UNIT 3
INTERMEDIATE 2
ACIDS,BASES AND METALS

1. The pH scale ranges from below pH 0 to above pH 14

	ACIDS							NEUTRAL	ALKALIS						
pH number	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Universal indicator	Red				yellow			green	Blue					purple	
pH paper	Red				orange			yellow	Green				blue		

Increasing acidity ←   increasing alkalinity →

2. Diluting an acid the H^+ ion concentration falls and the pH rises towards 7. In diluting an alkali the OH^- ion concentration falls and the pH falls towards 7
3. <u>Common laboratory acids and alkalis</u>

ACIDS		ALKALIS	
NAME	FORMULA	NAME	FORMULA
Hydrochloric acid	HCl	Sodium hydroxide	$NaOH$
Sulphuric acid	H_2SO_4	Calcium hydroxide(limewater)	$Ca(OH)_2$
Nitric acid	HNO_3	Ammonium hydroxide (ammonia solution)	NH_4OH
Phosphoric acid	H_3PO_4	Potassium hydroxide	KOH

4. <u>Common solutions found in the home</u>

ACIDS	NEUTRAL	ALKALIS
Vinegar	water	Baking soda
Lemonade	Salt water	Oven cleaner
Soda water		Dishwashing powder
coke		Soaps

5. Soluble metal oxides dissolve to give alkalis , soluble non-metal oxides dissolve to give acids .
6. Ammonia also dissolves in water to produce an alkaline solution
7. All acids contain the hydrogen ion $H^+_{(aq)}$
8. All alkalis contain the hydroxide ion $OH^-_{(aq)}$
9. In acids the concentration of H^+ ions is greater than the concentration of OH^- ions. In alkaline solutions the concentration of OH^- ions is greater than H^+ ions. In neutral solutions such as water the H^+ ion concentration is the same as the OH^- ion concentration.

10. In water there is a mixture of ions and molecules.

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

11. The ionisation of water is an example of a reversible reaction
12. In a reversible reaction when the rate of the forward reaction equals the rate of the reverse reaction , we say an equilibrium is established.
13. In a reaction at equilibrium the concentration reactants and products remain constant (although not necessarily equal) in the equilibrium mixture.
14. Strong acids are ones which compeletely disassociate into ions.

Eg. $HCl \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$

Weak acids are ones which only partially disassociate to form ions

Eg. $CH_3COOH \rightleftharpoons H^+_{(aq)} + CH_3COO^-_{(aq)}$
(ethanoic acid)

15. Similarly Bases can be defined as weak or strong depending on their degree of ionisation.
16.

ACIDS		**BASES**	
STRONG	**WEAK**	**STRONG**	**WEAK**
HCl	CH_3COOH	Metal hydroxides	ammonia
HNO_3			
H_2SO_4			

17. Properties of weak and strong acids/bases

PROPERTY	**ACIDS**		**BASES**	
	STRONG	WEAK	STRONG	WEAK
pH	Low(1-2)	Higher(3-6)	High(14-13)	Lower(13-8)
Conductivity	high	low	high	Low
Speed of reaction	fast	slower	fast	slower
Volume of reactant	same	same	same	same

(equal concentrations (equimolar) of strong and weak acids were compared)

18. A salt is an acid with the hydrogen ion replaced by a metal or an ammonium ion.
19.

ACIDS	SALTS
Hydrochloric acid	chlorides
Sulphuric acid	sulphates
Nitric acid	nitrates
Phosphoric acid	phosphate

20. ACID + CARBONATE $\longrightarrow$ SALT + WATER + CARBON DIOXIDE

21. ACID + ALKALI $\longrightarrow$ SALT + WATER

22. Neutralisation is the reaction of an acid with a base.(metal oxides,hydroxides and carbonates)
23. In neutralisation the pH moves towards pH 7.(acids rise to pH 7 ,bases fall to pH 7)

24.The reaction of acids with carbonates and alkalis are examples of neutralisation reactions.

$$CO_3^{2-} + 2H^+ \longrightarrow CO_2 + H_2O$$

$$H^+ + OH^- \longrightarrow H_2O$$

25.Everyday examples of neutralisation reactions are , indigestion remedies , reduction of soil , lake and river acidity by adding lime .
26. Acid rain is caused by the dissolving of sulphur dioxide (produced from burning fossil fuels) and nitrogen dioxide (produced by the sparking of air in car engines) in water found in the atmosphere.
27.Acid rain can damage buildings ,effect soils , plant and animal life.
28. Soluble salts which contain nitrogen are made by neutralisation reactions , to be used as fertilisers eg . NH_4NO_3 , KNO_3 and $(NH_4)_2SO_4$
29. When making a soluble salt it is easier to use an insoluble metal carbonate or oxide as the base . Since excess can easily be removed from the product by filtration.
30. Insoluble salts can be made by precipitation reactions.

