Reference Tables for Chemistry

A

PHYSICAL CONSTANTS AND CONVERSION FACTORS

Name	*Symbol*	*Value(s)*	*Units*
Angstrom unit	Å	1×10^{-10} m	meter
Avogadro number	N_A	6.02×10^{23} per mol	
Charge of electron	e	1.60×10^{-19} C	coulomb
Electron volt	eV	1.60×10^{-19} J	joule
Speed of light	c	3.00×10^{8} m/s	meters/second
Planck's constant	h	6.63×10^{-34} J•s	joule-second
		1.58×10^{-37} kcal•s	kilocalorie-second
Universal gas constant	R	0.0821 L•atm/mol•K	liter-atmosphere/mole-kelvin
		1.98 cal/mol•K	calories/mole-kelvin
		8.31 J/mol•K	joules/mole-kelvin
Atomic mass unit	μ(amu)	1.66×10^{-24} g	gram
Volume standard, liter	L	1×10^{3} cm^3 = 1 dm^3	cubic centimeters, cubic decimeter
Standard pressure, atmosphere	atm	101.3 kPa	kilopascals
		760 mmHg	millimeters of mercury
		760 torr	torr
Heat equivalent, kilocalorie	kcal	4.18×10^{3} J	joules

Physical Constants for H_2O

Molal freezing point depression	1.86°C
Molal boiling point elevation	0.52°C
Heat of fusion	79.72 cal/g
Heat of vaporization	539.4 cal/g

C_{steam} = 0.5 cal/g C
C_{water} = 1.0 cal/g C
C_{ice} = 0.5 cal/g C

B

STANDARD UNITS

Symbol	*Name*	*Quantity*
m	meter	length
kg	kilogram	mass
Pa	pascal	pressure
K	kelvin	thermodynamic temperature
mol	mole	amount of substance
J	joule	energy, work, quantity of heat
s	second	time
C	coulomb	quantity of electricity
V	volt	electric potential, potential difference
L	liter	volume

Selected Prefixes

Factor	*Prefix*	*Symbol*
giga 1,000,000,000		10^{9}
mega 1,000,000		10^{6}
kilo 1,000	Metric Progression	10^{3}
hecto 100		10^{2}
deca 10		10^{1}
1 meters, liters, grams, etc.		10^{0}
deci 0.1		10^{-1}
centi 0.01		10^{-2}
milli 0.001		10^{-3}
micro 0.000001		10^{-6}
nano 0.000000001		10^{-9}
pico 0.000000000001		10^{-12}

Polyatomic Ions

Name	Formula	Name	Formula
perPhosphate	$(PO_5)^{-3}$	perCarbonate	$(CO_4)^{-2}$
Phosphate	$(PO_4)^{-3}$	**Carbonate**	$(CO_3)^{-2}$
Phosphite	$(PO_3)^{-3}$	Carbonite	$(CO_2)^{-2}$
hypoPhosphite	$(PO_2)^{-3}$	hypocarbonite	$(CO)^{-2}$
perChlorate	$(ClO_4)^{-1}$	perNitrate	$(NO_4)^{-}$
Chlorate	$(ClO_3)^{-1}$	**Nitrate**	$(NO_3)^{-}$
Chlorite	$(ClO_2)^{-1}$	Nitrite	$(NO_2)^{-}$
hypoChlorite	$(ClO)^{-1}$	Hyponitrite	$(NO)^{-}$
perSulfate	$(SO_5)^{-2}$	perChromate	$(CrO_5)^{-2}$
Sulfate	$(SO_4)^{-2}$	**Chromate**	$(CrO_4)^{-2}$
Sulfite	$(SO_3)^{-2}$	Chromite	$(CrO_3)^{-2}$
hyposulfite	$(SO_2)^{-2}$	Hypochromite	$(CrO_2)^{-2}$
Acetate	$(C_2H_3O_2)^{-1}$	**Cyanide**	$(CN)^{-1}$
Hydroxide	$(OH)^{-1}$	**Manganate**	$(MnO_4)^{-2}$

