A level Chemistry

What will I learn?

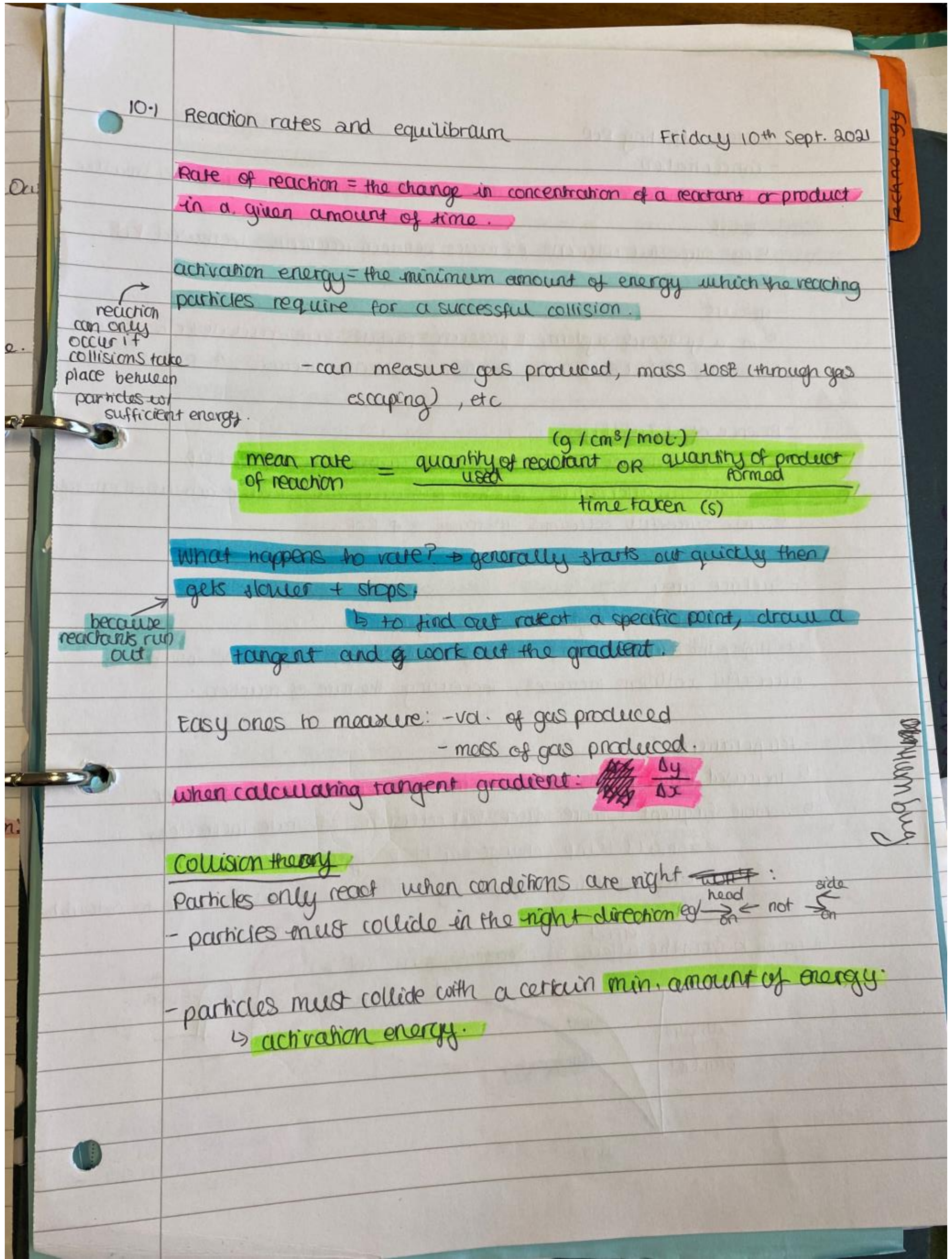
- We are following the OCR A course.
- Specification code: H432
- https://www.ocr.org.uk/qualifications/as-and-a-level/chemistry-a-h032-h432-from-2015/
- Split into 6 units, assessed over 3 papers. There is a separate practical endorsement which is assessed in school by your teachers.

- Module 1- Development of practical skills.
- Module 2- Foundations in chemistry
- Module 3- Periodic table and energy
- Module 4- Core organic chemistry
- Module 5- Physical chemistry and transition elements
- Module 6- Organic chemistry and analysis

How will I be taught?

