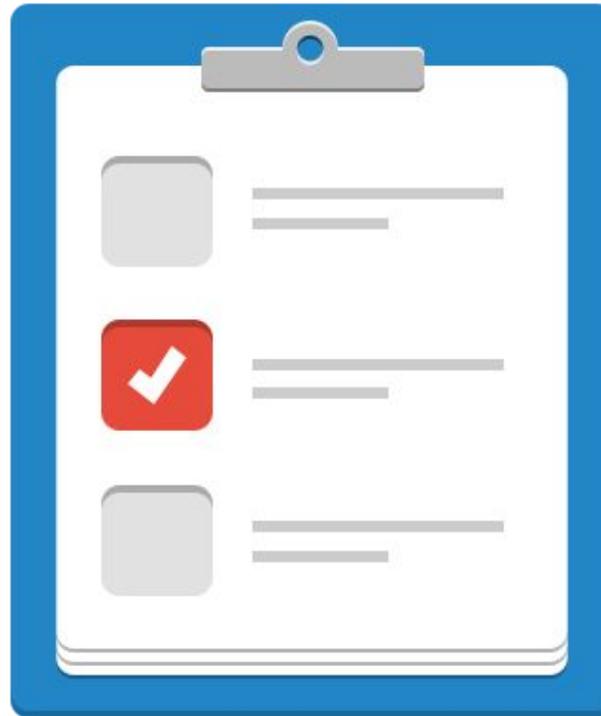
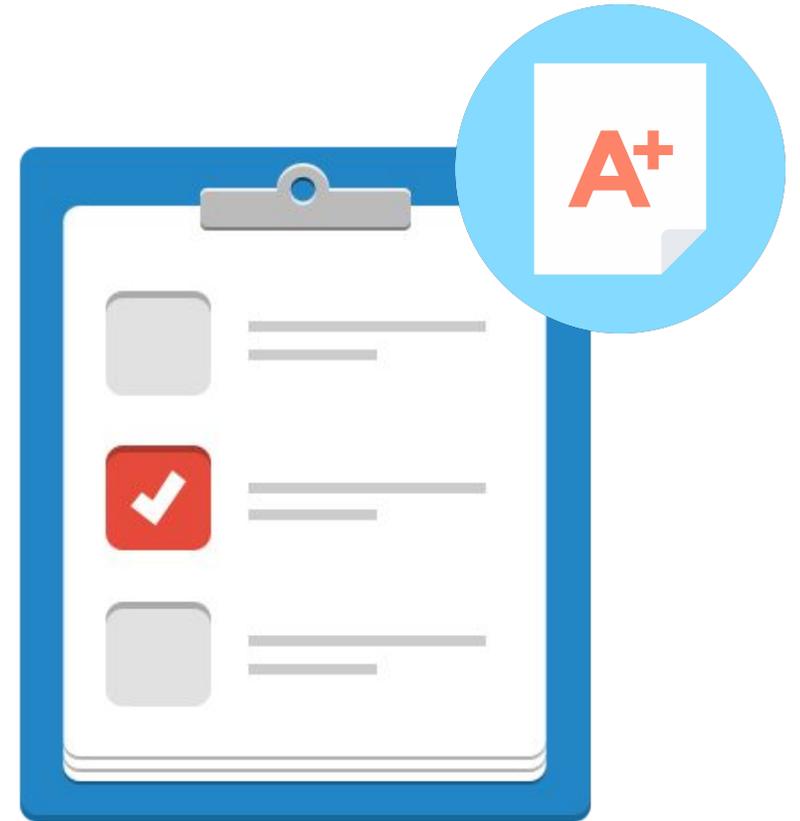


# Exam Technique



# What are we going to cover?

- Interpreting questions
- How to **set out answers**
- Examples of **command words**
- Tried and tested **exam wisdom**



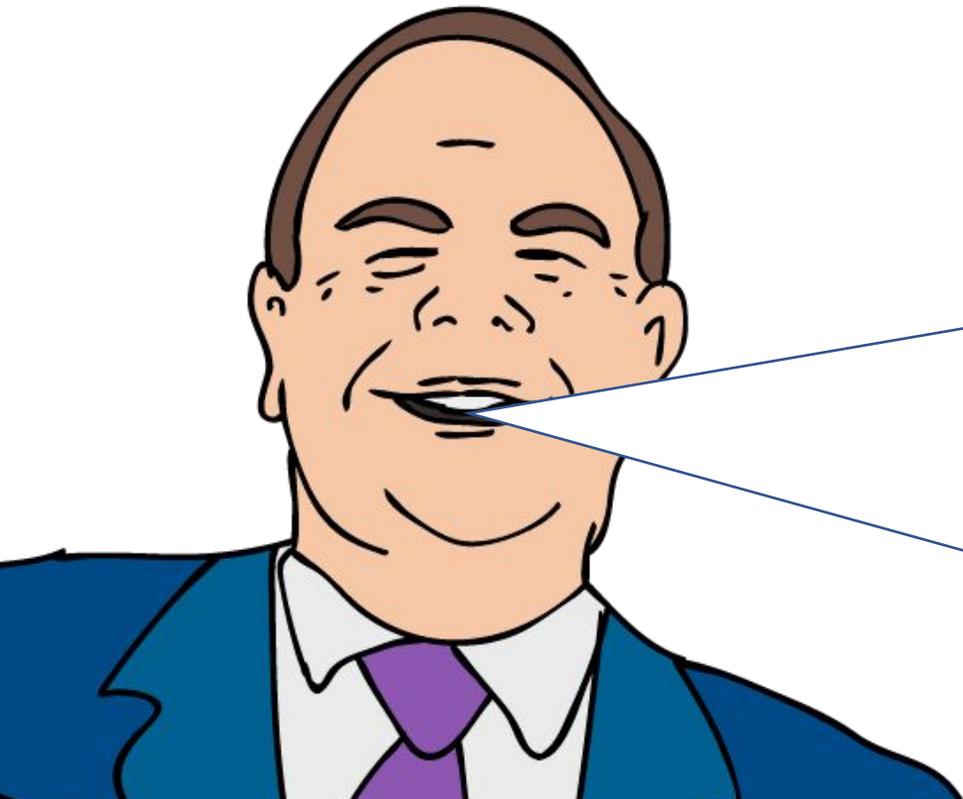
# Aim for today



To **revise** as much of A-Level Chemistry as possible, in a way that also gets you thinking about **answering questions** in the exam

