Chapter 7.Metals and Non-metals

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Solution 1:

Metals are the elements (except hydrogen) which form positive ions by losing electrons or donating electrons.

For example sodium metal forms positively charged sodium ion by losinig one electron as follows:

$Na \rightarrow Na^{+} + e^{-}$

Metals usually have 1, 2 or 3 electrons in the outermost shell.

Metals can conduct heat and electricity and they are also malleable and ductile.

- Five metals are sodium, potassium, magnesium, aluminium, calcium.

Solution 2:

Non-metals are the elements which form negative ions by accepting (or gaining electrons).

For example Chlorine forms negatively charged chloride ion by accepting one electron as follows:

$Cl + e^{-} \rightarrow Cl^{-}$

Non-metals usually have 4, 5, 6 or 7 electrons in their outermost shell.

Non-metals do not conduct heat and electricity and are neither malleable nor ductile. These are brittle in nature.

- Five non-metals are oxygen, nitrogen, silicon, phosphorous, chlorine.

Solution 3:
Metal which exist in liquid state is mercury.
Non-metal which exist in liquid state is bromine.
Concept Insight: Metals are usually solid while non-metals exist in all the three states.

Solution 4:
The most abundant metal in the earth's crust is aluminium and the most abundant non-metal in the earth's crust is oxygen.

Solution 5:

1. Metals.
2. Non-metals.
3. Platinum and Gold.
4. Potassium and Sodium.
5. Potassium, Sodium and Calcium.
6. Iron.
7. Potassium and Sodium.
8. Platinum.
9. Platinum and Gold.
10. Mercuric oxide (HgO) and Silver oxide (Ag_2O).
11. Potassium hydroxide (KOH) and Sodium hydroxide (NaOH).
12. Potassium carbonate (K_2CO_3) and Sodium carbonate (Na_2CO_3).

13. Potassium carbonate (K_2CO_3) and Sodium carbonate (Na_2CO_3).
14. Potassium nitrate (KNO_3) and Sodium nitrate ($NaNO_3$).
15. Mercuric nitrate ($Hg(NO_3)2$) and silver nitrate ($AgNO_3$)

Solution 6:

The arrangement of metals in a vertical column in the order of decreasing reactivity is called reactivity series of metals or activity series of metals.

Activity of sodium	Activity of iron
1) **With air:** Sodium get oxidized to sodium oxide when exposed to air. It burns in air when heated. $4Na + O_2 \rightarrow 2Na_2O$	1) **With air:** Iron rusts in moist air. It burns when heated strongly. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$.
2) **With water:** Sodium reacts vigorously with cold water to form alkali sodium hydroxide and hydrogen gas. $2Na + 2H_2O \rightarrow 2NaOH + H_2$	2) **With water:** Red hot iron reacts with steam to form tri iron tetroxide and hydrogen. The reaction is reversible. $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
3) **With dilute acids:** Sodium reacts with explosive violence and liberates hydrogen. $2Na + 2HCl \rightarrow 2NaCl + H_2$	3) **With dilute acids:** Iron reacts with acids gradually and less vigorously forming hydrogen. $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$

Solution 7:

1. Fe < Zn < Mg < Na.
2. Na = Al < Cu<Fe
3. Ca >Mg > Fe > Cu.

Solution 8:

(i) When sodium and potassium are placed in cold water they react vigorously to form their respective alkalis and hydrogen gas is evolved.

$2K + 2H_2O \rightarrow 2KOH + H_2$

$2Na + 2H_2O \rightarrow 2NaOH + H_2$

(ii) Burning magnesium continues to burn in steam to form oxide and hydrogen.

$Mg + H_2O \rightarrow MgO + H_2$

(iii) Copper hydroxide when heated forms copper oxide and water.

$Cu(OH)_2 \rightarrow CuO + H_2O$

(iv) Potassium nitrate when heated strongly decompose to give potassium nitrite and oxygen gas.

$2KNO_3 (s) \rightarrow 2KNO_2 (s) + O_2 (g)$

(v) Copper nitrate when heated strongly decompose to give copper oxide, nitroger dioxide gas and oxygen gas.

$2Cu(NO_3)_2 (s) \rightarrow 2CuO (s) + 4NO_2 (g) + O_2 (g)$

(vi) Mercuric nitrate when heated strongly decompose to yield mercury metal and nitrogen dioxide gas and oxygen gas.