- You will have 9 hours of lessons per cycle, split between 2 teachers.
- Lessons will be a mixture of taught theory, application of what has been taught and practicals linked to content.
- There are regular assessments to increase familiarity with exam questions and ensure to teachers know how students are doing in terms of learning and understanding content.

Student work



10·1 Reaction rates and equilibraum Friday 10th Sept. 2021

Rate of reaction = the change in concentration of a reactant or product in a given amount of time.

activation energy = the minimum amount of energy which the reacting particles require for a successful collision.

reaction can only occur if collisions take place between particles w/ sufficient energy.

- can measure gas produced, mass lost (through gas escaping), etc

mean rate of reaction = $\dfrac{\text{quantity of reactant used (g / cm}^3\text{/ mol) OR quantity of product formed}}{\text{time taken (s)}}$

What happens to rate? → generally starts out quickly then gets slower + stops.

because reactants run out

↳ to find out rate at a specific point, draw a tangent and work out the gradient.

Easy ones to measure: - vol. of gas produced
- mass of gas produced.

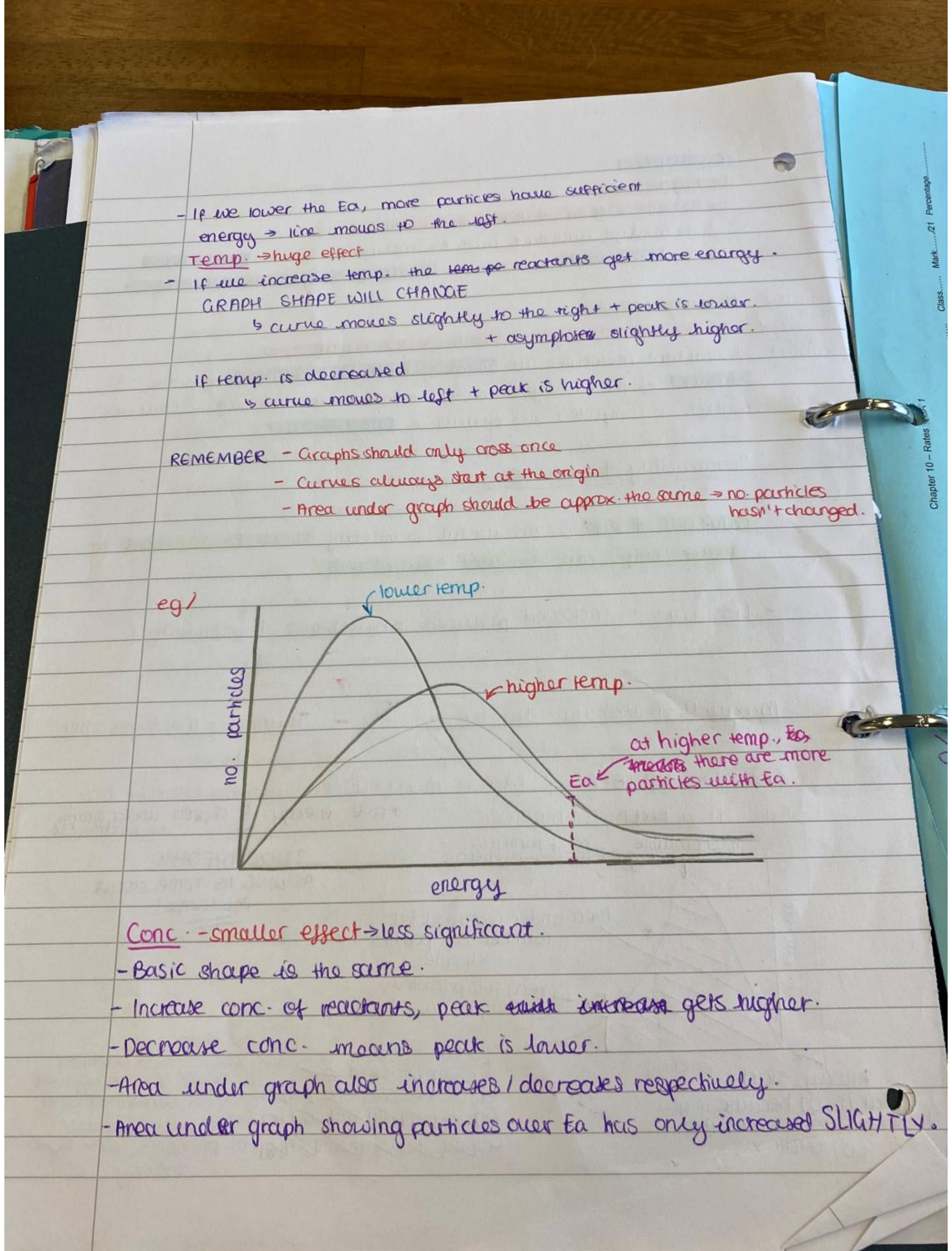
when calculating tangent gradient: $\frac{\Delta y}{\Delta x}$

