

# CA01 — Basic Concepts of Matter

→ Chemistry – CA01 · AFCAT General Awareness

AFCAT Level

This foundational chapter covers everything about matter — what it is, how it exists, and how we classify it. AFCAT tests the difference between physical and chemical changes, the three states of matter, and the distinction between elements, compounds and mixtures. These are scoring questions requiring pure recall.

✦ **AFCAT Focus:** Physical vs chemical change (burning = chemical; melting = physical); states of matter and their properties; element vs compound vs mixture. One direct question typically comes from this chapter. Memorise 3–4 examples of each type of change.

## PART 1 — STATES OF MATTER

### 1. Three States of Matter

All matter exists in one of three states depending on temperature and pressure. The differences arise from how tightly particles are packed and how freely they move.

FIG. 1 — THREE STATES OF MATTER: PARTICLE ARRANGEMENT, PROPERTIES AND EXAMPLES

## THREE STATES OF MATTER — Particles, Properties & Examples

### SOLID

Definite shape & volume



Tightly packed;  
vibrate in fixed positions

#### Properties:

Fixed shape & volume.

Incompressible.

Ice, iron, wood, rock  
salt, sugar, diamond

### LIQUID

Definite volume; no fixed shape



Loosely packed;  
flow freely between each other

#### Properties:

Fixed volume; no fixed shape.

Takes shape of container.

Water, mercury, petrol,  
alcohol, oil, milk

### GAS

No fixed shape or volume



Far apart; move rapidly  
in random directions

#### Properties:

No fixed shape/volume.

Highly compressible.

Air, oxygen, nitrogen,  
CO<sub>2</sub>, steam, LPG

## PART 2 — PHYSICAL vs CHEMICAL CHANGES

## 2. Physical vs Chemical Changes

This is one of the most directly tested topics in AFCAT Chemistry. The key test: does a new substance form? If yes — chemical change. If no — physical change.

FIG. 2 — PHYSICAL VS CHEMICAL CHANGE: KEY DIFFERENCES AND AFCAT EXAMPLES

### PHYSICAL vs CHEMICAL CHANGE — The Most Direct AFCAT Question

#### PHYSICAL CHANGE

No new substance formed

##### Characteristics:

- Chemical composition unchanged
- Usually reversible
- Only size, shape or state changes
- No energy released as light/sound

##### Examples (memorise 5):

- Melting of ice → water
- Boiling water → steam
- Cutting paper / wood
- Dissolving sugar / salt in water
- Magnetising iron; stretching rubber
- **Breaking glass; bending wire**

#### CHEMICAL CHANGE

New substance(s) formed

##### Characteristics:

- New substances with new properties
- Usually irreversible
- Energy change (heat / light / gas)
- Change in colour, smell or precipitate

##### Examples (memorise 5):

- Burning wood / candle / coal
- Rusting of iron
- Digestion of food
- Fermentation (glucose → alcohol + CO<sub>2</sub>)
- Cooking an egg; baking bread
- **Photosynthesis; respiration**

## PART 3 — ELEMENTS, COMPOUNDS & MIXTURES

### 3. Classification of Matter

FIG. 3 – ELEMENTS, COMPOUNDS AND MIXTURES: DEFINITIONS AND KEY DIFFERENCES

| MATTER CLASSIFICATION – Element, Compound and Mixture                  |  |  |   |
|--|--|--|---|
| Type   | Definition   | Properties   | Examples  |
| <b>ELEMENT</b><br>Pure substance<br>cannot be split further            | One type of atom only.<br>Simplest form of matter.<br>118 known elements.            | Cannot be broken down<br>by chemical methods.<br>Fixed, unique properties.   | H, O, Fe, Au, C<br>Al, Cu, Na, N<br>Cl, S, Hg, Ag   |
| <b>COMPOUND</b><br>Two+ elements chemically<br>combined in fixed ratio | Fixed composition by mass.<br>Properties different from<br>the constituent elements. | Separated only by<br>chemical methods<br>(not physical separation).          | H <sub>2</sub> O, CO <sub>2</sub> , NaCl<br>H <sub>2</sub> SO <sub>4</sub> , NH <sub>3</sub><br>CaCO <sub>3</sub> , glucose |
| <b>MIXTURE</b><br>Two+ substances<br>physically combined               | Variable composition.<br>Homogeneous (uniform) or<br>heterogeneous (non-uniform).    | Separated by physical<br>methods (filtration,<br>distillation, evaporation). | Air, seawater<br>brass (alloy)<br>soil, milk, blood   |

**Key Distinction – Compound vs Mixture:** In a *compound*, elements are chemically bonded in a fixed ratio – the properties are completely different from the elements (e.g., H<sub>2</sub>O is liquid, not a gas like H<sub>2</sub> or O<sub>2</sub>). In a *mixture*, substances retain their individual properties and can be separated by physical methods. Air is a mixture (not a compound) because its composition varies and can be separated by distillation.