31.The least reactive metals are found as uncombined metals in the ground.Most metals however are found as compounds.

32.

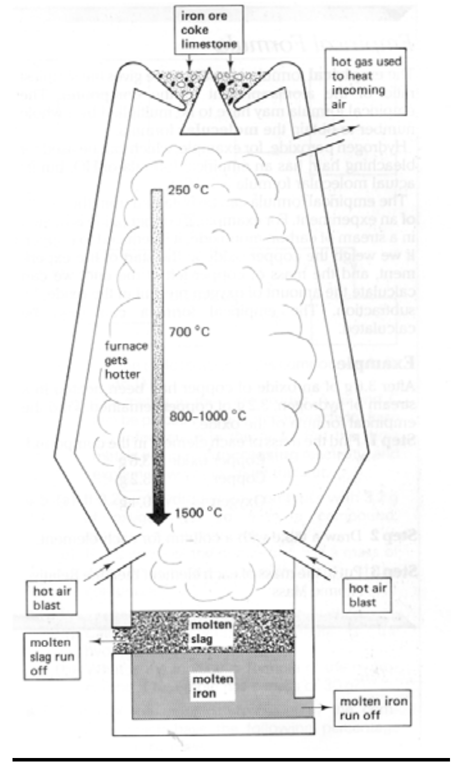
METAL	FOUND	EXTRACTION	REACTION WITH WATER	REACTION WITH ACID
Potassium	ore	Electrolysis of molten ore	Metal hydroxide + hydrogen	Salt + hydrogen
Sodium	ore			
Lithium	ore			
Calcium	ore			
Magnesium	ore			
Aluminium	ore		No reaction	
Zinc	ore	Heating with carbon or carbon monoxide		
Iron	ore			
Tin	ore			
Lead	ore			
Copper	Native metal			No reaction
Mercury	Native metal	Heat alone		
Silver	Native metal			
gold	Native metal			

33. The two main reactions in a blast furnace are
The production of carbon monoxide

$2C + O_2 \longrightarrow 2CO$

and the reduction of iron ore

$Fe_2O_3 + 3\,CO \longrightarrow 2Fe + 3CO_2$

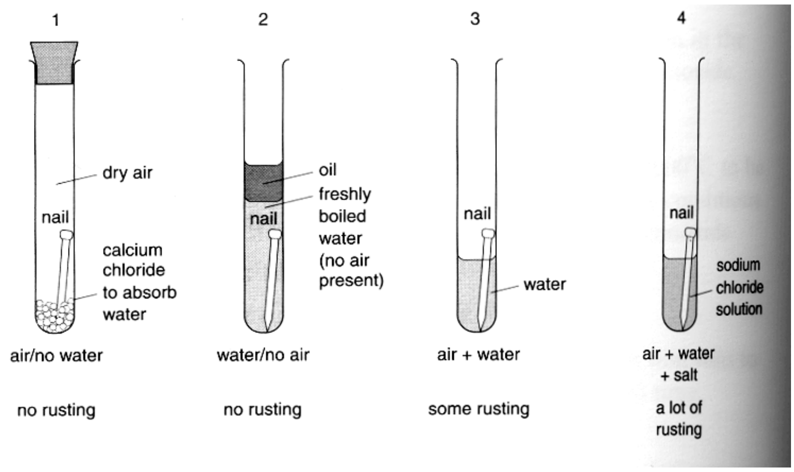


30. METAL + ACID ⟶ SALT + HYDROGEN
31. METAL + OXYGEN ⟶ METAL OXIDE
32. METAL + WATER ⟶ METAL HYDROXIDE + HYDROGEN
33. The test for hydrogen is that it burns with a pop .
34. Metals can be placed in order of their reactivity by their speed of reaction with water and acid.

35. Corrosion is the chemical reaction which involves the surface of a metal changing from an element to a compound.

Eg . $M \longrightarrow M^+ + e$

36.

