Learning objectives: Acids and Bases

Learning Objectives	For Achievement students must be able to: 1. Define acid, base, alkali, salt 2. Describe the common properties of acids and bases 3. Identify acids and bases using indicators, pH papers 4. Name some common lab acids and bases, acids at and bases at home 5. Describe reactions of acids with metals, bases and carbonates 6. Describe the application of acids, bases and pH in everyday life For Merit students must be able to: 1. Write formula equations to describe the reactions of acids 2. Know the range of the pH scale for acid, neutral and bases 3. Use the pH scale to predict if a solution is acidic or basic or neutral For Excellence students must be able to: 1. Prediction of salts formed during neutralisation 2. Suggest acids/alkalis to neutralise to form specific salts 3. Explain how acids should be treated in the event of an acid spill on clothing or skin, in the laboratory and on the street.
Activities	1. Testing a range of acids, alkalis and salt solutions with different indicators 2. Classifying everyday life solutions as strong or weak acids/alkalis using pH 3. Prepare indicators from common household substances 4. Investigating the reactions of acids with metals, bases and carbonates.

Experiment: The properties of acids and bases

☠Corrosive/caustic chemicals

Method:

Indicator: Litmus paper

1. Prepare a small beaker.
2. Place a small piece of blue litmus paper on the base of a beaker.
3. Apply a drop of the acid/base.
4. Observe the colour change.

Indicator: Universal Indicator

1. Prepare a small beaker.
2. Put 10mL fruit juice/fizzy drink into a test tube.
3. Apply two drops of the universal indicator.
4. Observe the colour change.

What would happen if we mix acid and base?

Result:

	Blue litmus paper	Red litmus paper	UI indicator	Acid or Base?
Hydrochloric acid	Turns red	stays red	red	Acid
Sulfuric acid	Turns red	Stays red	red	Acid
Sodium hydroxide	Stays blue	Turns blue	blue	Base
Water	No change	No change	green	Neutral
Fruit Juice	Red	No change	RED	Acid
Fizzy drink	red	No change	RED	Acid
1 drop of Acid + 2drops of Base	No change	No change	Green	Neutral

Properties of bases

- Turns red litmus blue. UI turns blue/purple.
- Bases are slippery to touch. They react with the natural oils in your skin, making soap.
  (Do not touch them as they can be caustic.)
- Taste bitter.
  (Do not taste them to check.)
- Acids can be neutralized (cancelled) by bases.
- Can be treated as the chemical opposite of acids.
- Bases contain hydroxide (OH-) ions.

Base	Formula	Common Name	Use/Found
Sodium hydroxide			
Calcium hydroxide			
Potassium hydroxide			
Ammonium hydroxide			
Magnesium hydroxide			Used as an antacid for indigestion
Sodium hydrogen carbonate			
Calcium carbonate			

Research assignment

Acid Rain

Research the problem of a type of pollution called acid rain.

1. Define the words “acid” and “base”. Describe ways you can test to see if a substance is an acid or a base.
2. What is pH? Draw a numbered scale to show the difference in the pH of an acid and a base.
3. Design a poster(A4 Sized) to inform people about ‘Acid Rain’. Put a caustic or corrosive warning and describe why such they have to be protected from the rain.
4. Design an experimental procedure to test ‘Acid Rain’.
5. You will need to find out what acid rain is, what is causing it, what damage it is doing and what action needs to be taken to solve the problem. Using your findings, write an article about acid rain.

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Marking Schedule: Acids Rain

Achieved	Merit	Excellence
• Define ‘acid’ and ‘base’. • Describe pH with a numbered scale. • A poster • Define acid rain. • Name the acidic gases that cause acid rain. • Identify what causes the acidic gases. Where do these gases come from? • Describe the damages that are caused by acidic rain.	• Explain what causes acid rain. • Explain the effects of acid rain. • Explain why NZ doesn’t suffer badly from acid rain or its effects in comparison to countries in Europe. • Experimental procedure that tests ‘Acid Rain’.	• Discuss the effects and problems of acidic rain. Eg. plants, animals, aquatic animals, buildings. Eg. When acid rain kills trees, birds and insects are also affected. • Suggest 5 actions that need to be taken to solve the problem.