Ammonium $(NH_4)^{+1}$

Name	Symbol	Value(s)	Units
Size of the nucleus		1×10^{-10} m	meter
Avogadro's #	N_A	6.02×10^{23} per mol	
Charge of the electron	e-	1.60×10^{-19} C	coulomb
Electron Volt	eV	1.60×10^{-19} j	joule
Speed of Light	C	3.0×10^{8} m/s	meters/second
Atomic Mass Unit	amu	1.66×10^{-24} g	gram
Volume equivalents	cm^3 = ml	dm^3 = L	
Molal freezing point depression of water … 1.86º C Molal boiling point elevation of water … 0.52º C			
Standard Pressure = 760 mm Hg = 760 torr = 101.3 kPa = 1 atm			
Heat of Fusion	H_f	80 cal/g	Water
Heat of vaporization	H_v	540 cal/g	water

Standard Units			Selected Prefixes		
Symbol	Name	Quantity	Factor	Prefix	Symbol
m	meter	Length	10^{9}	Giga	G
Kg	kilogram	Mass	10^{6}	Mega	M
kPa	kilipascal	Pressure	10^{3}	kilo	k
K	Kelvin	Temperature	10^{2}	hecto	h
Mol	mole	Amt of substance	10^{1}	Deka	D
J	Joule	Energy, work	10^{0}	standard	m L g
		Quantity of heat	10^{-1}	deci	d
s	second	Time	10^{-2}	centi	c
C	Coulomb	Electricity	10^{-3}	milli	m
V	Volt	Electric potential	10^{-6}	micro	µ
		Potential difference	10^{-9}	nano	n
L	liter	volume			

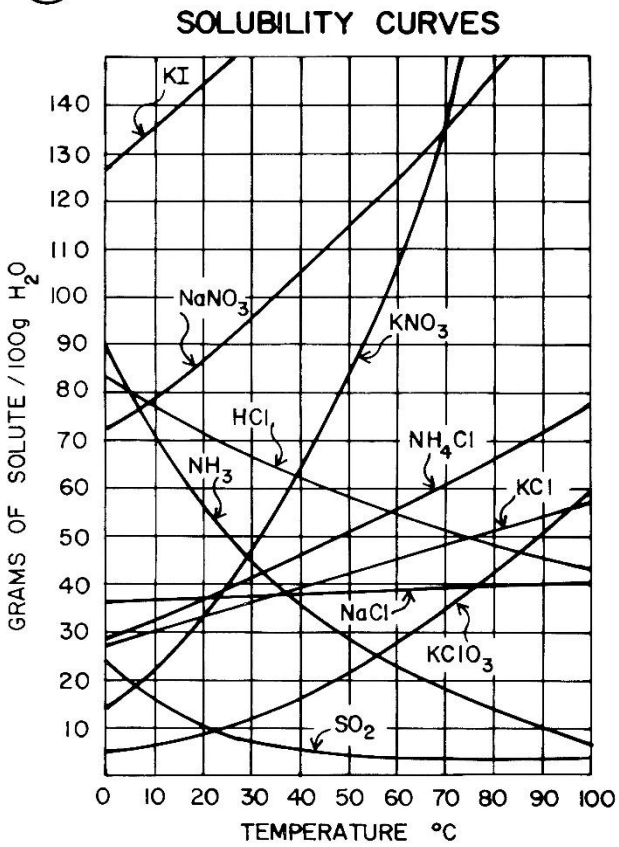
C

DENSITY AND BOILING POINTS OF SOME COMMON GASES

Name		*Density* grams/liter at STP*	*Boiling Point* (at 1 atm) K
Air	—	1.29	—
Ammonia	NH_3	0.771	240
Carbon dioxide	CO_2	1.98	195
Carbon monoxide	CO	1.25	82
Chlorine	Cl_2	3.21	238
Hydrogen	H_2	0.0899	20
Hydrogen chloride	HCl	1.64	188
Hydrogen sulfide	H_2S	1.54	212
Methane	CH_4	0.716	109
Nitrogen	N_2	1.25	77
Nitrogen (II) oxide	NO	1.34	121
Oxygen	O_2	1.43	90
Sulfur dioxide	SO_2	2.92	263

