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Revision Guide for Cambridge IGCSE™

Chemistry (0620)

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1st edition, for examination until 2025

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Equations

Ionization of acids

$HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$

$HNO_{3(aq)} \rightarrow H^+_{(aq)} + NO_3^-{}_{(aq)}$

$H_2SO_{4(aq)} \rightarrow 2H^+_{(aq)} + SO_4^{2-}{}_{(aq)}$

$H_2CO_{3(aq)} \rightarrow 2H^+_{(aq)} + CO_3^{2-}{}_{(aq)}$

$H_3PO_{4(aq)} \rightarrow 3H^+_{(aq)} + PO_4^{3-}{}_{(aq)}$

Ionization of acids takes place in water so it can also be written as follows..

$HCl_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$

$H_2SO_{4(aq)} + 2H_2O_{(l)} \rightarrow 2H_3O^+_{(aq)} + SO_4^{2-}{}_{(aq)}$

$H_3PO_{4(aq)} + 3H_2O_{(l)} \rightarrow 3H_3O^+_{(aq)} + PO_4^{3-}{}_{(aq)}$

Acid + Metal → Salt + Hydrogen

$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$

$Zn_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_{2(g)}$

$2Al_{(s)} + 6HNO_{3(aq)} \rightarrow 2Al(NO_3)_{3(aq)} + 3H_{2(g)}$

Acid + Base → Salt + Water

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

$CuO_{(s)} + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + H_2O_{(l)}$

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Acid + Carbonate/Bicarbonate → Salt + Water + CO2

$CuCO_{3(s)} + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + H_2O_{(l)} + CO_{2(g)}$

$NaHCO_{3(s)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

Base + Ammonium Salt → Salt + Water + Ammonia

$Ca(OH)_{2(aq)} + 2NH_4Cl_{(aq)} \rightarrow CaCl_{2(aq)} + 2H_2O_{(l)} + 2NH_{3(g)}$

$NaOH_{(aq)} + NH_4Cl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + NH_{3(g)}$

$2LiOH_{(aq)} + (NH_4)_2SO_{4(aq)} \rightarrow Li_2SO_{4(aq)} + 2H_2O_{(l)} + 2NH_{3(g)}$

Ionic reaction of acid and alkali

$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

Reactions of amphoteric oxides with alkali

$ZnO_{(s)} + 2NaOH_{(aq)} \rightarrow Na_2ZnO_{2(aq)} + H_2O_{(l)}$

$Al_2O_{3(s)} + 2NaOH_{(aq)} \rightarrow 2NaAlO_{2(aq)} + H_2O_{(l)}$

Preparation of insoluble salts

Soluble salt + Soluble salt → Insoluble salt + Soluble salt

$BaCl_{2(aq)} + MgSO_{4(aq)} \rightarrow BaSO_{4(s)} + MgCl_{2(aq)}$

$AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(aq)}$

$3Ca(NO_3)_{2(aq)} + 2Na_3PO_{4(aq)} \rightarrow Ca(PO_4)_{2(s)} + 6NaNO_{3(aq)}$

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Preparation of soluble salts by titration

Acid + Alkali → Soluble salt + Water

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

$2KOH_{(aq)} + H_2SO_{4(aq)} \rightarrow K_2SO_{4(aq)} + 2H_2O_{(l)}$

$NH_4OH_{(aq)} + HNO_{3(aq)} \rightarrow NH_4NO_{3(aq)} + H_2O_{(l)}$

$3LiOH_{(aq)} + H_3PO_{4(aq)} \rightarrow Li_3PO_{4(aq)} + 3H_2O_{(l)}$

Preparation of soluble salts by excess method

$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$

$CuO_{(s)} + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + H_2O_{(l)}$

$ZnCO_{3(s)} + 2HNO_{3(aq)} \rightarrow Zn(NO_3)_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$

$Zn_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_{2(g)}$

Displacement reactions of metals

$Mg_{(s)} + CuSO_{4(aq)} \rightarrow MgSO_{4(aq)} + Cu_{(s)}$

$Ag_{(s)} + CuSO_{4(aq)} \rightarrow$ No Reaction

Silver is less reactive than copper, therefore no reaction

$Fe_{(s)} + CuSO_{4(aq)} \rightarrow FeSO_{4(aq)} + Cu_{(s)}$

Burning of metals

$4Na_{(s)} + O_{2(g)} \rightarrow 2Na_2O_{(s)}$

$2Ca_{(s)} + O_{2(g)} \rightarrow 2CaO_{(s)}$

$2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$

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$2Fe_{(s)} + O_{2(g)} \rightarrow 2FeO_{(s)}$

