchanged to become the subscript of the other ion.

Ion	Symbol	Charge/Valency
Aluminium	Al	$+3$
Nitrate	NO_3	-1

Applying the criss-cross rule:

- The charge of Al $(+3)$ becomes the subscript of $NO_3 \Rightarrow (NO_3)_3$
- The charge of NO_3 (1) becomes the subscript of Al $\Rightarrow Al_1 = Al$

Formula: **$Al(NO_3)_3$**

Verification: Total charge $= (+3) + 3 \times (-1) = +3 - 3 = 0$ ✓

Note: $Al_2(NO_3)_3$ (option B) would result if Al had valency 3 and NO_3 had valency 2, which is incorrect. The subscripts must be reduced to simplest whole numbers; Al_1 simplifies to Al.

Answer: (D) Go Back to Q 5

6.

Solution

Concept: Formula unit mass = sum of atomic masses of all atoms in the formula unit.

Formula: Na_2CO_3 contains 2 sodium atoms, 1 carbon atom, 3 oxygen atoms.

Calculation:

$$\text{Formula unit mass} = 2 \times \underbrace{23}_{\text{Na}} + 1 \times \underbrace{12}_{\text{C}} + 3 \times \underbrace{16}_{\text{O}}$$

$$= 46 + 12 + 48 = \mathbf{106}\ \text{u}$$

Checking distractors:

- 82 u: incorrect (would result from Na + C + 3O = 23 + 12 + 48 — only one Na counted)
- 98 u: incorrect (common error — this is the formula mass of H_2SO_4)

- 124 u: incorrect (overcounting)

Answer: (C) Go Back to Q 6

7.

Solution

Concept: A **polyatomic ion** is an ion consisting of *two or more atoms* bonded together that carries an overall electric charge.

- **Na^+:** A single sodium atom that has lost one electron. Monoatomic *cation*. Not polyatomic.
- **CO_3^{2-} (carbonate):** Consists of 1 carbon + 3 oxygen atoms = 4 atoms total, carrying a $2-$ charge. This is a **polyatomic anion**. ✓
- **Mg^{2+}:** A single magnesium atom. Monoatomic cation.
- **Fe^{3+}:** A single iron atom. Monoatomic cation.

Option **B** (CO_3^{2-}) is the only polyatomic *anion* (negatively charged) among the choices.

Answer: (B) Go Back to Q 7

8.

Solution

Concept: Isoelectronic species have the *same number of electrons*, regardless of their charge or atomic number.

- **Na^+ and Ne (A):** Na has atomic number 11; Na^+ has lost 1 electron $\Rightarrow$ 10 electrons. Ne has atomic number 10 $\Rightarrow$ 10 electrons. **Both have 10 electrons.** ✓
- **Na and Mg (B):** Na has 11 electrons; Mg has 12 electrons. Not isoelectronic.
- **O^{2-} and S^{2-} (C):** O has $8 + 2 = 10$ electrons; S has $16 + 2 = 18$ electrons. Not isoelectronic (different number of electrons).
- **Ca^{2+} and K^+ (D):** Ca has atomic number 20; Ca^{2+} has $20 - 2 = 18$ electrons. K has atomic number 19; K^+ has $19 - 1 = 18$ electrons. Both actually have 18

electrons, but the option incorrectly claims "both have 20 electrons" — this statement is **wrong**. So option D is incorrect as stated.

The only option with a **correct** isoelectronic pair *and* a correct electron count is **A**.

Answer: (A) Go Back to Q 8

9.

Solution

Concept: Electronic configuration is the distribution of electrons in shells, following the maximum capacity rule: K $\leq$ 2, L $\leq$ 8, M $\leq$ 18.

Aluminium (Al), Z = 13:

$$\text{Total electrons} = 13$$

- K shell: fills first, maximum 2 $\Rightarrow$ **2 electrons**. Remaining: $13 - 2 = 11$.
- L shell: fills next, maximum 8 $\Rightarrow$ **8 electrons**. Remaining: $11 - 8 = 3$.
- M shell: **3 electrons** (outermost/valence shell).

Electronic configuration of Al = 2, 8, 3

Valency = number of electrons in the outermost shell (if ≤ 4) = **3**

(Al tends to lose its 3 outermost electrons to achieve a stable noble gas configuration, forming Al^{3+}.)

Checking wrong options:

- A: 2, 8 accounts for only 10 electrons — missing M shell.
- B: Order 2, 3, 8 is wrong (L shell cannot have 3 before M has 8).
- C: Configuration 2, 8, 3 is correct but valency stated as 8 is wrong.

Answer: (D) Go Back to Q 9

10.

Solution

Concept: Bohr's model (1913) was a major advance but had important limitations.

Successes of Bohr's model:

- It explained the line spectrum of *hydrogen* (single electron) accurately.
- It introduced the concept of quantised energy levels (orbits) for electrons.
- It predicted the correct number of electrons per shell (2, 8, 18...) at the NCERT level.

Limitations of Bohr's model:

- It **failed to explain** the spectra of *multi-electron atoms* (He, Li, etc.) — electron-electron repulsions were not accounted for.
- It could not explain the fine structure (splitting) of spectral lines.
- It violated the Heisenberg Uncertainty Principle (assumed precise orbits).