*STP is defined as 273 K and 1 atm

D



E

TABLE OF SOLUBILITIES IN WATER

i — nearly insoluble
ss — slightly soluble
s — soluble
d — decomposes
n — not isolated

	acetate	bromide	carbonate	chloride	chromate	hydroxide	iodide	nitrate	phosphate	sulfate	sulfide
Aluminum	ss	s	n	s	n	i	s	s	i	s	d
Ammonium	s	s	s	s	s	s	s	s	s	s	s
Barium	s	s	i	s	i	s	s	s	i	i	d
Calcium	s	s	i	s	s	ss	s	s	i	ss	d
Copper II	s	s	i	s	i	i	n	s	i	s	i
Iron II	s	s	i	s	n	i	s	s	i	s	i
Iron III	s	s	n	s	i	i	n	s	i	ss	d
Lead	s	ss	i	ss	i	i	ss	s	i	i	i
Magnesium	s	s	i	s	s	i	s	s	i	s	d
Mercury I	ss	i	i	i	ss	n	i	s	i	ss	i
Mercury II	s	ss	i	s	ss	i	i	s	i	d	i
Potassium	s	s	s	s	s	s	s	s	s	s	s
Silver	ss	i	i	i	ss	n	i	s	i	ss	i
Sodium	s	s	s	s	s	s	s	s	s	s	s
Zinc	s	s	i	s	s	i	s	s	i	s	i

F

SELECTED POLYATOMIC IONS

Hg_2^{2+}	dimercury (I)	CrO_4^{2-}	chromate
NH_4^+	ammonium	$Cr_2O_7^{2-}$	dichromate
$C_2H_3O_2^-$ / CH_3COO^-	acetate	MnO_4^-	permanganate
		MnO_4^{2-}	manganate
CN^-	cyanide	NO_2^-	nitrite
CO_3^{2-}	carbonate	NO_3^-	nitrate
HCO_3^-	hydrogen carbonate	OH^-	hydroxide
		PO_4^{3-}	phosphate
$C_2O_4^{2-}$	oxalate	SCN^-	thiocyanate
ClO^-	hypochlorite	SO_3^{2-}	sulfite
ClO_2^-	chlorite	SO_4^{2-}	sulfate
ClO_3^-	chlorate	HSO_4^-	hydrogen sulfate
ClO_4^-	perchlorate	$S_2O_3^{2-}$	thiosulfate

Ⓖ

STANDARD ENERGIES OF FORMATION OF COMPOUNDS AT 1 atm AND 298 K

Compound	*Heat (Enthalpy) of Formation** kcal/mol ($\triangle H_f^\circ$)	*Free Energy of Formation* kcal/mol ($\triangle G_f^\circ$)
Aluminum oxide $Al_2O_3(s)$	−400.5	−378.2
Ammonia $NH_3(g)$	−11.0	−3.9
Barium sulfate $BaSO_4(s)$	−352.1	−325.6
Calcium hydroxide $Ca(OH)_2(s)$	−235.7	−214.8
Carbon dioxide $CO_2(g)$	−94.1	−94.3
Carbon monoxide $CO(g)$	−26.4	−32.8
Copper (II) sulfate $CuSO_4(s)$	−184.4	−158.2
Ethane $C_2H_6(g)$	−20.2	−7.9
Ethene (ethylene) $C_2H_4(g)$	12.5	16.3
Ethyne (acetylene) $C_2H_2(g)$	54.2	50.0
Hydrogen fluoride $HF(g)$	−64.8	−65.3
Hydrogen iodide $HI(g)$	6.3	0.4
Iodine chloride $ICl(g)$	4.3	−1.3
Lead (II) oxide $PbO(s)$	−51.5	−45.0
Magnesium oxide $MgO(s)$	−143.8	−136.1
Nitrogen (II) oxide $NO(g)$	21.6	20.7
Nitrogen (IV) oxide $NO_2(g)$	7.9	12.3
Potassium chloride $KCl(s)$	−104.4	−97.8
Sodium chloride $NaCl(s)$	−98.3	−91.8
Sulfur dioxide $SO_2(g)$	−70.9	−71.7
Water $H_2O(g)$	−57.8	−54.6
Water $H_2O(\ell)$	−68.3	−56.7

* Minus sign indicates an exothermic reaction.