$2Cu_{(s)} + O_{2(g)} \rightarrow 2CuO_{(s)}$

Reduction of metal compounds with Carbon

$ZnO_{(s)} + C_{(s)} \rightarrow Zn_{(g)} + CO_{(g)}$

$CaO_{(s)} + C_{(s)} \rightarrow$ No Reaction

Carbon is less reactive than calcium, therefore no reaction

Reduction of metal with water

$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$

$Ca_{(s)} + 2H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)} + H_{2(g)}$

Reaction of metal with steam

$Mg_{(s)} + H_2O_{(g)} \rightarrow MgO_{(s)} + H_{2(g)}$

$Zn_{(s)} + H_2O_{(g)} \rightarrow ZnO_{(s)} + H_{2(g)}$

$3Fe_{(s)} + 4H_2O_{(g)} \rightarrow Fe_3O_{4(s)} + 4H_{2(g)}$

Reaction of group(I) metals

$4Li_{(s)} + O_{2(g)} \rightarrow 2Li_2O_{(s)}$

$2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$

$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$

$2K_{(s)} + 2H_2O_{(l)} \rightarrow 2KOH_{(aq)} + H_{2(g)}$

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Reaction of group(II) metals

$2Sr_{(s)} + O_{2(g)} \rightarrow 2SrO_{(s)}$

$Mg_{(s)} + Cl_{2(l)} \rightarrow MgCl_{2(s)}$

$Ca_{(s)} + 2H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)} + H_{2(g)}$

$Ba_{(s)} + 2H_2O_{(l)} \rightarrow Ba(OH)_{2(aq)} + H_{2(g)}$

Extraction of iron

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

$CO_{2(g)} + C_{(s)} \rightarrow 2CO_{(g)}$

$Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow 2Fe_{(s)} + 3CO_{2(g)}$

$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

$CaO_{(s)} + SiO_{2(s)} \rightarrow CaSiO_{3(l)}$

Action of chlorine on water

$Cl_{2(g)} + H_2O_{(l)} \rightarrow HCl_{(aq)} + HClO_{(aq)}$

Formation of particulate (incomplete combustion)

$2C_8H_{18(l)} + 9O_{2(g)} \rightarrow 16C_{(s)} + 18H_2O_{(l)}$

Nitrogen dioxide formation and acid rain formation

$N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$

$3NO_{2(g)} + H_2O_{(l)} \rightarrow 2HNO_3 + NO_{(g)}$

Photosynthesis

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$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Respiration

$C_6H_{12}0_6 + 6O_2 \rightarrow 6O_2 + 6H_2O + Energy$

Catalytic converter

$2NO_{(g)} + 2CO_{(g)} + Unburnt\ Hydrocarbon \rightarrow N_{2(g)} + 2CO_{2(g)} + H_2O_{(g)}$

Fuel cell

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$

Test for anions

$CO_{2(g)} + Ca(OH)_{2(aq)} \rightarrow CaCO_{3(s)}$

$Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$

$Ag^+_{(aq)} + Br^-_{(aq)} \rightarrow AgBr_{(s)}$

$Ag^+_{(aq)} + I^-_{(aq)} \rightarrow AgI_{(s)}$

$Ba^{2+}_{(aq)} + SO_4{}^{2-}_{(aq)} \rightarrow BaSO_{4(s)}$

Test for cations

$Ca^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Ca(OH)_{2(s)}$

$Mg^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mg(OH)_{2(s)}$

$Zn^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Zn(OH)_{2(s)}$

$Cu^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Cu(OH)_{2(s)}$

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$Cr^{3+}_{(aq)} + 3OH^-_{(aq)} \rightarrow Cr(OH)_{3(s)}$

$Al^{3+}_{(aq)} + 3OH^-_{(aq)} \rightarrow Al(OH)_{3(s)}$

$Fe^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Fe(OH)_{2(s)}$

$Fe^{3+}_{(aq)} + 3OH^-_{(aq)} \rightarrow Fe(OH)_{3(s)}$

Reactions of halogens

$2Al_{(s)} + 3Cl_{2(l)} \rightarrow 2AlCl_{3(s)}$

$2K_{(s)} + Br_{2(l)} \rightarrow 2KBr_{(s)}$

$H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$

$H_{2(g)} + Br_{2(l)} \rightarrow 2HBr_{(g)}$

$Cl_{2(aq)} + 2KBr_{(aq)} \rightarrow 2KCl_{(aq)} + Br_{2(aq)}$

$Cl_{2(aq)} + 2KF_{(aq)} \rightarrow$ No Reaction

$Br_{2(aq)} + 2KI_{(aq)} \rightarrow 2KBr_{(aq)} + I_{2(aq)}$

Haber process

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

Contact process

$2SO_{2(g)} + O_2 \rightleftharpoons 2SO_{3(g)}$

Decomposition of hydrogen peroxide

$2H_2O_{2(aq)} \rightarrow 2H_2O_{(l)} + O_{2(g)}$

Carbonates

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$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

$CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)}$

$CO_{2(g)} + Ca(OH)_{2(aq)} \rightarrow CaCO_{3(s)}$

Steam reforming

$CH_{4(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + 3H_{2(g)}$

$CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2(g)} + H_{2(g)}$ (Removal of CO)

Reactions of ammonia

$NH_{3(g)} + H_2O_{(l)} \rightarrow NH_4OH_{(aq)}$

$NH_{3(g)} + HCl_{(aq)} \rightarrow NH_4Cl_{(aq)}$

$2NH_{3(g)} + H_2SO_{4(aq)} \rightarrow (NH_4)_2SO_{4(aq)}$

$3NH_{3(g)} + H_3PO_{4(aq)} \rightarrow (NH_4)_3PO_{4(aq)}$

$NH_{3(g)} + HNO_{3(aq)} \rightarrow NH_4NO_{3(aq)}$

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Colors

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	grey-green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

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Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

Indicator	Color in acids	Color when neutral	Color in alkalis
Litmus	Red		Blue
Methyl Orange	Red	Orange	Yellow
Phenolphthalein	Colorless	Colorless	Pink
Thymolphthalein	Colorless	Colorless	Blue

Universal Indication				
Acid		Neutral	Alkali	
0 - 3	4 - 6	7	8 - 11	12 - 14

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Salt	Formula	Solid	Aqueous
Anhydrous Copper (II) Sulfate	$CuSO_4$	White	Blue
Hydrated Copper(II) Sulfate	$CuSO_4.5H_2O$	Blue crystals	Blue
Copper (II) Hydroxide	$Cu(OH)_2$	Blue	Insoluble
Copper (II) Nitrate	$Cu(NO_3)_2$	Blue	Blue
Copper (II) Chloride	$CuCl_2$	Green	Green
Copper(II) Carbonate	$CuCO_3$	Green	Insolube
Iron(II) Salts		Pale Green	Pale Green
Iron(III) Salts		Reddish Brown	Reddish Brown
Iron(II) Oxide	FeO	Black	Insolube
Mn(IV) Oxide	MnO_2	Black	Insolube

Transition metals form **colored compounds**

All group (I), group (II) and group (III) salts are white

All metals are silvery grey except **copper** and **gold**

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Uses

Uses of diamond

- Jewelry
- Cutting
- Drilling

Uses of graphite

- Lubricant
- Pencils
- Electrodes

Uses of silica

- Making glasses
- Making lenses

Applications of fractional distillation

- Various fractions from petroleum
- Different gasses from liquid air
- Separation of ethanol from water
- Separation of mixture of alkenes produced by cracking

Uses of chromatography

- Used to separate components like..
    - Dyes
    - Enzymes/Amino acids
    - Carbohydrates

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- Used to identify food additives like coloring and flavoring substances to check its purity

Applications and uses of electrolysis

- Refining of copper
- Electroplating
- Extraction of highly reactive metals from its molten compounds

Uses of aluminium

- Air crafts (airplanes) due to its low density
- Overhead cables
- Cooking utensils
- Food containers

Uses of hard steel

- Bridges
- Railway lines
- Building constructions
- Knives
- Hammers

Uses of mild steel

- Car bodies
- Machinery

Uses of stainless steel

- Cutlery
- Kitchen sinks and pipes
- Surgical tools

Uses of zinc

- Galvanizing
- Sacrificial protection
- Battery (cell)
- Brass alloy

Uses of copper

- Electric wires
- Cooking utensils
- Pipes
- Making alloys

Uses of water

At Home..

- Drinking
- Cooking
- Washing

In Industry..

- Solvent
- Coolant
- Manufacture of ethanol

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- Manufacture of sulfuric acid (contact process)

Uses of nitrogen

- Filling bags of chips as it is unreactive and to keep air (oxygen) away to avoid rancidity
- Making of ammonia and fertilizers (haber process)

Uses of oxygen

- Cutting and welding of metals

Uses of Carbon dioxide

- Fizzy drinks
- Fire extinguisher

Uses of noble gases

- Helium is used to fill balloons
- Argon is used as a filler in light bulbs
- Neon is used in advertising signs

Uses of limestone

- Used to make cement
- Neutralize acidity in soil and lakes
- Making of lime through thermal decomposition

