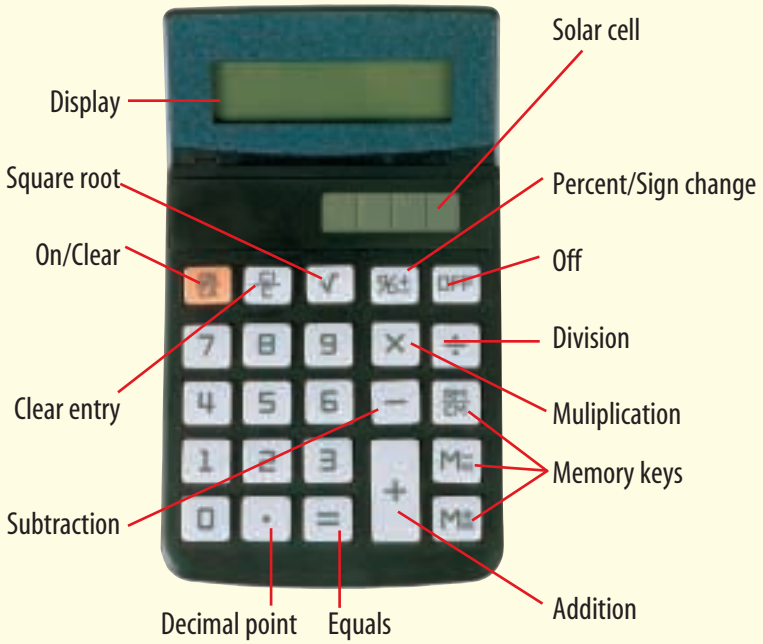
Using a Calculator



- Read the problem very carefully. Decide if you need the calculator to help you solve the problem.
- Clear the calculator by pressing the clear key when starting a new problem.
- If you see an E in the display, clear the error before you begin.
- If you see an M in the display, clear the memory and the calculator before you begin.
- If the number in the display is not one of the answer choices, check your work. You may have to round the number in the display.
- Your calculator will NOT automatically perform the correct order of operations.
- When working with calculators, use careful and deliberate keystrokes, and always remember to check your answer to make sure that it is reasonable. Calculators might display an incorrect answer if you press the keys too quickly.
- Check your answer to make sure that you have completed all of the necessary steps.

Science Reference Guide

Equations

Acceleration ($\bar{a}$)	=	$\frac{\text{change in velocity (m/s)}}{\text{time taken for this change (s)}}$	$\bar{a}$	$= \frac{v_f - v_i}{t_f - t_i}$
Average speed ($\bar{v}$)	=	$\frac{\text{distance}}{\text{time}}$	$\bar{v}$	$= \frac{d}{t}$
Density (D)	=	$\frac{\text{mass (g)}}{\text{Volume (cm}^3\text{)}}$	D	$= \frac{m}{V}$
Percent Efficiency (e)	=	$\frac{\text{Work out (J)}}{\text{Work in (J)}} \times 100$	eff	$= \frac{W_{out}}{W_{in}} \times 100$
Force in newtons (F)	=	mass (kg) × acceleration (m/s^2)	F	= ma
Frequency in hertz (f)	=	$\frac{\text{number of events (waves)}}{\text{time (s)}}$	f	$= \frac{n \text{ of events}}{t}$
Momentum (p)	=	mass (kg) × velocity (m/s)	p	= mv
Wavelength (λ)	=	$\frac{\text{velocity (m/s)}}{\text{frequency (Hz)}}$	λ	$= \frac{v}{f}$
Work (W)	=	Force (N) × distance (m)	W	= Fd

Units of Measure

cm = centimeter
g = gram
Hz = hertz
J = joule (newton-meter)
kg = kilogram
m = meter
N = newton
s = second

Understanding Scientific Terms

This list of prefixes, suffixes, and roots is provided to help you understand science terms used throughout this textbook. The list identifies whether the prefix, suffix, or root is of Greek *(G)* or Latin *(L)* origin. Also listed is the meaning of the prefix, suffix, or root and a science word in which it is used.

