

# REFERENCE TABLES FOR PHYSICS

## LIST OF PHYSICAL CONSTANTS

Name	Symbol	Value(s)
Gravitational constant	$G$	$6.7 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$
Acceleration due to gravity (up to 16 km altitude)	$g$	$9.8 \text{ m/s}^2$
Speed of light in a vacuum	$c$	$3.0 \times 10^8 \text{ m/s}$
Speed of sound at STP		$3.3 \times 10^2 \text{ m/s}$
Mass-energy relationship		$1 \text{ u (amu)} = 9.3 \times 10^2 \text{ MeV}$
Mass of the Earth		$6.0 \times 10^{24} \text{ kg}$
Mass of the Moon		$7.4 \times 10^{22} \text{ kg}$
Mean radius of the Earth		$6.4 \times 10^6 \text{ m}$
Mean radius of the Moon		$1.7 \times 10^6 \text{ m}$
Mean distance from Earth to Moon		$3.8 \times 10^8 \text{ m}$
Electrostatic constant	$k$	$9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$
Charge of the electron (1 elementary charge)		$1.6 \times 10^{-19} \text{ C}$
One coulomb	$C$	$6.3 \times 10^{18} \text{ elementary charges}$
Electronvolt	$eV$	$1.6 \times 10^{-19} \text{ J}$
Planck's constant	$h$	$6.6 \times 10^{-34} \text{ J}\cdot\text{s}$
Rest mass of the electron	$m_e$	$9.1 \times 10^{-31} \text{ kg}$
Rest mass of the proton	$m_p$	$1.7 \times 10^{-27} \text{ kg}$
Rest mass of the neutron	$m_n$	$1.7 \times 10^{-27} \text{ kg}$

### ABSOLUTE INDICES OF REFRACTION

$$(\lambda = 5.9 \times 10^{-7} \text{ m})$$

Air	1.00
Alcohol	1.36
Canada Balsam	1.53
Corn Oil	1.47
Diamond	2.42
Glass, Crown	1.52
Glass, Flint	1.61
Glycerol	1.47
Lucite	1.50
Quartz, Fused	1.46
Water	1.33

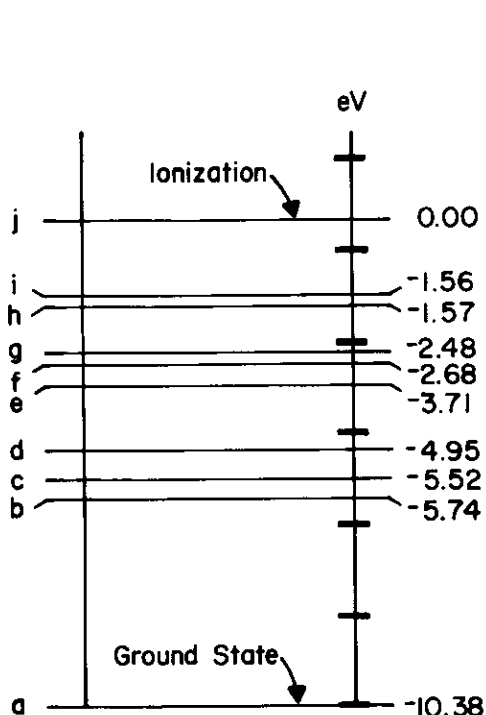
### WAVELENGTHS OF LIGHT IN A VACUUM

Violet	$4.0 - 4.2 \times 10^{-7} \text{ m}$
Blue	$4.2 - 4.9 \times 10^{-7} \text{ m}$
Green	$4.9 - 5.7 \times 10^{-7} \text{ m}$
Yellow	$5.7 - 5.9 \times 10^{-7} \text{ m}$
Orange	$5.9 - 6.5 \times 10^{-7} \text{ m}$
Red	$6.5 - 7.0 \times 10^{-7} \text{ m}$