Collision theory

Particles only react when conditions are right ~~WHT~~:
- particles must collide in the right direction eg/ $\xrightarrow[\text{on}]{\text{head}}\leftarrow$ not $\xrightarrow[\text{on}]{\text{side}}$

- particles must collide with a certain min. amount of energy:
  ↳ activation energy.

Technology



- If we lower the Ea, more particles have sufficient energy → line moves to the left.

Temp. → huge effect
- If we increase temp. the ~~temp pe~~ reactants get more energy.

GRAPH SHAPE WILL CHANGE
↳ curve moves slightly to the right + peak is lower.
+ asymptotes slightly higher.

if temp. is decreased
↳ curve moves to left + peak is higher.

REMEMBER
- Graphs should only cross once
- Curves always start at the origin
- Area under graph should be approx. the same → no. particles hasn't changed.

eg/

Conc. - smaller effect → less significant.
- Basic shape is the same.
- Increase conc. of reactants, peak ~~with~~ ~~increase~~ gets higher.
- Decrease conc. means peak is lower.
- Area under graph also increases / decreases respectively.
- Area under graph showing particles over Ea has only increased SLIGHTLY.

Chapter 10 – Rates

Class...... Mark....../21 Percentage.........

– equation – shows how rate is linked to conc. of reactants.

→ rate $= k[\text{conc}]^{\text{no.}}$

→ zero order → doesn't appear in equation and = 1

orders of reaction

zero order – conc. has no effect on rate

1st order – $[A]^1$

→ conc. doubles, rate doubles $[2]^1 = 2$

→ conc. triples, rate triples $[3]^1 = 3$

2nd order – $[A]^2$

→ conc. doubles, rate quadruples $[2]^2 = 4$

→ conc. triples, rate increases by factor of 9 $[3]^2 = 9$

$A + B \rightarrow C + D$

rate $= k[A]^m[B]^n$ → orders → power to which the conc. of that reactant is raised in the rate eqs

↳ rate constant → proportionality constant links rate to concs. in eq.

overall order = sum of all orders

Balancing numbers are ignored.

e.g. $B + C + D \rightarrow E + F$

rate $= k[B]^2[D]$ overall = 3

3rd order uncommon

changing concentrations

$B + C + D \rightarrow E + F$

Rate $= k[B]^2[D]$

- double conc. of B, rate increases by factor of 4. $(\times2)^2 = 4$
- double conc. of C, no change. $(\times2)^0 = 1$
- double conc. of D, rate doubles. $(\times2)^1 = 2$
- double conc. of all, rate increases by factor of 8. $(\times2)^2(\times2)^0(\times2)^1 = 8$

UNITS:

rate = $\text{mol dm}^{-3}\,\text{s}^{-1}$

conc. = mol dm^{-3}

k = depends on overall order

1 s^{-1}

2 $\text{mol}^{-1}\,\text{dm}^{3}\,\text{s}^{-1}$

3 $\text{mol}^{-2}\,\text{dm}^{6}\,\text{s}^{-1}$

4 $\text{mol}^{-3}\,\text{dm}^{9}\,\text{s}^{-1}$

5 $\text{mol}^{-4}\,\text{dm}^{12}\,\text{s}^{-1}$

e.g. $k[A]^2[B]$

overall = 3

rate $= k \times (\text{conc})^3$

$\text{mol dm}^{-3}\,\text{s}^{-1} = k(\text{mol dm}^{-3}\,\text{s}^{-1})^3$

$$k = \frac{\text{mol dm}^{-3}\,\text{s}^{-1}}{(\text{mol dm}^{-3})^3} = \frac{\text{mol dm}^{-3}\,\text{s}^{-1}}{\text{mol}^3\,\text{dm}^{-9}}$$

$k = \text{mol}^{-2}\,\text{dm}^{6}\,\text{s}^{-1}$

~~CONC~~ Concentration-Time Graphs:

– Plotted from continuous monitoring [illegible].

e.g. monitoring gas loss or mass loss [illegible] x seconds during a reaction

– Also can measure colour change with a colorimeter.

orders from shape

zero order – straight line, – gradient, rate doesn't change, gradient = k

1st order – downward curve, decreasing gradient as reaction gradually slows down

2nd order – similar to 1st but steeper at start & trails off more slowly

HALF-LIFE 1st ORDER REACTIONS:

Calculating k from rate:

→ Draw tangent to curve at specific conc.