Sample equations:

$$2Al(s) + \frac{3}{2}O_2(g) \rightarrow Al_2O_3(s) + 400.5 \text{ kcal}$$

$$2Al(s) + \frac{3}{2}O_2(g) \rightarrow Al_2O_3(s) \quad \triangle H = -400.5 \text{ kcal/mol}$$

Ⓗ

SELECTED RADIOISOTOPES

Nuclide	*Half-Life*	*Decay Mode*
^{198}Au	2.69 d	β^-
^{14}C	5730 y	β^-
^{60}Co	5.26 y	β^-
^{137}Cs	30.23 y	β^-
^{220}Fr	27.5 s	α
^{3}H	12.26 y	β^-
^{131}I	8.07 d	β^-
^{37}K	1.23 s	β^+
^{42}K	12.4 h	β^-
^{85}Kr	10.76 y	β^-
^{85m}Kr*	4.39 h	γ
^{16}N	7.2 s	β^-
^{32}P	14.3 d	β^-
^{239}Pu	2.44×10^4 y	α
^{226}Ra	1600 y	α
^{222}Rn	3.82 d	α
^{90}Sr	28.1 y	β^-
^{99}Tc	2.13×10^5 y	β^-
^{99m}Tc*	6.01 h	γ
^{232}Th	1.4×10^{10} y	α
^{233}U	1.62×10^5 y	α
^{235}U	7.1×10^8 y	α
^{238}U	4.51×10^9 y	α

y = years; d = days; h = hours; s = seconds

*m = meta stable or excited state of the same nucleus. Gamma decay from such a state is called an isomeric transition (IT).
Nuclear isomers are different energy states of the same nucleus, each having a different measurable lifetime.

(K)

IONIZATION ENERGIES AND ELECTRONEGATIVITIES

1																	18
313 H 2.2	← First Ionization Energy (kcal/mol of atoms) ← Electronegativity*																567 He
	2											13	14	15	16	17	
125 Li 1.0	215 Be 1.5											191 B 2.0	260 C 2.6	336 N 3.1	314 O 3.5	402 F 4.0	497 Ne
119 Na 0.9	176 Mg 1.2											138 Al 1.5	188 Si 1.9	242 P 2.2	239 S 2.6	300 Cl 3.2	363 Ar
100 K 0.8	141 Ca 1.0											138 Ga 1.6	182 Ge 1.9	226 As 2.0	225 Se 2.5	273 Br 2.9	323 Kr
96 Rb 0.8	131 Sr 1.0											133 In 1.7	169 Sn 1.8	199 Sb 2.1	208 Te 2.3	241 I 2.7	280 Xe
90 Cs 0.7	120 Ba 0.9											141 Tl 1.8	171 Pb 1.8	168 Bi 1.9	194 Po 2.0	248 At 2.2	248 Rn
122 Fr 0.7	122 Ra 0.9																

* Arbitrary scale based on fluorine = 4.0

I

HEATS OF REACTION AT 1 atm and 298 K	
Reaction	$\triangle H$ (kcal)
$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$	-212.8
$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$	-530.6
$CH_3OH(\ell) + \frac{3}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$	-173.6
$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(\ell)$	-669.9
$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$	-67.7
$C_8H_{18}(\ell) + \frac{25}{2}O_2(g) \rightarrow 8CO_2(g) + 9H_2O(\ell)$	-1302.7
$KNO_3(s) \xrightarrow{H_2O} K^+(aq) + NO_3^-(aq)$	+8.3
$NaOH(s) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$	-10.6
$NH_4Cl(s) \xrightarrow{H_2O} NH_4^+(aq) + Cl^-(aq)$	+3.5
$NH_4NO_3(s) \xrightarrow{H_2O} NH_4^+(aq) + NO_3^-(aq)$	+6.1
$NaCl(s) \xrightarrow{H_2O} Na^+(aq) + Cl^-(aq)$	+0.9
$KClO_3(s) \xrightarrow{H_2O} K^+(aq) + ClO_3^-(aq)$	+9.9
$LiBr(s) \xrightarrow{H_2O} Li^+(aq) + Br^-(aq)$	-11.7
$H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell)$	-13.8

J

SYMBOLS USED IN NUCLEAR CHEMISTRY		
alpha particle	^4_2He	α
beta particle (electron)	$^0_{-1}e$	β^-
gamma radiation		γ
neutron	^1_0n	n
proton	^1_1H	p
deuteron	^2_1H	
triton	^3_1H	
positron	$^0_{+1}e$	β^+

