CHAPTER 1

Chemical Reactions and Equations

CBSE Class 10 · Science · Chapter 1

CBSE · Science · Class 10

WHAT THIS CHAPTER DOES

A Balance any chemical equation correctly using the conservation of mass.

B Identify which of the 4 reaction types a given equation belongs to.

Boards prep that builds confidence, not anxiety.

TODAY'S MISSION

Today's mission

1. Balance any chemical equation correctly using the conservation of mass.
2. Identify which of the 4 reaction types a given equation belongs to.
3. Pinpoint the oxidising and reducing agents in any redox reaction.
4. Score 6/7 marks on this chapter's slice of the board paper.

WHY THIS MATTERS

Why this chapter matters

1. 5-7 marks every CBSE board paper — single highest-yield Chemistry chapter in Class 10.
2. Every later chapter (Acids/Bases, Metals/Non-metals, Carbon Compounds) ASSUMES you can balance equations fluently.
3. Real-world bridge to daily life — why bridges rust, why chips go stale, why photographic film darkens in light.

TOPIC

A

Fundamentals — what IS a chemical reaction?

TOPIC

Chemical reaction · 5 signs to look for

COLOUR CHANGE

A visible colour shift is the most readable laboratory cue that a reaction is underway, and CBSE has tested this identification line multiple times since 2018. The NCERT-standard demo is iron filings dropped into copper sulphate: the deep blue of $CuSO_4(aq)$ pales toward the green of $FeSO_4(aq)$, while red-brown copper metal coats the iron

TEMPERATURE CHANGE

Heat-flow direction tells you which way bond-energy is moving. Quick-lime slaking $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$ is the showcase exothermic reaction; the beaker becomes uncomfortably hot to touch within seconds, releasing about 65 kJ per mole. Endothermic reactions absorb heat from the surroundings, so the

GAS EVOLUTION

A reaction is signalled by audible fizzing or visible bubbling when one product is a gas with low solubility in the medium. The NCERT-classic $Zn(s)$ + dil. $H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)\uparrow$ liberates hydrogen, identifiable by the pop-sound test with a burning splint. Other diagnostic gases CBSE tests: CO_2 from carbonates with acid (lime-

PRECIPITATE FORMATION

When two clear solutions are mixed and a solid suddenly appears suspended or settling, you have observed precipitation — formation of an insoluble product whose lattice energy beats the available solvation energy. Three textbook precipitates appear repeatedly in CBSE papers: barium sulphate $BaSO_4$ (dense white, used

THEOREM · LOAD-BEARING RESULT

Law of Conservation of Mass

> *In every chemical reaction, the total mass of reactants equals the total mass of products. Atoms are rearranged — never created, never destroyed.*

STATEMENT

If A grams of reactants completely react, the products also weigh A grams (mass balance). Operationally: number of atoms of each element on the LHS must equal the number on the RHS.

WHY THIS MATTERS

- Bonds break and re-form, but atoms persist
- This is what 'balancing an equation' is — making the atom-count visibly equal on both sides.

WATCH OUT FOR

NOTE NEVER balance by changing subscripts. H_2O_2 is hydrogen peroxide (a different substance) — it is NOT '2 × H_2O'. Coefficients only.

