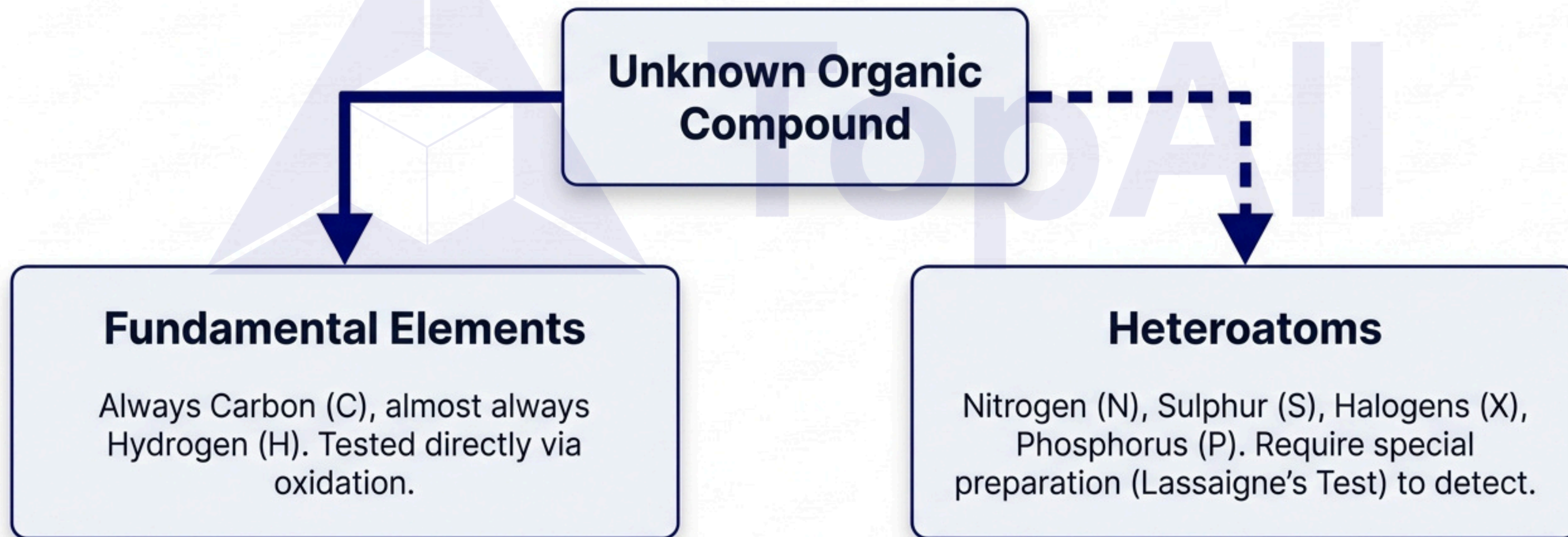


Qualitative Analysis: The Diagnostic First Step

Goal: To systematically identify the elemental composition of an unknown organic compound.

Core Question: What elements are present? (Before we can ever ask How much?)



Detecting the Baseline: Carbon & Hydrogen



Lime Water
[Ca(OH)₂]

Turns Milky
(CaCO₃ precipitate)



Anhydrous
CuSO₄ (White)

Turns Blue
(CuSO₄·5H₂O)



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Heteroatom Detection: Lassaigne's Framework

The Sodium Fusion Principle



Converts non-reactive covalent heteroatoms into reactive ionic salts (NaCN , Na_2S , NaX) for standard inorganic testing.

Nitrogen

Active Species: CN^-

Reagents: FeSO_4 +
conc. H_2SO_4

**Prussian Blue
(Ferriferrocyanide)**



Sulphur

Active Species: S^{2-}

Reagent: Sodium
Nitroprusside
(OR Lead Acetate)

Violet coloration

Black precipitate

Halogens

Active Species: X^-

Reagents:
 HNO_3 + AgNO_3

White ppt (AgCl)

Pale Yellow ppt (AgBr)

Yellow ppt (AgI)

Phosphorus

Active Species: PO_4^{3-}
(after Na_2O_2 oxidation)

Reagents: HNO_3 +
Ammonium Molybdate

**Yellow precipitate
(Ammonium
phosphomolybdate)**

The Paradigm Shift: Qualitative vs. Quantitative



Qualitative Analysis

Goal: Identify which elements are present.

Key Question: What is it?

Methods: Precipitation, Color Changes, Lassaigne's Test.

Output Type: Binary (Presence / Absence).



Quantitative Analysis

Goal: Determine the percentage composition by mass.

Key Question: How much is there?

Methods: Liebig's, Dumas, Kjeldahl, Carius methods.

Output Type: Numeric (Mass %, Empirical Formula).

You cannot perform quantitative analysis without first completing qualitative analysis to know which protocol to run.

Revision Frame: Qualitative Analysis Master Matrix

Element	Test Name / Reagents	Key Chemical Formed	Visual Observation
Carbon	CuO Oxidation	CaCO_3	Milky
Hydrogen	CuO Oxidation	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	Turns Blue
Nitrogen	Lassaigne's + FeSO_4 + H_2SO_4	$\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$	Prussian Blue
Sulphur	Lassaigne's + Sodium Nitroprusside	$[\text{Fe}(\text{CN})_5\text{NOS}]^{4-}$	Violet
Nitrogen + Sulphur	Lassaigne's + Fe^{3+}	$[\text{Fe}(\text{SCN})]^{2+}$	Blood Red
Chlorine	Lassaigne's + AgNO_3	AgCl	White ppt (sol. in NH_4OH)
Bromine	Lassaigne's + AgNO_3	AgBr	Pale Yellow ppt
Iodine	Lassaigne's + AgNO_3	AgI	Yellow ppt (insol. in NH_4OH)
Phosphorus	Na_2O_2 + Ammonium Molybdate	$(\text{NH}_4)_3\text{PO}_4 \cdot 12\text{MoO}_3$	Yellow ppt



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