(L) RELATIVE STRENGTHS OF ACIDS IN AQUEOUS SOLUTION AT 1 atm AND 298 K

Conjugate Pairs *ACID* = *BASE*	K_a
$HI = H^+ + I^-$	very large
$HBr = H^+ + Br^-$	very large
$HCl = H^+ + Cl^-$	very large
$HNO_3 = H^+ + NO_3^-$	very large
$H_2SO_4 = H^+ + HSO_4^-$	large
$H_2O + SO_2 = H^+ + HSO_3^-$	1.5×10^{-2}
$HSO_4^- = H^+ + SO_4^{2-}$	1.2×10^{-2}
$H_3PO_4 = H^+ + H_2PO_4^-$	7.5×10^{-3}
$Fe(H_2O)_6^{3+} = H^+ + Fe(H_2O)_5(OH)^{2+}$	8.9×10^{-4}
$HNO_2 = H^+ + NO_2^-$	4.6×10^{-4}
$HF = H^+ + F^-$	3.5×10^{-4}
$Cr(H_2O)_6^{3+} = H^+ + Cr(H_2O)_5(OH)^{2+}$	1.0×10^{-4}
$CH_3COOH = H^+ + CH_3COO^-$	1.8×10^{-5}
$Al(H_2O)_6^{3+} = H^+ + Al(H_2O)_5(OH)^{2+}$	1.1×10^{-5}
$H_2O + CO_2 = H^+ + HCO_3^-$	4.3×10^{-7}
$HSO_3^- = H^+ + SO_3^{2-}$	1.1×10^{-7}
$H_2S = H^+ + HS^-$	9.5×10^{-8}
$H_2PO_4^- = H^+ + HPO_4^{2-}$	6.2×10^{-8}
$NH_4^+ = H^+ + NH_3$	5.7×10^{-10}
$HCO_3^- = H^+ + CO_3^{2-}$	5.6×10^{-11}
$HPO_4^{2-} = H^+ + PO_4^{3-}$	2.2×10^{-13}
$HS^- = H^+ + S^{2-}$	1.3×10^{-14}
$H_2O = H^+ + OH^-$	1.0×10^{-14}
$OH^- = H^+ + O^{2-}$	$< 10^{-36}$

Note: $H^+(aq) = H_3O^+$

Sample equation: $HI + H_2O = H_3O^+ + I^-$

(M) CONSTANTS FOR VARIOUS EQUILIBRIA AT 1 atm AND 298 K

$H_2O(\ell) = H^+(aq) + OH^-(aq)$	$K_w = 1.0 \times 10^{-14}$
$H_2O(\ell) + H_2O(\ell) = H_3O^+(aq) + OH^-(aq)$	$K_w = 1.0 \times 10^{-14}$
$CH_3COO^-(aq) + H_2O(\ell) = CH_3COOH(aq) + OH^-(aq)$	$K_b = 5.6 \times 10^{-10}$
$Na^+F^-(aq) + H_2O(\ell) = Na^+(OH)^- + HF(aq)$	$K_b = 1.5 \times 10^{-11}$
$NH_3(aq) + H_2O(\ell) = NH_4^+(aq) + OH^-(aq)$	$K_b = 1.8 \times 10^{-5}$
$CO_3^{2-}(aq) + H_2O(\ell) = HCO_3^-(aq) + OH^-(aq)$	$K_b = 1.8 \times 10^{-4}$
$Ag(NH_3)_2^+(aq) = Ag^+(aq) + 2NH_3(aq)$	$K_{eq} = 8.9 \times 10^{-8}$
$N_2(g) + 3H_2(g) = 2NH_3(g)$	$K_{eq} = 6.7 \times 10^{5}$
$H_2(g) + I_2(g) = 2HI(g)$	$K_{eq} = 3.5 \times 10^{-1}$

Compound	K_{sp}	*Compound*	K_{sp}
AgBr	5.0×10^{-13}	Li_2CO_3	2.5×10^{-2}
AgCl	1.8×10^{-10}	$PbCl_2$	1.6×10^{-5}
Ag_2CrO_4	1.1×10^{-12}	$PbCO_3$	7.4×10^{-14}
AgI	8.3×10^{-17}	$PbCrO_4$	2.8×10^{-13}
$BaSO_4$	1.1×10^{-10}	PbI_2	7.1×10^{-9}
$CaSO_4$	9.1×10^{-6}	$ZnCO_3$	1.4×10^{-11}