ORIGIN	MEANING	EXAMPLE
A		
ad (L)	to, toward	adaxial
aero (G)	air	aerobic
an (G)	without	anaerobic
ana (G)	up	anaphase
andro (G)	male	androecium
angio (G)	vessel	angiosperm
anth/o (G)	flower	anthophyte
anti (G)	against	antibody
aqu/a (L)	of water	aquatic
archae (G)	ancient	archaebacteria
arthro, artio (G)	jointed	arthropod
askos (G)	bag	ascospore
aster (G)	star	Asteroidea
autos (G)	self	autoimmune
B		
bi (L)	two	bipedal
bio (G)	life	biosphere
C		
carn (L)	flesh	carnivore
cephalo (G)	head	cephalopod
chlor (G)	light green	chlorophyll
chroma (G)	pigmented	chromosome
cide (L)	to kill	insecticide
circ (L)	circular	circadian
cocc/coccus (G)	small and round	streptococcus
con (L)	together	convergent
cyte (G)	cell	cytoplasm
D		
de (L)	remove	decompose
dendron (G)	tree	dendrite
dent (L)	tooth	edentate
derm (G)	skin	epidermis
di (G)	two	disaccharide
dia (G)	apart	diaphragm
dorm (L)	sleep	dormancy
E		
echino (G)	spiny	echinoderm
ec (G)	outer	ecosystem
endo (G)	within	endosperm
epi (G)	upon	epidermis
eu (G)	true	eukaryote
exo (G)	outside	exoskeleton
F		
fer (L)	to carry	conifer
G		
gastro (G)	stomach	gastropod
gen/(e)(o) (G)	kind	genotype
genesis (G)	to originate	oogenesis
gon (G)	reproductive	archegonium
gravi (L)	heavy	gravitropism
gymn/o (G)	naked	gymnosperm
gyn/e (G)	female	gynoecium
H		
hal(o) (G)	salt	halophyte
hapl(o) (G)	single	haploid
hemi (G)	half	hemisphere
hem(o) (G)	blood	hemoglobin
herb/a(i) (L)	vegetation	herbivore
heter/o (G)	different	heterotrophic
hom(e)/o (G)	same	homeostasis
hom (L)	human	hominid
hydr/o (G)	water	hydrolysis
I		
inter (L)	between	internode
intra (L)	within	intracellular
is/o (G)	equal	isotonic

ORIGIN	MEANING	EXAMPLE
K		
kary (G)	nucleus	eukaryote
kera (G)	hornlike	keratin
L		
leuc/o (G)	white	leukocyte
logy (G)	study of	biology
lymph/o (L)	water	lymphocyte
lysis (G)	break up	dialysis
M		
macr/o (G)	large	macromolecule
meg/a (G)	great	megaspore
meso (L)	in the middle	mesophyll
meta (G)	after	metaphase
micr/o (G)	small	microscope
mon/o (G)	only one	monocotyledon
morph/o (G)	form	morphology
N		
nema (G)	a thread	nematode
neuro (G)	nerve	neuron
nod (L)	knot	nodule
nomy(e) (G)	system of laws	taxonomy
O		
olig/o (G)	small, few	oligochaete
omni (L)	all	omnivore
orni(s) (G)	bird	ornithology
oste/o (G)	bone formation	osteocyte
ov (L)	an egg	oviduct
P		
pal(a)e/o (G)	ancient	paleontology
para (G)	beside	parathyroid
path/o (G)	suffering	pathogen
ped (L)	foot	centipede
per (L)	through	permeable
peri (G)	around, about	peristalsis
phag/o (G)	eating	phagocyte
phot/o (G)	light	photosynthesis
phyl (G)	race, class	phylogeny
phyll (G)	leaf	chlorophyll
phyte (G)	plant	epiphyte
Origin	Meaning	Example
pinna (L)	feather	pinnate

ORIGIN	MEANING	EXAMPLE
plasm/o (G)	to form	plasmodium
pod (G)	foot	gastropod
poly (G)	many	polymer
post (L)	after	posterior
pro (G) (L)	before	prokaryote
prot/o (G)	first	protocells
pseud/o (G)	false	pseudopodium
R		
re (L)	back to original	reproduce
rhiz/o (G)	root	rhizoid
S		
scope (G)	to look	microscope
some (G)	body	lysosome
sperm (G)	seed	gymnosperm
stasis (G)	remain constant	homeostasis
stom (G)	mouthlike opening	stomata
syn (G)	together	synapse
T		
tel/o (G)	end	telophase
terr (L)	of Earth	terrestrial
therm (G)	heat	endotherm
thylak (G)	sack	thylakoid
trans (L)	across	transpiration
trich (G)	hair	trichome
trop/o (G)	a change	gravitropism
trophic (G)	nourishment	heterotrophic
U		
uni (L)	one	unicellular
V		
vacc/a (L)	cow	vaccine
vore (L)	eat greedily	omnivore
X		
xer/o (G)	dry	xerophyte
Z		
zo/o (G)	living being	zoology
zygous (G)	two joined	homozygous