We've chosen year 13 chemistry topics that have **overlap** with other topics, can be used to **summarise concepts** and that are covered by AQA, Edexcel and OCR

# What do the examiners say?

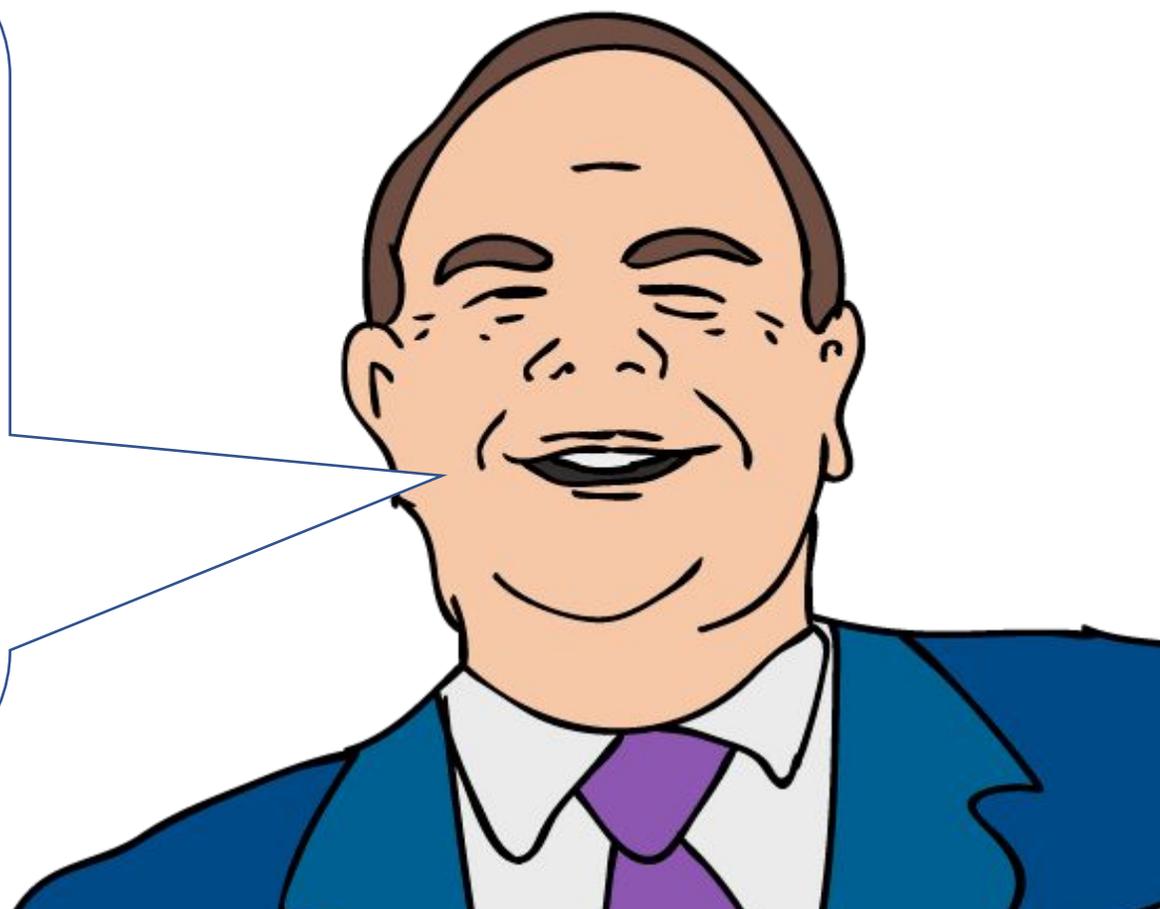


“Questions that demanded an **extended response** proved tough, and only the best students were able to **organize their thoughts** into a **logical sequence** enabling them to score the highest marks.”

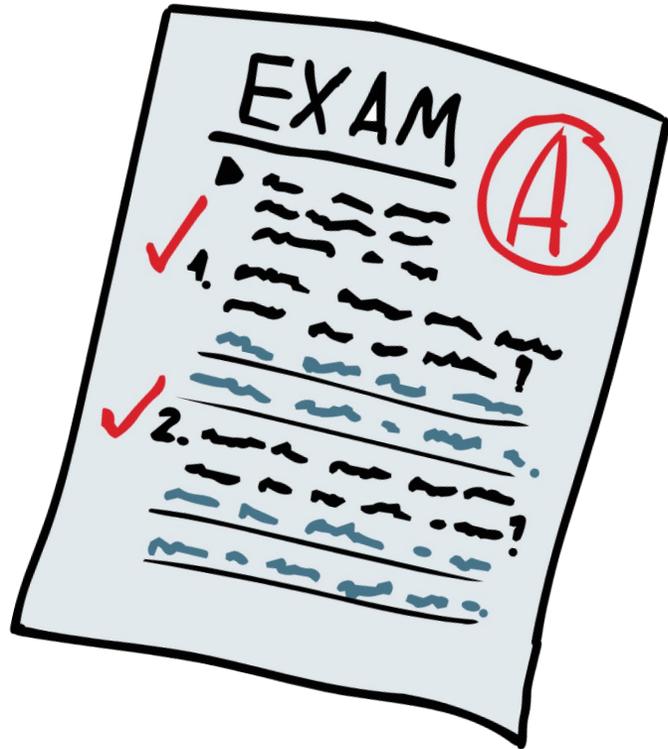
“Key lessons from this paper are the need to develop **mathematical skills** and to place a far greater emphasis on doing and **understanding practical work.**”

# What do the examiners say?

“Less able students did not use **correct scientific terminology**, for example, they interchanged atoms, molecules, ions, radicals, elements and compounds without understanding what the correct word should be and were **careless** in the way they **drew structures** of organic molecules.”