→ gradient = rate

→ $k = \dfrac{\text{rate}}{\text{tangent conc.}}$

k from ½ life:

$$k = \frac{\ln 2}{t_{\frac{1}{2}}}$$

→ more accurate than tangent

Half-life → time taken [illegible] conc. to half.

→ used to find k

MODULE 5

CHAPTER 18

temperature

- Rate constant dependent on temp.
- If we change temp., this will cause rate to change as well as any changes made to concs. of reactants.
- A small increase in temp. massively affects rate. As temp increases, so does k. Increase is exponential. →

deducing & using orders of reaction

- Question containing "at a constant temp." is important because rate is affected by temp. so data isn't comparable if experiments are carried out at different temperatures.

e.g. $2NO_2 + O_3 \rightarrow N_2O_5 + O_2$

	NO_2	O_3	Rate
1	1×10^{-3}	2.5×10^{-3}	3.2×10^{-8}
2	2×10^{-3} ×2	2.5×10^{-3}	6.4×10^{-8} ×2
3	2×10^{-3}	5×10^{-3} ×2	1.28×10^{-7} ×2

rate $= k[NO_2][O_3]$

$3.2\times10^{-8} = k[1\times10^{-3}][2.5\times10^{-3}]$

$$\frac{3.2\times10^{-8}}{2.5\times10^{-6}} = 0.0128\,\text{mol}^{-1}\,\text{dm}^{3}\,\text{s}^{-1}$$

Rate-Concentration Graphs:

orders from shape

zero order – horizontal straight line, conc. has no effect on rate.

1st order – straight line through origin. Rate is directly proportional to concentration. k = gradient

2nd order – upwards curve, increasing gradient. To find k, a second graph needs to be plotted of rate vs conc². The gradient of this one = k.

initial rates – instantaneous rate at start of reaction.

- Found by drawing a tangent at t = 0 on a conc-time graph.
- Can also carry out a clock reaction. T is how long from the start of a reaction until a visual change is seen e.g. colour change.
  - We can assume the average rate = initial rate.
  - Initial rate is proportional to $\frac{1}{t}$.
  - We would need to carry this out for multiple concentrations and do $\frac{1}{t}$ for each.

→ Iodine clock is commonly used → we measure time taken for deep blue/black colour to form.

Orders of Reaction:

- We know how to work out the order of a reaction and how to write that in an equation, but we can also use this to work out the mechanism of a reaction.

e.g. $A + 2B \rightarrow AB_2$ *

→ Could occur in 2 stages: $A + B \rightarrow AB$

$AB + B \rightarrow AB_2$

- We can add the steps together, do some cancelling out and end up with the overall rea

→ $A + B + AB + B \rightarrow AB + AB_2$

- If we cancel out, we end up with what we started with at the beginning.