Diversity of Life: Classification of Living Organisms

A six-kingdom system of classification of organisms is used today. Two kingdoms—Kingdom Archaebacteria and Kingdom Eubacteria—contain organisms that do not have a nucleus and that lack membrane-bound structures in the cytoplasm of their cells. The members of the other four kingdoms have a cell or cells that contain a nucleus and structures in the cytoplasm, some of which are surrounded by membranes. These kingdoms are Kingdom Protista, Kingdom Fungi, Kingdom Plantae, and Kingdom Animalia.

Kingdom Archaebacteria

one-celled; some absorb food from their surroundings; some are photosynthetic; some are chemosynthetic; many are found in extremely harsh environments including salt ponds, hot springs, swamps, and deep-sea hydrothermal vents

Kingdom Eubacteria

one-celled; most absorb food from their surroundings; some are photosynthetic; some are chemosynthetic; many are parasites; many are round, spiral, or rod-shaped; some form colonies

Kingdom Protista

Phylum Euglenophyta one-celled; photosynthetic or take in food; most have one flagellum; euglenoids

Phylum Bacillariophyta one-celled; photosynthetic; have unique double shells made of silica; diatoms

Phylum Dinoflagellata one-celled; photosynthetic; contain red pigments; have two flagella; dinoflagellates

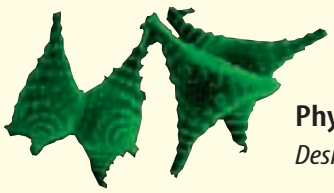
Phylum Chlorophyta one-celled, many-celled, or colonies; photosynthetic; contain chlorophyll; live on land, in freshwater, or salt water; green algae

Phylum Rhodophyta most are many-celled; photosynthetic; contain red pigments; most live in deep, saltwater environments; red algae

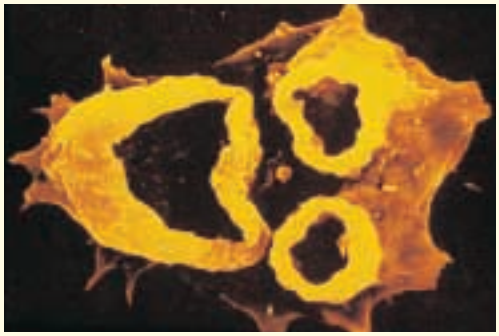
Phylum Phaeophyta most are many-celled; photosynthetic; contain brown pigments; most live in saltwater environments; brown algae

Phylum Rhizopoda one-celled; take in food; are free-living or parasitic; move by means of pseudopods; amoebas

Kingdom Eubacteria
Bacillus anthracis



Phylum Chlorophyta
Desmids



Amoeba

Phylum Zoomastigina one-celled; take in food; free-living or parasitic; have one or more flagella; zoomastigotes

Phylum Ciliophora one-celled; take in food; have large numbers of cilia; ciliates

Phylum Sporozoa one-celled; take in food; have no means of movement; are parasites in animals; sporozoans

Phylum Myxomycota
Slime mold

Phylum Oomycota
Phytophthora infestans

Phyla Myxomycota and Acrasiomycota one- or many-celled; absorb food; change form during life cycle; cellular and plasmodial slime molds

Phylum Oomycota many-celled; are either parasites or decomposers; live in freshwater or salt water; water molds, rusts and downy mildews

Kingdom Fungi

Phylum Zygomycota many-celled; absorb food; spores are produced in sporangia; zygote fungi; bread mold

Phylum Ascomycota one- and many-celled; absorb food; spores produced in asci; sac fungi; yeast

Phylum Basidiomycota many-celled; absorb food; spores produced in basidia; club fungi; mushrooms

Phylum Deuteromycota members with unknown reproductive structures; imperfect fungi; *Penicillium*

