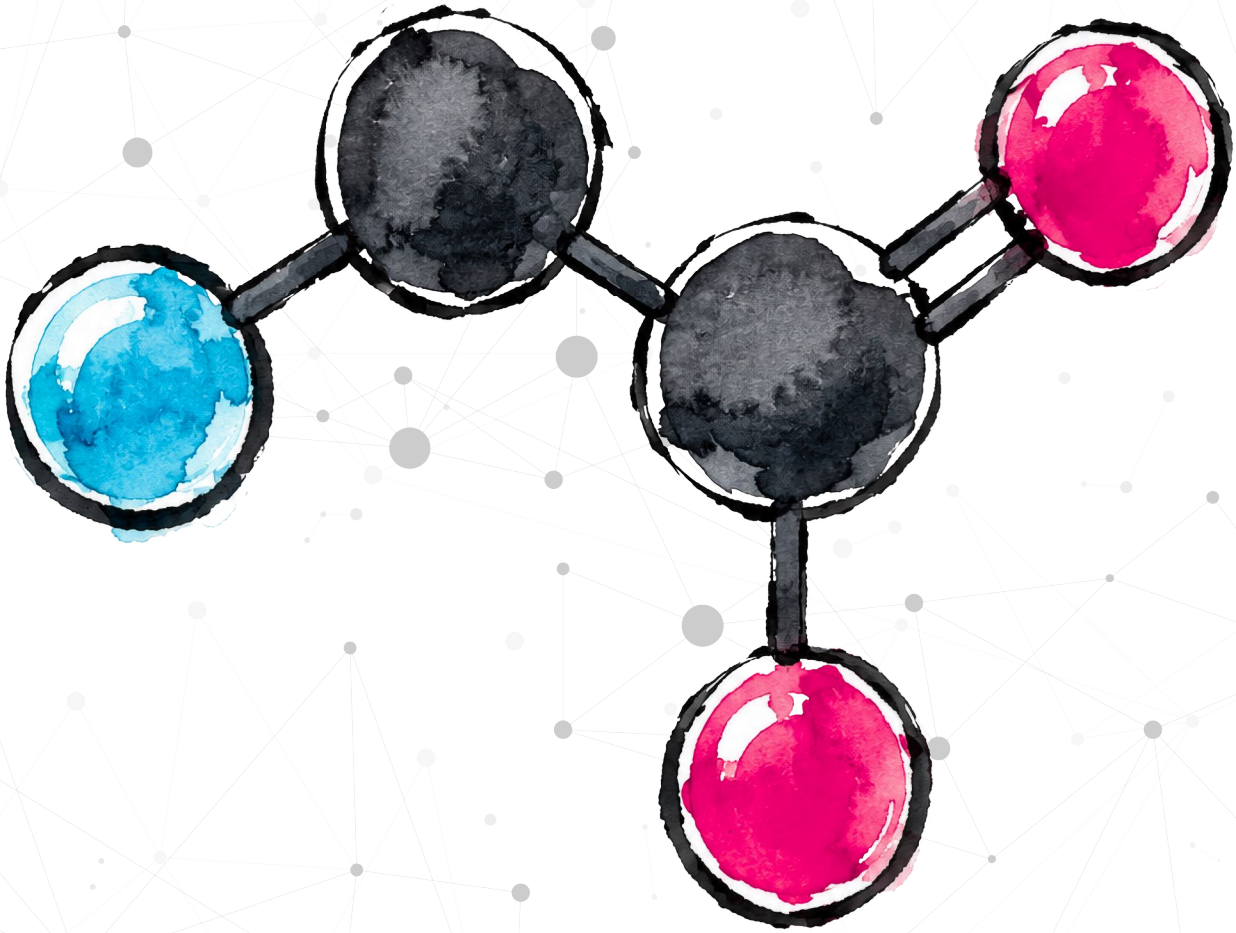
edexcel iAL

A2 CHEMISTRY



COMPLETE NOTES

LATEST SYLLABUS
MODULE & LINEAR

How to use this book

Every page is built straight from the Edexcel mark schemes — nothing off-spec, nothing wasted. **Follow the four steps below to turn each chapter into marks.**