#### AFCAT PYQs – Basic Concepts of Matter

Q1. Which of the following is a chemical change? AFCAT PYQ

- (a) Melting of ice    (b) Evaporation of water    (c) Burning of coal  
(d) Dissolving sugar in water

✓ Answer: (c) Burning of coal

Burning coal reacts with oxygen to form CO<sub>2</sub> and ash – new substances with completely different properties. This is an irreversible chemical change. Melting, evaporation, and dissolving are physical changes – the substance (H<sub>2</sub>O or sugar) remains chemically the

same and can be recovered by cooling or evaporation. This exact question type repeats across AFCAT papers.

**Q2. Air is classified as a:** AFCAT PYQ

- (a) Element (b) Compound (c) Mixture (d) Pure substance

✓ Answer: (c) Mixture

Air is a **homogeneous mixture** of gases (mainly  $N_2$  ~78%,  $O_2$  ~21%, Ar ~0.9%,  $CO_2$  ~0.04%). Its composition varies by location and altitude. The gases can be separated by fractional distillation of liquid air. Since no chemical bonding occurs between the components, it is a mixture, not a compound.

**Q3. Which state of matter has no definite shape but a definite volume?**

AFCAT PYQ

- (a) Solid (b) Liquid (c) Gas (d) Plasma

✓ Answer: (b) Liquid

A **liquid** has a fixed volume (unlike gas) but takes the shape of its container (unlike solid). Solids have both fixed shape and fixed volume. Gases have neither. This is the most basic states-of-matter question and is tested directly in AFCAT. Plasma is the fourth state, at very high temperatures.

**Q4. Rusting of iron is an example of:** AFCAT PYQ

- (a) Physical change only (b) Reversible physical change  
(c) Chemical change (slow oxidation) (d) Neither physical nor chemical

✓ Answer: (c) Chemical change

Rusting:  $4Fe + 3O_2 + 6H_2O \rightarrow 4Fe(OH)_3$  (iron oxide — a completely new substance). It is irreversible under normal conditions and requires both oxygen AND moisture. This makes it a **slow chemical change** (slow oxidation/corrosion). A common trap: some students think rusting is physical because it's slow — speed does not determine the type of change.

## 🌀 States of Matter

- ♦ Solid: fixed shape & volume
- ♦ Liquid: fixed volume, no fixed shape
- ♦ Gas: no fixed shape or volume
- ♦ Particle motion: solid < liquid < gas
- ♦ Compressibility: solid < liquid < gas

## 🌀 Physical vs Chemical

- ♦ Physical: no new substance; reversible
- ♦ Chemical: new substance; usually irreversible
- ♦ Burning, rusting = chemical
- ♦ Melting, dissolving = physical
- ♦ Cooking egg = chemical (irreversible)

## 📌 Classification

- ♦ Element: one type of atom (H, Fe, O)
- ♦ Compound: chemically combined, fixed ratio
- ♦ Mixture: physically combined, variable
- ♦ Air = mixture; Water = compound
- ♦ Separated: mixture by physical, compound by chemical

## Practice Exercise

**E1. Which of the following is a physical change?**

- (a) Burning of wood    (b) Rusting of iron    (c) Melting of wax    (d) Digestion of food

**E2. Water is a compound because:**

- (a) It exists in three states    (b) H and O are combined in a fixed ratio by mass  
(c) It can be separated by filtration    (d) It is transparent

**E3. Which of the following is NOT a characteristic of a chemical change?**

- (a) Formation of precipitate    (b) Gas evolution    (c) Change in colour  
(d) Change in size or shape

### Answers:

E1 → (c) Melting of wax [wax → liquid wax; same chemical composition; reversible on cooling] | E2 → (b) H and O combined in fixed ratio (H:O = 1:8 by mass; always) | E3 →

(d) Change in size/shape [this is the indicator of a physical change; the other three indicate chemical change]



**Mock Tests**



**Subject Quiz**



**Telegram**

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