# Past Papers



Identify **which topics** appear in **which papers** for your exam board

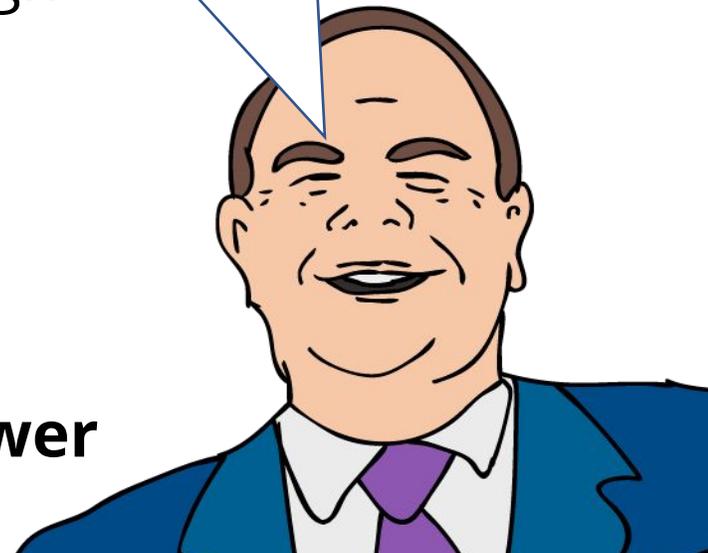
All the **specifications changed** in 2015 so there might be a **limited** number of **past papers** available: you can look at the old-style ones but be aware that there are a number of **changes**

# Past Papers

The newer papers that you'll take have:

- **Fewer multiple-choice questions**
- **More calculations** especially those which are '**unstructured**': meaning that they don't walk you through mark-by-mark
- **More** questions based on **practical techniques**
- **More** questions that require an **extended written answer**

"**Practical work** is a greater component of the examination questions due to the removal of coursework."



(b) The table shows the standard electrode (redox) potentials,  $E^\ominus$ , for some half-cell reactions.

Redox system	Half-cell reaction	$E^\ominus / \text{V}$
1	$\text{V}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{V}(\text{s})$	-1.20
2	$\text{V}^{3+}(\text{aq}) + \text{e}^- \rightleftharpoons \text{V}^{2+}(\text{aq})$	-0.26
3	$\text{VO}^{2+}(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{V}^{3+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+0.34
4	$\text{VO}_2^+(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{VO}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+1.00
5	$\text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$	+0.17

(i) Explain, using information from the table, the colour changes that take place when  $\text{SO}_2$  gas is bubbled slowly through an acidified solution containing  $\text{VO}_2^+$  ions.

Equations are not required.

(3)

.....

.....

.....

.....

.....

.....

**Context** – this should help you identify the part of the specification that is relevant to the question

**Command words** – these tell you what form you must write your answer in

**Directions** – these tell you specifically what information you need to include in your answer

This is from the **previous part** of the question – be sure to **make use of all relevant resources given**

- 3 Vanadium is a transition metal that forms ions with several oxidation numbers. Four of these ions are shown in the table.

Formula of ion	Oxidation number of vanadium	Colour of ion
$V^{2+}$	+2	violet
$V^{3+}$	+3	green
$VO^{2+}$	+4	blue
$VO_2^+$	+5	yellow

- (b) The table shows the standard electrode (redox) potentials,  $E^\ominus$ , for some half-cell reactions.

Redox system	Half-cell reaction	$E^\ominus / \text{V}$
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5	$\text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$	+0.17

- (i) Explain, using information from the table, the colour changes that take place when  $\text{SO}_2$  gas is bubbled slowly through an acidified solution containing  $\text{VO}_2^+$  ions.

Equations are not required.

$E^\ominus$  of redox system 5 is more negative than redox systems 3 and 4. <sup>(3)</sup>

So  $\text{SO}_2$  will reduce  $\text{VO}_2^+$  to  $\text{VO}^{2+}$  to  $\text{V}^{3+}$ .

The colour changes from yellow to blue to green.

# Interpreting Questions

You will find that questions tend to come in **4 different types**

- **Statement** ~1-2 mark
- **Short answer** ~2-3 marks
- **Calculation** ~1-6 marks
- **Long answer** ~3-6 marks

# Statement Questions

- Test of **rote learning** – your ability to **remember facts**
- Questions usually require information from the **specification**
- May have some **context** from which you will need to **interpret** or **extract** the **subject** of the question

## Command Words:

- **Name/State/Define**
- **Write/Balance/Construct**
- **Identify/Determine**
- **Multiple Choice**
- **Draw**

## Examples:

- Name the mechanism...
- State the conditions...
- Define the term...
- Identify the compound...
- Draw the product...

# Statement – Command Words

**Name/State:** give a **simple one word answer** or a **short sentence**

- **No justification** or **explanation** required but use scientific terminology correctly
- Don't **waste time writing more** than is necessary

**Define:** respond with a **sentence** or **bullet-point** instead of a single word

- It's best if you know the **standard wording**

(i) State what is meant by the term *rate-determining step*.

.....

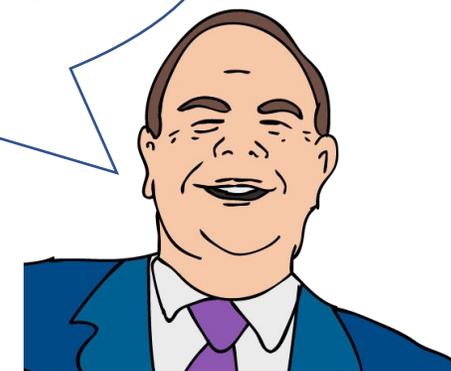
..... [1]

(i) State what is meant by the term *rate-determining step*.

The slowest step of a chemical reaction (which will determine the reaction  
.....  
rate).

..... [1]

“The question just used the command word ‘state’ so no explanation is necessary. Some candidates lost the mark by including a contradictory explanation.”



**Identify/Determine:** select **key information** (sometimes from the question)

- Look carefully at the **context** of the question and **consider all possible options**, eliminating incorrect answers

**Write/Balance/Construct:** usually refers to **chemical expressions** or **reactions**

- Should always be **balanced**, but look out for whether you need **state symbols** or not

(f) Compounds of calcium have many uses.

(i) Identify a compound of calcium that could be used to convert a soil pH from 5.8 to 7.5.

..... [1]

(ii) Calcium phosphide,  $\text{Ca}_3\text{P}_2$ , is an ionic compound used in rat poison.

Calcium phosphide can be prepared by reacting calcium metal with phosphorus,  $\text{P}_4$ .

Write the equation for the reaction of calcium with phosphorus to form calcium phosphide.

