7. Projects

7.1 Literature Project I: Biographies of Eminent Chemists

(a) Marie Curie (nee Sklodowska) (1867 â€“ 1934).

Marie Curie was a Polish immigrant to France. She registered as a student in Paris in 1891. In 1894, she got married to Pierre Curie, but continued her work as a research student. Her topic for investigation was Radio-activity which Becquerel had recently discovered. There was no laboratory for her at the University, so she worked in a shed in her husbandâ€™s work place. Pierre was the chief of the laboratory at the School of Physics and Chemistry.

Pierre himself was doing a research in electricity, but his wifeâ€™s findings interested him so much that he joined in her research. For that research, the Curies shared the Nobel price with Becquerel in 1903. Marie was awarded the doctorate degree in 1903.

In 1904, Pierre was appointed Professor of Physics at the University of Paris. With the funds from the Nobel price, he built a laboratory. However, the new-found joy of the Curies was short-lived, for Pierre died of an accident in 1906. Marie succeeded her husband as Professor of Physics at the University of Paris. She continued her research in radioactivity. In 1911, she became the first (and till now the only) person to be awarded the Nobel price twice. She traced radioactivity to uranium, thorium, polonium (an element she named after her native country), and radium (so called because it radiates light).

(b) Joseph John Thompson (1856 â€“ 1940) :

J. J. Thompson was born near Manchester in 1856. He attended Owens College in his hometown between 1870 and 1876, then went to Trinity College from where he graduated in Mathematics and Physics in 1880. He worked in Trinity from 1880 till his death in 1940.

His investigations were on the popular topic at the time:â€“ conductivity of electricity by gases at reduced pressure. His work convincingly established the fact that cathode rays were streams of negatively charged particles which he called corpuscles, but which we today call electrons. He rose to the post of Head of the Cavendish

Laboratory which Maxwell and Rayleigh headed before him.

(c) Wilhelm Konrad Roentgen (1849 â€“ 1923):

Roentgen was a professor of physics at the University of Wurzburg. His discovery of x-rays brought him fame. The discovery came to him by surprise while he was investigating a report that cathode rays could pass through a thin foil of metal. He saw that the new rays passed through each of the following: a book 1000 pages thick, two packs of cards, a sheet of tin foil, half an inch of aluminium, thick sheet or rubber and glass, but was stopped by flint glass containing lead.

The most significant effect of the rays which aroused the interest of scientists and medical doctors was that it produced a shadow of Roentgenâ€™s bone when he placed his hand on their path. The implication of this was that they could be used in the diagnosis of broken bones and foreign bodies, and possibly to cure some diseases.

Roentgen called the strange rays x-rays because he was clever in algebra, a subject in which Ã— usually represents an unknown. They are still called x-rays today, though some people call them Roentgen rays, after the discoverer.

Nuclear Hazards

The nuclear industry can be very hazardous. The hazards could be from the heat of an exploded atomic bomb which can be so tremendous that lives and property are distroyed (as was the case in Hiroshima). Also, radiations from radioactive power generators are dangerous. The highly penetrating gamma rays can kill animal and plant tissues. Strontiumâ€”90, which is the fuel for many generators presents a special biological problem. It is a bone-seeking radioisotope. It is harmful when absorbed by living organisms. It enters and remains in the bone, destroying bone marrow, etc. Beta rays from strontiumâ€”90 do not constitute a radiation hazard, as they are low-penetrating, being stopped by materials surrounding the fuel cell. But as they are stopped, secondary radiations, known as bremsstrahlung, are produced. These radiations are extremely dangerous to man.

Plutoniumâ€”238, the only radioisotope so far used in space flights, emits alpha particles, very low energy gamma rays and neutrons. Infact, even without shielding, it presents no radiation hazards to man because its radiations are either low penetrating or have low energy. In addition, there is no danger of explosion because its nuclear characteristics are such that it cannot maintain a chain reaction. All forms of plutonium are extremely poisonous to living things.

Adequate precautions are taken to ensure safety in nuclear industries. Uraniumâ€“ 235 and other fissionable materials are used in sub-critical masses to avoid explosions. The modem reactor is housed in an enclosure backed up by a series of detectors to warn of malfunctioning equipments. Several barriers, including concrete and steel walls, are built to avoid escape of radiation.

However, being a man-made device, a nuclear industry may fail (as one did fail. recently in Chernobyl, USSR and caused the death of many people). The advantages derived from nuclear energy are however so immense that it is worth investing in nuclear technology despite its attendant risks.

Project:

Find out more about contemporary eminent chemists and write on their achievements. Submit this to your teacher for evaluation.