TOPIC

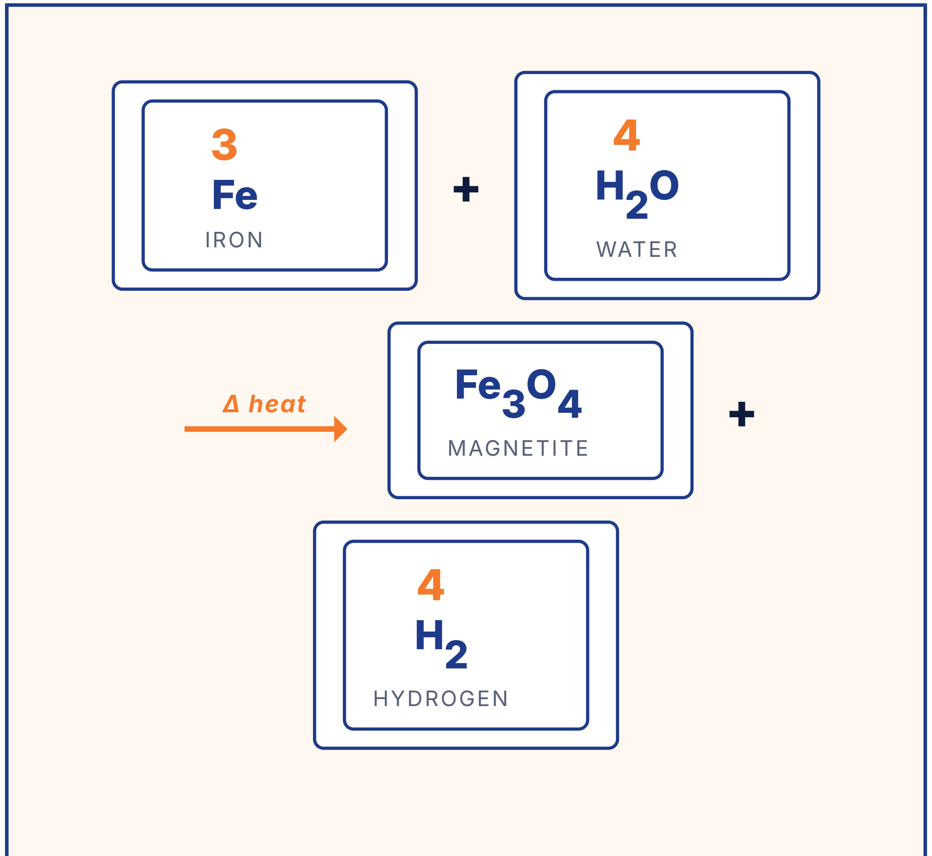
B

Balancing equations — the algorithm

WORKED EXAMPLE

Balance: $Fe + H_2O \rightarrow Fe_3O_4 + H_2$

1. Count atoms each side. LHS: Fe = 1, H = 2, O = 1. RHS: Fe = 3, O = 4, H = 2.
2. Balance the most-complex compound first: Fe_3O_4 has 3 Fe and 4 O. Put 3 in front of Fe (LHS) and 4 in front of H_2O.
3. Now: $3\ Fe + 4\ H_2O \rightarrow Fe_3O_4 + ?\ H_2$. LHS H = 8, so put 4 in front of H_2 on the RHS.
4. Final balanced: $3\ Fe + 4\ H_2O \rightarrow Fe_3O_4 + 4\ H_2$. Check: Fe = 3 = 3, H = 8 = 8, O = 4 = 4 ✓



TRY IT · SOLVE BEFORE YOU PEEK

Balance: __Al + __O_2 → __Al_2O_3. What are the smallest whole-number coefficients?

SOLUTION

ANSWER 4 Al + 3 O_2 → 2 Al_2O_3. Each side: 4 Al and 6 O. Check by counting — the answer with subscripts unchanged is unique.

TOPIC

C

The four types of chemical reaction

TOPIC

Combination reaction · A + B → AB

DEFINITION

A combination — or synthesis — reaction takes two or more reactants (elements, compounds, or both) and produces exactly ONE product, so the equation has the structural form A + B → AB. The hallmark on the page is multiple species on the left and a single chemical formula on the right. Combination reactions are

CLASSIC EXAMPLE

The slaking of lime — $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$ — is the most-tested combination reaction in the CBSE board pool (appears in 2016/2018/2019/2022 sets). Quick-lime CaO is added to water during whitewashing of walls; the slaked lime $Ca(OH)_2$ formed reacts slowly with atmospheric CO_2 over weeks to deposit

OTHER EXAMPLES

Burning is the most common everyday combination reaction. $2 H_2(g) + O_2(g) \rightarrow 2 H_2O(l)$, the combustion of hydrogen, is the chemistry behind hydrogen-fuel-cell vehicles and releases 286 kJ per mole of water formed. $C(s) + O_2(g) \rightarrow CO_2(g)$ — wood/coal/charcoal burning in plentiful air — is exothermic and

TELL-TALE SIGN

The decisive structural test on an unseen equation is a simple atom-counting rule: two or more reactants reducing to exactly ONE product is combination, with no exception in CBSE Class 10 syllabus. Do not be distracted by reactant complexity or whether they are simple/complex; even slow rusting ($4 Fe + 3 O_2 + 6 H_2O \rightarrow 2 Fe_2O_3{\cdot}3H_2O$) is

TOPIC

Decomposition · AB → A + B

DEFINITION

A decomposition reaction is the structural mirror of combination: one reactant breaks apart to give two or more products, so the equation reads AB → A + B (or AB → A + B + C). Because bonds must be broken, decomposition is almost always endothermic and needs an energy input — heat (thermolysis), light (photolysis), or electricity