$Hg(NO_3)_2 (s) \rightarrow Hg (l) + 2NO_2 (g) + O_2 (g)$

Chapter 7. Metallurgy

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Solution 9:

(i) Sodium is more reactive than aluminium because sodium can lose electron easily to form sodium ions which can react with other substances readily while aluminium cannot lose electrons so easily as compared to sodium hence it is less reactive.

(ii) Gallium and caesium metals melt below 30°C so if room temperature is around 30°C they may also be in liquid state along with mercury.

(iii) Metals always combine with electro valency because they always have a tendency to form positive ions by losing electrons.

(iv) Metal ions are always positively charged because these are formed by loss of electrons from the metal atoms as:

$$M \rightarrow M^+ + e^-$$

Hence the resulting metal ions have less number of electrons and more number of protons so overall these are positively charged.

(v) Since metal ions are always positively charged so they are attracted towards negatively charged cathode (negatively charged) in the electrolytic cell and are discharged or get reduced there as:

At cathode: $M^+ + e^- \rightarrow M$

(vi)Metals generally do not form hydrides because hydrogen itself behaves like metals and has the tendency to lose its electron.

(vii) Metal atoms have largest atomic sizes among all the elements. Hence due to large size they cannot combine with other similar atoms to form diatomic or triatomic molecules so metals are monoatomic.

(viii) Sodium and potassium cannot be kept exposed to air get oxidized to fom their respective oxides as:

$$4K + O_2 \rightarrow 2K_2O$$
$$4Na + O_2 \rightarrow 2Na_2O$$

(ix) Sodium and potassium should not be treated with acids because they react with acids with explosive violence and liberates hydrogen gas:

$$2K + 2H_2SO_4 \rightarrow 2K_2SO_4 + H_2$$
$$2Na + 2HCl \rightarrow 2NaCl + H_2$$

(x) Hydrogen is not a metal but it has been assigned a place in the reactivity series of metals because like metals, hydrogen also loses electrons and form positive ions, H^+.

Solution 10:

(i) $2Na + 2H_2O \rightarrow 2NaOH + H_2$

(ii) $Mg + H_2O \rightarrow MgO + H_2$

(iii) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

(iv) $2HgO \rightarrow 2Hg + O_2$

(v) $2Ag_2O \rightarrow 4Ag + O_2$

(vi) $Cu(OH)_2 \rightarrow CuO + H_2O$

(vii) $Ca(OH)_2 \rightarrow CaO + H_2O$

(viii) $PbCO_3 \rightarrow PbO + CO_2$

(ix) $2KNO_3\ (s) \rightarrow 2KNO_2\ (s) + O_2\ (g)$

(x) $2Cu(NO_3)_2\ (s) \rightarrow 2CuO\ (s) + 4NO_2\ (g) + O_2\ (g)$

(xi) $Hg(NO_3)_2\ (s) \rightarrow Hg\ (l) + 2NO_2\ (g) + O_2\ (g)$

(xii) $2Ag(NO_3)_2\ (s) \rightarrow 2Ag\ (s) + 2NO_2\ (g) + O_2\ (g)$

Solution 11:

(i) Reduction with carbon.

The oxide of metal is lead oxide (PbO).

(ii) Electrolytic reduction

The oxide of metal is disodium oxide Na_2O.

$2NaCl \rightarrow 2Na^+ + Cl^-$

$2Na^+ + 2e^- \rightarrow 2Na$ (at cathode)

$Cl^- - 2e^- \longrightarrow Cl_2$(anode)

(iii) Reduction with heat alone

The oxide of metal is mercuric oxide HgO

$2HgO \rightarrow 2Hg + O_2$

Solution 12:

1. Aqueous solution of sodium chloride is not used for electrolytic reduction of sodium metal because sodium metal formed at cathode after discharge of sodium ions(at cathode) will react with water to form alkali NaOH.
2. For the reduction of a metal oxide a reducing agent other than carbon is carbon monoxide (CO).

Solution 13:

Corrosion is a process involving the conversion of a metal into an undesirable compound (usually oxide) on exposure to atmospheric conditions i.e. moisture and oxygen. In case of iron, corrosion is known as rusting.

Chemically rust is hydrated ferric oxide $Fe_2O_3.xH_2O$.