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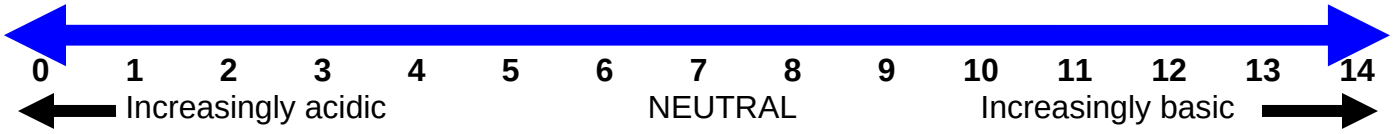
Concentration of Hydrogen ions compared to distilled water				Examples of solutions and their respective pH
	1/10,000,000	14	Liquid drain cleaner, Caustic soda	
	1/1,000,000	13	bleaches, oven cleaner	
	1/100,000	12	Soapy water	
	1/10,000	11	Household Ammonia (11.9)	
	1/1,000	10	Milk of magnesium (10.5)	
	1/100	9	Toothpaste (9.9)	
	1/10	8	Baking soda (8.4), Seawater, Eggs	
	0	7	"Pure" water (7)	
	10	6	Urine (6) Milk (6.6)	
	100	5	Acid rain (5.6) Black coffee (5)	
	1,000	4	Tomato juice (4.1)	
	10,000	3	Grapefruit & Orange juice, Soft drink	
	100,000	2	Lemon juice (2.3) Vinegar (2.9)	
	1,000,000	1	Hydrochloric acid secreted from the stomach lining (1)	
	10,000,000	0	Battery Acid	

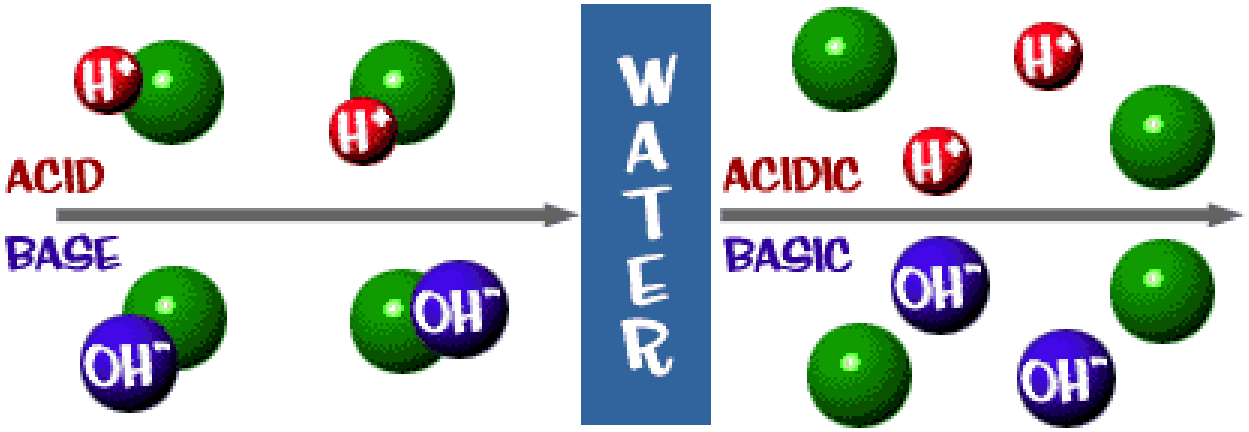
pH scale

Indicators tell you if a substance is acidic, basic or neutral. However, some acids are more acidic than others, hence we have “very acidic”, “slightly acidic”, “very basic”, “slightly basic”.
pH is measured using Universal Indicator(UI) or Universal Test Paper(UTP)

pH scale tell us about the degree of acidity of the solution.



- A substance with a pH = 7 is neutral (neither acidic nor basic).
- A substance with a pH > 7 (8-14) is basic.
- A substance with a pH < 7 (0-6) is acidic.