THERMAL

Thermal decomposition uses heat as the activation source. The cement-industry workhorse $CaCO_3(s) \rightarrow(\Delta, \sim 1100\ K)\ CaO(s) + CO_2(g)\uparrow$ converts limestone to quicklime, releasing about 178 kJ per mole of CaO — every cement kiln in India runs this reaction at scale and contributes meaningfully to the country's industrial CO

PHOTOCHEMICAL

Light — specifically ultraviolet photons — supplies the activation in a photochemical decomposition by breaking the silver-halide bond. $2\ AgCl(s) \rightarrow(h\nu)\ 2\ Ag(s) + Cl_2(g)$ and $2\ AgBr(s) \rightarrow(h\nu)\ 2\ Ag(s) + Br_2(g)$ are the chemistry behind traditional black-and-white photography; the grey-violet darkening you see on

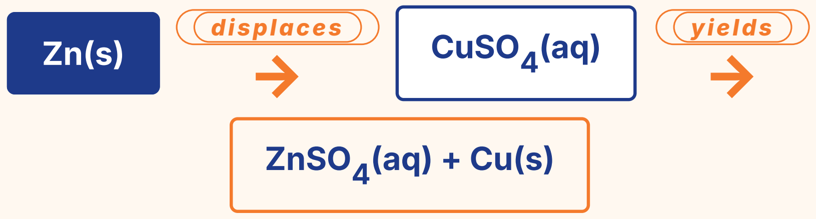
ELECTROLYTIC

Electrolysis uses electrical energy to drive an otherwise non-spontaneous decomposition. In the NCERT water-electrolysis experiment, acidified water is split by direct current into $2\ H_2O(l) \rightarrow(elec)\ 2\ H_2(g) + O_2(g)$, with hydrogen collected at the cathode and oxygen at the anode in a 2:1 volume ratio — this volume ratio is the most-

WORKED EXAMPLE

Type 3 — Displacement: Zn displaces Cu

1. Reaction: Zn(s) + $CuSO_4$(aq) → $ZnSO_4$(aq) + Cu(s).
2. Zn is ABOVE Cu in the reactivity series → Zn can displace Cu.
3. Observation: blue $CuSO_4$ solution slowly fades, red-brown Cu deposit on the Zn strip.
4. Reverse (Cu + $ZnSO_4$) does NOT occur — Cu sits below Zn, so no displacement.



TOPIC

Double displacement · AB + CD → AD + CB

DEFINITION

A double displacement is the mutual ion-swap between two soluble ionic compounds in solution — AB + CD → AD + CB, where the cations exchange anionic partners. Both reactants must be ionic and (in CBSE's treatment) aqueous; the driving force is the formation of either an insoluble precipitate ($BaSO_4$, AgCl, PbI_2), a

PRECIPITATION CASE

Na_2SO_4(aq) + $BaCl_2$(aq) → $BaSO_4$(s)↓ + 2 NaCl(aq) is the showcase precipitation reaction in NCERT — mixing two clear solutions produces a dense white $BaSO_4$ suspension within seconds. The driver is $BaSO_4$'s extremely low solubility product (Ksp ≈ 1.1 × 10^{-10}), so the sulphate-barium pairing forms an insoluble solid before

NEUTRALISATION CASE

Acid-base neutralisation is structurally a double-displacement: NaOH(aq) + HCl(aq) → NaCl(aq) + H_2O(l). The driver here is not a solid but the formation of weakly-ionised water — H^+ from the acid pairs with OH^- from the base to give covalent H_2O, removing the free ions from solution. The reaction is mildly exothermic (~57 kJ per

QUICK TEST

The reliable classifier on an unseen double-displacement question: identify the ion partners on both sides, then check if any new pairing forms a precipitate, a gas, or a weak/molecular compound. If none — for example NaCl(aq) + KNO_3(aq) — no reaction occurs because the ions simply remain dissociated. CBSE 2-mark

TOPIC

D

Redox — oxidation and reduction

THEOREM · LOAD-BEARING RESULT

Oxidation, Reduction, and the Agents

> *Oxidation = gain of oxygen / loss of hydrogen / loss of electrons. Reduction = the exact opposite. In a redox reaction, BOTH happen together — they're two faces of the same electron transfer.*

STATEMENT

If species X loses electrons (oxidised), some species Y must gain those electrons (reduced). The species that GETS reduced is called the OXIDISING AGENT. The species that GETS oxidised is called the REDUCING AGENT. The

WHY THIS MATTERS

- All combustion, all corrosion, all batteries, all photosynthesis — every electron-shifting chemistry is redox
- Mastering this unlocks half of Class 12 Chemistry too.