Reaction of corrosion: $4Fe + 3O_2 + xH_2O \rightarrow 2Fe_2O_3.xH_2O$

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Solution 1:

1. Gold and Platinum.
2. Charge.
3. Gangue.
4. Flux.
5. Calcination.
6. Roasting.
7. Iron pyrites.
8. Bauxite.
9. Cryolite, aluminium fluoride, Calcium fluoride.
10. **Cathode:** inner lining of gas-carbon of the electrolytic cell.
    Anode: Thick carbon rods dipping into the fused electrolytes.
11. Thermite welding.
12. Copper and silver.
13. Aluminium, Iron.
14. platinum and gold
15. sodium and potassium

Solution 2:

1. Zinc is used in galvanization and dry cells because zinc coating protects the iron from corrosion as it is more electropositive than iron hence it would be attacked first.
2. Nitric acid can be stored in aluminium containers because it do not attack aluminium. It renders aluminium passive due to the formation of an oxide film on surface of aluminum.
3. Aluminium oxide cannot be reduced by carbon because it is comparatively high in electrochemical series hence more reactive than carbon.
4. A neutral gas other than oxygen is formed at the anode during electrolysis of fused alumina because the oxygen gas formed at the anode oxidizes the carbon of the anode to carbon dioxide.
5. Extraction of aluminium was very difficult in the beginning because it was very expensive.
6. Carbon anodes are used in the electrolytic extraction of aluminium because carbon in the form of graphite is a good conductor of electricity.
7. Galvanized metal ions should not be used for storing food as food acids may react with the zinc coating and cause food poisoning.

Solution 3:

1. **Mineral:** The naturally occurring compounds of metals which are generally mixed with earthy such as soil, sand, limestone and rocks are known as minerals.
2. **Ore:** Those minerals from which a metal can be extracted profitably are called ores.
3. **Gangue:** The rocky impurities like (SiO_2) present in an ore are called gangue.
4. **Charge:** The mixture of materials fed into a furnace to extract a metal is called charge.
5. **Flux:** The substance added to get rid of gangue in the extraction of metal is called flux.
6. **Slag:** The product obtained by the combination of gangue with flux is called slag.

Solution 4:

(i) The set of processes used to remove as much of gangue as possible, is known as concentration of ores. It is also known as 'ore dressing.'

(ii) The process of concentration

a. Based on densities is Gravity separation.
b. Based on magnetic nature is Electromagnetic separation.

(iii) Concentrated of an ore by froth floatation process: This process depends on preferential wettability of the ore and the gangue particles. Crushed ore is taken in a large tank containing water and certain oils. The ore particles get wetted by the oil and the gangue particles get wetted by water. The mixture is then agitated with the help of compressed air. The ore particles that get wetted with the oil form a froth on the top, and can be scooped out. This method is used for the concentration of sulphide ores.

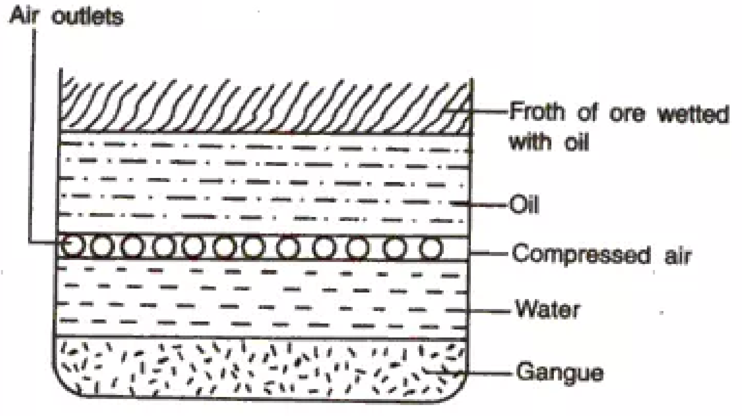

Figure: Froth floatation process

Solution 5:

1. Mercury.
2. Silver.
3. Zinc.
4. Aluminium.

Solution 6:
As we know that minerals are the naturally occurring compounds of metals which are generally mixed with earthy such as soil, sand, limestone and rocks while ores are those minerals from which a metal can be extracted profitably.
Hence "All ores are minerals but all minerals are not ores".

