LOGIC BLOOM · ORGANIC CHEMISTRY · NEET & JEE

+I, −I, +M and −M Effects

Two wires, one question: is this group taking electrons or giving them?

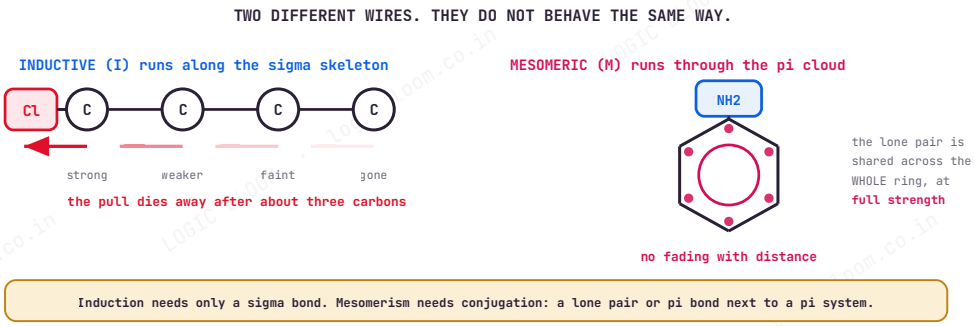
2 PAGES

THE WHOLE NOTE IN ONE LINE

The sign tells you what happens to the rest of the molecule.

Minus means the molecule **loses** electron density. Plus means it **gains**. The letter tells you which wire the effect travels on: **I** along sigma bonds, **M** through the pi cloud.

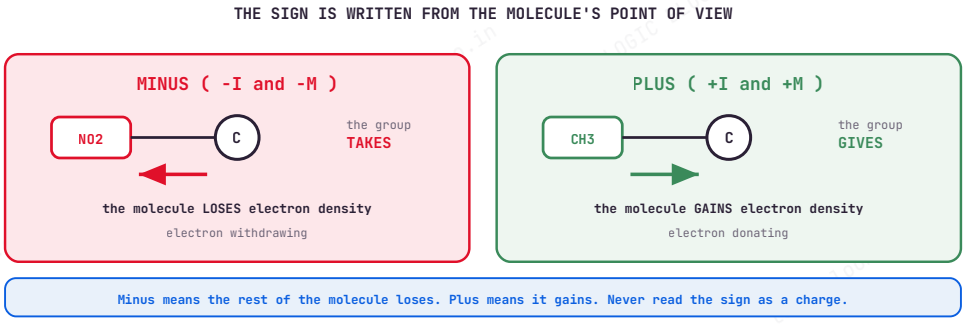
01 Two wires, and they behave differently



Induction fades with distance. Mesomerism does not, because the electrons are genuinely delocalised.

	INDUCTIVE (I)	MESOMERIC (M)
Travels through	sigma bonds	the pi system, or a lone pair next to it
Needs	a bond and an electronegativity difference	conjugation
With distance	fades fast, gone after about 3 carbons	does not fade
Electrons	only shifted, never fully moved	genuinely delocalised

02 Reading the sign



A greedy group is negative. A generous group is positive. The sign is never a charge.

Groups that PULL

−I (by electronegativity):
$-NO_2$ > −CN > −COOH > −F > −Cl > −Br > −I > $-OCH_3$ > −OH > $-C_6H_5$

−M (a multiple bond to an electronegative atom):
$-NO_2$, −CN, −CHO, −COR, −COOH, −COOR, $-CONH_2$, $-SO_3H$

Groups that PUSH

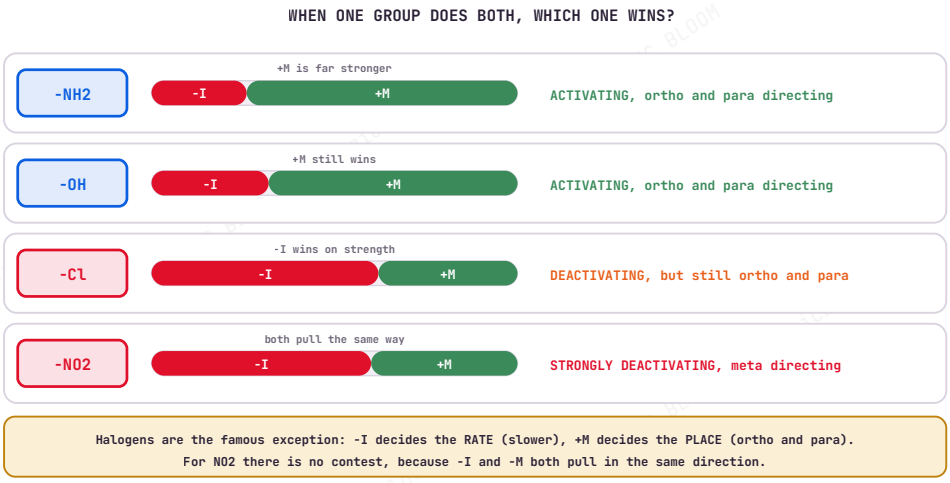
+I (alkyl groups, and anions):
$-C(CH_3)_3$ > $-CH(CH_3)_2$ > $-CH_2CH_3$ > $-CH_3$, and $-O^-$, $-COO^-$

+M (a lone pair to donate):
$-NH_2$, −NHR, $-NR_2$, −OH, −OR, −SH, −SR, and the halogens

HOW TO SPOT WHICH EFFECT A GROUP CAN SHOW

- Every group has an **I** effect. Every bond has some electronegativity difference.
- A group shows **M** only if it sits on a pi system *and* has a lone pair or pi bond of its own.
- Lone pair to give away, pointing into the ring: **+M**. Multiple bond to an electronegative atom, pulling out: **−M**.

03 When one group does both: which wins?



Most exam questions live in this table. The halogen row is the one that catches people.

THE HALOGEN EXCEPTION, ASKED ALMOST EVERY YEAR

Halogens are **deactivating** yet **ortho and para directing**, which sounds contradictory. It is not. The strong −I makes the whole ring poorer, so the reaction is **slower**. But the weak +M still feeds electron density specifically to the ortho and para positions, so when it does react, it reacts **there**. Rate and position are decided by different effects.

04 The proof: watch the pKa fall

Top: more pulling groups, stronger acid. Bottom: the same group moved away, and the effect fades.

TURNING THE EFFECT INTO AN ANSWER

- **Acid strength:** **−I and −M** groups stabilise the negative conjugate base, so the acid gets **stronger**. **+I** groups destabilise it, so the acid gets weaker.
- **Base strength:** **+I** makes an amine **stronger**. In aniline the lone pair is delocalised into the ring, so it is far weaker than ammonia.
- **Carbocation stability:** **+I and +M** feed the positive centre, so 3° > 2° > 1°.
- **Ring substitution:** **+M** activates, ortho and para. **−M** deactivates, meta.

TWO MISTAKES WORTH AVOIDING

- Reading the sign as a charge, or applying induction past three carbons.
- Forgetting that −OH and $-NH_2$ are **−I** as well as **+M**. With no ring to conjugate with, only the −I is left, which is why ethanol is more acidic than ethane.

THE SIXTY SECOND DRILL

1. Lone pair or multiple bond? That decides whether M is possible at all. Then ask: greedy or generous?
2. If both effects exist and disagree, say which wins **and** what each one controls.