

Day 1
Metals and Metallurgy
Duration: 3hr

Topics of discussion:

- 1) Introduction
- 2) Metals and periodic table
- 3) Metallurgy and principles
- 4) Ores and minerals
- 5) Different ores and their compositions
- 6) Discussion

Introduction

- **Metallurgy** is defined as a process that is used for the *extraction of metal* in their purest form
- Multistep process
- Applicable for all metals from lump to minute quantities

Metals and periodic table

Periodic Table of the Elements

Legend:

- State of matter (color of name):** GAS (light blue), LIQUID (orange), SOLID (green), UNKNOWN (grey).
- Subcategory in the metal-metalloid-nonmetal trend (color of background):**
 - Alkali metals (red)
 - Alkaline earth metals (orange)
 - Transition metals (blue)
 - Lanthanides (light blue)
 - Actinides (green)
 - Post-transition metals (purple)
 - Metalloids (yellow)
 - Reactive nonmetals (light green)
 - Noble gases (pink)
- Unknown chemical properties (grey background).

1 IA 1 H Hydrogen 1.008 1																	2 VIIIA 2 He Helium 4.003 2																		
3 IIA 3 Li Lithium 6.941 3	4 IIA 4 Be Beryllium 9.012 4											5 IIIA 5 B Boron 10.811 5	6 IVA 6 C Carbon 12.011 6	7 VA 7 N Nitrogen 14.007 7	8 VIA 8 O Oxygen 15.999 8	9 VIIA 9 F Fluorine 18.998 9	10 VIIIA 10 Ne Neon 20.180 10																		
11 IIA 11 Na Sodium 22.990 11	12 IIA 12 Mg Magnesium 24.305 12	13 IIIB 13 Al Aluminum 26.982 13	14 IIIB 14 Si Silicon 28.086 14	15 IIIB 15 P Phosphorus 30.974 15	16 IIIB 16 S Sulfur 32.065 16	17 IIIB 17 Cl Chlorine 35.453 17	18 IIIB 18 Ar Argon 39.948 18	19 IIIB 19 K Potassium 39.098 19	20 IIIB 20 Ca Calcium 40.078 20	21 IIIB 21 Sc Scandium 44.956 21	22 IIIB 22 Ti Titanium 47.883 22	23 IIIB 23 V Vanadium 50.942 23	24 IIIB 24 Cr Chromium 51.996 24	25 IIIB 25 Mn Manganese 54.938 25	26 IIIB 26 Fe Iron 55.845 26	27 IIIB 27 Co Cobalt 58.933 27	28 IIIB 28 Ni Nickel 58.693 28	29 IIIB 29 Cu Copper 63.546 29	30 IIIB 30 Zn Zinc 65.38 30	31 IIIB 31 Ga Gallium 69.723 31	32 IIIB 32 Ge Germanium 72.631 32	33 IIIB 33 As Arsenic 74.922 33	34 IIIB 34 Se Selenium 78.96 34	35 IIIB 35 Br Bromine 79.904 35	36 IIIB 36 Kr Krypton 83.798 36										
37 IIIB 37 Rb Rubidium 85.468 37	38 IIIB 38 Sr Strontium 87.62 38	39 IIIB 39 Y Yttrium 88.906 39	40 IIIB 40 Zr Zirconium 91.224 40	41 IIIB 41 Nb Niobium 92.906 41	42 IIIB 42 Mo Molybdenum 95.94 42	43 IIIB 43 Tc Technetium 98 43	44 IIIB 44 Ru Ruthenium 101.07 44	45 IIIB 45 Rh Rhodium 102.91 45	46 IIIB 46 Pd Palladium 106.42 46	47 IIIB 47 Ag Silver 107.87 47	48 IIIB 48 Cd Cadmium 112.41 48	49 IIIB 49 In Indium 114.82 49	50 IIIB 50 Sn Tin 118.71 50	51 IIIB 51 Sb Antimony 121.76 51	52 IIIB 52 Te Tellurium 127.60 52	53 IIIB 53 I Iodine 126.91 53	54 IIIB 54 Xe Xenon 131.29 54	55 IIIB 55 Cs Cesium 132.91 55	56 IIIB 56 Ba Barium 137.33 56	57-71 IIIB Lanthanides	72 IIIB 72 Hf Hafnium 178.49 72	73 IIIB 73 Ta Tantalum 180.948 73	74 IIIB 74 W Tungsten 183.84 74	75 IIIB 75 Re Rhenium 186.21 75	76 IIIB 76 Os Osmium 190.23 76	77 IIIB 77 Ir Iridium 192.22 77	78 IIIB 78 Pt Platinum 195.08 78	79 IIIB 79 Au Gold 196.97 79	80 IIIB 80 Hg Mercury 200.59 80	81 IIIB 81 Tl Thallium 204.38 81	82 IIIB 82 Pb Lead 207.2 82	83 IIIB 83 Bi Bismuth 208.98 83	84 IIIB 84 Po Polonium 209 84	85 IIIB 85 At Astatine 210 85	86 IIIB 86 Rn Radon 222 86
87 IIIB 87 Fr Francium 223 87	88 IIIB 88 Ra Radium 226 88	89-103 IIIB Actinides	104 IIIB 104 Rf Rutherfordium 261 104	105 IIIB 105 Db Dubnium 262 105	106 IIIB 106 Sg Seaborgium 266 106	107 IIIB 107 Bh Bohrium 264 107	108 IIIB 108 Hs Hassium 277 108	109 IIIB 109 Mt Meitnerium 268 109	110 IIIB 110 Ds Darmstadtium 285 110	111 IIIB 111 Rg Roentgenium 282 111	112 IIIB 112 Cn Copernicium 285 112	113 IIIB 113 Nh Nihonium 284 113	114 IIIB 114 Fl Flerovium 289 114	115 IIIB 115 Mc Moscovium 288 115	116 IIIB 116 Lv Livermorium 293 116	117 IIIB 117 Ts Tennessine 289 117	118 IIIB 118 Og Oganesson 284 118																		
57 IIIB 57 La Lanthanum 138.91 57	58 IIIB 58 Ce Cerium 140.12 58	59 IIIB 59 Pr Praseodymium 140.91 59	60 IIIB 60 Nd Neodymium 144.24 60	61 IIIB 61 Pm Promethium 145 61	62 IIIB 62 Sm Samarium 150.36 62	63 IIIB 63 Eu Europium 151.96 63	64 IIIB 64 Gd Gadolinium 157.25 64	65 IIIB 65 Tb Terbium 158.93 65	66 IIIB 66 Dy Dysprosium 162.50 66	67 IIIB 67 Ho Holmium 164.93 67	68 IIIB 68 Er Erbium 167.26 68	69 IIIB 69 Tm Thulium 168.93 69	70 IIIB 70 Yb Ytterbium 173.05 70	71 IIIB 71 Lu Lutetium 174.96 71																					
89 IIIB 89 Ac Actinium 227 89	90 IIIB 90 Th Thorium 232.04 90	91 IIIB 91 Pa Protactinium 231.04 91	92 IIIB 92 U Uranium 238.03 92	93 IIIB 93 Np Neptunium 237 93	94 IIIB 94 Pu Plutonium 244 94	95 IIIB 95 Am Americium 243 95	96 IIIB 96 Cm Curium 247 96	97 IIIB 97 Bk Berkelium 247 97	98 IIIB 98 Cf Californium 251 98	99 IIIB 99 Es Einsteinium 252 99	100 IIIB 100 Fm Fermium 257 100	101 IIIB 101 Md Mendelevium 258 101	102 IIIB 102 No Nobelium 259 102	103 IIIB 103 Lr Lawrencium 260 103																					