1 Learn

get the content down

- **Concise notes** — one fact per line, in mark-scheme wording
- **Comparison tables** — every difference laid out at a glance
- **Mark-earning terms** — the exact words that score, and the ones that don't

2 Drill

train your exam technique

- **Exam tips & mistake boxes** — what examiners reward, and the traps they punish
- **Solved Questions** 1 2 3 — model answers showing where every mark is earned
- **Core practicals** — each one broken down to method, reason and marks

3 Test

check it has stuck

- **Interactive quizzes** — active recall to find your weak spots
- **Flashcards** — quick spaced-repetition drilling between sessions

4 Review

lock it in for exam day

- **One-page chapter summaries** — your final-night refresher
- **Quiz score low?** Loop back to that topic's notes and run it again

Unit 4

Reaction Rates

Unit 5

Unit 6

Practical Skills in Chemistry II

Solved Question ❶❷❸ — calculating a lattice energy

Use a Born–Haber cycle to find the lattice energy of NaCl.
$\Delta fH(NaCl) = -411$, $\Delta atH(Na) = +107$, $IE_1(Na) = +496$, $\Delta atH(Cl) = +122$, $EA(Cl) = -349$ kJ mol^{-1}.

Step	Working / answer	Marks
❶ Set the direct route equal to the indirect route	$\Delta fH = \Delta atH(Na) + IE_1(Na) + \Delta atH(Cl) + EA(Cl) + LE$	1
❷ Rearrange for the lattice energy	$LE = \Delta fH - \Delta atH(Na) - IE_1(Na) - \Delta atH(Cl) - EA(Cl)$	1
❸ Substitute and evaluate	$LE = -411 - 107 - 496 - 122 - (-349) =$ **-787 kJ mol^{-1}**	1

Marking note: any step travelled backwards changes sign; the negative result confirms the lattice forms exothermically.

Born–Haber Cycles for Group 2 Chlorides

- A Born–Haber cycle for a Group 2 chloride such as $MgCl_2$ or $CaCl_2$ needs two changes.

Second ionisation energy

Include the **second ionisation energy** of the metal, because the metal forms a 2+ ion.

Double the halogen terms

Double both the atomisation enthalpy and the electron affinity of chlorine, because there are two chloride ions.

Common mistake — double the halogen terms for MX_2

Students forget that $MgCl_2$ or $CaCl_2$ contains two chloride ions, so they count the atomisation and electron affinity of chlorine once instead of twice.

For an MX_2 compound, **double both ΔatH(X) and EA(X)**, and include the **second ionisation energy** of the 2+ metal.

— Hosni

4.20 How Buffers Work

An acidic buffer contains a weak acid HA and its conjugate base A^- in equilibrium: **$HA \rightleftharpoons H^+ + A^-$**. The solution holds a large reserve of both HA and A^-.

Adding Acid (H^+)

The extra H^+ reacts with A^- to form HA, so the equilibrium **shifts left** and $[H^+]$ returns close to its original value.

$A^- + H^+ \rightarrow HA$

Adding Base (OH^-)

The OH^- reacts with H^+ to form water, then more HA dissociates to replace it, so the equilibrium **shifts right** and $[H^+]$ returns close to its original value.

$HA + OH^- \rightarrow A^- + H_2O$

An alkaline buffer of a weak base B and its salt BH^+ works the same way: B removes added H^+, and BH^+ releases H^+ to replace any removed by added base.