..... [1]

**(f)** Compounds of calcium have many uses.

**(i)** Identify a compound of calcium that could be used to convert a soil pH from 5.8 to 7.5.

Calcium carbonate..... [1]

**(ii)** Calcium phosphide,  $\text{Ca}_3\text{P}_2$ , is an ionic compound used in rat poison.

Calcium phosphide can be prepared by reacting calcium metal with phosphorus,  $\text{P}_4$ .

Write the equation for the reaction of calcium with phosphorus to form calcium phosphide.

$6 \text{Ca} + \text{P}_4 \rightarrow 2 \text{Ca}_3\text{P}_2$ ..... [1]

## Multiple Choice:

- Often there's one **totally wrong** answer and two answers deliberately chosen to **confuse** you
- If you're running out of time and aren't sure, **eliminate** any totally wrong answers and **guess** out of those that are left
- If a **calculation** is required, the incorrect answers will be chosen to reflect **common mistakes**

(c) One way in which diamond differs from graphene and graphite is that only diamond has (1)

- A a high melting temperature
- B a precise molecular formula
- C poor electrical conductivity
- D a giant structure

How many secondary amines have the molecular formula  $C_4H_{11}N$ ? [1 mark]

- A 2
- B 3
- C 4
- D 5

(c) One way in which diamond differs from graphene and graphite is that only diamond has (1)

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How many secondary amines have the molecular formula  $C_4H_{11}N$ ?

[1 mark]

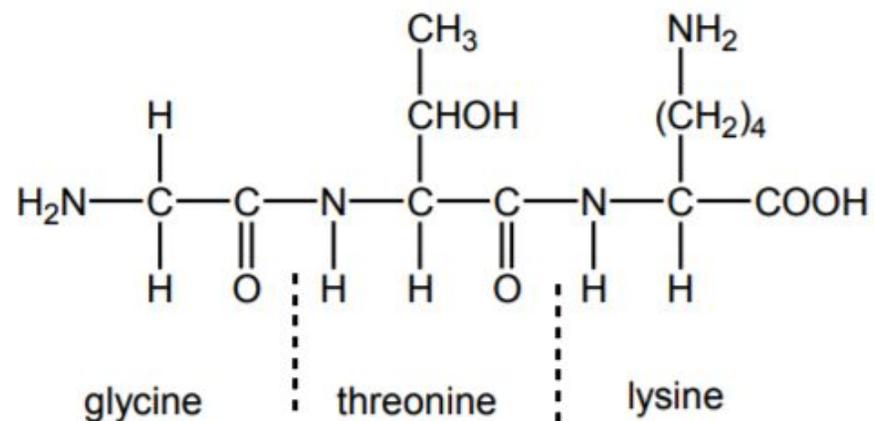
- A 2
- B 3
- C 4
- D 5

**Draw:** **don't rush**, but try to finish these questions **quickly** as they can **take a lot of time** and aren't worth a large amount of marks

6

The tripeptide shown in **Figure 4** is formed from the amino acids glycine, threonine and lysine.

Figure 4



0 6

. 1

Draw a separate circle around **each** of the asymmetric carbon atoms in the tripeptide in **Figure 4**.

[1 mark]



# Short Answer Questions

- Require only **short ~2 line answers**
- Test **understanding** of **general principles/meaning** of **qualitative** results
- Can be combined with **Calculate** questions

## Command Words:

- **Explain**
- **Describe**
- **Suggest/Predict**
- **Plot/Sketch**
- **Draw**

## Examples:

- Explain why...
- Describe how...
- Suggest why...
- Plot a graph...
- Draw the mechanism...

# Short Answer – Command Words

**Explain:** give **step-by-step logical reasoning** for why data/ experiments **show what they show**

- Give a **well-developed** line of **reasoning** which is **clear** and **logically structured**

Explain why sodium oxide forms an alkaline solution when it reacts with water.

**[2 marks]**

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Explain why sodium oxide forms an alkaline solution when it reacts with water.

**[2 marks]**

Sodium oxide contains  $O^{2-}$  ions which react with water to  
\_\_\_\_\_  
produce  $OH^-$  ions.  
\_\_\_\_\_



The number of dotted lines given for the answer is indicative of the length of answer expected for the question.

**Suggest/Predict: application of knowledge and understanding to novel theoretical and practical concepts**

- You must determine which **topic** is related to the information and then **apply** the relevant knowledge
- Often **information** (context) not on the syllabus is provided
- **Suggestion** questions often include **another command word** (e.g. suggest an explanation/ name/ description...)

The entropy change of solution of  $K_2SO_4$  is  $+225 JK^{-1} mol^{-1}$ .

(i) Suggest, in terms of the states of the particles involved, why this entropy change is positive.

.....

.....

.....

..... [1]

The entropy change of solution of  $\text{K}_2\text{SO}_4$  is  $+225\text{J K}^{-1}\text{ mol}^{-1}$ .

- (i) Suggest, in terms of the states of the particles involved, why this entropy change is positive.

Potassium sulfate is a solid meaning it is ordered and has a low  
.....  
entropy.

.....  
Entropy increases as it dissolves as ions become less ordered in  
.....  
solution.

..... [1]

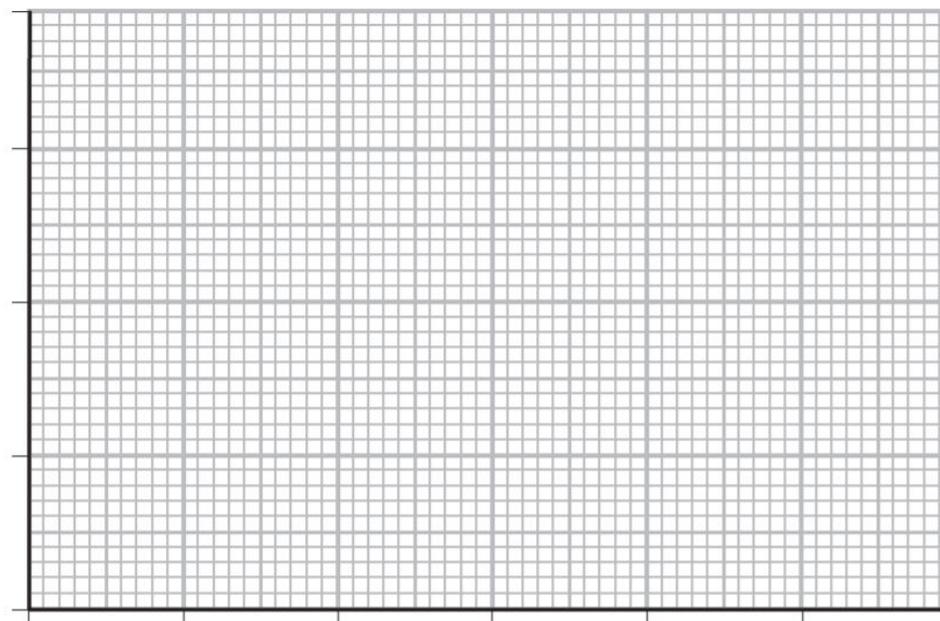
## Plot/Sketch/Draw:

- Picking the right **axis** and **scale** are the toughest parts
- **Practice** these as it's easy to think you know how to draw graphs and skip them when revising
- **Practice** will make you **faster** and **less likely** to **make mistakes**

$[I^-]$ /mol dm <sup>-3</sup>	Time /s	1/time /s <sup>-1</sup>
0.0100	40.0	0.0250
0.0075	53.3	0.0188
0.0050	80.0	0.0125
0.0040	100.0	0.0100

(i) Plot a graph of 1/time on the vertical axis against concentration of iodide ions.

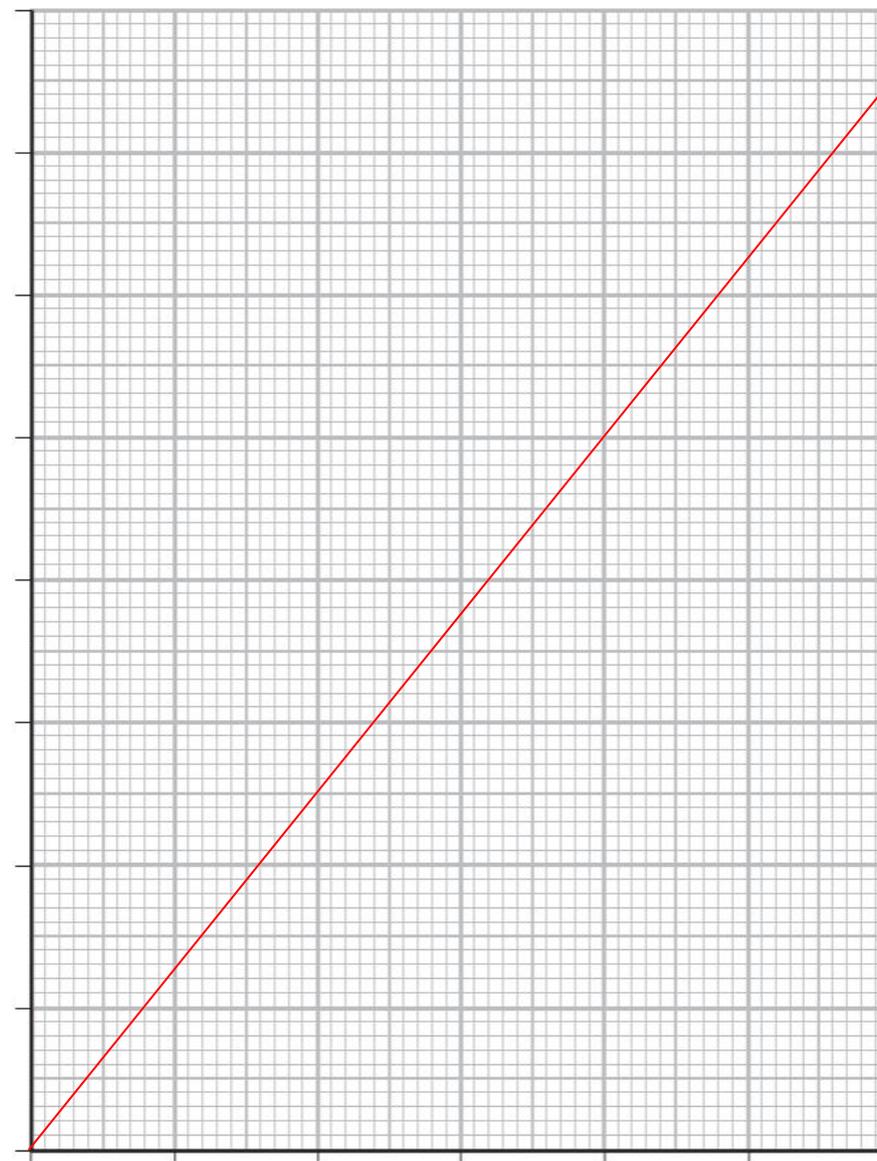
(2)



(i) Plot a graph of  $1/\text{time}$  on the vertical axis against concentration of iodide ions.

(2)

$[\text{I}^-]$ /mol dm <sup>-3</sup>	Time /s	$1/\text{time}$ /s <sup>-1</sup>
0.0100	40.0	0.0250
0.0075	53.3	0.0188
0.0050	80.0	0.0125
0.0040	100.0	0.0100



# Calculation Questions

- **Quantitative** questions
- Include **deduction** of **equations**
- May require **interpreting data sets, figures, equations, or graphs** to **obtain values** required for **calculation**
- May have **multiple dependent steps** – if you **can't do a step** keep going for **error carried forward marks**

## Command Words:

- **Calculate**
- **Determine**
- **Show your working**

## Examples:

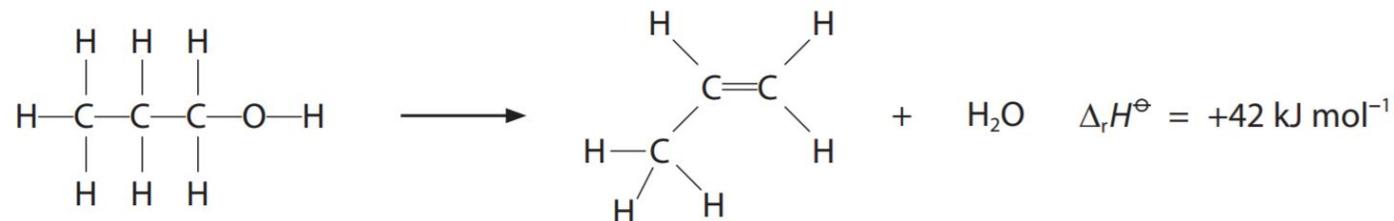
- Calculate a value...
- Determine the...
- Show your working....