Phylum Mycophycota organisms formed by symbiotic relationship between an ascomycote or a basidiomycote and green alga or cyanobacterium; lichens

Lichens

Kingdom Plantae

Divisions Bryophyta (mosses), **Anthocerophyta** (hornworts), **Hepaticophyta** (liverworts), **Psilophyta** (whisk ferns) many-celled nonvascular plants; reproduce by spores produced in capsules; green; grow in moist, land environments

Division Lycophyta many-celled vascular plants; spores are produced in conelike structures; live on land; are photosynthetic; club mosses

Division Arthrophyta vascular plants; ribbed and jointed stems; scalelike leaves; spores produced in conelike structures; horsetails

Division Pterophyta vascular plants; leaves called fronds; spores produced in clusters of sporangia called sori; live on land or in water; ferns

Division Ginkgophyta deciduous trees; only one living species; have fan-shaped leaves with branching veins and fleshy cones with seeds; ginkgoes

Division Cycadophyta palmlike plants; have large, featherlike leaves; produces seeds in cones; cycads

Division Coniferophyta deciduous or evergreen; trees or shrubs; have needlelike or scalelike leaves; seeds produced in cones; conifers

Division Anthophyta
Tomato plant

Division Gnetophyta shrubs or woody vines; seeds are produced in cones; division contains only three genera; gnetum

Division Anthophyta dominant group of plants; flowering plants; have fruits with seeds

Kingdom Animalia

Phylum Porifera aquatic organisms that lack true tissues and organs; are asymmetrical and sessile; sponges

Phylum Cnidaria radially symmetrical organisms; have a digestive cavity with one opening; most have tentacles armed with stinging cells; live in aquatic environments singly or in colonies; includes jellyfish, corals, hydra, and sea anemones

Phylum Platyhelminthes bilaterally symmetrical worms; have flattened bodies; digestive system has one opening; parasitic and free-living species; flatworms

Division Bryophyta
Liverwort

Phylum Platyhelminthes
Flatworm

Phylum Chordata

Phylum Nematoda round, bilaterally symmetrical body; have digestive system with two openings; free-living forms and parasitic forms; roundworms

Phylum Mollusca soft-bodied animals, many with a hard shell and soft foot or footlike appendage; a mantle covers the soft body; aquatic and terrestrial species; includes clams, snails, squid, and octopuses

Phylum Annelida bilaterally symmetrical worms; have round, segmented bodies; terrestrial and aquatic species; includes earthworms, leeches, and marine polychaetes

Phylum Arthropoda largest animal group; have hard exoskeletons, segmented bodies, and pairs of jointed appendages; land and aquatic species; includes insects, crustaceans, and spiders

Phylum Echinodermata marine organisms; have spiny or leathery skin and a water-vascular system with tube feet; are radially symmetrical; includes sea stars, sand dollars, and sea urchins

Phylum Chordata organisms with internal skeletons and specialized body systems; most have paired appendages; all at some time have a notochord, nerve cord, gill slits, and a post-anal tail; include fish, amphibians, reptiles, birds, and mammals

Martin Harvey/DRK Photo

CONTENTS

Use and Care of a Microscope

Eyepiece Contains magnifying lenses you look through.

Arm Supports the body tube.

Low-power objective Contains the lens with the lowest power magnification.

Stage clips Hold the microscope slide in place.

Coarse adjustment Focuses the image under low power.

Fine adjustment Sharpens the image under high magnification.

Body tube Connects the eyepiece to the revolving nosepiece.

Revolving nosepiece Holds and turns the objectives into viewing position.

High-power objective Contains the lens with the highest magnification.

Stage Supports the microscope slide.

Light source Provides light that passes upward through the diaphragm, the specimen, and the lenses.

Base Provides support for the microscope.

Caring for a Microscope

1. Always carry the microscope holding the arm with one hand and supporting the base with the other hand.
2. Don't touch the lenses with your fingers.
3. The coarse adjustment knob is used only when looking through the lowest-power objective lens. The fine adjustment knob is used when the high-power objective is in place.
4. Cover the microscope when you store it.