rate-determining step

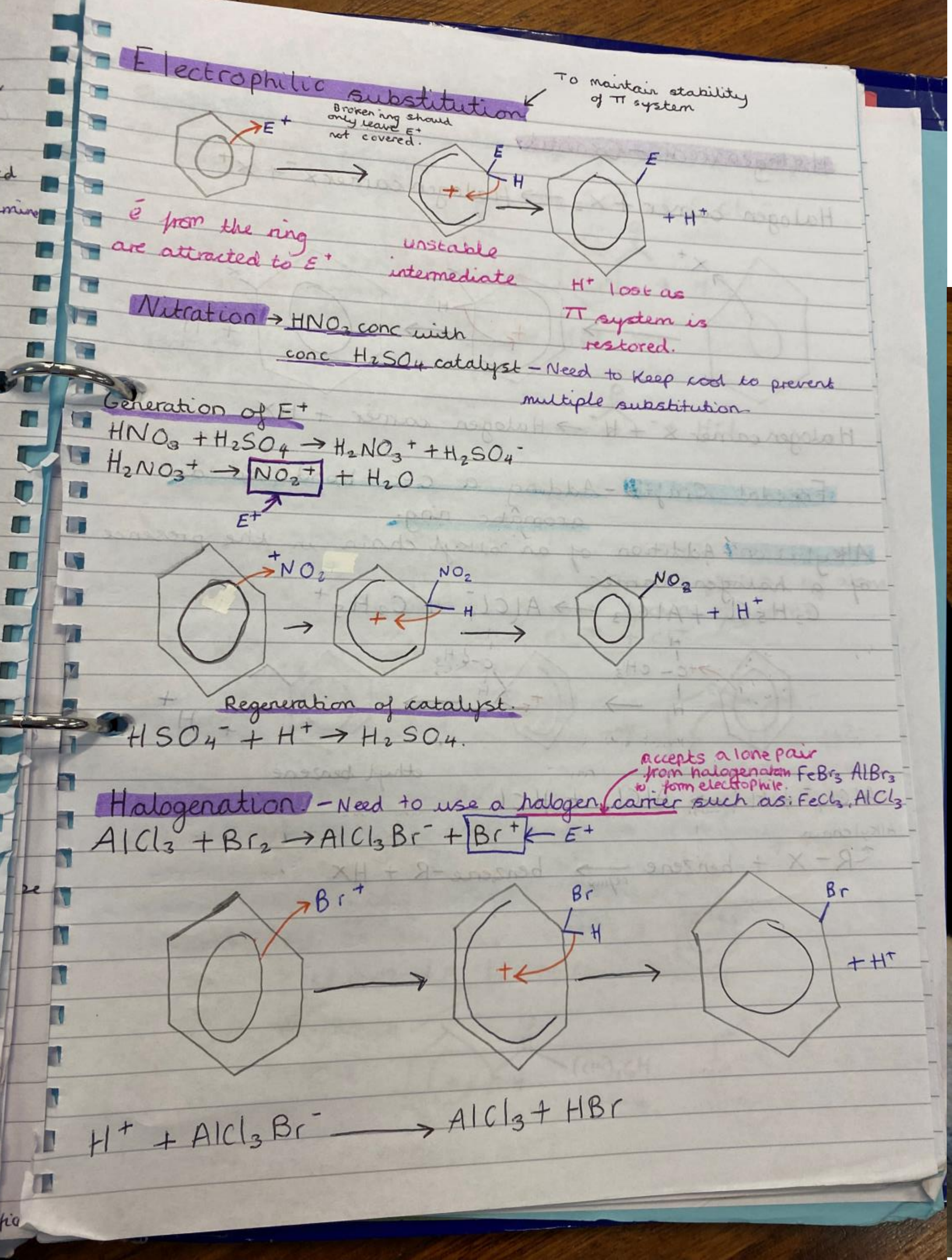
- Any step in the ~~[illegible]~~ mechanism can be the rate determining step.
- It is the slowest step, and as such it dictates the rate of reaction.
- The species reacting in the rate determining step are those which are present concentrations with orders that are NOT zero.
  - Reactants in the overall equation with zero orders have no involvement rate determining step.

* e.g. $k[N_2O]$ $2N_2O \rightarrow 2N_2 + O_2$

rds * $N_2O \rightarrow N_2 + \cancel{O}$

~~O+~~ $N_2O \rightarrow N_2 + O_2$

$\therefore 2N_2O \rightarrow 2N_2 +$



Electrophilic substitution

To maintain stability of π system

Broken ring should only leave E^+ not covered.

é from the ring are attracted to E^+

unstable intermediate

H^+ lost as π system is restored.

Nitration → HNO_3 conc with conc H_2SO_4 catalyst – Need to keep cool to prevent multiple substitution

Generation of E^+

$HNO_3 + H_2SO_4 \rightarrow H_2NO_3^+ + H_2SO_4^-$

$H_2NO_3^+ \rightarrow \boxed{NO_2^+} + H_2O$

E^+

Regeneration of catalyst.