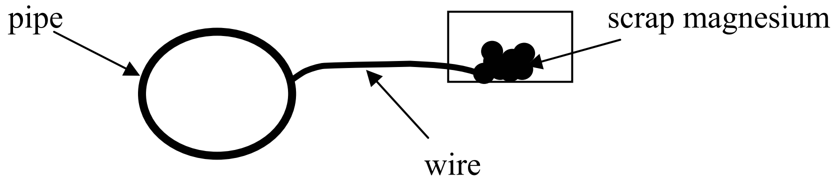


Both oxygen(from the air) and water are needed for corrosion

37. Rusting is the corrosion of iron.
38. Rusting results in a metal losing its strength
39. An electrolyte is also needed for corrosion to take place.(normally dissolved carbon dioxide acts as an electrolyte in water)
40. Salt water and acid rain speed up corrosion because they are better electrolytes than water. Eg. Car bodies rust quicker than the rest of the car due to the salt spray from the road.
41. Corrosion can be prevented by physical protection or by chemical protection.
42. Physical protection provides a barrier , preventing air and water reaching the metal.
43. Chemical protection feeds electrons to the metal being protected.
44.

PHYSICAL	CHEMICAL	BOTH
Painting	Sacrificial protection	galvanising
Greasing	Cathodic protection	
Electroplating		
Coating with plastic		

45. Galvanising is the covering of a metal in molten zinc.
46. Sacrificial protection is caused by a metal being attached to a more reactive metal. The more reactive metal corrodes in preference to the less reactive metal. Eg iron pipes are protected by attaching them up to lumps of scrap magnesium.



47. Rust indicator can be used to show the degree of rusting
48. Ferroxyl indicator(Rust indicator) turns from yellow to blue in the presence of Fe^{2+} ion.
49. Ferroxyl indicator turns from yellow to pink in the presence of OH^- ion