WATCH OUT FOR

NOTE Most common error: swapping oxidising and reducing agents. The agent does the OPPOSITE of what its name suggests. Reducing agent → reduces the OTHER substance → itself gets oxidised.

WORKED EXAMPLE

$CuO + H_2 \rightarrow Cu + H_2O$ · Who is what?

1. Track oxygen: CuO LOSES oxygen → CuO is REDUCED (to Cu).
2. Track hydrogen / oxygen: H_2 GAINS oxygen → H_2 is OXIDISED (to H_2O).
3. Oxidising agent = the one that GETS reduced = CuO.
4. Reducing agent = the one that GETS oxidised = H_2. Both halves happen in one equation → redox.

TOPIC

E

Effects of oxidation in daily life

TOPIC

Why iron rusts (and how to stop it)

WHAT RUST IS

Rust is hydrated iron(III) oxide, formulaically $Fe_2O_3 \cdot xH_2O$ — the water of crystallisation (x ranges from 1.5 to 3, structurally variable) is what makes it brittle, crumbly, and orange-brown rather than the dense black of anhydrous Fe_2O_3. The CBSE marking scheme is strict: writing rust as plain Fe_2O_3

THE REACTION

The rusting equation is $4\ Fe(s) + 3\ O_2(g) + xH_2O(l) \rightarrow 2\ Fe_2O_3 \cdot xH_2O(s)$, and the CBSE-favourite teaching point is that BOTH air (specifically dioxygen) AND moisture (liquid water) must be present simultaneously — neither alone is enough. The classic NCERT three-test-tube demonstration verifies this: an iron nail in

PREVENTION — BARRIERS

Barrier methods of rust prevention work by physically excluding O_2 and H_2O from the iron surface — paint on the Howrah Bridge, grease on machine parts, polyethylene coating on reinforcement bars, and tin-plating on canned food containers all act as inert physical shields. The weakness of barriers is that

PREVENTION — SACRIFICIAL

Sacrificial protection exploits the activity series — a more reactive metal donates electrons in preference to iron, so the more-reactive metal corrodes ('sacrifices itself') instead. Galvanisation coats iron with zinc; even if the zinc layer is scratched, the exposed iron is cathodically protected because Zn ($E°$ =

TOPIC

Why fried food goes bad

WHAT RANCIDITY IS

Rancidity is the slow atmospheric oxidation of the unsaturated C=C bonds in fats and oils, producing short-chain aldehydes, ketones, and free fatty acids that the human palate perceives as a sharp, bitter, 'off' smell and taste. The chemistry is autocatalytic — once a few peroxide radicals form, they accelerate further oxidation

WHY IT MATTERS

Rancidity is the single biggest cause of shelf-life loss in fat-rich packaged foods — ghee, butter, namkeen, biscuits, fried snacks, chocolate, baked goods — and the Indian food-processing industry loses an estimated few thousand crore rupees annually to rancid stock that must be withdrawn from market. Beyond the

PREVENTION

Four prevention strategies map onto four chemical levers: (1) airtight packaging excludes the O_2 reactant entirely — the gold standard for ghee tins and oil bottles; (2) refrigeration slows the reaction kinetics by lowering temperature — the Arrhenius equation predicts roughly a 2× slowdown per 10 °C drop; (3) antioxidants such as

REAL-WORLD

The pillow-like puffiness of a sealed Lay's or Kurkure packet is not an air-cushion — it is pure nitrogen, deliberately flushed in to displace oxygen and arrest oil rancidity, and this is why crisps stay crisp for months on the shelf. Read any namkeen label and you will see 'INS 320' (BHA) or 'INS 321' (BHT) under the additive list — both are

TOPIC

Balancing equations

TRAP → TRUTH

× **MISTAKE** Change subscripts to balance (e.g. write H_2O_2 instead of 2 H_2O).

✓ **CORRECT** NEVER change subscripts — that changes the substance. Balance ONLY by adjusting the coefficient in front of the formula. H_2O_2 is hydrogen peroxide, a different compound entirely.

TOPIC

Reaction-type identification

TRAP → TRUTH

× **MISTAKE** Any reaction that releases heat is a 'combination' reaction.