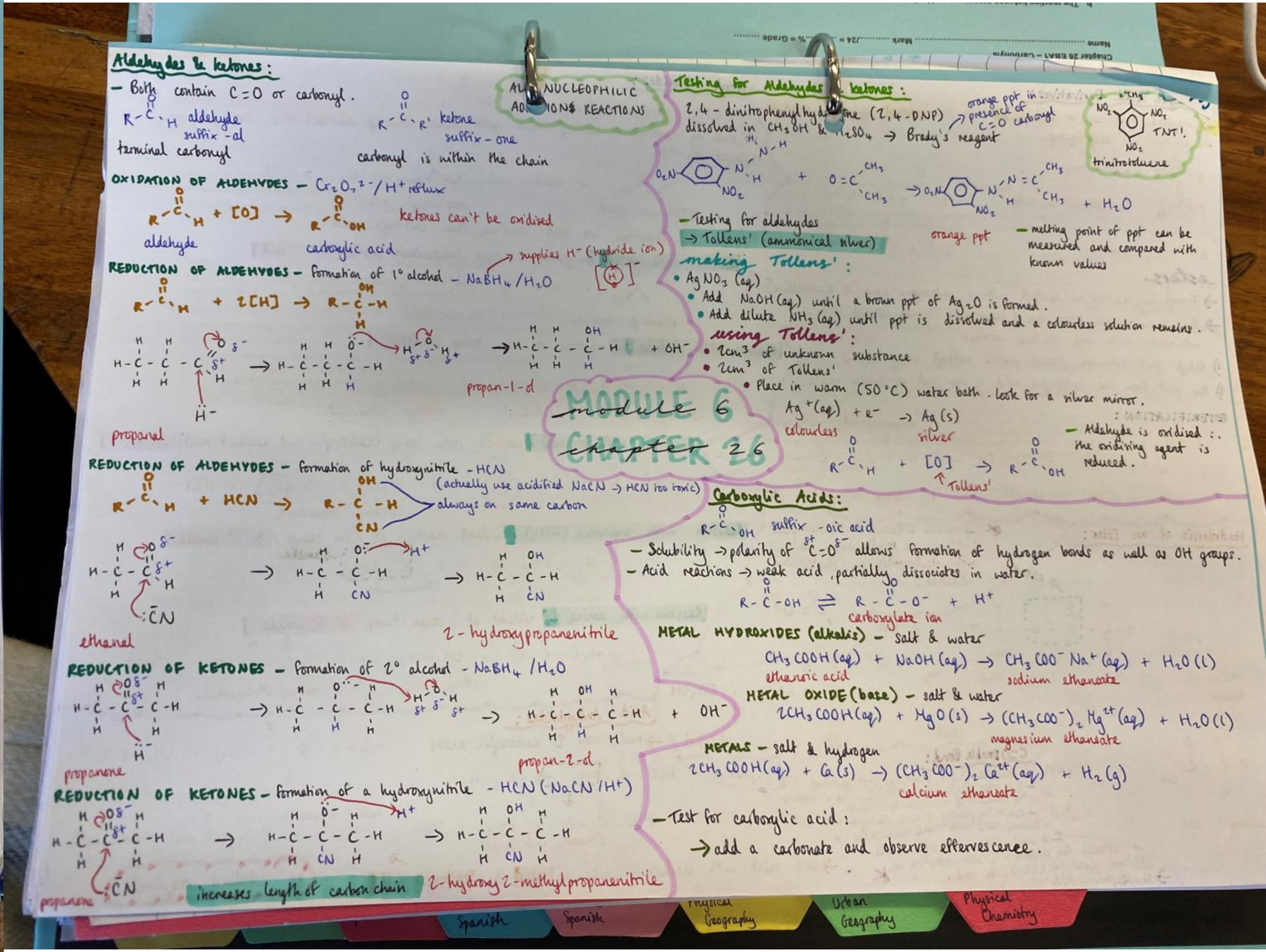
$HSO_4^- + H^+ \rightarrow H_2SO_4$.

Halogenation – Need to use a halogen carrier such as: $FeCl_3$, $AlCl_3$

accepts a lone pair from halogen atom to form electrophile. $FeBr_3$ $AlBr_3$

$AlCl_3 + Br_2 \rightarrow AlCl_3Br^- + \boxed{Br^+} \leftarrow E^+$

$H^+ + AlCl_3Br^- \longrightarrow AlCl_3 + HBr$



Chapter 26 EBA1 – Carbonyls

Name ……………… Mark ………/24 = ……% = Grade ………

Aldehydes & ketones:

- Both contain C=O or carbonyl.

R–C(=O)–H aldehyde, suffix -al, terminal carbonyl

R–C(=O)–R' ketone, suffix – one, carbonyl is within the chain

AL[L] NUCLEOPHILIC AD[DIT]IONS REACTIONS

OXIDATION OF ALDEHYDES – $Cr_2O_7^{2-}/H^+$ reflux

$R\text{–}CHO + [O] \rightarrow R\text{–}COOH$

aldehyde → carboxylic acid

ketones can't be oxidised

REDUCTION OF ALDEHYDES – Formation of 1° alcohol – $NaBH_4/H_2O$ → supplies H^- (hydride ion) $[H]^-$

$R\text{–}CHO + 2[H] \rightarrow R\text{–}CH_2OH$

propanal → propan-1-ol

REDUCTION OF ALDEHYDES – Formation of hydroxynitrile – HCN (actually use acidified NaCN → HCN too toxic)