# Calculation – Command Words

**Calculate:** require a **numerical answer**, to the correct number of **significant figures** and with **units**

- Set your work out **step by step** - include **all** of your steps, however small
- You usually get a mark for **each piece** of working
- State any **relevant formulae** even if you can't start the calculation

(b) Propan-1-ol is dehydrated to form propene.

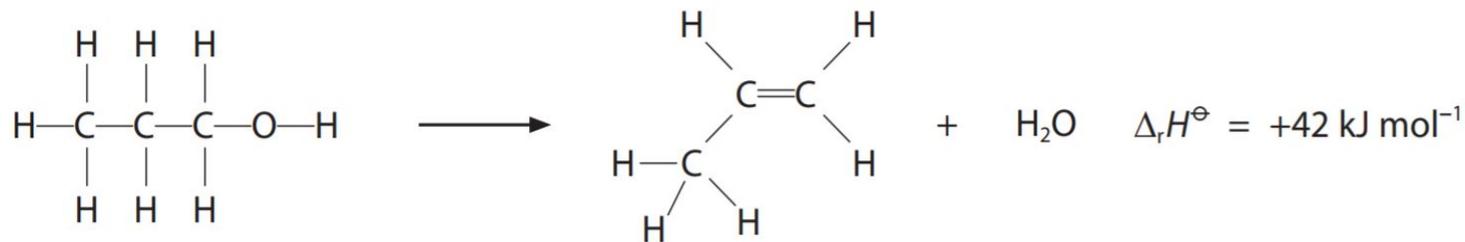


The relevant mean bond enthalpies are given in the table.

Bond	Mean bond enthalpy / $\text{kJ mol}^{-1}$
C—C	347
C=C	612
C—H	413
O—H	464

Calculate the C—O mean bond enthalpy, using the mean bond enthalpies given in the table and the enthalpy change of reaction.

(b) Propan-1-ol is dehydrated to form propene.



The relevant mean bond enthalpies are given in the table.

Bond	Mean bond enthalpy / $\text{kJ mol}^{-1}$
C—C	347
C=C	612
C—H	413
O—H	464

Calculate the C—O mean bond enthalpy, using the mean bond enthalpies given in the table and the enthalpy change of reaction.

(3)

**Energy needed to break bonds – need to break C-C, C-O, C-H**

$$= (347 + x + 413)$$

$$= (760 + x)$$

**Energy released when bonds are made – need to make C=C, O-H**

$$= (-)(612 + 464)$$

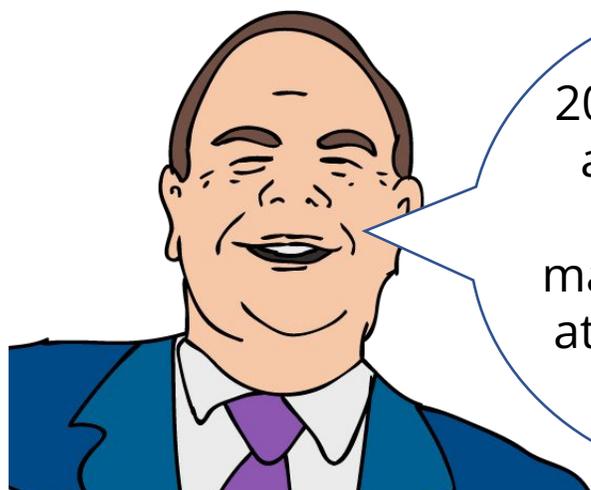
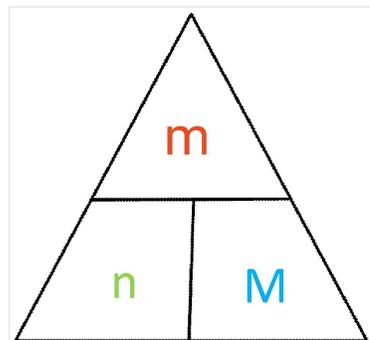
$$= -1076$$

$$42 = (760 + x) - 1076$$

$$x = 358 \text{ kJ mol}^{-1}$$

# Top Tips: Maths

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$



20% of the overall assessment will contain mathematical skills at GCSE Level 4 or above

Make sure you can:

- **Rearrange** the **subject** of an equation (try the **triangle method** if you find this difficult)
- Solve **quadratic equations** (using **factorisation** or the **formula**)
- Understand **ratios** (and use **moles** to convert to molar values)

Look out for:

- **Units** (and practise **conversions**)
- Does your **answer make sense**?
- Correct number of **significant figures**
- **Signs** (particularly in enthalpy calculations)

# Long Answer Questions

- Long form answers **~5+ lines**
- **Interpret** and **analyse** (including **comparing**) **data, figures, and methods** and **explain** how to **conduct experiments** with **diagrams**
- Test **practical knowledge** in **unseen contexts** and may require **mechanisms (OCR)**
- **Longer questions** are marked using **levels** based on the **quality** of your writing – is your answer **coherent, logically structured**, with correct use of **terminology**

## Command Words:

- **Describe**
- **Explain/Justify**
- **Discuss/Evaluate**
- **Deduce**

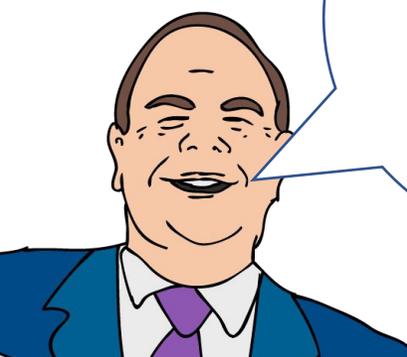
## Examples:

- Describe how...
- Explain/Justify why...
- Discuss/Evaluate the effects...
- Deduce why...

# Long Answer – Command Words

**Describe:** what is **happening** and what can you **see** in a **graph, diagram, or experiment**

- Show how a **process** will **progress** in a **series of separate stages**



The number of dotted lines given for the answer is indicative of the length of answer expected for the question.

Describe what you would observe when dilute aqueous ammonia is added dropwise, to excess, to an aqueous solution containing copper(II) ions.  
Write equations for the reactions that occur.