Using a Microscope

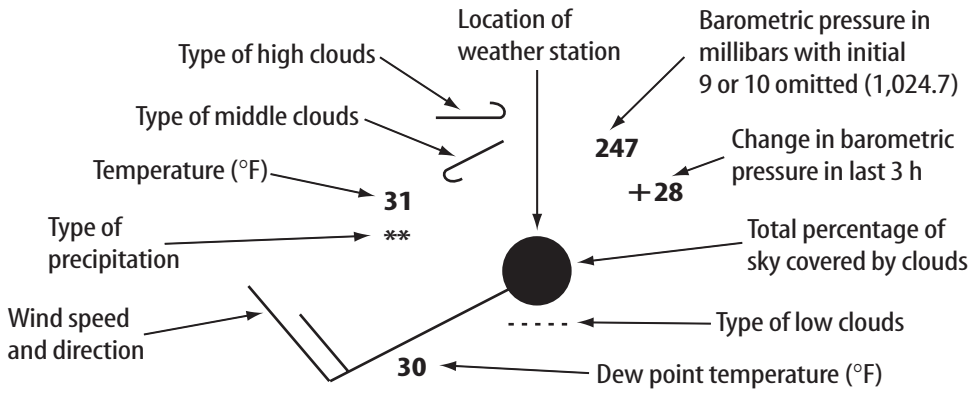
1. Place the microscope on a flat surface that is clear of objects. The arm should be toward you.
2. Look through the eyepiece. Adjust the diaphragm so light comes through the opening in the stage.
3. Place a slide on the stage so the specimen is in the field of view. Hold it firmly in place by using the stage clips.
4. Always focus with the coarse adjustment and the low-power objective lens first. After the object is in focus on low power, turn the nosepiece until the high-power objective is in place. Use ONLY the fine adjustment to focus with the high-power objective lens.

Making a Wet-Mount Slide

1. Carefully place the item you want to look at in the center of a clean, glass slide. Make sure the sample is thin enough for light to pass through.
2. Use a dropper to place one or two drops of water on the sample.
3. Hold a clean coverslip by the edges and place it at one edge of the water. Slowly lower the coverslip onto the water until it lies flat.
4. If you have too much water or a lot of air bubbles, touch the edge of a paper towel to the edge of the coverslip to draw off extra water and draw out unwanted air.

Weather Map Symbols

Sample Station Model



Sample Plotted Report at Each Station

Precipitation	Wind Speed and Direction	Sky Coverage	Some Types of High Clouds
Fog	0 calm	No cover	Scattered cirrus
★ Snow	1–2 knots	1/10 or less	Dense cirrus in patches
● Rain	3–7 knots	2/10 to 3/10	Veil of cirrus covering entire sky
Thunderstorm	8–12 knots	4/10	Cirrus not covering entire sky
, Drizzle	13–17 knots	–	
Showers	18–22 knots	6/10	
	23–27 knots	7/10	
	48–52 knots	Overcast with openings	
	1 knot = 1.852 km/h	Completely overcast	

Some Types of Middle Clouds	Some Types of Low Clouds	Fronts and Pressure Systems
Thin altostratus layer	Cumulus of fair weather	(H) or High (L) or Low — Center of high- or low-pressure system
Thick altostratus layer	Stratocumulus	Cold front
Thin altostratus in patches	Fractocumulus of bad weather	Warm front
Thin altostratus in bands	Stratus of fair weather	Occluded front
		Stationary front

Physical Science Reference Tables

Standard Units

Symbol	Name	Quantity
m	meter	length
kg	kilogram	mass
Pa	pascal	pressure
K	kelvin	temperature
mol	mole	amount of a substance
J	joule	energy, work, quantity of heat
s	second	time
C	coulomb	electric charge
V	volt	electric potential
A	ampere	electric current
V	ohm	resistance

