L1 ACIDS & BASES
CHEAT SHEET

STUDY TIME

ABOUT THE STANDARD

- Acids and Bases is arguably the meatiest topic in Level 1 Science, but it's a lot more manageable once you break it down into the four main topics:
  - **Atoms and ions:** atomic structure, the periodic table, ions, and ionic bonding
  - **Acids and bases:** definition of acids and bases, pH, litmus paper, universal indicator, and the relationship between ions and acids and bases.
  - **Neutralisation reactions:** writing *and* balancing equations, observations and laboratory procedures on how to make a neutral salt.
  - **Rates of reaction and how it is affected by:** concentration, surface area, temperature and catalysts.
- The exam will be a mixture of balancing equations, interpreting graphs/tables (for rates of reaction) and predominantly conceptual questions involving written explanations.
- If you take on the strategies we're about to discuss, you'll be able to come out on top.

ATOMS & IONS

- **An easy Merit or Excellence question is explaining why ions form from atoms;** for example, why the O^{2-} ion forms from the O atom. To get the highest grade possible in this question make sure to mention the following:
  - Partially filled outer (valence) electron shells are unstable, and therefore need to gain or lose electrons in order to gain a completely full or empty outermost shell, which is stable.
  - Make sure you compare the new number of electrons with the number of electrons. For example, if O^{2-} has gained 2 electrons in its outermost shell, it now has 10 electrons but it still has 8 protons. As electrons are negative, and protons are positive, this means that the 2 extra electrons will give it a charge of 2− overall.
- Another ion related question will ask you to **discuss ionic bonding**. Remember that ionic bonding is when atoms with too many valence electrons donate these electrons to atoms with too little valence electrons. This transfer of electrons causes ions to form and the *electrostatic* attraction between the oppositely charged ions is called an ionic bond. For example, Na needs to lose one electron to have a full valence shell, and Cl needs to gain an electron to gain a full valence electron shell, so therefore Na will donate an electron to Cl, resulting in Na+ and Cl− forming, which results in an ionic bond, forming NaCl.
- Also, remember that you may need more than one ion of the same type in order to make an ionic compound with a neutral charge. For example, Mg has a charge of 2+ and Cl has a charge of −, so, therefore, we need two Cls for each Mg atom.
- Another type of question will ask to relate the group (the term for a column) in the periodic table to the number of valence electrons. **Remember that atoms in the same group of the periodic table will have the same number of valence electrons and therefore have the same charge.**

ACIDS & BASES

- The main key to success in understanding acids and bases is understanding their definitions:
  - An acid produces H+ ions in water
  - A base produces OH− ions in water
- In a question, they may ask you to relate the pH to the ions present in an acid and/or base solution.
  - The higher the concentration of H+ ions, the lower the pH, the more acidic the solution is.
  - The higher the concentration of OH− ions, the higher the pH and the more basic the solution is.
  - What about neutral compounds with a pH of 7? Well, just say you start with a strong acid with a high concentration of H+ ions, and start adding drops of a strong base, i.e. OH− ions. If you combine H+ and OH− ions, they react together to form H_2O ions, which is water, which is neutral.
  - This is often a Merit or Excellence question, so make sure you watch this part of the video a few times to check your full understanding.
- Make sure you are also able to link pH to the colour of the universal indicator. Here's a useful diagram that illustrates the colours:
- Another common question is around how to identify neutral compound using litmus paper. Most people write that they would add blue litmus paper and red litmus paper to the solution and if both did not change colour then it would be neutral. This is correct, but this answer alone won't get you an excellence grade!
  - Instead, you should also mention that if blue litmus paper did turn red, then that would mean the compound is acidic and that if red litmus paper did turn blue, that would mean that the compound is basic.

NEUTRALISATION REACTIONS

- NCEA really loves giving you questions where you have to write equations for neturalisation reactions, and balance them. In fact, there are usually around 3 questions the exam that ask you to do this – and they can all get you an excellence grade – so make sure you are practicing these heaps!
- Remember the following types of neutralisation word equations:
  - Acid + base ⟶ water + neutral ionic salt (e.g. $MgCl_2$)
  - Acid + carbonate base (e.g. Na_2CO_3) ⟶ water + neutral ionic salt (e.g. $MgCl_2$) **+ CO_2** (to account for the carbonate in the base)
  - If you see fizzing, then you know you have CO_2 in there.
- To write the equation, you'll have to convert the names of compounds, like Magnesium Hydroxide, into symbols.
  - If it's an acid, good news, you only need to know the symbols of three acids:
    - Hydrochloric acids, HCl
    - Sulfuric acid, H_2SO_4
    - And nitric acid, HNO_3
  - If it involves water or carbon dioxide, that's easy, H_2O and CO_2
  - For everything else in the reaction, you'll need the table of ions to figure out the correct symbols, so make sure you know the names of each ion in the table.

