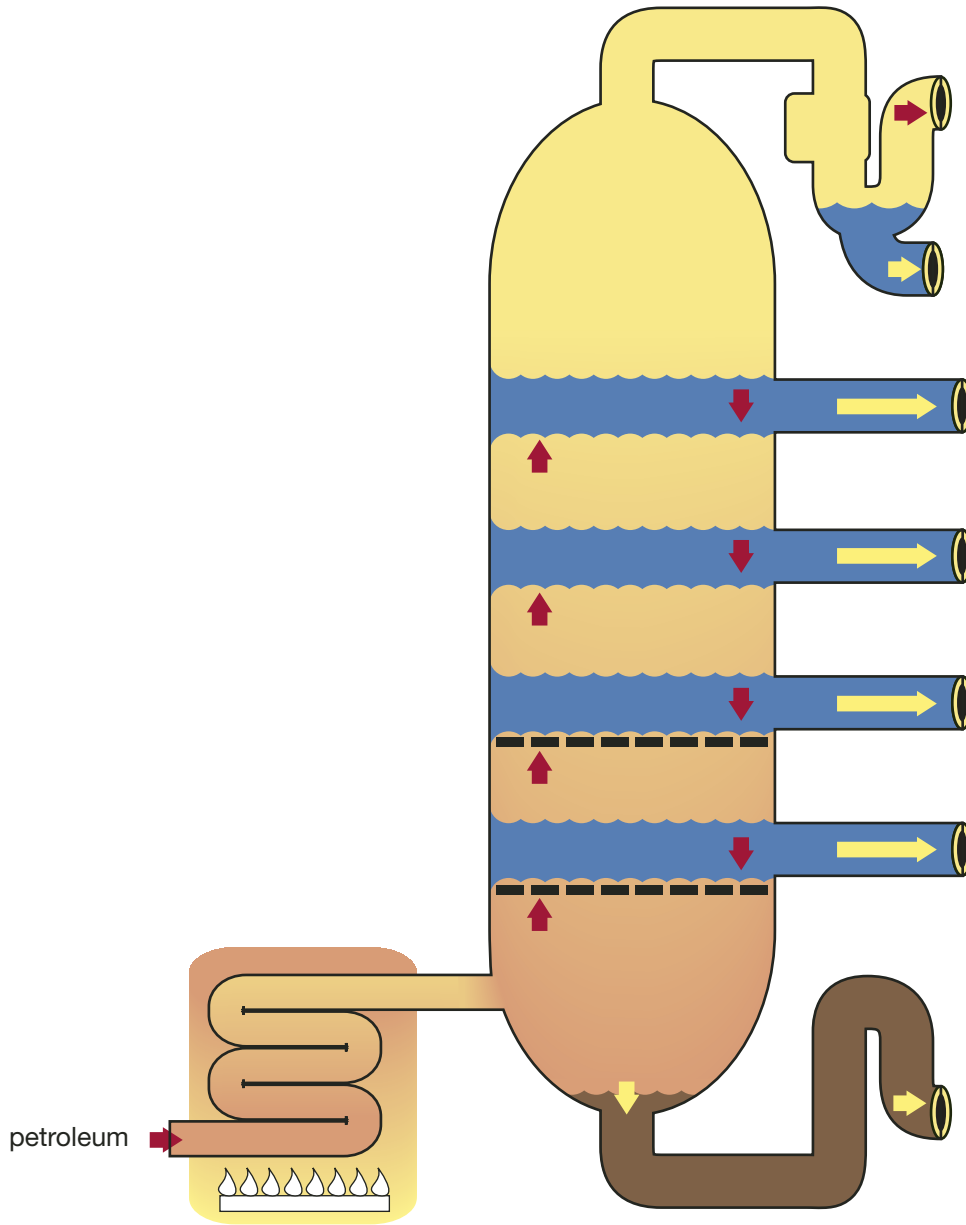


SCIENCE 20
UNIT A TEXTBOOK CD
(HANDOUTS)