$R\text{–}CHO + HCN \rightarrow R\text{–}CH(OH)CN$ – OH and CN always on same carbon

ethanal → 2-hydroxypropanenitrile

REDUCTION OF KETONES – Formation of 2° alcohol – $NaBH_4/H_2O$

propanone → propan-2-ol

REDUCTION OF KETONES – Formation of a hydroxynitrile – HCN (NaCN/H^+)

propanone → 2-hydroxy 2-methylpropanenitrile

increases length of carbon chain

~~module~~ MODULE 6

~~chapter~~ CHAPTER 26

Testing for Aldehydes & ketones:

2,4-dinitrophenylhydrazine (2,4-DNP) dissolved in CH_3OH & H_2SO_4 → Brady's reagent → orange ppt in presence of C=O carbonyl

orange ppt

- melting point of ppt can be measured and compared with known values

NO_2 CH_3 NO_2 NO_2 TNT! trinitrotoluene

- Testing for aldehydes

→ Tollens' (ammonical silver)

making Tollens':

- $AgNO_3$ (aq)
  - Add NaOH(aq) until a brown ppt of Ag_2O is formed.
  - Add dilute NH_3(aq) until ppt is dissolved and a colourless solution remains.

using Tollens':

- $2cm^3$ of unknown substance
- $2cm^3$ of Tollens'
  - Place in warm (50 °C) water bath. Look for a silver mirror.

$Ag^+(aq) + e^- \rightarrow Ag(s)$

colourless → silver

$R\text{–}CHO + [O] \rightarrow R\text{–}COOH$ ([O] ↑ Tollens')

- Aldehyde is oxidised ∴ the oxidising agent is reduced.

Carboxylic Acids:

R–C(=O)–OH suffix -oic acid

- Solubility → polarity of $\overset{\delta+}{C}=\overset{\delta-}{O}$ allows formation of hydrogen bonds as well as OH groups.
- Acid reactions → weak acid, partially dissociates in water.

$R\text{–}C(=O)\text{–}OH \rightleftharpoons R\text{–}C(=O)\text{–}O^- + H^+$ carboxylate ion

METAL HYDROXIDES (alkalis) – salt & water

$CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COO^-Na^+(aq) + H_2O(l)$

ethanoic acid → sodium ethanoate

METAL OXIDE (base) – salt & water

$2CH_3COOH(aq) + MgO(s) \rightarrow (CH_3COO^-)_2Mg^{2+}(aq) + H_2O(l)$

magnesium ethanoate

METALS – salt & hydrogen

$2CH_3COOH(aq) + Ca(s) \rightarrow (CH_3COO^-)_2Ca^{2+}(aq) + H_2(g)$

calcium ethanoate

- Test for carboxylic acid:

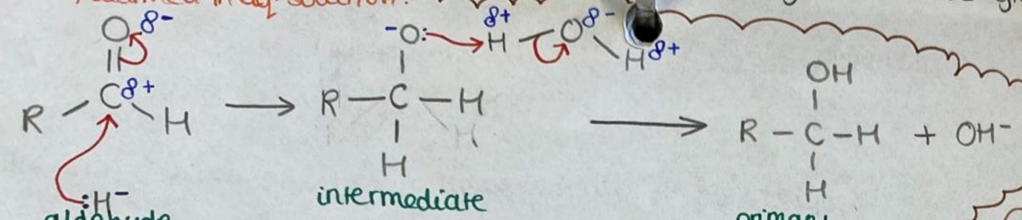
→ add a carbonate and observe effervescence.

Spanish
Spanish
Physical Geography
Urban Geography
Physical Chemistry

Chapter 2 - Carbonyls and carboxylic acid

Reduction of an aldehyde/ketone

↳ $NaBH_4$, warmed in aq. solution.



aldehyde

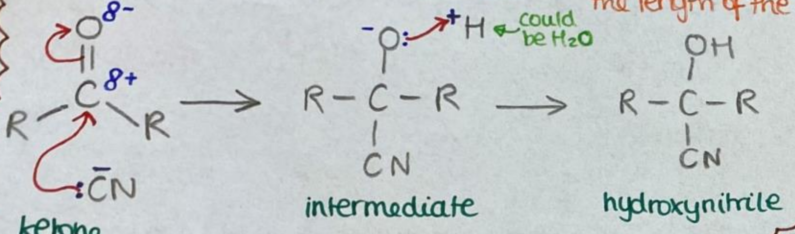
↳ same with ketones but a secondary alcohol is formed

intermediate

primary alcohol

Reduction of an aldehyde/ketone

↳ HCN (H_2SO_4/NaCN form ~~HCN~~ HCN in situ) ⇒ v. useful because it increases the length of the carbon chain



ketone

↳ same with aldehydes

intermediate

hydroxynitrile

Detecting carbonyls

- 2,4-dinitrophenylhydrazine – dissolved in methanol and sulfuric acid. (↳ explosive, solid, orange)
- Yellow/orange ppt indicates presence of a C=O group.