Solution 7:

1. **Iron:** Haematite(Fe_2O_3) and Magnetite (Fe_3O_4).
2. **Zinc:** Zinc blende (ZnS) and Calamine ($ZnCO_3$).
3. **Aluminium:**Bauxite(Al_2O_3) and Cryolite ($AlF_3.3NaF$).

Solution 8:

Comparison of calcination and roasting:

Calcination	Roasting
• It is the process of heating the ore to a high temperature in the absence of air, or where air does not take part in the reaction. • Usually carbonate ores or ores containing water are calcined. • Organic matter, if present in the ore, gets expelled and the ore becomes porous. • It is done in reverbratory furnace. The holes of the furnace are kept closed.	• The process of heating the concentrated ore in the presence of air to a high temperature so as not to melt it is called roasting. • Usually sulphide ores are roasted. • The impirirties of P, As and S are removed as their oxides which being volatile, escape as gases. • It is also done in reverbratory furnace but the holes of the furnace are kept open to allow the entry of air into the furnace.

Solution 9:

Refining of metals: It is the further purification of metals obtained by reduction process to remove all the impurities.
Depending upon the nature of metal, nature of impurities and purpose for which metal is to be used. The three methods used for refining are:

1. Liquation.
2. Distillation.
3. Electrolytic refining.

Solution 10:

Electrolytic method: This method is based upon the phenomenon of electrolysis and is widely used to refine a number of metals such as copper, silver, gold etc. In this method, impure metal is made anode whereas a thin sheet of pure metal is used as cathode in an electrolytic tank. The electrolyte used in the tank is usually the acidified aqueous solution of a salt or complex salt of metal. On passing the electric current through electrodes the metal ions from anode go into the electrolyte solution. These cations gain electrons from the cathode and get deposited on it. The impurities either remain dissolved or get precipitated as anode mud.

At anode: $M \rightarrow M^{n+} + ne^-$

At cathode: $M^{n+} + ne^- \rightarrow M$ where M is the metal to be refined.

Solution 11:

(a) Bauxite.

(b) Purification of aluminium ore is done by the Baeyer's process.

Baeyer's process involves the following steps:

1. Bauxite is crushed to a fine powder.
2. The powdered bauxite is then treated with a strong solution of sodium hydroxide.
3. The mixture is then heated under pressure to 150°C to 250°C, for about 30 minutes. The heat and the pressure cause the alumina to dissolve in the sodium hydroxide to form sodium aluminate.

$$Al_2O_3.2H_2O + 2NaOH \rightarrow 2NaAlO_2 + 3H_2O$$

Alumina being amphoteric dissolves in sodium hydroxide.

4. The sodium aluminate solution is then filtered to separate the impurities.
5. The solution of sodium aluminate is then cooled lightly and sent into tanks called precipitators.
6. Crystals of aluminium hydroxide are then added when most of the sodium aluminate undergoes hydrolysis to precipitate insoluble aluminium hydroxide.

$$NaAlO_2 + 2H_2O \rightarrow NaOH + Al(OH)_3$$

7. The solid aluminium hydroxide is separated by filtration.
8. The solid aluminium hydroxide is then washed and again filtered and dried, and then heated to about 1100°C to 1200°C, when aluminium hydroxide decomposes to form aluminium oxide.

$$2Al(OH)_3 \rightarrow Al_2O_3 + 3\ H_2O$$

(c) Aluminium is obtained from pure ore by Hall – Heroult's process as follows:

i. Electrolyte used:

a. Pure alumina

b. Cryolite

c. Aluminium fluoride

d. Calcium fluoride or Fluorspar

Solution 12:

(a) Fluorspar is CaF_2 and it helps in the mobility of the fused mixture.

(b)Cathode is the inner lining of gas-carbon of the electrolytic cell and anode is the thick carbon rods dipping into the fused electrolytes.

At cathode: Aluminium ions get reduced as:

$Al^{3+} + 3e^- \rightarrow Al$

At anode: oxygen gas is liberated as:

$O^{2-} - 2e^- \rightarrow [O]$

$[O] + [O] \rightarrow O_2$

The oxygen formed at anode oxidizes the carbon of the anode to carbon dioxide.

$C + O_2 \rightarrow CO_2$

As a result the anode gets oxidized and it has to be replaced periodically.

Solution 13:

Cryolite acts as a solvent for the electrolytic mixture in the electrolytic reduction of alumina in the Hall's process.