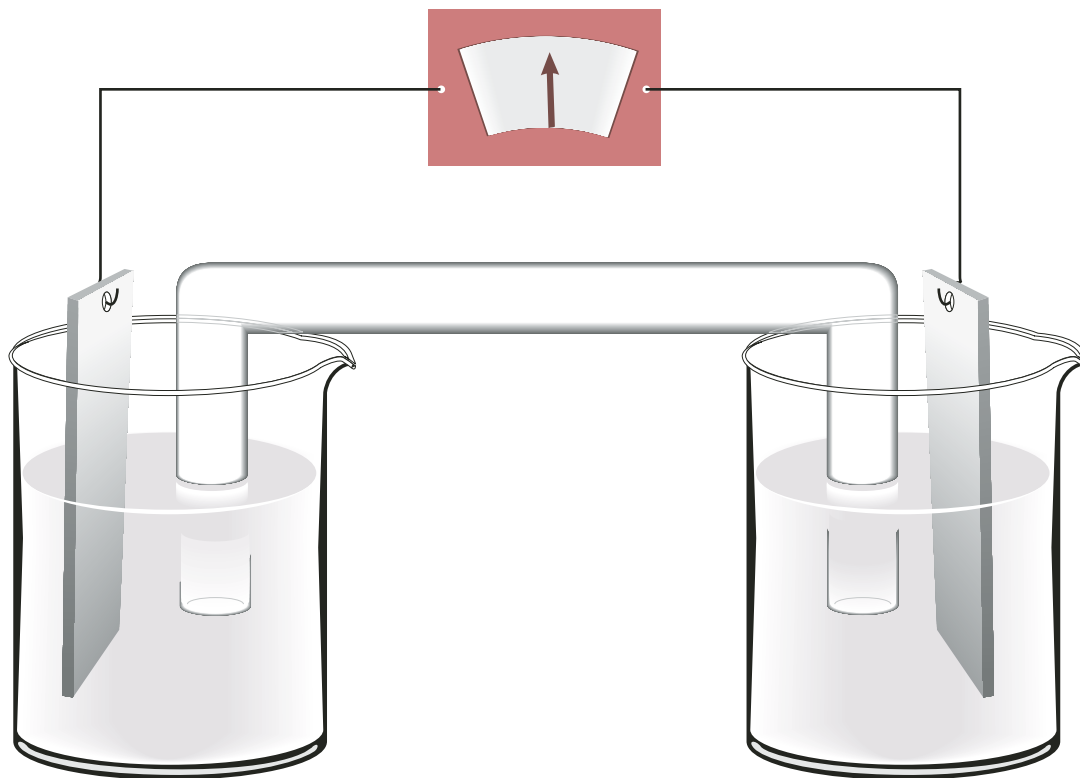
METAL IONS

Ore Compound	Chemical Formula	Metal Ion	Number of Electrons Lost by Metal Ion
aluminium oxide	$\text{Al}_2\text{O}_3(\text{s})$	$\text{Al}^{3+}(\text{aq})$	
iron(III) oxide	$\text{Fe}_2\text{O}_3(\text{s})$		3
silver oxide	$\text{Ag}_2\text{O}(\text{s})$	$\text{Ag}^+(\text{aq})$	
silver sulfide	$\text{Ag}_2\text{S}(\text{s})$		1
iron(II) sulfide	$\text{FeS}(\text{s})$	$\text{Fe}^{2+}(\text{aq})$	
zinc nitrate	$\text{Zn}(\text{NO}_3)_2(\text{s})$		2
calcium carbonate	$\text{CaCO}_3(\text{s})$	$\text{Ca}^{2+}(\text{aq})$	
potassium phosphate	$\text{K}_3\text{PO}_4(\text{s})$		1

Atmospheric Distillation Tower



Voltaic Cell Diagram



Activity Series for Metals and Metal Ions

Reactions Read as Reductions



Reduction Half-Reaction

most reactive
metal ion
on the list

$\text{Au}^{3+}(\text{aq})$	+	3e^{-}	\rightarrow	$\text{Au}(\text{s})$
$\text{Hg}^{2+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{Hg}(\text{l})$
$\text{Ag}^{+}(\text{aq})$	+	e^{-}	\rightarrow	$\text{Ag}(\text{s})$
$\text{Cu}^{2+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{Cu}(\text{s})$
$2\text{H}^{+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{H}_2(\text{g})$
$\text{Pb}^{2+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{Pb}(\text{s})$
$\text{Sn}^{2+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{Sn}(\text{s})$
$\text{Ni}^{2+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{Ni}(\text{s})$
$\text{Cd}^{2+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{Cd}(\text{s})$
$\text{Fe}^{2+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{Fe}(\text{s})$
$\text{Zn}^{2+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{Zn}(\text{s})$
$\text{Cr}^{2+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{Cr}(\text{s})$
$\text{Al}^{3+}(\text{aq})$	+	3e^{-}	\rightarrow	$\text{Al}(\text{s})$
$\text{Mg}^{2+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{Mg}(\text{s})$
$\text{Na}^{+}(\text{aq})$	+	e^{-}	\rightarrow	$\text{Na}(\text{s})$
$\text{Ca}^{2+}(\text{aq})$	+	2e^{-}	\rightarrow	$\text{Ca}(\text{s})$
$\text{Li}^{+}(\text{aq})$	+	e^{-}	\rightarrow	$\text{Li}(\text{s})$