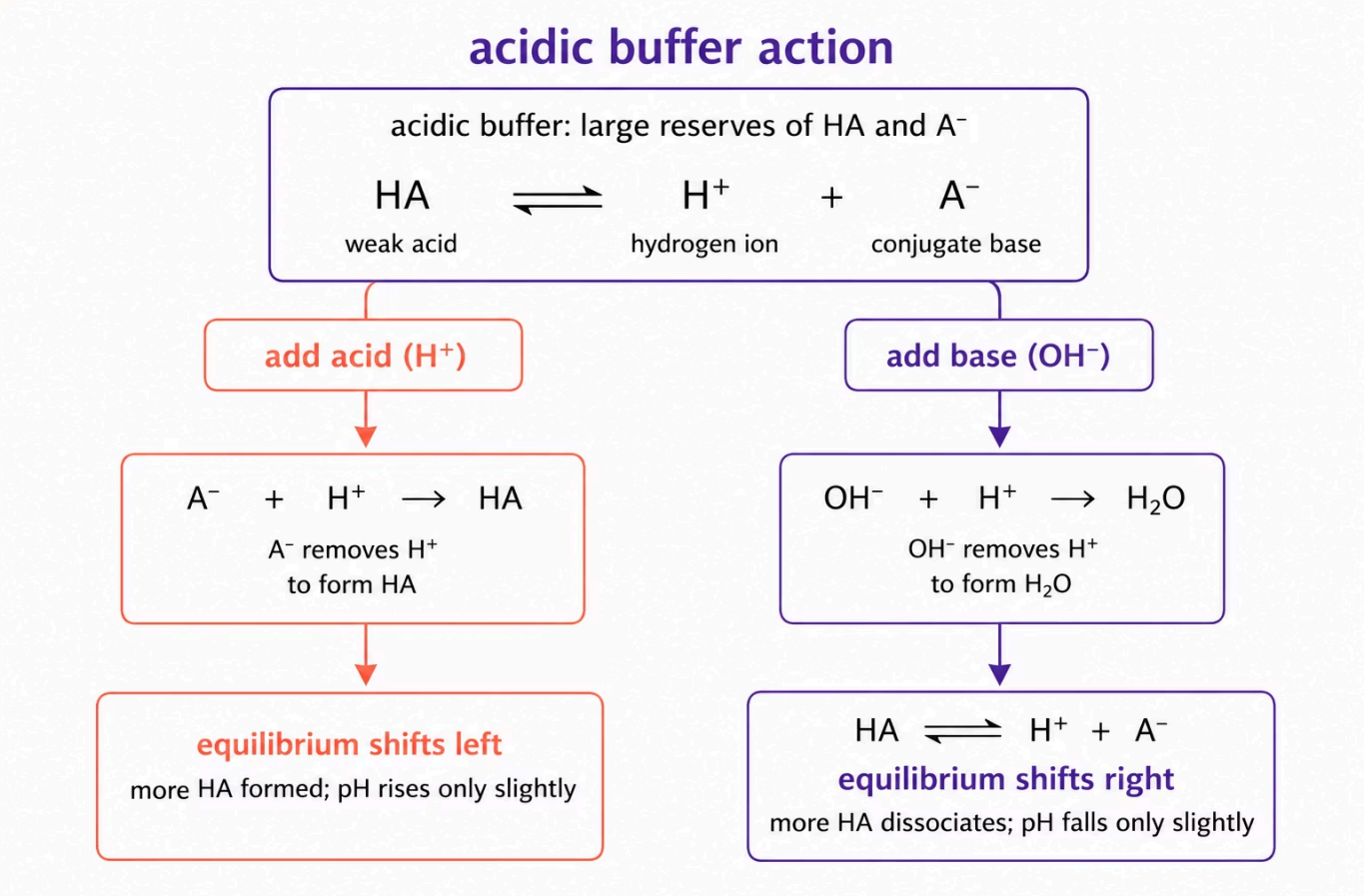
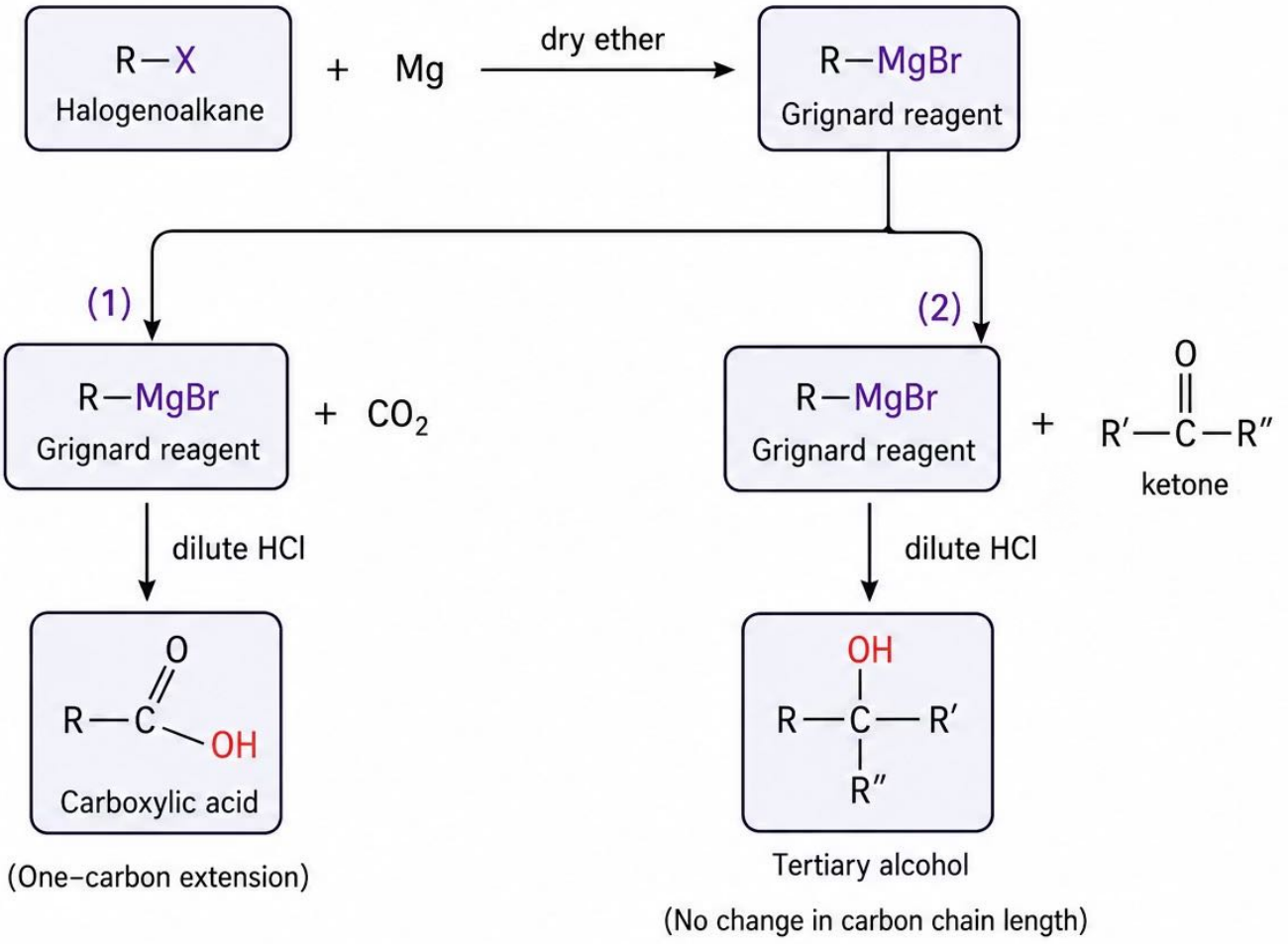