Distinguishing between aldehydes and ketones

Making Tollens'

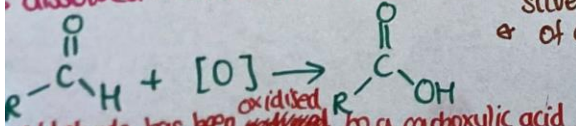
- Add NaOH(aq) to $AgNO_{3(aq)}$ until a brown ppt is formed – $Ag_2O_{(s)}$
- Add dilute $NH_{3(aq)}$ until ppt dissolved → colourless solution.

Using Tollens'

- 2cm³ unknown substance
- 2cm³ Tollens'
- Place in 50°C water bath

↓

silver mirror indicates presence of aldehyde.



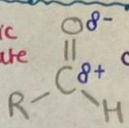
Aldehyde has been ~~reduced~~ oxidised to a carboxylic acid

$Ag^+_{(aq)} + e^- \rightarrow Ag_{(s)}$

Ag^+ ions of Ag_2O are reduced to silver ppt.

CARBOXYLIC ACID FACT FILE

- Te for carboxylic acid = add a carbonate and see if it fizzes.



- polar bond means that it can make H bonds with water molecules - soluble
- weak acid - can partially dissociate in water

Reactions:

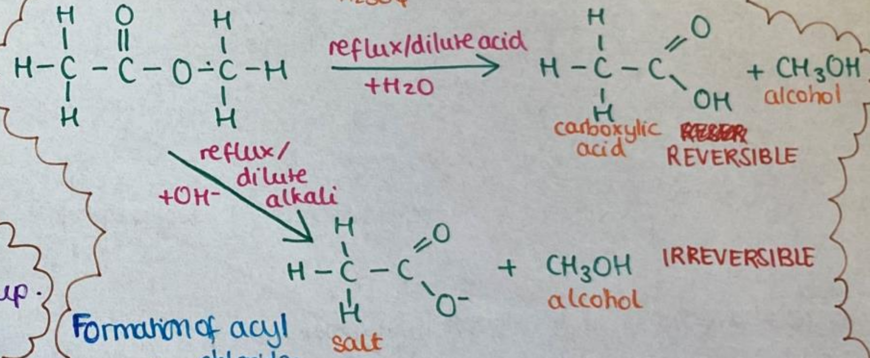
carboxylic acid + metal hydroxide → salt (eg sodium ethanoate) + H_2O

carboxylic acid + metal oxide → salt + water

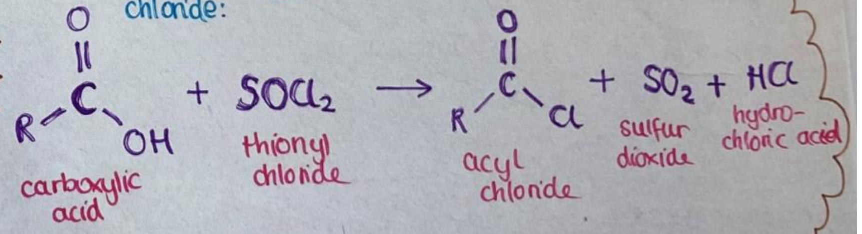
carboxylic acid + metal → salt + hydrogen

carboxylic acid + metal carbonate → salt + water + carbon dioxide

carboxylic acid + alcohol $\xrightarrow[\text{conc. } H_2SO_4]{\text{warm}}$ ester + water



Formation of acyl chloride:



acyl chlorides are more reactive than carboxylic acids.

Where can I go with this?

- **Apprenticeships-** pharmacy assistant, theatre support worker, laboratory/science technician, gas installation engineer, polymer production technician
- **University courses-** Chemistry, medicine, veterinary science, dentistry, biochemistry, biomedicine, chemical engineering, pharmacy, food science, environmental science

- This website has more info about where a level chemistry can lead and what it links well with
- https://successatschool.org/advicedetails/190/Why-Study-Chemistry%3F

- UCAS website has more examples of pathways:
- https://www.ucas.com/job-subjects/chemistry