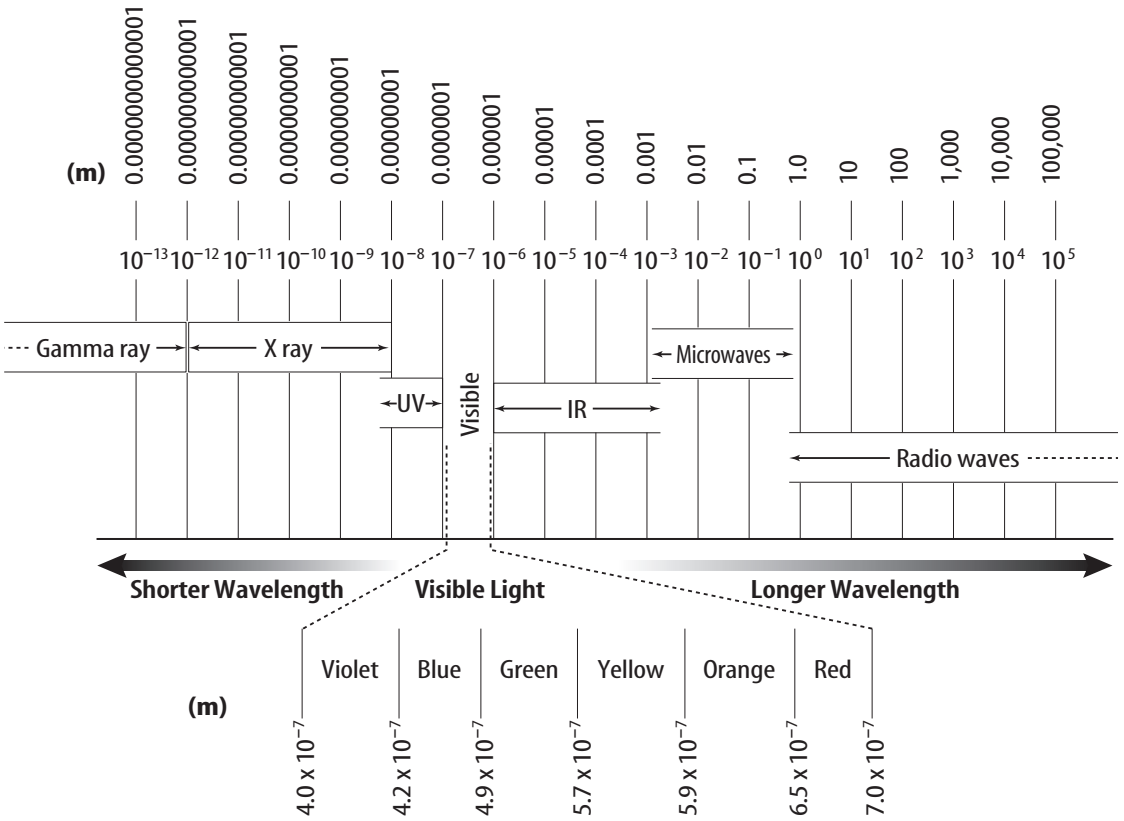
Physical Constants and Conversion Factors

Acceleration due to gravity	g	9.8 m/s/s or m/s^2
Avogadro's Number	N_A	6.02×10^{23} particles per mole
Electron charge	e	1.6×10^{219} C
Electron rest mass	m_e	9.11×10^{231} kg
Gravitation constant	G	6.67×10^{211} N m^2/kg^2
Mass-energy relationship		1 u (amu) = 9.3×10^2 MeV
Speed of light in a vacuum	c	3.00×108 m/s
Speed of sound at STP	331 m/s	
Standard Pressure	1 atmosphere	
	101.3 kPa	
	760 Torr or mmHg	
	14.7 lb/$in.^2$	