7.2 Literature Projects II: Metals:-

Lead

Lead has been known and used for a long time. In Europe, lead water pipes were in common use. Lead is more abundant in the earthâ€™s crust than tin. Lead occurs as galena, PbS. It occurs in Abakaliki, Bauchi, Kaduna and Jos in Nigeria.

Extraction: Lead is extracted from galena, PbS. The ore is concentrated by oil flotation. It is then roasted to convert the sulphide to volatile sulphur(IV) oxide and lead(II) oxide.

$2PbS(s) + 3O_2(g)$ â†’ $2PbO(s) + 2SO_2(g)$

The lead(II) oxide is mixed with lead(II) sulphide and coke. The mixture is then smelted in the blast furnace.

$PbS(s) + 2PbO(s)$ â†’ $3Pb(s) + SO_2(g)$

$2PbO(s) + C(s)$ â†’ $2Pb(s) + CO_2\ (g)$

Lead obtained from the above method still contains impurities such as silver.

Further purification is achieved by electrolysis, using lead fluorosilicate $PbSiF_6$ as electrolyte and a little Hexafluorosilicic(IV) acid. The anode is made of impure lead, and the cathode of thin sheets of pure lead.

Chemistry of the process: Lead ions migrate to the cathode and each lead ion gains two electrons to become deposited as lead:

$Pb^{2+}(aq) + 2e$ â†’ Pb

The pure lead anode dissolves and goes into solution as lead ions.

$Pb(s)$ â†’ $Pb^{2+} + 2e$.

Other impurities higher than lead in the activity series remain in solution.

Properties:

(a) The metal is usually soft.

(b) If heated in air, it forms lead(II) oxide.

$$2Pb(s) + O_2(g) \xrightarrow{heat} 2PbO(s)$$

(c) Lead exhibits two oxidation states: lead(II) ion and lead(IV) ion. The two states are amphoteric.

(d) Dilute acids have little effect on lead.

(e) Only concentrated trioxonitrate(V) acid attacks lead.

Uses of lead

(i) It was used in the past for making water pipes. But because of the attendant risk of lead poisoning, it is no longer used.

(ii) It is used in lead accumulators. Batteries contain alternate plates of lead and lead(IV) oxide.

(iii) It is used in making alloys.

Lead(IV) oxide, PbO_2 : This is formed on the anode of the lead storage batter during charging. Lead(IV) oxide contains a lot of oxygen and is a strong oxidzing agent.

$2PbO_2$ (s) â†’ $2PbO$(s) + O_2 (g)

Lead ethanoate: It is prepared by reacting ethanoic acid with lead(II) oxide.

PbO(s) + $2CH_3COOH$(aq) â†’ $(CH_3COO)_2$ Pb(s) + H_2 O(l)

It is used for testing for hydrogen sulphide in the laboratory. Lead ethanoate is sweet. Note: it is poisonous to taste it! It is often referred to as â€œsugar of leadâ€.

Lead sulphide: It is prepared by passing hydrogen sulphide into lead trioxoni trate(V) solution:

Pb^{2+}(aq) + H_2S(g) â†’ PbS(s) + $2H^+$(aq)

White lead, $Pb(OH)_2.2PbCO_3$: This is basic lead(II) trioxocarbonate(IV). It is used in paints.

Tetraethyl lead, $Pb(C_2 H_5)_4$: It is added to petrol (gasoline) to raise the octane number of the gasoline. Good grade gasoline contains about 2 cm^3 of tetraethyl lead per gallon.

Projects:

Literature project III:

Explore for information on vineral ores in Nigeria.

Iron

Iron does not occur free in nature, except in meteorites. It has been known since about 2000 B.C. It was also recorded that about 2,500 tonnes of iron were used in the construction of Solomonâ€™s temple. (circa 1000 B.C.) In Delhi, there is a famous iron pillar which was built at about 300 A.D. Itâ€™s importance lies in the fact that the iron pillar is free from rust. Iron occurs mainly as, haematite, $Fe_2 O_3$; magnetite, Fe_3O_4 â€œ limonite, $2Fe_2O_3.3H_2O$; siderite, $FeCO_3$; and iron pyrites, FeS_2 . Iron is also present in the sulphide ores of copper, nickel and cobalt.

It is extracted by the reduction of the ore with coke in the blast furnace. The most modern method of extraction is the Lâ€”D process. Iron and steel industries have been established in Nigeria in Oshogbo, Ajaokuta, Aladja, etc.

Tin

Search for information on the occurence and mining of tin in Nigeria. Tin is found occasionally free in nature. However, the principal ore is cassiterite, SnO_2.