Uses of lime and slaked lime

- Flue gas desulfurization
- Neutralize acidity of lakes

Uses of dilute sulfuric acid

- Acid in car battery
- Laboratory reagent
- Making of fertilizer

Uses of concentrated sulfuric acid

- Dehydration agent (removes water from compounds)
- Drying agent (removes water from mixture)
- Catalyst

Uses of ammonia

- Making of fertilizers
- Making of nitric acid

Uses of fertilizers

- Increase soil fertility
- Promote plant growth
- Increase the crop yield

Uses of alkanes

- Methane is the main component of natural gas (used as a fuel)
- Butane is used in the bottled gas

Uses of ethene

- Manufacture of polymers (like polyethene)
- Making ethanol

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Uses of ethanol

- Biofuel
- Solvent
- Making perfumes
- Making esters
- To make vinegar (ethanoic acid)
- Antiseptic

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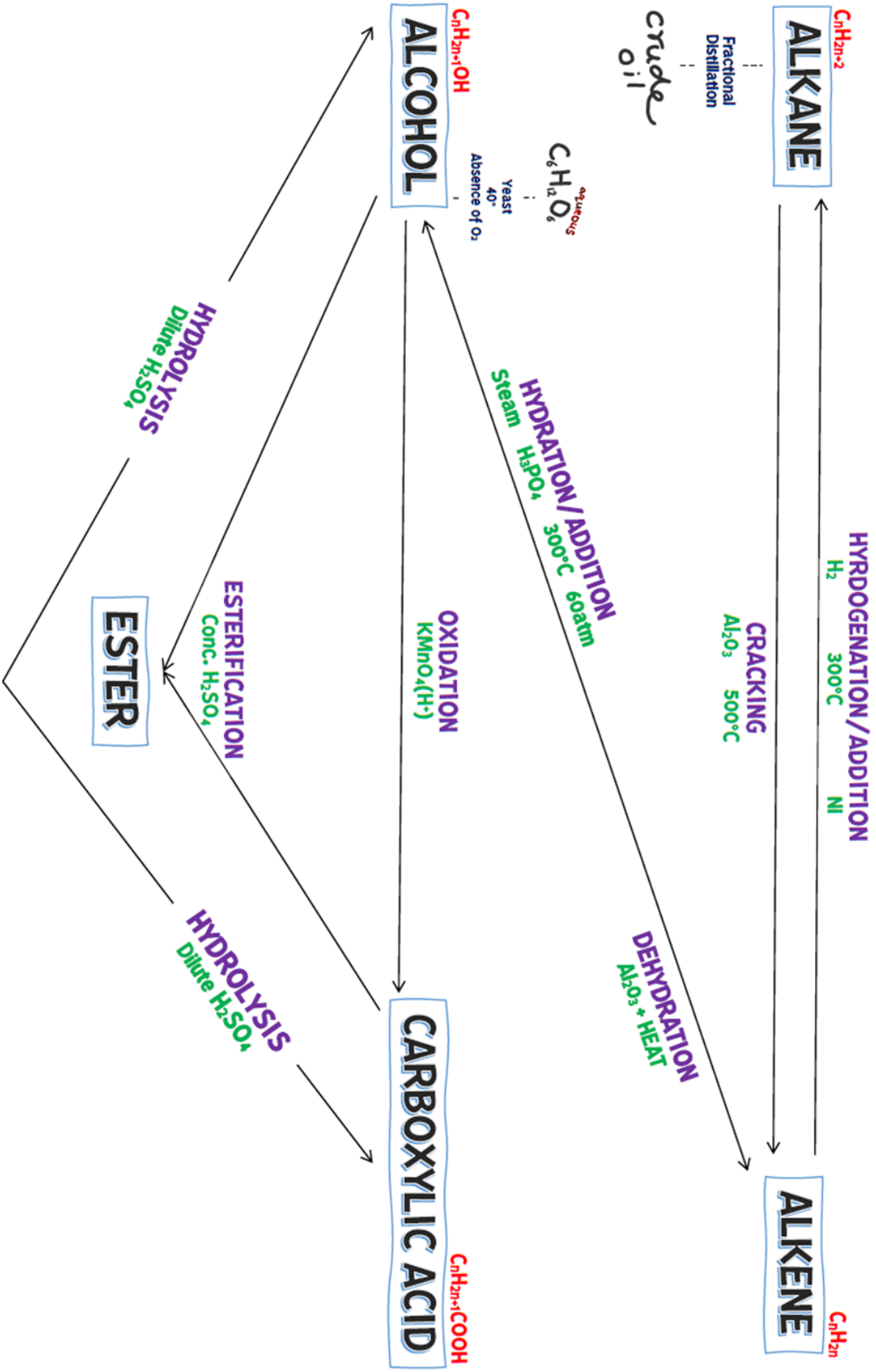
Organic Chemistry



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