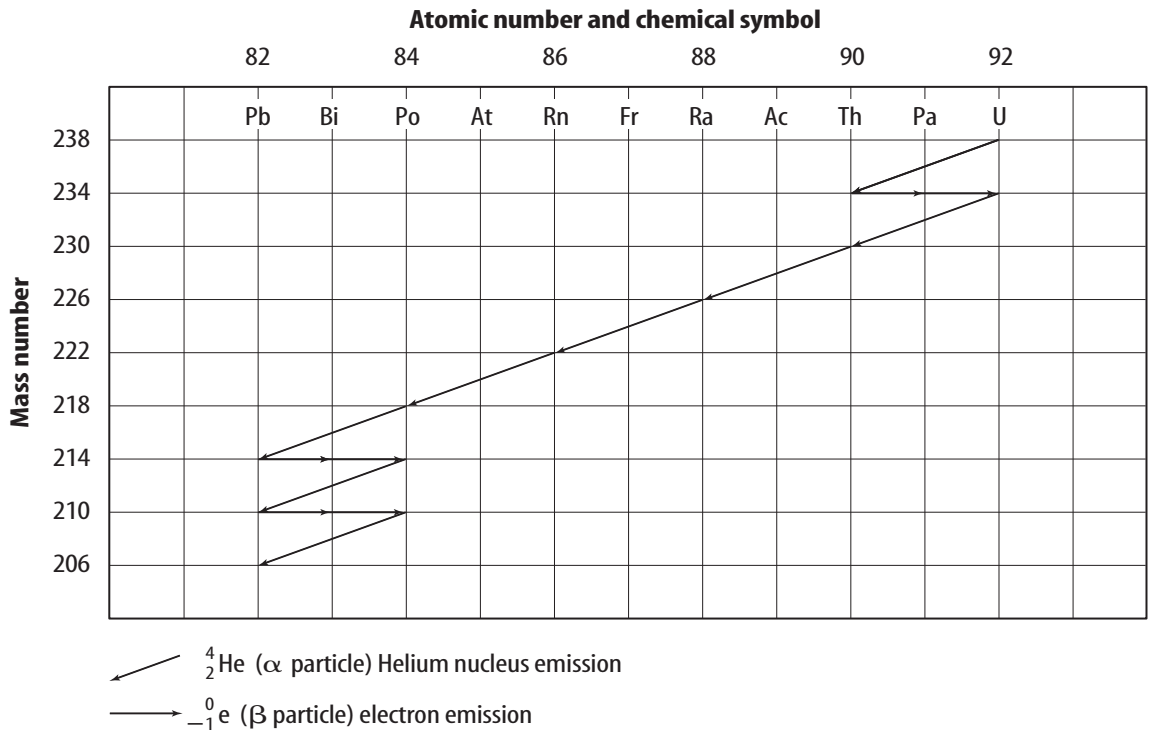
Heat Constants

	Specific Heat (average) (kJ/kg × °C) (J/g × °C)	Melting Point (°C)	Boiling Point (°C)	Heat of Fusion (kJ/kg) (J/g)	Heat of Vaporization (kJ/kg) (J/g)
Alcohol (ethyl)	2.43 (liq.)	2117	79	109	855
Aluminum	0.90 (sol.)	660	2467	396	10500
Ammonia	4.71 (liq.)	278	233	332	1370
Copper	0.39 (sol.)	1083	2567	205	4790
Iron	0.45 (sol.)	1535	2750	267	6290
Lead	0.13 (sol.)	328	1740	25	866
Mercury	0.14 (liq.)	239	357	11	295
Platinum	0.13 (sol.)	1772	3827	101	229
Silver	0.24 (sol.)	962	2212	105	2370
Tungsten	0.13 (sol.)	3410	5660	192	4350
Water (solid)	2.05 (sol.)	0	–	334	–
Water (liquid)	4.18 (liq.)	–	100	–	–
Water (vapor)	2.01 (gas)	–	–	–	2260
Zinc	0.39 (sol.)	420	907	113	1770

Standard Units



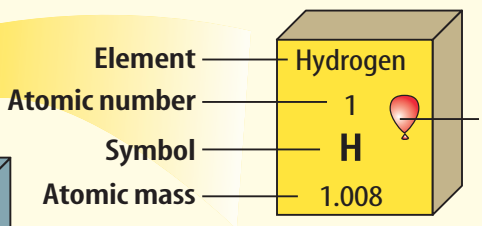
Uranium Decay Series



Reference Handbook

PERIODIC TABLE OF THE ELEMENTS

Columns of elements are called groups. Elements in the same group have similar chemical properties.



Gas
Liquid
Solid
Synthetic

The first three symbols tell you the state of matter of the element at room temperature. The fourth symbol identifies elements that are not present in significant amounts on Earth. Useful amounts are made synthetically.