Acid strength: Strong or Weak

- Strong acids are acids whose molecule completely **break up** / nearly **break up** and release lots of H+ ions into the solution.
- In weak acids, only some of the acid molecules break up so only few H+ ions are found in the solution.
- A strong acid will always have a lower pH number than a weak acid of the same concentration.

Acid concentration

Concentrated H_2SO_4 contains 99% H_2SO_4 and 2% water.
Diluted H_2SO_4 contains greater % of water.

The concentration of an acid tells you how much **water** has been added to the acid. If you add more water, the solution will become less **concentrated**(=more **diluted**).

Experiment: pH of Household Chemicals

Aim: To find out whether household substances are acidic, basic or neutral.

Method:

1. Pour a small amount of five household substances into a separate test tube.
2. Add 2mL water and stir with a stirring rod.
3. Add 2-3 drops of UI to each test tube.
4. Record the colour the indicator shows in the chart.

Result:

Household chemical	Colour in UI	pH	Acid, base, neutral	Degree: Slight/Very
Water				

Questions:

1. Which household substances are:
   (a) Acidic? (b) Very acidic?

2. Which household substances are:
   (a) Basic? (b) Very basic?

3. Which household substances are neutral?

Experiment: Carbon dioxide – what type of gas is it?

Aim:

- **Part A:** To find out if CO_2 forms an acidic, basic or neutral solution
- **Part B:** To see the effect of increasing temperature on the pH of CO_2 solution.

Equipment: UI, straw, boiling tube, Bunsen burner, test tube rack, tong

Method: Part A

1. Fill a third of a boiling tube with water, enough to cover the bottom of the straw
2. Add 5 drops of UI
3. Blow gently with the straw, exhaling your breath into the solution in the boiling tube.

- **Result**: What colour does the solution go after blowing into it?

- **Conclusion**: What type of solution is formed when CO_2 dissolves in water?

- **Discussion**: What implications could this have on animals living in rock pools?

Method: Part B

1. Remove the straw.
2. Using a tong, gently heat the boiling tube over a moderate Bunsen flame. Allow it to boil gently.

- **Result:** Describe colour change that happened in the solution as you boil it.

- **Conclusion**: What could happen in the solution as it was heated to have cause this change?

- **Discussion**: What implications could this have on tropical fish living in warm water?

Demonstration: Formation of Acid Rain

☠ Asthmatics beware

Aim: To make a gas that will form acid rain.
Equipment: Sulfur powder, deflagrating spoon, gas jar, Bunsen burner, universal indicator

Questions:

1. Name the product that is formed when sulfur is burned with oxygen. Sulfur dioxide
2. Describe the colour of the sulfur flame. blue
3. Why did the flame go out after a while? Lack of oxygen
4. Describe the type of solution that forms when SO_2 dissolves in water and explain how you knew it was that type of solution. Sulfuric acid

Questions:

1. Name the product that is formed when sulfur is burned with oxygen. **Sulfur dioxide**

2. Describe the colour of the sulfur flame. **Blue/Mauve**

3. Why did the flame go out after a while?
   All the oxygen gas was used up

4. Describe the type of solution that forms when SO_2 dissolves in water and explain how you knew it was that type of solution.
   Acid – universal indicator went red

Table of Ions

All acid reactions involve knowing your table of ions.

1+	2+	3+	2-	1-
H^+	Mg^{2+}	Al^{3+}	Carbonate ion CO_3^{2-}	Chloride ion Cl^-
K^+	Ca^{2+}		Sulfate ion SO_4^{2-}	Nitrate ion NO_3^-
Na^+	Zn^{2+}			Hydroxide Ion OH^-
	Cu^{2+}			

Reactions

1. Acid and Base Reactions
2. Acid and Metal Reactions
3. Acid and Metal Carbonate

Acid and Base Reactions
Acid react with bases in a **<u>neutralization</u>** to form a metal salt and water.

Acid + Base ⟶ Metal salt + **Water**

Water is always produced because $\mathbf{H^+}$ ion from the acid joins with the $\mathbf{OH^-}$ ion from the base.

The type of metal salt produced depends on the type of **acid** used.