most stable
metal atom
on the list

most stable
metal ion
on the list

most reactive
metal atom
on the list

Reactions Read as Oxidations



Periodic Table of Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H hydrogen 1.01	2 He helium 4.00	3 Li lithium 6.94	4 Be beryllium 9.01	5 B boron 10.81	6 C carbon 12.01	7 N nitrogen 14.01	8 O oxygen 16.00	9 F fluorine 19.00	10 Ne neon 20.18	11 Na sodium 22.99	12 Mg magnesium 24.31	13 Al aluminum 26.98	14 Si silicon 28.09	15 P phosphorus 30.97	16 S sulfur 32.07	17 Cl chlorine 35.45	18 Ar argon 39.95
19 K potassium 39.10	20 Ca calcium 40.08	21 Sc scandium 44.96	22 Ti titanium 47.87	23 V vanadium 50.94	24 Cr chromium 52.00	25 Mn manganese 54.94	26 Fe iron 55.85	27 Co cobalt 58.93	28 Ni nickel 58.69	29 Cu copper 63.55	30 Zn zinc 65.41	31 Ga gallium 69.72	32 Ge germanium 72.64	33 As arsenic 74.92	34 Se selenium 78.96	35 Br bromine 79.90	36 Kr krypton 83.80
37 Rb rubidium 85.47	38 Sr strontium 87.62	39 Y yttrium 88.91	40 Zr zirconium 91.22	41 Nb niobium 92.91	42 Mo molybdenum 95.94	43 Tc technetium (98)	44 Ru ruthenium 101.07	45 Rh rhodium 102.91	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.60	53 I iodine 126.90	54 Xe xenon 131.30
55 Cs cesium 132.91	56 Ba barium 137.33	57-71 La lanthanum 138.91	72 Hf hafnium 178.49	73 Ta tantalum 180.95	74 W tungsten 183.84	75 Re rhenium 186.21	76 Os osmium 190.23	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.38	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium (209)	85 At astatine (210)	86 Rn radon (222)
87 Fr francium (223)	88 Ra radium (226)	89-103 Ac actinium (227)	104 Rf rutherfordium (261)	105 Db dubnium (262)	106 Sg seaborgium (266)	107 Bh bohrium (264)	108 Hs hassium (277)	109 Mt meitnerium (268)	110 Ds darmstadtium (271)	111 Rg roentgenium (272)	112 Uub ununbium (285)	113 Nh nihonium (284)	114 Uuq ununquadium (289)	115 Uup ununpentium (288)	116 Uuh ununhexium (289)	117 Uuhs ununheptium (289)	118 Uuo ununoctium (289)

Legend for the elements

Solid	Liquid	Gas	Seeldom forms ions
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Table of Polyatomic Ions and Elements

Polyatomic ions	Elements
acetate CH ₃ COO ⁻	astatine At ₂
ammonium NH ₄ ⁺	bromine Br ₂
bicarbonate HCO ₃ ⁻	chlorine Cl ₂
bicarbonate HCO ₃ ⁻	fluorine F ₂
carbonate CO ₃ ²⁻	hydrogen H ₂
cyanide CN ⁻	iodine I ₂
hydroxide OH ⁻	nitrogen N ₂
hypochlorite ClO ⁻	oxygen O ₂
nitrate NO ₃ ⁻	phosphorus P ₄
perchlorate ClO ₄ ⁻	sulfur S ₈
permanganate MnO ₄ ⁻	
sulfite SO ₃ ²⁻	
sulfate SO ₄ ²⁻	
hydrogen phosphate HPO ₄ ²⁻	
hydrogen sulfide HS ⁻	
hydrogen sulfate HSO ₄ ⁻	
hydrogen sulfite HSO ₃ ⁻	

Note: The legend at the right denotes the physical state of the elements at 101.325 kPa and 298.15 K (25°C).

* The isotopic mix of naturally occurring lead is more variable than other elements, preventing precision to greater than tenths of a gram per mole.

57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium (145)	62 Sm samarium 150.36	63 Eu europium 151.96	64 Gd gadolinium 157.25	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.04	71 Lu lutetium 174.97
89 Ac actinium (227)	90 Th thorium 232.04	91 Pa protactinium (231)	92 U uranium 238.03	93 Np neptunium (237)	94 Pu plutonium (244)	95 Am americium (243)	96 Cm curium (247)	97 Bk berkelium (247)	98 Cf californium (251)	99 Es einsteinium (252)	100 Fm fermium (257)	101 Md mendelevium (258)	102 No nobelium (259)	103 Lr lawrencium (262)

Key

Atomic number → 91 Pa

Name of the element → protactinium (231.04)

Atomic mass → 231.04

→ Ion charge → Pa³⁺

→ Stock name (IUPAC) → protactinium(III)

→ Symbol of ion → Pa³⁺

Based on IUPAC

Most stable or common ion is listed above the dotted line () indicates mass of the most stable isotope

References: Lide, D.R. 2005. CRC Handbook of Chemistry and Physics, 86th Edition: 2005-2006. Boca Raton, FL, CRC Press

IUPAC Periodic table of the Elements, 2005. http://www.iupac.org/reports/periodic_table/index.html