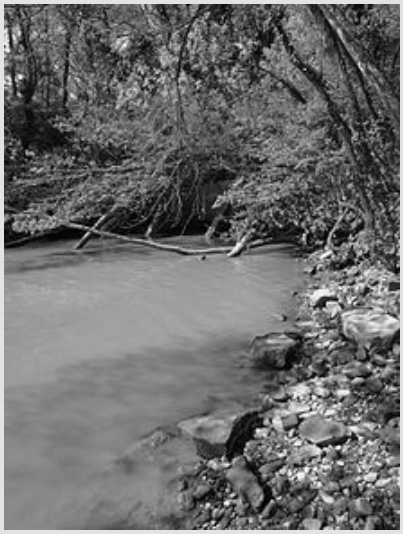
CaO Cycle

$CaCO_3$	⇒	$CaO + CO_2$
$CaO + H_2O$	⇒	$Ca(OH)_2$
$Ca(OH)_2 + CO_2$	⇒	$CaCO_3 + H_2O$

Eutrophication



Eutrophication arises from the oversupply of nutrients, which induces explosive growth of plants and algae which, when such organisms die, consume the oxygen in the body of water, thereby creating the state of hypoxia.

Reactivity Series

Pottasium	K
Sodium	Na
Calcium	Ca
Magnesium	Mg
Aluminium	Al
Zinc	Zn
Iron	Fe
Lead	Pb
Hydrogen	H
Copper	Cu
Mercury	Hg
Silver	Ag
Gold	Au

Reactivity increases upwards

More reactive a metal is, it will be less stable in its elemental form

Compounds of a more reactive metal will be more stable than the compounds of a less reactive metal

Extraction of Metals

The method of extraction of metals depends on the reactivity of the metal or the stability of the metal compound (usually metal oxides or chlorides).
There are three methods for the extraction of metals:
1. Electrolytic Reduction of molten metal compounds.
2. Chemical reduction by heating metal oxide with carbon
3. Thermal Decomposition
K - Al by Method 1
Zn - Cu by Method 2
Hg - Ag by Method 3

Composition of Air

Nitrogen	78% ≈ 80%
Oxygen	21% ≈ 20%
Other Gases	1%

Experimental Verification of Oxygen in Air

Diagram

Cu is heated

Plungers in A and B are moved back and forth so that air passes over Cu again and again until there is no decrease in volume

$2Cu(s) + O_2$ ⇒ heat $2CuO(s)$

Fractional Distillation of Air

CO_2 and H_2O and any dust particles are removed.

Air is cooled to -200^oC. Air is liquified at this temperature

On increasing the temperature, N_2 boils off at -196^oC, Ar at -185^oC and O_2 at -183^oC

Air Pollutants

Pollutant	Source	Effect	How to reduce?
CO	Incomplete combustion in car engines or furnaces	It forms carboxylic-hemoglobin and can cause death	Keep the car engine well tuned.
SO_2/ SO_3	Burning of coal & fossil fuels and volcanic eruptions	Can cause acid rain	Fuel should be desulfurized.
NxOy	Lightning and Car Engines	Causes acid rain and is irritant and causes rashes and breathing problems; asthma.	Using catalytic converter.

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Haber Process

N2 Source	Fractional Distillation of air
H2 Source	Oil or Natural Gas
Temperature	$500^{o}C$
Pressure	200 - 250 atm
Catalyst	Powdered Iron(Fe)

$N_2(g) + 3H(g) \Leftrightarrow 2NH_3(g)$

Manufacture of Ammonia

Properties of Ammonia

Physical

Colourless Gas

Has pungent smell

Lighter than air; Mr = 17

Highly soluble in water

Weakly basic; Turns damped red litmus paper blue

Irritant and can cause rashes

Chemical

Dissolves in water to produce ammonium hydroxide

$NH_3(g) + H_2O(l) \Leftrightarrow NH_4OH(aq)$

Reacts with acids to produce salts

$NH_3 + HCl \Rightarrow NH_4Cl$

$2NH_3 + H_2SO_4 \Rightarrow (NH_4)_2SO_4$

$NH_3 + HNO_3 \Rightarrow NH_4NO_3$

Uses of Ammonia

A large amount of ammonia is used to make fertilizers

An important lab reagent; Used to identify metal cations

Used to manufacture of Explosives

Used as a Refrigerant

Used in Pharmaceutical Industry

Used to manufacture cosmetics

Extraction of Iron

Ore	Haematite (Fe_2O_3)	
Method	2 (refer to Extraction of Metals)	
Reducing Agent	Carbon (C)	Carbon Monoxide (CO)
Chemical Reactions	in Blast Furnace	