FIG 10.3 Grignard summary



The whole sequence runs in **dry ether**, because the Grignard reagent reacts violently with water and would be destroyed before it could react.

Write **dilute acid** as the final step every time, because the intermediate is a salt that must be protonated to give the acid or alcohol.

Examiners also accept "water" for the final hydrolysis step.

Sample question (6 marks) — Grignard reagents lengthen the carbon chain. An outline synthesis of propanoic acid from ethanoic acid passes through compound X and a Grignard reagent. Give the reagents and conditions for each step, the identity of X, and the formula of the Grignard reagent.

Step	Working / answer	Marks
❶ reduce the acid to an alcohol	**$LiAlH_4$ in dry ether** → ethanol	1
❷ convert the alcohol to X	HBr (or KBr + conc H_2SO_4, or red P + I_2)	1
❸ identify X	**bromoethane, C_2H_5Br**	1
❹ make the Grignard reagent	**magnesium in dry ether**	1
❺ give the Grignard formula	**C_2H_5MgBr**	1
❻ extend and release the acid	**CO_2, then dilute acid** → propanoic acid	1

ⓘ Marking note: iodoethane and chloroethane are accepted for X. Phosphoric(V) acid is accepted for sulfuric acid. — Hosni

⊗ Students reach for $NaBH_4$ to reduce the carboxylic acid, so they lose the first mark.