Solution 14:

(a) Aluminium is a more active metal than iron, but suffers less corrosion because of t he formation of a thin, transparent, protective, non-porous adhering film of aluminium oxide on the surface of aluminium which makes it resistant to corrosion.

(b) Aluminium vessels should not be cleaned with powders containing alkalis because alunimun reacts with alkalis to form respective aluminate and hydrogen as:

$2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$

(c) Food containing iron salts should not be cooked in aluminium utensils as there is a danger of aluminium toxicity.

Solution 15:

(i) $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$

(ii) $2Al(OH)_3 \rightarrow Al_2O_3 + 3H_2O$

(iii) $2Al + N_2 \rightarrow 2AlN$

(iv) $Al_2O_3 + 2H_2O + 2NaOH \rightarrow 2NaAlO_2 + 3H_2O$

Solution 16:

An alloy is a homogeneous mixture of two or more metals fused together and then solidified.
Alloys are made because they have many salient features:

1. Tensile strength.
2. Strength.
3. Electrical hardness.

Solution 17:
The properties of alloys which are different from constituent metals are:

1. Alloys are stronger and harder than the metals of which they are made.
2. Alloys are more resistant to corrosion.

Solution 18:

Amalgam: A mixture or an alloy of mercury with a number of metals or non-metals is known as amalgams. An amalgam may be liquid such as Na/Hg or a solid like Zn/Hg.

1. Iron does not form amalgam.
2. Dental amalgam which is a mixture of mercury with a silver tin alloy is used for dental fillings.

Solution 19:

Alloys	Composition	Uses
Stainless steel	Fe = 75% Ni = 8 – 10% Cr = 15 – 18% C = 0.5 – 1%	Cutlery Utensils Surgical instruments Decorative articles Automobile bodies Furniture Scientific instruments
Duralumin	Al = 95% Cu = 4% Mg = 0.5% Mn = 0.5%	Aircrafts Automobiles Tools
Brass	Cu = 55 to 95% Zn = 5 to 45%	Hardware Electrical fixture Jewellery Decorative metal items Medals Musical instruments
Magnalium	Al = 70 to 95% Mg= 5 to 30 %	Machine parts Aircrafts Scientific instruments
Solder	Pb = 50% Sn = 50%	Joining metal wires, especially in electrical and electronic equipments
Bronze	Cu = 80% Sn = 20% P, Pb, Zn etc. may be present in small quantities.	Statues Coins Medals Utensils Decorative items

Solution 20:

1. Galvanization protects iron from rusting because in galvanization coating of zinc is done over iron articles and zinc being more electropositive would be attacked preferably than iron.
2. Stainless steel is more useful than steel as it is harder, has high tensile strength, more lustre, more resistance to corrosion and many chemicals.
3. Aluminium is extensively used for making aircraft parts because of features like high tensile strength, corrosion resistance light but hard and tough.
4. Cold water has no action on aluminium while burning aluminium decomposes steam.

Solution 21:

(i) $4Al + 3O_2 \rightarrow 2Al_2O_3$ (s)

(ii) $2Al + N_2 \rightarrow 2AlN$

(iii) $2Al + 2KOH + 2H_2O \rightarrow 2KAlO_2 + 3H_2$

(iv) $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$

(v) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

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Solution 1991-1:

1. Iron having a coating of zinc is called galvanized iron.
2. iron which cannot be easily acted upon by acidsis called as passive iron. Galvanized iron is called passive iron since coating of zinc protects the iron from corrosion as zinc is more electropositive and so would be attacked first.

Solution 1991-2:
Zinc amalgam which is a mixture of zinc and mercury.

Solution 1992-1:

$2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$

Solution 1992-3:

1. Nitrogen.
2. Iodine
3. Bromine
4. Carbon in the form of graphite

Solution 1992-:

1. Cryolite is Na_3AlF_6 and its chemical name is Sodium aluminium fluoride.
2. Cryolite is used in the electrolysis of alumina. The function of cryolite is to
   - Reduce melting point of alumina
   - Make molten alumina a good conductor of electricity

Solution 1993-1:
Gold.

Solution 1993-2:

An ore of zinc is Zinc blende (ZnS).