1. **Hydrochloric** acid (H**Cl**) produces metal **chloride salts.**
2. **Sulfuric** acid (H_2**SO_4**) produces metal **sulfate salts.**
3. **Nitric** acid(H**NO_3**) produces metal **nitrate salts**.

The type of metal in the metal salt is determined by the type of **metal** in the base.

1. **Sodium** hydroxide (NaOH) produces **sodium s**alt.
2. **Potassium** hydroxide (KOH) produces **potassium s**alt.
3. **Calcium** hydroxide (Ca(OH)2) produces **calcium** salt.

PRACTICE CHEMICAL (WORD) EQUATIONS

Stage 1: Word equations

1. Hydrochloric acid + potassium hydroxide → _____+water
2. Hydrochloric acid + calcium hydroxide → _____+water
3. Sulfuric acid + sodium hydroxide → _____+water
4. Sulfuric acid + potassium hydroxide → _____+water
5. Sulfuric acid + calcium hydroxide → _____+water
6. Nitric acid + sodium hydroxide → _____+water
7. Nitric acid + potassium hydroxide → _____+water
8. Nitric acid + calcium hydroxide → _____+water

Stage 2: Word equations

1. Nitric acid + _____ → sodium nitrate + water
2. Sulfuric acid + _____ → potassium _____+ water
3. _____ acid + _____ →calcium hydroxide + water
4. _____acid + magnesium _____ → _____nitrate + water
5. _____ + aluminium hydroxide → aluminium sulfate + water

Acid and Base : Formulae Equations

Hydrochloric acid + Sodium hydroxide → sodium chloride + water

$$HCl + NaOH \rightarrow NaCl + H_2O$$

Sulfuric acid + Sodium Hydroxide → Sodium sulfate + water

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

Acid and Metal Reactions

Metal + Acid → Metal salt + Hydrogen gas

<u>Aim:</u> To find out what gas is produced when an acid and metal react.

<u>Method:</u>

1. **Take a piece of Magnesium ribbon and place it in a test tube containing 20mL of HCl**
2. **Trap the gas being released by placing a test tube over the top.**
3. **Release the gas into burning splint.**

<u>Results:</u> The gas produced make a "pop" sound when ignited (explodes).

<u>Conclusion:</u> The gas produced when an acid reacts with a metal is hydrogen gas. Acid react with metals to form a metal salt and hydrogen gas.

RECALL:

- **HCl produces ……chloride ions**
- **H_2SO_4 produces …….. sulfate ions**
- **HNO_3 produces ……. Nitrate ions**

The type of metal reacting with the acid will determine the type of metal in the **metal salt.**

Hydrogen gas is always produced as the H^+ ion from the acid react to form hydrogen gas.

ACID AND CARBONATE COMPOUNDS

- Carbonate compounds are group of compounds which have CO_3 in their formula.
- Examples of carbonates
    1. Sodium bicarbonate / Sodium hydrogen carbonate = baking soda
    2. Sodium carbonate = washing soda
    3. Calcium carbonate = marble
    4. Copper carbonate = $CuCO_3$

Acid + Carbonate → salt + water + carbon dioxide (gas)

- **Aim:** To investigate the reaction between acid and _____ carbonate

- **Method:**

1. Carefully pour 1 cm of _____acid into a test tube.
2. Carefully pour about 5 cm of limewater ($Ca(OH)_2$) into other test tube.
3. Add a small amount of _____ carbonate into _____ acid.
4. Test for carbon dioxide (CO_2): Immediately after adding carbonate, seal the test tube with rubber stopper connected to gas tube. Place the open end of the gas tube directly into the test tube filled with limewater.
5. Observe and record results for reaction and carbon dioxide test in table, including the rate (speed) or reaction and any **colour** or appearance changes.
6. Add 2 drops of Universal Indicator into **acid+carbonate** test tube.
7. Using a evaporating dish : Evaporate water from a drop of acid + carbonate

Result:

- _calcium__carbonate fizzed in the hydrochloric acid.
- Limewater changed from clear to cloudy/milky.
- Universal Indicator: green

Conclusion:

- Carbonate compounds are **base**
- Carbonates fizz in acids because carbon dioxide gas is produced.
- **water** is made by the reaction.