$C + O`2 \Rightarrow CO_2$

$CO_2 + C \Rightarrow 2CO$

$3C + 2Fe_2O_3 \Rightarrow 4Fe + 3CO_2$

$3CO + Fe_2O_3 \Rightarrow 2Fe + 3CO_2$

Haematite contains sand (SiO_2) as impurity which is converted to slag (floats on surface) by the following reaction

$CaCO_3 \Rightarrow CaO + CO_2$

Extraction of Iron (cont)

$CaO + SiO_2 \Rightarrow CaSiO_3$ (slag)

Steel

Low carbon steel	upto 0.3% C
Medium carbon steel	0.4 - 0.6 % C
High carbon steel	0.7 - 1 % C

Rusting of Iron

Iron reacts with O_2 in presence of H_2O (moisture) to form $Fe_2O_3 \cdot XH_2O$ (rust)

Reaction is slow but is promoted in presence of any electrolyte in water especially under acidic conditions

Prevention

Coating	Coating Iron with plastic, paint, oil or grease
Electroplating	Electroplating Iron with chromium, nickel, silver
Galvonizing	Dipping in molten zinc to coat with zinc metal
Cathodic Protection	Connecting Iron body to negative terminal of a battery
Sacrificial Protection	Attaching Iron to a more reactive metal eg Mg or Zn

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Properties of Sulfur

It is a yellow solid

It has a low melting point of 113^{o}C

Found as a mineral

Burns with blue flames to produce SO_2

SO_2 is highly soluble in water

SO_2 can be further oxidized to SO_3 which causes acid rain

$SO_3 + H_2O \Rightarrow H_2SO_4$

Contact Process

Burning of Sulfur to produce SO_2

$S + O_2 \Rightarrow SO_2$

Catalytic oxidation of SO_2 to SO_3

$2SO_2 + O_2 \Leftrightarrow 2SO_3$

600^{o}C 1-2 atm V_2O_5 as catalyst

Making Oleum

SO_3 is dissolved in H_2SO_4 to form Oleum ($H_2S_2O_7$)

$SO_3 + H_2SO_4 \Rightarrow H_2S_2O_7$

React with water

$H_2S_2O_7 + H_2O \Rightarrow 2H_2SO_4$

Manufacture of H_2O_4 (Sulfuric Acid)

Extraction of Aluminium

Method	1 (refer to Extraction of Metals)	
Ore	Bauxite (Al_2O_3)	MP = 2000^{o}C

To prevent to heating to such a large temperature, Bauxite is dissolved in molten Cryolite (Na_2AlF_6) which melts at 900^{o}C

Graphite electrodes are used.

At Cathode

$Al^{3+} + 3e^{-} \Rightarrow Al(l)$

MP = 660^{o}C

At Anode

$O^{2-}(l) \Rightarrow O + 2e^{-}$

$O + O \Rightarrow O_2$

Oxygen produced at anode reacts with C (from the anode) due to high temperature and produces CO or CO_2

Anode burns away and needs to be replaced periodically

Properties and Uses of Aluminium

Light metal with high tensile strength

Very good conductor (three valance electrons)

Can reflect light and heat radiation

Used in aircraft bodies

Used in circuit wires

Used in milk tanks

Properties and Uses of Aluminium (cont)

Cost of Al is high due to:	cost of electricut
	cost of graphite anodes
	cost of fuel to keep electrolyte molten
Rusting	Al reacts with O_2 to form a non-porous Al_2O_3 coating which seals Al inside

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