✓ **CORRECT** Exothermic and combination are independent. Many combination reactions ARE exothermic ($CaO + H_2O$), but displacement ($Zn + CuSO_4$) is also exothermic. Classify by structure of the equation ($A + B \rightarrow AB$), not by heat.

TOPIC

Oxidation / Reduction

TRAP → TRUTH

× **MISTAKE** Oxidation always means 'reacts with oxygen'.

✓ **CORRECT** Oxidation has 3 equivalent definitions: gain of O, loss of H, OR loss of electrons. $CuO + H_2 \rightarrow Cu + H_2O$: H_2 is oxidised (gained O), but in $2\ Na + Cl_2 \rightarrow 2\ NaCl$, Na is oxidised even though no oxygen is present (it loses an electron).

TOPIC

Reactivity series — displacement

TRAP → TRUTH

× **MISTAKE** Copper can displace iron from $FeSO_4$.

✓ **CORRECT** A metal can displace another ONLY if it is MORE reactive. In the series K > Na > Ca > Mg > Al > Zn > Fe > Pb > [H] > Cu > Hg > Ag > Au, copper sits BELOW iron, so Cu cannot displace Fe. Memorise the series in order; questions assume you know it cold.

TOPIC

Double-displacement

TRAP → TRUTH

× **MISTAKE** If both products are soluble, it's still a precipitation reaction.

✓ **CORRECT** A precipitation reaction requires at least ONE insoluble product (the precipitate, marked ↓ or (s)). $NaCl + KNO_3 \rightarrow NaNO_3 + KCl$ has no precipitate — not a precipitation reaction even though ions exchange.

TOPIC

Rust formula

TRAP → TRUTH

× **MISTAKE** Rust is iron oxide, written as Fe_2O_3.

✓ **CORRECT** Anhydrous Fe_2O_3 is iron(III) oxide — a different compound. Rust is HYDRATED iron(III) oxide: $Fe_2O_3 \cdot xH_2O$. The water of crystallisation is what makes rust crumbly. CBSE marking schemes deduct 0.5 marks for missing the x H_2O.

TOPIC

Galvanisation

TRAP → TRUTH

× **MISTAKE** Galvanisation prevents rusting because the zinc coating physically blocks air and water.

✓ **CORRECT** It is SACRIFICIAL protection — zinc is MORE reactive than iron, so even if the coating gets scratched, zinc oxidises preferentially and iron underneath stays unrusted. The physical barrier is secondary; the electrochemical sacrifice is the real mechanism.

TOPPER TEMPLATE · MARK-BY-MARK

3-mark question: 'Balance the following equation and identify the type of reaction.'

1	COUNT ATOMS EACH SIDE	1 m	Identify the most complex compound, count atoms of each element on left vs right. Write the count clearly: 'LHS: Fe = 1, H = 2, O = 1' etc.
2	ADJUST COEFFICIENTS (NEVER SUBSCRIPTS)	1 m	Place coefficients in front of formulas to equalise atom counts. Balance most-complex compound first, then H, then O. Show the balanced equation with state symbols: $3\ Fe(s) + 4\ H_2O(g) \rightarrow Fe_3O_4(s) + 4\ H_2(g)$.
3	IDENTIFY REACTION TYPE WITH JUSTIFICATION	1 m	State the type and ONE-line justification: 'Type — Displacement (Fe is more reactive than H, displaces hydrogen).' Without the justification, only half the mark is awarded.

TOPPER TEMPLATE · MARK-BY-MARK

3-mark question: 'In the reaction [given], identify the substance being oxidised and the substance being reduced.

1	**IDENTIFY GAIN/LOSS OF O OR H** 1 m	Track oxygen and hydrogen movement. In $CuO + H_2 \rightarrow Cu + H_2O$: CuO LOSES oxygen → CuO is reduced. H_2 GAINS oxygen → H_2 is oxidised.
2	**NAME THE SPECIES BEING OXIDISED AND REDUCED** 1 m	'H_2 is oxidised to H_2O' and 'CuO is reduced to Cu'. Be explicit — naming the PRODUCT is part of the answer.
3	**IDENTIFY THE AGENTS (THE OTHER SPECIES)** 1 m	Oxidising agent — the substance that GETS REDUCED (= CuO). Reducing agent — the substance that GETS OXIDISED (= H_2). Common student error: writing the wrong direction. Tip: 'agent does the OPPOSITE of what its name suggests'.

TOPPER TEMPLATE · MARK-BY-MARK

3-mark question on rusting / corrosion: cause + balanced equation + prevention.