[4 marks]

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Describe what you would observe when dilute aqueous ammonia is added dropwise, to excess, to an aqueous solution containing copper(II) ions.  
Write equations for the reactions that occur.

**[4 marks]**

A blue precipitate will form when dilute aqueous ammonia is added  
 \_\_\_\_\_  
 dropwise,

\_\_\_\_\_ and then dissolve to give a dark blue solution as it is added in excess.



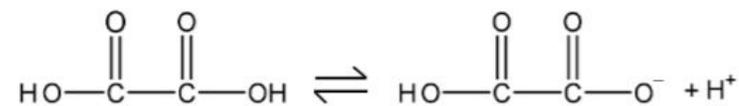
**Explain/Justify:** give **step-by-step logical reasoning** for why data/experiments **show what they show**

- Give a **well-developed** line of **reasoning** which is **clear** and **logically structured**
- Could ask you to write the **steps** you would follow to **carry out an experiment** – including describing **observations** or even involving **calculations**

4

Ethanedioic acid is a weak acid.

Ethanedioic acid acts, initially, as a monoprotic acid.



0 4 . 1

Use the concept of electronegativity to justify why the acid strengths of ethanedioic acid and ethanoic acid are different.

[6 marks]

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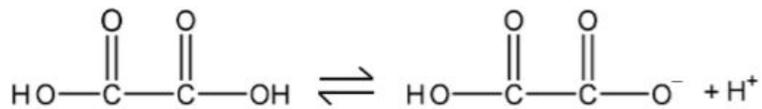
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Ethanedioic acid acts, initially, as a monoprotic acid.



Use the concept of electronegativity to justify why the acid strengths of ethanedioic acid and ethanoic acid are different.

[6 marks]

### Level 3 (5-6 marks):

All stages are covered and the **explanation** of each stage is generally **correct** and virtually **complete**.

Answer is **communicated coherently** and shows a **logical progression** from stage 1 to stage 2 to stage 3.

Steps in stage 3 must be **complete**, **ordered** and include a **comparison**.

#### Stage 1 – difference in the structure of the two acids:

The acids are in the form RCOOH: in ethanoic acid R = CH<sub>3</sub>, whilst in ethanedioic acid R = COOH.

**Stage 2 – the inductive effect:** the unionised COOH group contains two very electronegative O atoms, therefore has a negative inductive (electron withdrawing) effect, whereas the CH<sub>3</sub> group has a positive inductive (electron donating) effect.

#### Stage 3 – how the polarity of OH affects acid strength:

the O-H bond in the ethanedioic acid is more polarised/H becomes more δ<sup>+</sup> and there is more dissociation into H<sup>+</sup> ions. Ethanedioic acid is stronger than ethanoic acid.

# How do you set out a longer written answer?



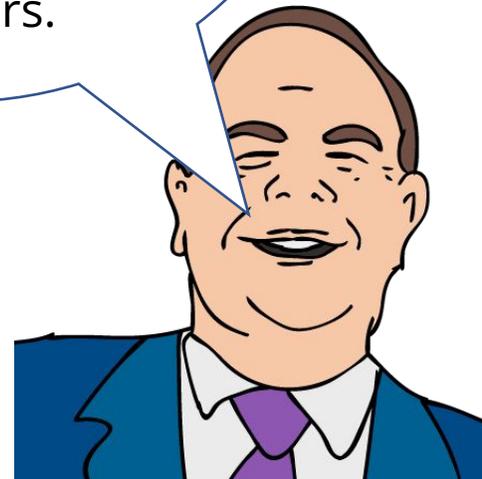
Material that is not required by the question is not penalised (unless it is chemically incorrect) but it wastes the candidate's time.

- **Clearly!**
  - **Think**, then **write** – make **brief notes** if it helps you
  - **Refer** back to the **question** - make sure you're **answering the question** that's been given (not the one you wanted)
  - Use **scientific terminology**
  - Keep it **simple**

# How do you set out a longer written answer?

- Also remember you're **not writing an essay: no need for full sentences**
  - **Bullet points** ✓ (number your thoughts)
  - **Subheadings** ✓
  - A **well-labelled diagram** (✓ if appropriate)
  - If you're short on time, just jot down **equations**
- Leave the question and **come back** if you're drawing a blank, another question might give you some ideas

(Candidates) should be cautious about writing very long answers, as this can increase the possibility of contradicting themselves and can reduce the clarity and coherence of their answers.



# Top Tips

**Distinguish** between:

- what you **need to learn**
- what you **need to understand**
- what **techniques** you need to **master**

# Know what you need to know

The rate constant  $k$  varies with temperature as shown by the equation:

$$k = Ae^{-E_a/RT}$$

These equations and the gas constant,  $R$ , will be given when required.

**AQA**

(k)

the Arrhenius equation:

**OCR**

- (i) the exponential relationship between the rate constant,  $k$  and temperature,  $T$  given by the Arrhenius equation,  $k = Ae^{-E_a/RT}$

Explanation of  $A$  is **not** required.

Equations provided on the *Data Sheet*.

**Edexcel**

12. be able to use graphical methods to find the activation energy for a reaction from experimental data