Option **C** correctly identifies a key limitation. Options A, B, and D all describe *successes* of Bohr's model, not limitations.

Answer: (C) Go Back to Q 10

11.

Solution

Concept: Metal oxides react with water to form metal hydroxides, which are **basic** (alkaline) in nature.

Reaction:

$$CaO + H_2O \rightarrow Ca(OH)_2 \quad \text{(calcium hydroxide / slaked lime)}$$

$Ca(OH)_2$ is a **base** (alkali when dissolved in water). It turns red litmus **blue**, confirming its basic nature.

General principle:

$$\text{Metal oxide} + \text{Water} \rightarrow \text{Metal hydroxide (base / alkali)}$$

This is a fundamental property distinguishing metal oxides (basic oxides) from

non-metal oxides (acidic oxides, e.g., SO_2, CO_2).

- Option A is wrong: metal oxides are *basic*, not acidic.
- Option C is wrong: they are not neutral.
- Option D is wrong: carbonates are not formed by reacting oxides with water.

Answer: (B) Go Back to Q 11

12.

Solution

Concept: White phosphorus (P_4) is an extremely reactive non-metal. It has a **very low ignition temperature** ($\approx 34^\circ$C) and **ignites spontaneously in air** — a property called *pyrophoricity*.

Because white phosphorus catches fire on contact with oxygen in air even at room temperature, it **must be stored under water** to prevent it from being exposed to air. Water acts as a physical barrier between the phosphorus and atmospheric oxygen.

- Option **A** is correct: storage under water prevents contact with O_2 and thus prevents spontaneous ignition.
- Option **B** is wrong: white phosphorus does *not* react violently with water; it is insoluble in water and water does not react with it.
- Option **C** is wrong: white phosphorus is *insoluble* in water.
- Option **D** is wrong: white phosphorus is a waxy solid at room temperature ($\approx 25^\circ$C), not a liquid (it melts at 44.2°C).

Answer: (A) Go Back to Q 12

13.

Solution

Concept: Calorific value is the amount of heat energy produced on complete combustion of 1 kg of a fuel (unit: kJ/kg). Higher calorific value = better fuel.

Approximate calorific values (NCERT Class 8):

Fuel	Calorific Value (kJ/kg)
Wood	$\approx 17\,000$
Coal	$\approx 25\,000$
LPG (Liquefied Petroleum Gas)	$\approx 55\,000$

Correct decreasing order:

$$\text{LPG}(55\,000) > \text{Coal}(25\,000) > \text{Wood}(17\,000)$$

This matches option **D**. Options A, B, and C all give incorrect orderings. Note: Option A lists fuels in *increasing* order. Option C places Wood above Coal, which is incorrect.

LPG is preferred as a household fuel precisely because of its high calorific value and clean combustion.

Answer: (D) Go Back to Q 13

14.

Solution

Concept: The brightness of a bulb in a conductivity tester depends on the **concentration of ions** in the solution. More ions $\Rightarrow$ greater conductivity $\Rightarrow$ brighter bulb.

HCl (hydrochloric acid) — Strong acid / Strong electrolyte:

$$\text{HCl} \xrightarrow{\text{H}_2\text{O}} \text{H}^+ + \text{Cl}^- \quad \text{(almost 100\% ionisation)}$$

High ion concentration $\Rightarrow$ bulb glows **brightly**.

CH_3COOH (acetic acid) — Weak acid / Weak electrolyte:

$$\text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}^+ \quad \text{(only } \sim 1\text{–}2\% \text{ ionisation)}$$

Low ion concentration $\Rightarrow$ bulb glows **dimly**.

- A is wrong: HCl *is* a strong electrolyte.
- B is wrong: molar mass does not determine conductivity.
- D is wrong: acetic acid (density ≈ 1.05 g/mL) is only slightly denser than HCl solution; ion mobility difference is negligible and is not the reason.

Option **C** correctly explains the observation.

Answer: (C) Go Back to Q 14

15.

Solution

Concept: Plastics are classified as **thermoplastics** (soften on heating, can be re-moulded) or **thermosetting plastics** (set permanently on heating, cannot be re-moulded).

Bakelite is a **thermosetting plastic** (phenol-formaldehyde resin):

- Once moulded and hardened (cross-linked polymer network), it **cannot be softened** by reheating.
- It is a **poor conductor of heat and electricity** (thermal and electrical insulator).
- These properties make it ideal for **electric switches** (prevents electric shock) and **handles of cooking utensils** (prevents heat transfer to hands).

Checking wrong options:

- A: Bakelite is *not* a thermoplastic (thermoplastics soften on heating — e.g., PVC, polythene).
- C: Bakelite is a *synthetic* polymer, not a natural fibre. Natural fibres come from plants or animals (cotton, wool, silk).
- D: Bakelite does not melt at low temperatures; it is heat-resistant, which is why it is used in hot environments.

Answer: (B) Go Back to Q 15

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	D	2	C	3	B	4	A	5	D
6	C	7	B	8	A	9	D	10	C
11	B	12	A	13	D	14	C	15	B