1 **DEFINE CORROSION + NAME CONDITIONS** — 1 m

'Corrosion is the slow oxidation of metal surfaces when exposed to moisture and atmospheric oxygen. Iron rusts; copper develops green carbonate; silver tarnishes black.' Both moisture AND air are necessary — say it explicitly.

2 **WRITE THE RUSTING EQUATION WITH HYDRATED FORMULA** — 1 m

'$4\ Fe(s) + 3\ O_2(g) + xH_2O(l) \rightarrow 2\ Fe_2O_3 \cdot xH_2O(s)$ (rust)'. Mention the rust formula is HYDRATED iron(III) oxide. Bare Fe_2O_3 loses half a mark.

3 **TWO PREVENTION METHODS + MECHANISM** — 1 m

Any TWO of: (i) painting/oiling — physical barrier preventing air/moisture contact; (ii) galvanisation — sacrificial zinc coating that oxidises before iron; (iii) alloying — stainless steel (Fe + Cr + Ni) is intrinsically corrosion-resistant. Name + 1-line mechanism per method.

PYQ PATTERNS

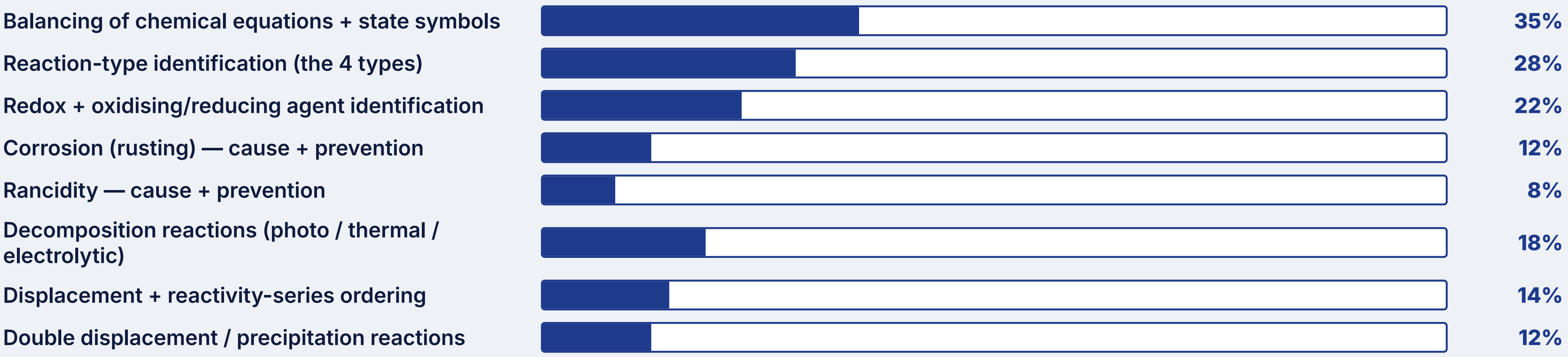
Top PYQ patterns to drill

#1	Balance: [equation] and state the type of reaction. (3 marks (2-mark balance + 1-mark type) marks)	Almost every year (2017, 2018, 2019, 2020, 2022, 2023)
#2	What happens when iron reacts with copper sulphate? Write the balanced equation and colour change. (3 marks)	2018, 2019 OD, 2022 AI
#3	Define oxidation and reduction. Identify oxidising/reducing agent in [given equation]. (3 marks)	Nearly every year since 2017
#4	Explain rusting / corrosion. State two methods of prevention. (2-3 marks)	2017, 2019, 2020, 2023
#5	Why are antioxidants added to oily/fatty food? What is rancidity? (2 marks)	2018, 2022, 2024

MARKS DISTRIBUTION

10-year marks distribution

10-YEAR PYQ MARKS DISTRIBUTION



RECAP · MEMORISE THESE

5-line revision

1 Conservation — Conservation of mass → balance every chemical equation. Coefficients only, never subscripts.

2 Four types — Combination, decomposition, displacement, double-displacement. Classify by equation STRUCTURE, not by 'heat released'.

3 Redox — Oxidation (+O / −H / −e^-) and reduction (opposite) happen together. OIL RIG.

WHAT'S NEXT

What's next

- → Chapter 2 — Acids, Bases and Salts (builds directly on neutralisation reactions you saw in Type 4).
- → Sit the 15-MCQ Quick Drill (companion PDF) — under 20 minutes, target ≥ 12/15.
- → Then the full Board-Pattern Paper — 30 marks, 60 minutes, real CBSE pattern.

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