(a) $2ZnS + 3O_2 \longrightarrow 2ZnO + 3SO_2$

(b) $ZnO + C \longrightarrow Zn + CO$

(c) In addition to zinc oxide carbon is put in the furnace to reduce it to zinc metal, large scale use of zinc is that it is used for electroplating

Solution 1994-1:

Reactivity of metals with water Sodium, calcium, magnesium, iron

Solution 1994-2:

i. Reaction of sodium with water:

$2Na + H_2O \rightarrow 2NaOH + H_2$

ii. Reaction of calcium with water:

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

iii. Reaction of magnesium with water:

$Mg + H_2O \rightarrow MgO + H_2$

iv. Reaction of iron with water:

$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

Solution 1995-1:

(a) Ore of iron is haematite and ore of aliminium is bauxite.

(b) Reduction of the oxide is the most important chemical process in the extraction of any metal.

(i) In case of iron:
$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(ii) In case of aluminium:

Al_2O_3 cannot be easily reduced; hence it is subjected to electrolysis. Aluminium is collected at the cathode..

(c)

Aluminium	Iron
1. Aluminium ore contains impurities of FeO and SiO_2	1. Iron ore contains impurities of silica and sand. These are removed by magnetic separation.
2. Bauxite containing FeO is calcinated at high temperature	2. FeO is oxidized to Fe_2O_3
3. Calcinated ore is then treated with NaOH when Al_2O_3 is converted into soluble $NaAlO_2$ (sodium meta-aluminate)	3. The insoluble Fe_2O_3 and silica can thus be filtered off
The filtrate is hydrolysed to get Aluminum hydroxide which on ignition gives pure alumina (Al_2O_3)	

(d) Carbon.

Solution 1995-2:

Zinc amalgam.

Solution 1996-1:

(a) Bauxite: It is the principle ore from which aluminium is extracted.

(b) Sodium hydroxide: It reacts with alumina to form sodium aluminate which is then further filtered to separate impurities.

$Al_2O_3.2H_2O + 2NaOH \rightarrow 2NaAlO_2 + 3H_2O$

Alumina Sodium aluminate

(c) Cryolite is used in the electrolysis of alumina. The function of cryolite is to
(1) Reduce melting point of alumina
(2) Make molten alumina a good conductor of electricity

(d) Graphite: It acts as electrodes in the electrolytic extraction of aluminium.

Solution 1996-2:

(a) Reaction at cathode:

$Al^{3+} + 3e^- \rightarrow Al$

(b) Oxygen gas is liberated at anode as:

$O^{2-} - 2e^- \rightarrow [O]$

$[O] + [O] \rightarrow O_2$

The oxygen formed at anode oxidizes the carbon of the anode to carbon dioxide.

$C + O_2 \rightarrow CO_2$

As a result the anode gets oxidized and it has to be replaced periodically.

Solution 1996-3:

An alloy is a homogeneous mixture of two or more metals fused together and then solidified.

1. The special property of duralumin is:
    - Light but hard
    - Resistant to corrosion
    - Ductile
2. Type metal = Hard

Solution 1997-1:

Chromium and nickel is added to steel to make it stainless steel.

Solution 1997-2:

Ore: Those minerals from which a metal can be extracted profitably are called ores. For example bauxite ore is used to extract aluminium metal, hematite ore is used to extract iron metal.

Solution 1998-1:

1. good, poor.
2. non-malleable.
3. form negative ions.
4. basic oxides.

Solution 1998-2:

1. Mercury.
2. Graphite.

Solution 1998-3:
Metals have 1, 2, 3 valence electrons while non-metals have 4, 5, 6 or 7 valence electrons.

Solution 1999-1:
Magnesium oxide, iron (II) oxide, lead (II) oxide and then copper (II) oxide.

Solution 1999-2:

(a) Reduction of copper oxide by hydrogen:

$CuO + H_2 + heat \rightarrow Cu + H_2O$

(b) Reduction of iron (III) oxide by carbon monoxide:

$Fe_2O_3 + 3CO + heat \rightarrow 2Fe + 3CO_2$

(c) Reduction of lead (II) oxide by carbon:

$PbO + C + heat \rightarrow Pb + CO$

Solution 1999-3:

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Solution 2000-1:

1. Blue
2. Red
3. Hydrogen
4. acidic, acidic
5. graphite.

Solution 2001-1:

1. Copper
2. Iron
3. Zinc
4. Magnesium

Solution 2001-2:

Sodium > magnesium > Zinc > Iron > Copper

Solution 2002-1:

Metal	1	2	3	4	5
Use	B	D	E	A	C

Solution 2002-2:

(a) (i) Aluminium oxide being an amphoteric oxide reacts with sodium hydroxide solution to form soluble sodium meta aluminate.

$$\underset{\text{Alumina}}{Al_2O_3.2H_2O} + 2NaOH + 2H_2O \rightarrow \underset{\text{Sodium aluminate}}{2NaAlO_2} + 3H_2O$$

(ii) Iron(III) oxide remains undissolved in the sodium hydroxide solution and settles down.