N

STANDARD ELECTRODE POTENTIALS	
Ionic Concentrations 1 M Water At 298 K, 1 atm	
Half-Reaction	E^0 (volts)
$F_2(g) + 2e^- \rightarrow 2F^-$	+2.87
$8H^+ + MnO_4^- + 5e^- \rightarrow Mn^{2+} + 4H_2O$	+1.51
$Au^{3+} + 3e^- \rightarrow Au(s)$	+1.50
$Cl_2(g) + 2e^- \rightarrow 2Cl^-$	+1.36
$14H^+ + Cr_2O_7^{2-} + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$	+1.23
$4H^+ + O_2(g) + 4e^- \rightarrow 2H_2O$	+1.23
$4H^+ + MnO_2(s) + 2e^- \rightarrow Mn^{2+} + 2H_2O$	+1.22
$Br_2(\ell) + 2e^- \rightarrow 2Br^-$	+1.09
$Hg^{2+} + 2e^- \rightarrow Hg(\ell)$	+0.85
$Ag^+ + e^- \rightarrow Ag(s)$	+0.80
$Hg_2^{2+} + 2e^- \rightarrow 2Hg(\ell)$	+0.80
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	+0.77
$I_2(s) + 2e^- \rightarrow 2I^-$	+0.54
$Cu^+ + e^- \rightarrow Cu(s)$	+0.52
$Cu^{2+} + 2e^- \rightarrow Cu(s)$	+0.34
$4H^+ + SO_4^{2-} + 2e^- \rightarrow SO_2(aq) + 2H_2O$	+0.17
$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$	+0.15
$2H^+ + 2e^- \rightarrow H_2(g)$	0.00
$Pb^{2+} + 2e^- \rightarrow Pb(s)$	–0.13
$Sn^{2+} + 2e^- \rightarrow Sn(s)$	–0.14
$Ni^{2+} + 2e^- \rightarrow Ni(s)$	–0.26
$Co^{2+} + 2e^- \rightarrow Co(s)$	–0.28
$Fe^{2+} + 2e^- \rightarrow Fe(s)$	–0.45
$Cr^{3+} + 3e^- \rightarrow Cr(s)$	–0.74
$Zn^{2+} + 2e^- \rightarrow Zn(s)$	–0.76
$2H_2O + 2e^- \rightarrow 2OH^- + H_2(g)$	–0.83
$Mn^{2+} + 2e^- \rightarrow Mn(s)$	–1.19
$Al^{3+} + 3e^- \rightarrow Al(s)$	–1.66
$Mg^{2+} + 2e^- \rightarrow Mg(s)$	–2.37
$Na^+ + e^- \rightarrow Na(s)$	–2.71
$Ca^{2+} + 2e^- \rightarrow Ca(s)$	–2.87
$Sr^{2+} + 2e^- \rightarrow Sr(s)$	–2.89
$Ba^{2+} + 2e^- \rightarrow Ba(s)$	–2.91
$Cs^+ + e^- \rightarrow Cs(s)$	–2.92
$K^+ + e^- \rightarrow K(s)$	–2.93
$Rb^+ + e^- \rightarrow Rb(s)$	–2.98
$Li^+ + e^- \rightarrow Li(s)$	–3.04

O

VAPOR PRESSURE OF WATER			
°C	torr (mmHg)	°C	torr (mmHg)
0	4.6	26	25.2
5	6.5	27	26.7
10	9.2	28	28.3
15	12.8	29	30.0
16	13.6	30	31.8
17	14.5	40	55.3
18	15.5	50	92.5
19	16.5	60	149.4
20	17.5	70	233.7
21	18.7	80	355.1
22	19.8	90	525.8
23	21.1	100	760.0
24	22.4	105	906.1
25	23.8	110	1074.6

(P)

RADII OF ATOMS

KEY

Symbol →	F
Covalent Radius, Å →	0.64
Atomic Radius in Metals, Å →	(–)
Van der Waals Radius, Å →	1.35

A dash (–) indicates data are not available.