Principles of metallurgy

The metallurgical process can be classified as the following:

1. **Crushing and grinding:** The first process in metallurgy is crushing of ores into a fine powder in a jaw crusher or ball/stamp mill. This process is known as pulverization.
2. **Washing of powdered ore:** The washing of ore by gravity washing or in wilfey table
3. **The concentration of ores:** The process of removing impurities from ore is known as a concentration of minerals or ore dressing. In metallurgy, we concentrate the ores mainly by the following methods.
4. **Conversion of the concentrated ores to their oxides:** By roasting and calcination
5. **Reduction of metal oxides to free metal:** By different reducing agents like carbon, charcoal, aluminium or electrolytic process
6. **Purification of metals:** By different processes like liquation, electro refining, zone refining, cupellation etc.

Ore and minerals

- **Minerals** are the natural materials in which the metals and their compounds are found in earth.
- **Ores** are those minerals from which metal are extracted conveniently and profitably. These ores contain good percentage of metal.

“All ores are minerals but all minerals are not ores”

Different ores and their composition

Types of ores	Element	Name of ores
Oxides	Aluminium	Bauxite ($\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$)
	Copper	Cuprites (Cu_2O)
	Iron	Hematite (Fe_2O_3)
	Tin	Cassiterite (SnO_2)
Carbonate	Calcium	Limestone (CaCO_3)
	Zinc	Calamine (ZnCO_3)
	Iron	Siderite (FeCO_3)
Sulphide	Zinc	Zinc blende (ZnS)
	Copper	Copper glance (Cu_2S)
	Lead	Galena (PbS)
	Mercury	Cinnabar (HgS)
Halide	Sodium	Rock Salt (NaCl)
	Fluoride	Fluorspar (CaF_2)
	Silver	Horn silver (AgCl)

Metals	Occurrence
1. Lithium	Spodumene $\text{LiAl}(\text{SiO}_3)_2$ Lepidolite
2. Sodium	Rock salt (NaCl)
3. Magnesium	Carnallite ($\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$) Magnesite (MgCO_3)
4. Calcium	Limestone (CaCO_3) Dolomite ($\text{MgCO}_3 \cdot \text{CaCO}_3$) Gypsum (CaSO_4)
5. Copper	Cuprites (Cu_2O) Copper glance (Cu_2S)
6. Aluminum	Bauxite ($\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$) Cryolite (Na_2AlF_6)
7. Zinc	Zinc blende (ZnS) Zincite (ZnO) Calamine (ZnCO_3)
8. Lead	Galena (PbS)
9. Iron	Hematite (Fe_2O_3) Magnetite (Fe_3O_4) Siderite (FeCO_3) Iron pyrite (FeS_2) Limonite ($\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$)

Discussion

1. What do you mean by metallurgy?
2. Explain “*All ores are minerals but all minerals are not ores*”
3. *Difference between metal , non metal and metalloids*