Articles have been found made of tin, dated to 1400 B.C. Cornwall in the south of England was the major world source of tin. At the present time, tin is mined in Jos in Nigeria.

Tin is extracted from cassiterite, SnO_2, by reduction with coke. The ore is concentrated by washing and oil flotation to remove impurities such as sand, etc. This is followed by reduction with coke in the blast furnace.

SnO_2(s) + 2C(s) â†’ Sn(s) + 2CO(g)

The importance of tin lies in the fact mat it resists atmospheric corrosion.

Uranium

Uranium was first discovered by Klaproth in 1789. Its name was derived from the planet uranius. Uranium is the first element in which radiactivity was observed. It occurs as pitchblende.

Extraction: Uranium can be isolated from its compounds by diffusion. This is based on Grahamâ€™s law of diffusion which states that the rate of diffusion of a gas varies inversely as the square root of its density. A gaseous compound of uranium, uranium hexafluoride UF_6, contains the lighter isotope, and it has been used to obtain uraniumâ€”235.

Compounds of uranium: Compounds of uranium include:-

Uranyl trioxonitrate(V), $UO_2 (NO_3)_2$;

Sodium zinc uranyl ethanoate, $NaZn(UO_2)_3.(CH_3COO)_2.H_2O$

Sodium diuranate, $Na_2 U_2 O_7.6H_2 O$;

â€œgreen oxideâ€, U_3O_8 ;

Uranium hexafluoride, UF_6 ;

Uranium peroxide, $UO_4.4H_2O$;

Uranium dioxide, UO_2.

7.3 Experimental Project: Analysis of Rock Samples and Samples of Ores

Analysis of Laterite

List of materials:- Laterite sample, beaker, 2 M trioxonitrate(V) acid, filter paper, filter funnel, and 2 M sodium hydroxide. Grind some laterite sample. Put this in a beaker. Add 2 M trioxonitrate(V) acid and shake well. Warm if necessary. Filter off solid particles. Put the filtrate in a test-tube and add 2 M sodium hydroxide solution. Identify all the metallic ions present and record your observations.

Analysis of Limestone:

List of materials: test tube, limewater, some limestone, dilute hydrochloric acid, and 2 M sodium hydroxide.

Put some limestone in a boiling-tube. Add dilute hydrochloric acid to it. What do you observe? Any effervescence? Pass the gas into limewater. If the limewater was turned milky, then the gas must be carbon(IV) oxide. This shows that limestone contains trioxocarbonate(IV) ion.

Put a fresh sample of limestone in another test-tube. Add dilute hydrochloric acid to dissolve it. Add 2 M sodium hydroxide solution. Describe what you observe. A white crystalline precipitate shows the presence of calcium.

Limestone is mined at Nkalagu, Ewekoro and many other places in Nigeria. It is used in the manufacture of cement. Cement factories are usually sited near limestone deposits. Limestone is also used in making glass. It is used in agriculture to control soil acidity and for the manufacture of fertilizers.

Analysis of Tin Ore

Add dilute hyrochloric acid to tin oxide in a test-tube, and warm. Filter off the solution. To the filtrate in a test tube, pass hydrogen sulphide gas. A brown precipitate shows the presence of tin.

TABLE 7.1 Information on mineral ores in Nigeria

Mineral Ore	Where found	Uses

Diamond	Not mined yet in Nigeria.	In making modern cutting tools for industry.
Iron ore	Ajaokuta, Lokoja	For making machines, and other tools.
Bauxite	Untapped	For making aluminium sheet, etc
Tin ore	Jos Plateau	Tin plating, etc.
Columbite	Jos Plateau	For making gas turbine engines for the jet aeroplanes.
Coal	Enugu, Bauchi, Kabba	As coke in steel production.
Lead and zinc ores	Abakaliki, Bauchi, and Jos	Zinc plating. Making lead batteries.
Limestone	Ewekoro, Nkalagu,Sokoto, Shagamu	Making cement, fertilizers and glass.
Salt	Valley of river Benue and elsewhere.	In soap and alkali industries.
Uranium	Occurs in Nigeria.Not mined.	Making nuclear reactors and atomic bombs.
Gold	Ilesha, Minna, Sokoto	Making ornament.
Marble	Igbeti, Lokoja	Making ornaments.
Petroleum oil	Niger-Delta areas.	As fuel and lubricant, etc.
Zinc blende	Bauchi, Jos	Zinc plating.

You should read about other mineral ores in Nigeria from suitable text-books, and draw up a table as shown above.