(b) (i) Baeyer's process or Hall's process is used for the purification of bauxite.

(ii) $2Al(OH)_3 + \text{Heat} \rightarrow Al_2O_3 + 3H_2O$

(c) (i) Na_3AlF_6. It is also known as Sodium aluminium fluoride.

(ii) Conducting solution is produced.

(iii) Because it reacts with O_2, produced at anode and gets consumed to form CO_2.

$O^{2-} - 2e^- \rightarrow [O]$

$C + 2[O] \rightarrow CO_2$

So carbon rods are replaced from time to time.

(iv) $2Al^{3+} + 6e^- \rightarrow 2Al$

(d) Duralumin is light, strong and more resistant to corrosion than aluminium.

Solution 2003-1:

Property	Metal	Non-metal
Electronic configuration	Usually have 1, 2 or 3 electrons in valence shell.	Usually have 5, 6 or 7 electrons in the valence shell.
Nature of oxides	They generally form basic oxides some of which are amphoteric as Al_2O_3	Generally form acidic oxides (CO_2, SO_2). Some oxides are neutral as NO N_2O.
Oxidizing or reducing action	Reducing agents	Oxidizing agents
Conductivity of heat and electricity	Generally they are Good conductors of both heat and electricity.	Generally they are Poor conductors of heat and non conductors of electricity.

Solution 2004-1:

Iodine is a non- metal that has a metallic luster and sublimes on heating.

Solution 2004-2:

$2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$

Solution 2004-3:

Zinc blende (ZnS)

Solution 2004-4:

(i) $Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$

(ii) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

(iii) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

Solution 2004-5:

Galvanization.

Solution 2004-6:

(a) $Na_3AlF_6 \rightleftharpoons 3Na^+ + Al^{3+} + 6F^-$

$CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$

$Al_2O_3 \rightleftharpoons 2Al^{3+} + 3O_2^-$

(b) Fluorspar and cryolite act as solvent. The percentage by weight composition is as follows:

Alumina -20% by mass

Cryolite – 60% by mass

Fluorspar – 20% by mass

(c) $O^{2-} - 2e^- \rightarrow [O]$

$[O] + [O] \rightarrow O_2$

(d) As a reducing agent: Aluminium has a high affinity for oxygen. It readily removes oxygen from oxides of less reactive metals.

Solution 2005-1:

1. (i) B, D F
   (ii) A, C E
2. (i) Sodium hydroxide solution
   (ii) Cryolite
3. Na_3AlF_6

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Solution 2005-2:

1. For stainless steel: iron, chromium
2. For brass: Copper and zinc.

Solution 2006-1:

1. Mercury.
2. Cryolite.
3. Roasting.
4. Calcium silicate.
5. Zone of heat absorption.

Solution 2007-1:

(a) Sodium hydroxide.

(b) $2Al(OH)_3 + Heat \rightarrow Al_2O_3 + 3H_2O$

(c) Carbon

(d) $[Al^{3+} + 3e^- \rightarrow Al] \times 2$

(e) $[O^{2-} - 2e^- \rightarrow O_2]$

Solution 2008-1:

(b)

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Solution 2009-1:

1. Carbon as it forms very large number of compounds while the rest do not.
2. Mercury as it is a liquid metal while the rest aresolid.

Solution 2009-2:

1. Copper reacts with concentrated nitric acid to produce nitrogen dioxide.
2. Bauxite is the chief ore of aluminium.

Solution 2009-3:

1. A is cathode and B is anode.
2. Molten fluorides of Al, Na and Ba.
3. Graphite rods.

Solution 2009-4:

Use of Metal	Property
Zinc in Galvanization	Not affected by air and moisture
Aluminium in Thermite welding	Strong affinity for oxygen as compared to iron.