H 0.37 (–) 1.2																	**He** (–) (–) 1.22
Li 1.23 1.52 (–)	**Be** 0.89 1.13 (–)											**B** 0.88 (–) 2.08	**C** 0.77 (–) 1.85	**N** 0.70 (–) 1.54	**O** 0.66 (–) 1.40	**F** 0.64 (–) 1.35	**Ne** (–) (–) 1.60
Na 1.57 1.54 2.31	**Mg** 1.36 1.60 (–)											**Al** 1.25 1.43 (–)	**Si** 1.17 (–) 2.0	**P** 1.10 (–) 1.90	**S** 1.04 (–) 1.85	**Cl** 0.99 (–) 1.81	**Ar** (–) (–) 1.91
K 2.03 2.27 2.31	**Ca** 1.74 1.97 (–)	**Sc** 1.44 1.61 (–)	**Ti** 1.32 1.45 (–)	**V** 1.22 1.32 (–)	**Cr** 1.17 1.25 (–)	**Mn** 1.17 1.24 (–)	**Fe** 1.17 1.24 (–)	**Co** 1.16 1.25 (–)	**Ni** 1.15 1.25 (–)	**Cu** 1.17 1.28 (–)	**Zn** 1.25 1.33 (–)	**Ga** 1.25 1.22 (–)	**Ge** 1.22 1.23 (–)	**As** 1.21 (–) 2.0	**Se** 1.17 2.0	**Br** 1.14 (–) 1.95	**Kr** 1.89 (–) 1.98
Rb 2.16 2.48 2.44	**Sr** 1.92 2.15 (–)	**Y** 1.62 1.81 (–)	**Zr** 1.45 1.60 (–)	**Nb** 1.34 1.43 (–)	**Mo** 1.29 1.36 (–)	**Tc** (–) 1.36 (–)	**Ru** 1.24 1.33 (–)	**Rh** 1.25 1.35 (–)	**Pd** 1.28 1.38 (–)	**Ag** 1.34 1.44 (–)	**Cd** 1.41 1.49 (–)	**In** 1.50 1.63 (–)	**Sn** 1.40 1.41 (–)	**Sb** 1.41 (–) 2.2	**Te** 1.37 (–) 2.20	**I** 1.33 (–) 2.15	**Xe** 2.09 (–) (–)
Cs 2.35 2.65 2.62	**Ba** 1.98 2.17 (–)	**La-Lu**	**Hf** 1.44 1.56 (–)	**Ta** 1.34 1.43 (–)	**W** 1.30 1.37 (–)	**Re** 1.28 1.37 (–)	**Os** 1.26 1.34 (–)	**Ir** 1.26 1.36 (–)	**Pt** 1.29 1.38 (–)	**Au** 1.34 1.44 (–)	**Hg** 1.44 1.60 (–)	**Tl** 1.55 1.70 (–)	**Pb** 1.54 1.75 (–)	**Bi** 1.52 1.55 (–)	**Po** 1.53 1.67 (–)	**At** (–) (–) (–)	**Rn** 2.14 (–) (–)
Fr (–) 2.7 (–)	**Ra** (–) 2.20 (–)	**Ac-Lr**															

La 1.69 1.88 (–)	**Ce** 1.65 1.83 (–)	**Pr** 1.65 1.83 (–)	**Nd** 1.64 1.82 (–)	**Pm** (–) 1.81 (–)	**Sm** 1.66 1.80 (–)	**Eu** 1.85 2.04 (–)	**Gd** 1.61 1.80 (–)	**Tb** 1.59 1.78 (–)	**Dy** 1.59 1.77 (–)	**Ho** 1.58 1.77 (–)	**Er** 1.57 1.76 (–)	**Tm** 1.56 1.75 (–)	**Yb** 1.70 1.94 (–)	**Lu** 1.56 1.73 (–)
Ac (–) 1.88 (–)	**Th** (–) 1.80 (–)	**Pa** (–) 1.61 (–)	**U** (–) 1.39 (–)	**Np** (–) 1.31 (–)	**Pu** (–) 1.51 (–)	**Am** (–) 1.84 (–)	**Cm** (–) (–) (–)	**Bk** (–) (–) (–)	**Cf** (–) (–) (–)	**Es** (–) (–) (–)	**Fm** (–) (–) (–)	**Md** (–) (–) (–)	**No** (–) (–) (–)	**Lr** (–) (–) (–)