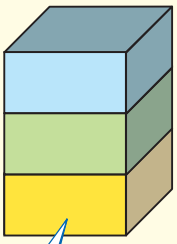
	1	2	3	4	5	6	7	8	9
1	Hydrogen 1 H 1.008								
2	Lithium 3 Li 6.941	Beryllium 4 Be 9.012							
3	Sodium 11 Na 22.990	Magnesium 12 Mg 24.305							
4	Potassium 19 K 39.098	Calcium 20 Ca 40.078	Scandium 21 Sc 44.956	Titanium 22 Ti 47.867	Vanadium 23 V 50.942	Chromium 24 Cr 51.996	Manganese 25 Mn 54.938	Iron 26 Fe 55.845	Cobalt 27 Co 58.933
5	Rubidium 37 Rb 85.468	Strontium 38 Sr 87.62	Yttrium 39 Y 88.906	Zirconium 40 Zr 91.224	Niobium 41 Nb 92.906	Molybdenum 42 Mo 95.94	Technetium 43 Tc (98)	Ruthenium 44 Ru 101.07	Rhodium 45 Rh 102.906
6	Cesium 55 Cs 132.905	Barium 56 Ba 137.327	Lanthanum 57 La 138.906	Hafnium 72 Hf 178.49	Tantalum 73 Ta 180.948	Tungsten 74 W 183.84	Rhenium 75 Re 186.207	Osmium 76 Os 190.23	Iridium 77 Ir 192.217
7	Francium 87 Fr (223)	Radium 88 Ra (226)	Actinium 89 Ac (227)	Rutherfordium 104 Rf (261)	Dubnium 105 Db (262)	Seaborgium 106 Sg (266)	Bohrium 107 Bh (264)	Hassium 108 Hs (277)	Meitnerium 109 Mt (268)

The number in parentheses is the mass number of the longest-lived isotope for that element.

Rows of elements are called periods. Atomic number increases across a period.

Lanthanide series	Cerium 58 Ce 140.116	Praseodymium 59 Pr 140.908	Neodymium 60 Nd 144.24	Promethium 61 Pm (145)	Samarium 62 Sm 150.36
Actinide series	Thorium 90 Th 232.038	Protactinium 91 Pa 231.036	Uranium 92 U 238.029	Neptunium 93 Np (237)	Plutonium 94 Pu (244)

The arrow shows where these elements would fit into the periodic table. They are moved to the bottom of the table to save space.



Metal

Metalloid

Nonmetal

The color of an element's block tells you if the element is a metal, nonmetal, or metalloid.

Science Online

Visit fl6.msscience.com for updates to the periodic table.

10	11	12	13	14	15	16	17	18
								Helium 2 He 4.003
			Boron 5 B 10.811	Carbon 6 C 12.011	Nitrogen 7 N 14.007	Oxygen 8 O 15.999	Fluorine 9 F 18.998	Neon 10 Ne 20.180
			Aluminum 13 Al 26.982	Silicon 14 Si 28.086	Phosphorus 15 P 30.974	Sulfur 16 S 32.065	Chlorine 17 Cl 35.453	Argon 18 Ar 39.948
Nickel 28 Ni 58.693	Copper 29 Cu 63.546	Zinc 30 Zn 65.409	Gallium 31 Ga 69.723	Germanium 32 Ge 72.64	Arsenic 33 As 74.922	Selenium 34 Se 78.96	Bromine 35 Br 79.904	Krypton 36 Kr 83.798
Palladium 46 Pd 106.42	Silver 47 Ag 107.868	Cadmium 48 Cd 112.411	Indium 49 In 114.818	Tin 50 Sn 118.710	Antimony 51 Sb 121.760	Tellurium 52 Te 127.60	Iodine 53 I 126.904	Xenon 54 Xe 131.293
Platinum 78 Pt 195.078	Gold 79 Au 196.967	Mercury 80 Hg 200.59	Thallium 81 Tl 204.383	Lead 82 Pb 207.2	Bismuth 83 Bi 208.980	Polonium 84 Po (209)	Astatine 85 At (210)	Radon 86 Rn (222)
Darmstadtium 110 Ds (281)	Roentgenium 111 Rg (272)	Ununbium * 112 Uub (285)		Ununquadium * 114 Uuq (289)				

* The names and symbols for elements 112–114 are temporary. Final names will be selected when the elements' discoveries are verified.

Europium 63 Eu 151.964	Gadolinium 64 Gd 157.25	Terbium 65 Tb 158.925	Dysprosium 66 Dy 162.500	Holmium 67 Ho 164.930	Erbium 68 Er 167.259	Thulium 69 Tm 168.934	Ytterbium 70 Yb 173.04	Lutetium 71 Lu 174.967
Americium 95 Am (243)	Curium 96 Cm (247)	Berkelium 97 Bk (247)	Californium 98 Cf (251)	Einsteinium 99 Es (252)	Fermium 100 Fm (257)	Mendelevium 101 Md (258)	Nobelium 102 No (259)	Lawrencium 103 Lr (262)

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