Write **$LiAlH_4$**, because $NaBH_4$ is too weak to reduce a –COOH group.

Sample question (6 marks)

Compare and contrast the bromination of benzene and the bromination of phenol. Include equations in your answer. Detailed mechanisms are not required.

Step	Working / answer	Marks
❶ Similarity	Both reactions are **electrophilic substitution**	1
❷ Benzene equation	$C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$	1
❸ Phenol equation	$C_6H_5OH + 3Br_2 \rightarrow C_6H_2Br_3OH + 3HBr$	1
❹ Benzene conditions	Benzene **needs a halogen-carrier catalyst ($FeBr_3$ or $AlBr_3$) and heat**	1
❺ Phenol conditions	Phenol reacts with **bromine water at room temperature** with no catalyst	1
❻ Why phenol is more reactive	The **oxygen lone pair is delocalised into the ring**, so the ring is more open to electrophilic attack	1

⚠ Marking note: do not award "bromine water" as benzene's reagent; a lone pair "on the O–H" will not score — it must be the oxygen lone pair delocalising into the ring.

11.7 Mark-Earning Terminology and Accepted Alternatives

Mark point	Wording that scores	Accepted alternatives	Wording to avoid
Apparatus for the acid	A (volumetric) pipette	"burette"	"teat/dropping pipette"; "measuring cylinder"
Why rinse the burette	Otherwise the sodium hydroxide would be diluted	"to remove the remaining distilled water"	"to decrease the titre"; "to increase the concentration"
Why unequal portions	Smaller portions are added as the pH change becomes greater	"large portions would miss the equivalence point"	Adding equal portions throughout
Finding Ka	pH = pKa at half-neutralisation, so Ka = 10^(−pH)	"[salt] = [acid] at the half-equivalence volume"	Reading the pH at the full equivalence point

11.5 The Experimental Procedure

1 Transfer the acid

Use a **volumetric pipette** to transfer 20.0 cm^3 of the weak acid into a conical flask.

2 Prepare the burette

Wash the burette with distilled water, then **rinse it with the sodium hydroxide solution** so the titrant is not diluted, and fill it.

3 Calibrate and record start

Calibrate the pH probe with buffer solutions, place it in the acid, and **record the starting pH**.

4 Add alkali in portions

Add the sodium hydroxide in portions with swirling, **recording the pH after each addition**.

5 Smaller portions near the rise

Add **smaller portions near the steep rise**, because the pH changes rapidly close to the equivalence point.