Chemical equations

Hydrochloric acid + Magnesium carbonate →
Hydrochloric acid + Calcium carbonate →
Hydrochloric acid + Cupper carbonate →

Acid and Metal Reactions

Metal + Acid → Metal salt + Hydrogen gas

Zinc + Hydrochloric acid → _____ + _____

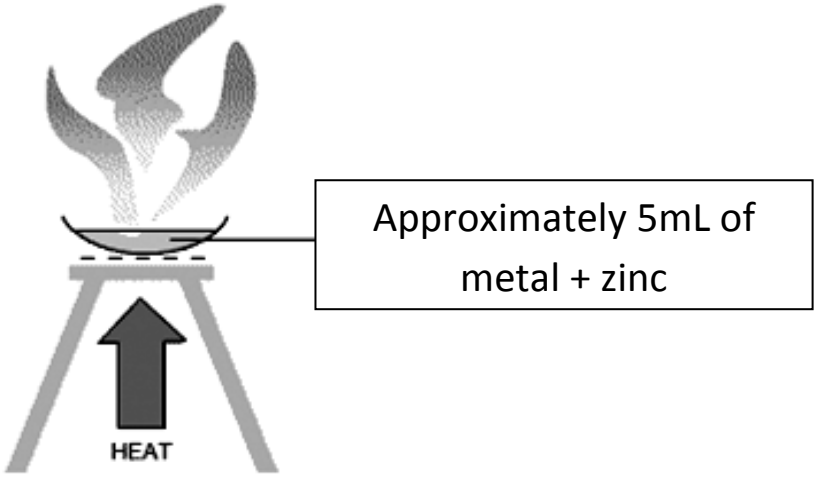
Aim: To find out two products from acid and metal reaction.

Method:

A. Hydrogen gas test

1. Take a piece of Zinc and place it in a test tube containing 20mL of HCl.
2. Trap the gas being released by placing a test tube over the top.
3. Burn the gas into burning splint.

B. Evaporation: Metal Salt



Results:

A. The gas produced made a "pop" sound when ignited (explodes).
B. Bubbles of gas / zinc fizzed
C. Zinc dissolved in hydrochloric acid.
D. Test tube got warmed up.

Conclusion: The gas produced when an acid reacts with a metal is hydrogen gas. Acid react with metals to form a metal salt and hydrogen gas.

Coke and Mentos

Bubbly Diet Coke + Mentos → Flat Coke + Mentos + Gas

Observation

When Mentos lollies are added to a carbonated drink such as Diet Coke, however, there are no new products formed. The rapid production of bubbles is instead a result of the dissolved carbon dioxide in the drink rapidly coming out of solution and forming a gas. As the gas bubbles expand, the pressure inside the bottle increases, resulting in a stream of foam shooting out through its narrow opening

Conclusion:

1. What gas is dissolved in fizzy drinks?
2. Can you suggest a reason for the explosion?
3. Is this a Physical or Chemical change?

There are **two main reasons** for this rapid build up of carbon dioxide.

1. The gums and proteins from the Mentos coating help to break the surface tension of the water in the drink, which in turn allows the gas bubbles to escape more readily.

2. The many small pits on the surface of the Mentos lollies : Physical reaction in which the dissolution of mints attracts the dissolved carbon dioxide in the soda, with the process appearing so rapidly that the carbon dioxide precipitates out rather explosively.

Why would…

1. **Mint Mentos** works better than Fruit mentos.
2. Diet coke works better than a normal coke.

http://www.newscientist.com/article/dn14114-science-of-mentosdiet-coke-explosions-explained.html

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06/April/2011

1. **Equation worksheets**
2. **Year10 Science Pg78-79**
   Q1, 3, 5, 6, 8, 9

07/April/2011 – 12/April/2011

1. Year10 Science Pg 78-79
   Complete 1,3,5,6,8,9
2. Practice Test Questions

13/April/2011(Tuesday), 14/April/2011(Wednesday), 15/April/2011(Thursday) – **Practical Test**

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