*The Arrhenius equation will be given if needed.*

**Key point:** don't learn things if you don't have to

# Top Tips

1. Understand what the **periodic table** can tell you.

1 <b>H</b> hydrogen 1.008 [1.0078, 1.0082]																	2 <b>He</b> helium 4.0026
3 <b>Li</b> lithium 6.94 [6.938, 6.997]	4 <b>Be</b> beryllium 9.0122											5 <b>B</b> boron 10.81 [10.806, 10.821]	6 <b>C</b> carbon 12.011 [12.009, 12.012]	7 <b>N</b> nitrogen 14.007 [14.006, 14.008]	8 <b>O</b> oxygen 15.999 [15.999, 16.000]	9 <b>F</b> fluorine 18.998	10 <b>Ne</b> neon 20.180
11 <b>Na</b> sodium 22.990	12 <b>Mg</b> magnesium 24.305 [24.304, 24.307]											13 <b>Al</b> aluminium 26.982	14 <b>Si</b> silicon 28.085 [28.084, 28.086]	15 <b>P</b> phosphorus 30.974	16 <b>S</b> sulfur 32.06 [32.059, 32.076]	17 <b>Cl</b> chlorine 35.45 [35.446, 35.457]	18 <b>Ar</b> argon 39.948
19 <b>K</b> potassium 39.098	20 <b>Ca</b> calcium 40.078(4)	21 <b>Sc</b> scandium 44.956	22 <b>Ti</b> titanium 47.867	23 <b>V</b> vanadium 50.942	24 <b>Cr</b> chromium 51.996	25 <b>Mn</b> manganese 54.938	26 <b>Fe</b> iron 55.845(2)	27 <b>Co</b> cobalt 58.933	28 <b>Ni</b> nickel 58.693	29 <b>Cu</b> copper 63.546(3)	30 <b>Zn</b> zinc 65.38(2)	31 <b>Ga</b> gallium 69.723	32 <b>Ge</b> germanium 72.630(8)	33 <b>As</b> arsenic 74.922	34 <b>Se</b> selenium 78.971(8)	35 <b>Br</b> bromine 79.904 [79.901, 79.907]	36 <b>Kr</b> krypton 83.798(2)
37 <b>Rb</b> rubidium 85.468	38 <b>Sr</b> strontium 87.62	39 <b>Y</b> yttrium 88.906	40 <b>Zr</b> zirconium 91.224(2)	41 <b>Nb</b> niobium 92.906	42 <b>Mo</b> molybdenum 95.95	43 <b>Tc</b> technetium	44 <b>Ru</b> ruthenium 101.07(2)	45 <b>Rh</b> rhodium 102.91	46 <b>Pd</b> palladium 106.42	47 <b>Ag</b> silver 107.87	48 <b>Cd</b> cadmium 112.41	49 <b>In</b> indium 114.82	50 <b>Sn</b> tin 118.71	51 <b>Sb</b> antimony 121.76	52 <b>Te</b> tellurium 127.60(3)	53 <b>I</b> iodine 126.90	54 <b>Xe</b> xenon 131.29
55 <b>Cs</b> caesium 132.91	56 <b>Ba</b> barium 137.33	57-71 lanthanoids	72 <b>Hf</b> hafnium 178.49(2)	73 <b>Ta</b> tantalum 180.95	74 <b>W</b> tungsten 183.84	75 <b>Re</b> rhenium 186.21	76 <b>Os</b> osmium 190.23(3)	77 <b>Ir</b> iridium 192.22	78 <b>Pt</b> platinum 195.08	79 <b>Au</b> gold 196.97	80 <b>Hg</b> mercury 200.59	81 <b>Tl</b> thallium 204.38 [204.38, 204.39]	82 <b>Pb</b> lead 207.2	83 <b>Bi</b> bismuth 208.98	84 <b>Po</b> polonium	85 <b>At</b> astatine	86 <b>Rn</b> radon
87 <b>Fr</b> francium	88 <b>Ra</b> radium	89-103 actinoids	104 <b>Rf</b> rutherfordium	105 <b>Db</b> dubnium	106 <b>Sg</b> seaborgium	107 <b>Bh</b> bohrium	108 <b>Hs</b> hassium	109 <b>Mt</b> meitnerium	110 <b>Ds</b> darmstadtium	111 <b>Rg</b> roentgenium	112 <b>Cn</b> copernicium	113 <b>Nh</b> nihonium	114 <b>Fl</b> flerovium	115 <b>Mc</b> moscovium	116 <b>Lv</b> livermorium	117 <b>Ts</b> tennessine	118 <b>Og</b> oganesson

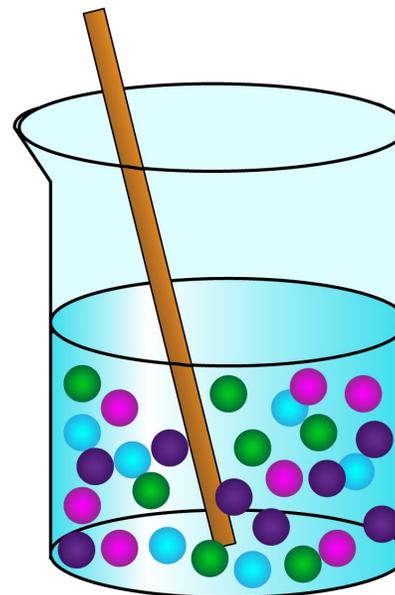
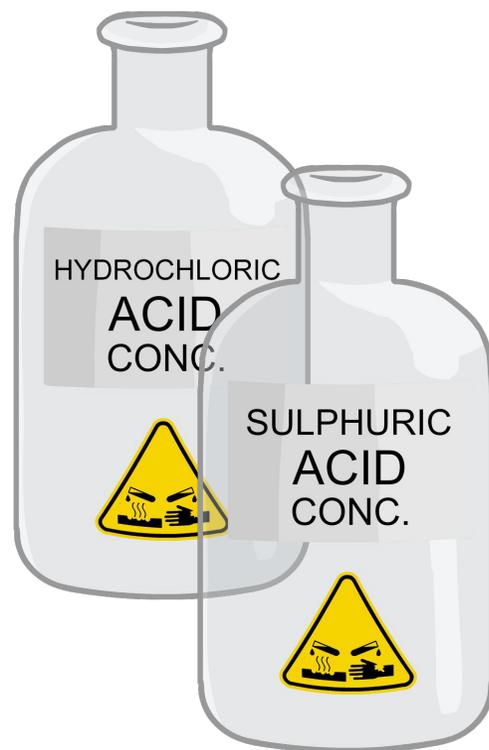
# Top Tips

## 2. Master **common formulae**...

$\text{H}_2\text{SO}_4$ : **Sulphuric acid**

$\text{HCl}$ : **Hydrochloric acid**

$\text{HNO}_3$ : **Nitric acid**



**Hydroxide:**  $\text{OH}^-$

**Sulphate:**  $\text{SO}_4^{2-}$

**Carbonate:**  $\text{CO}_3^{2-}$

**Nitrate:**  $\text{NO}_3^-$

**Ammonium:**  $\text{NH}_4^+$

# Top Tips

## 2. ...standard reactions...

acid + metal  $\square$  salt + hydrogen

acid + base  $\square$  salt + water

acid + carbonate  $\square$  salt + water + carbon dioxide

Group 1 metal + water  $\square$  metal hydroxide + hydrogen



# Top Tips

## 2. ...and chemical tests