6 Continue past equivalence

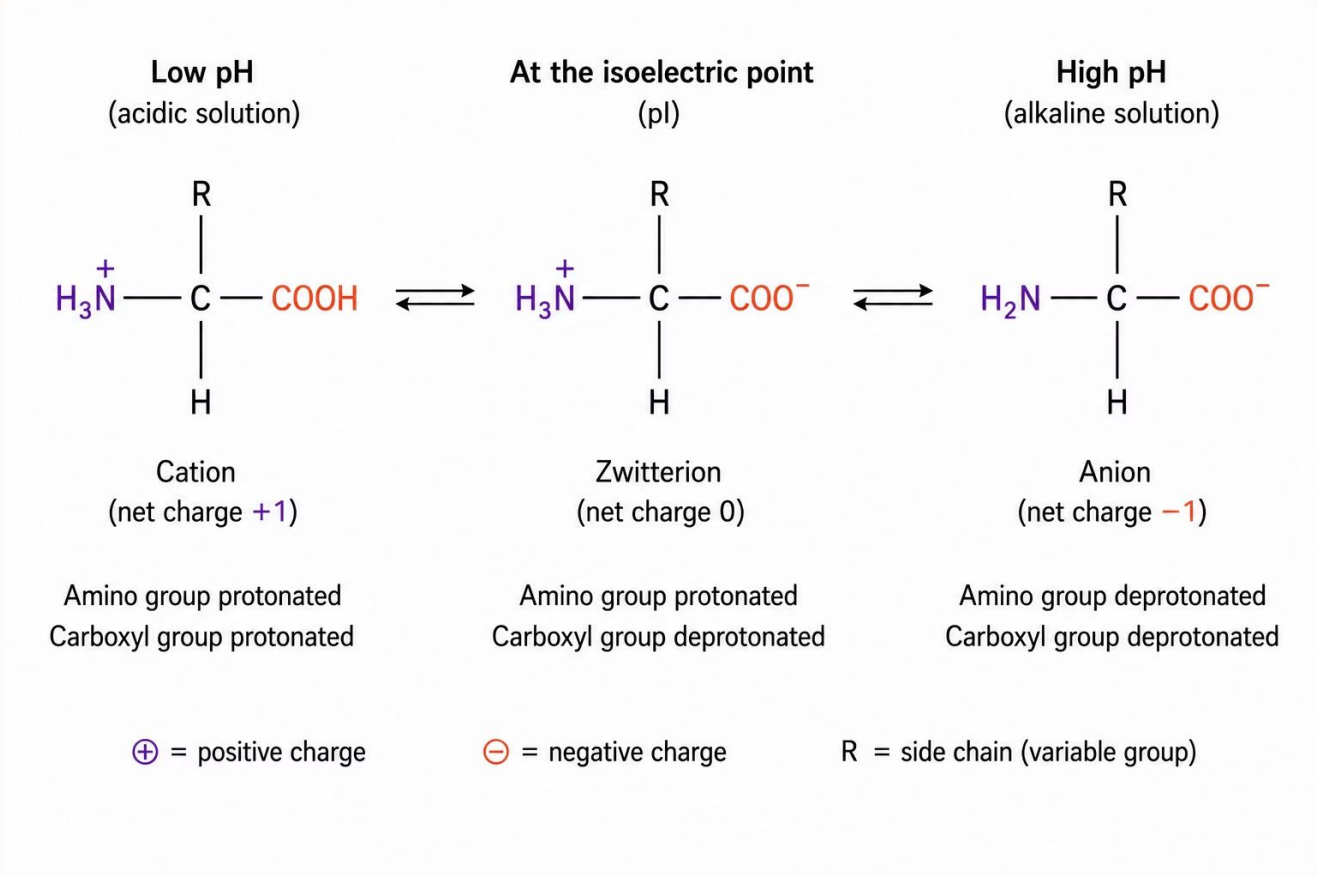
Continue adding alkali past the equivalence point until the pH levels off.

7 Plot the curve

Plot pH against the volume of sodium hydroxide added to obtain the titration curve.

9.9 — An Amino Acid at Different pH

Attribute	Low pH (acidic)	Isoelectric point	High pH (basic)
–NH_2 group	Protonated to –NH_3^+	–NH_3^+	–NH_2
–COOH group	–COOH	–COO^-	Loses its proton to –COO^-
Overall charge	Positive	Zero (zwitterion)	Negative
Reason	Excess H^+ protonates the basic amino group	Both groups are ionised, so the charges cancel	Excess OH^- removes the acidic proton



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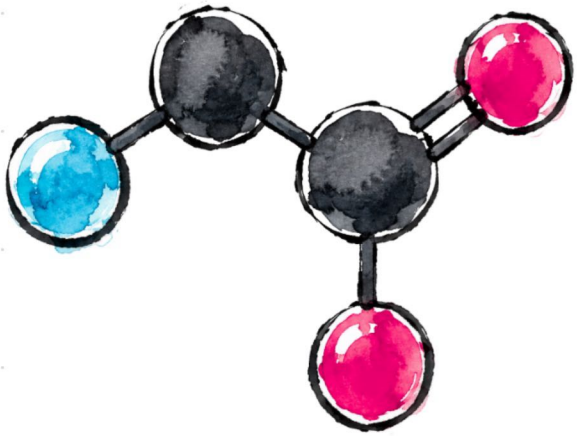

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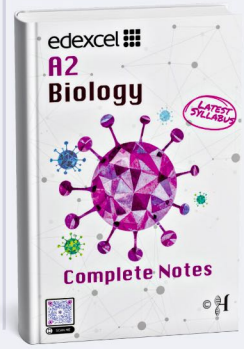

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