- A helpful memory hack is that if the ion ends with a O_3 or O_4, then it will end with "ate" e.g. NO_3 is Nitrate, SO_4^{2-} is Sulfate, etc.
- Then, you need to make sure you balance the ionic charges.
- Let's illustrate with Magnesium Hydroxide. Magnesium is Mg^{2+} and Hydroxide is OH^-. To balance the charges, we'll need 2 x OHs so the symbol formula is $Mg(OH)_2$. We put the OH in brackets because we want 2 whole OHs. Without the brackets, like OH_2, we would only be doubling the H atoms and not the O atoms.

- Once you've written the symbol equation for your reaction, that's a Merit. To get excellence, we must balance it correctly. To do that, you should break it down into a table like shown:
  - $H_2SO_4 + NaOH \rightarrow NaCl + H_2O$

    ~~H_2SO_4~~ + ~~$NaOH$~~ $\rightarrow NaCl + H_2O$

    $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + H_2O$

    $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + H_2O$

4 x H	2 x H
1 x S	1 x S ✓
6 x O	5 x O
2 x Na	2 x Na ✓

    $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

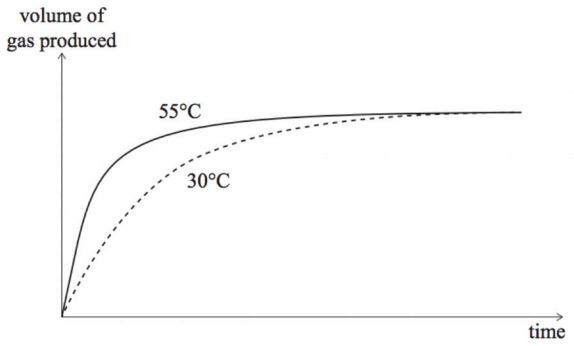
4 x H	4 x H ✓
1 x S	1 x S ✓
6 x O	6 x O ✓
2 x Na	2 x Na ✓

  - See how we've done a stock take of each individual atom involved? From there, we can add numbers in front of each molecule and update the table until we have equal numbers of atoms on each side.
- Another variation of a neutralisation question may ask you how you would make this in the lab. Fortunately, the steps are simple:
  - Add an acid and base together until they react and the solution is neutral (check using litmus paper and universal indicator).
  - Put the contents into an evaporating dish so that the water can evaporate to leave the neutral salt.
  - It is left for a few days to ensure that all the water has evaporated as this process takes time or you could heat it using a bunsen burner should you want to speed up the process.

RATES OF REACTION

- With rate of reaction questions, it's important to know what causes an increased rate of reaction.
- The answer is a higher frequency of successful collisions between particles. Therefore your answer should finish with "This results in a higher frequency of successful collisions between particles, therefore leading to a higher rate of reaction", or vice versa if the rate of reaction is decreasing.
- There are two ways you can achieve a higher frequency of successful collisions:
  - Increase **chances of collisions** being successful
  - Or increase **frequency of collisions** per time unit
- **Increasing the surface area** increases the frequency of collisions per time unit because more particles are available to react at once
- **Increasing concentration increases** the number of particles, which increases the frequency of collisions per time unit
- In the exam, they may ask you to explain why a rate of reaction graph goes flat as the reaction progresses. To explain this, mention that as reactant particles react and are converted into products, the concentration

of reactants decreases and therefore the rate of reactions decreases until it becomes zero and the graph becomes flat.

- 

- With Temperature there are two effects: as the temperature increases from 30°C to 55°C, the reactant particles gain kinetic energy, i.e. the average kinetic energy of particles increases. This: (1) causes the particles to move more quickly and therefore increases the frequency of collisions and (2) more of the collisions are successful because the particles have more energy. This leads to a faster rate of reaction.
- Finally, don't forget that catalysts lower the activation energy (energy needed) and so, therefore, more of the collisions are successful as the required energy for a successful collision is less.

OVERALL

- We've covered some important strategies and things to remember, but we haven't covered everything.
- As we said at the start of this video, we really recommend going through the last 3-4 years of exam papers, and also using the StudyTime Walkthrough Guide and Checklist to really check and consolidate your knowledge and feel 100% prepared!