50. Oxidation is the loss of electrons. Reduction is the gain of electrons. (OILRIG)

51. In corrosion metals lose electrons and become oxidised.
Water and oxygen gain electrons and become reduced.

$M_{(s)} \longrightarrow M^{+}_{(s)} + e$ OXIDATION

$2\ H_2O_{(l)} + O_{2(g)} + 4e^- \longrightarrow 4OH^-_{(s)}$ REDUCTION

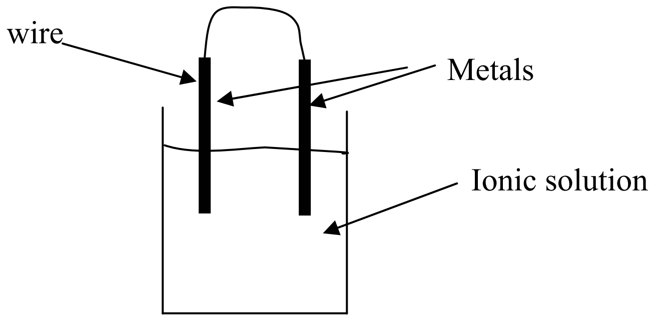
in rusting

$Fe \longrightarrow Fe^{2+} + 2e^-$

Later this is further oxidised to Fe^{3+}

52. Tin cans corrode quicker than steel cans since electrons are fed from the iron to the Tin.

53. Electricity can be produced by connecting different metals in a solution containing ions.

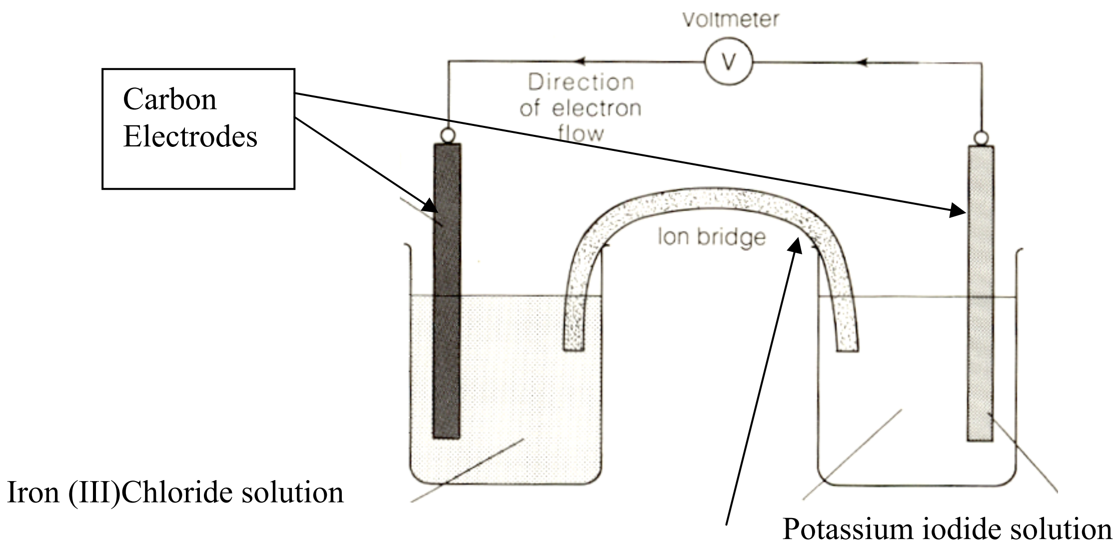


54. The ionic solution(electrolyte) provides ions to complete the circuit

55. The further apart the metals in the reactivity series the higher the voltage produced.

56. Electrons flow from the most reactive metal(negative) to the least reactive metal(positive)

57. Electrochemical cells can be set up without using metals.



salt bridge allows ions to flow in order to complete the circuit.

58. A more reactive metal will displace a less reactive metal (or hydrogen) from a solution.

Eg. $Ca + CuSO_4 \longrightarrow CaSO_4 + Cu$

59. Displacement is an example of a redox reaction.

The ion electron half equation for this reaction are
$Ca \longrightarrow Ca^{2+} + 2e^-$ oxidation
$Cu^{2+} + 2e^- \longrightarrow Cu$ reduction

There are other examples of oxidations and reductions

OXIDATION	REDUCTION
A metal forming a compound	Extraction of a metal from its ore
Reaction at the positive electrode during electrolysis	Reaction at the negative electrode during electrolysis
Reaction at the negative side of an electrochemical cell	Reaction at the positive side of an electrochemical cell
	Production of hydrogen or a metal by displacement reaction

60. Spectator ions are ions which do not change in a reaction. Ionic equations are equations which omit spectator ions.

Eg. $Na_2CO_{3(aq)} + Cu(NO_3)_{2(aq)} \longrightarrow 2\ NaNO_{3(aq)} + CuCO_{3(s)}$

A balanced equation

Since $NO_3^-{}_{(aq)}$ remains the same at the end of the reaction it is a spectator ion

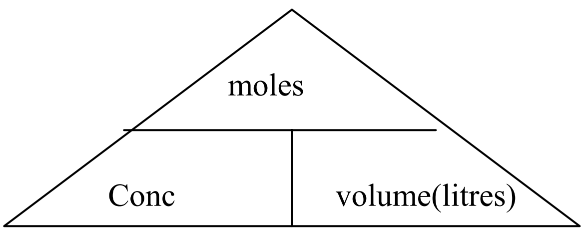
. $Na_2CO_{3(aq)} + Cu^{2+}{}_{(aq)} \longrightarrow 2\ Na^+{}_{(aq)} + CuCO_{3(s)}$

An ionic equation

61. Writing REDOX equations

Step 1 obtain 2 ion electrons half equations
Step2 Balance the number of electrons being lost in the oxidation step with the number of electrons being gained in the reduction step.
Step 3 Join the two half equations together into one REDOX equation , leaving out the electrons.

62.



63. The units of concentration are moles per litre ($moll^{-1}$)

64. Calculating the concentration of an acid/alkali by titration.

STEP 1 Obtain a balanced equation
STEP 2 Use number of moles = concentrationX volume (litres)
STEP 3 Use balanced equation ratio to calculate other number of moles
STEP 4 Calculate concentration using concentration = moles/volume(litres)

Eg. In a reaction 20 ml of sulphuric acid is neutralised by 10 ml of 4 $moll^{-1}$ sodium hydroxide solution . Calculate the concentration of the acid used.

STEP 1 $H_2SO_4 + 2\ NaOH \longrightarrow Na_2SO_4 + 2\ H_2O$

STEP 2 number moles NaOH = concX volume = 4 X (10/1000) = 0.04 moles

STEP 3 ratio H_2SO_4 : NaOH
1: 2
actual 0.02 : 0.04

There is 0.02 moles of H_2SO_4

STEP 4 conc of H_2SO_4 = moles/volume = 0.02/(20/1000) = 1 $moll^{-1}$