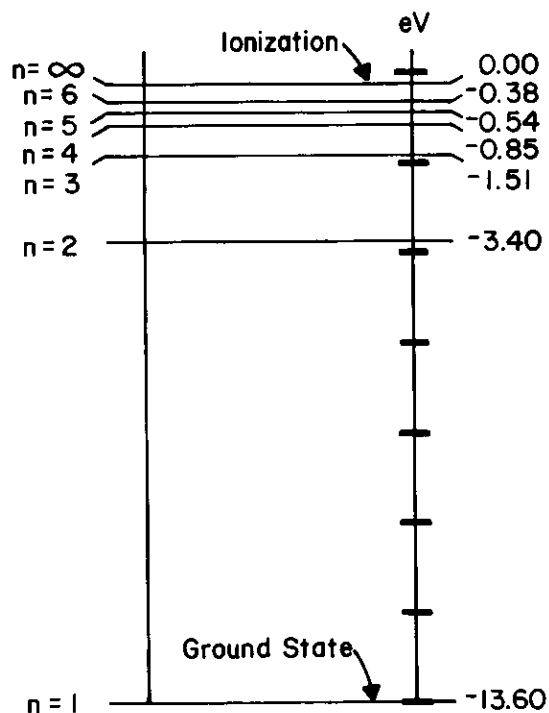
### HEAT CONSTANTS

	Specific Heat (average) (kJ/kg·C°)	Melting Point (°C)	Boiling Point (°C)	Heat of Fusion (kJ/kg)	Heat of Vaporization (kJ/kg)
Alcohol (ethyl)	2.43 (liq.)	-117	79	109	855
Aluminum	0.90 (sol.)	660	2467	396	10500
Ammonia	4.71 (liq.)	-78	-33	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.)	-39	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	ice	2.05 (sol.)	0	334	—
	water	4.19 (liq.)	—	100	2260
	steam	2.01 (gas)	—	—	—
Zinc	0.39 (sol.)	420	907	113	1770

### ENERGY LEVEL DIAGRAMS FOR MERCURY AND HYDROGEN



A few energy levels for the mercury atom



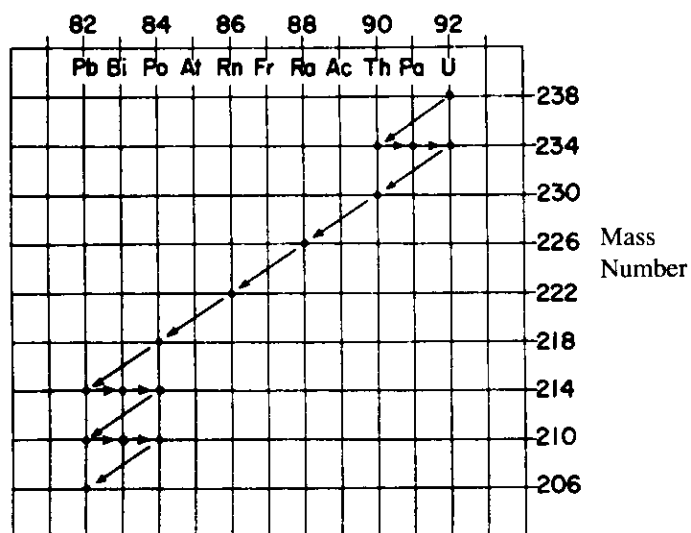
Energy levels for the hydrogen atom

### VALUES OF TRIGONOMETRIC FUNCTIONS

Angle	Sine	Cosine	Angle	Sine	Cosine
1°	.0175	.9998	46°	.7193	.6947
2°	.0349	.9994	47°	.7314	.6820
3°	.0523	.9986	48°	.7431	.6691
4°	.0698	.9976	49°	.7547	.6561
5°	.0872	.9962	50°	.7660	.6428
6°	.1045	.9945	51°	.7771	.6293
7°	.1219	.9925	52°	.7880	.6157
8°	.1392	.9903	53°	.7986	.6018
9°	.1564	.9877	54°	.8090	.5878
10°	.1736	.9848	55°	.8192	.5736
11°	.1908	.9816	56°	.8290	.5592
12°	.2079	.9781	57°	.8387	.5446
13°	.2250	.9744	58°	.8480	.5299
14°	.2419	.9703	59°	.8572	.5150
15°	.2588	.9659	60°	.8660	.5000
16°	.2756	.9613	61°	.8746	.4848
17°	.2924	.9563	62°	.8829	.4695
18°	.3090	.9511	63°	.8910	.4540
19°	.3256	.9455	64°	.8988	.4384
20°	.3420	.9397	65°	.9063	.4226
21°	.3584	.9336	66°	.9135	.4067
22°	.3746	.9272	67°	.9205	.3907
23°	.3907	.9205	68°	.9272	.3746
24°	.4067	.9135	69°	.9336	.3584
25°	.4226	.9063	70°	.9397	.3420
26°	.4384	.8988	71°	.9455	.3256
27°	.4540	.8910	72°	.9511	.3090
28°	.4695	.8829	73°	.9563	.2924
29°	.4848	.8746	74°	.9613	.2756
30°	.5000	.8660	75°	.9659	.2588
31°	.5150	.8572	76°	.9703	.2419
32°	.5299	.8480	77°	.9744	.2250
33°	.5446	.8387	78°	.9781	.2079
34°	.5592	.8290	79°	.9816	.1908
35°	.5736	.8192	80°	.9848	.1736
36°	.5878	.8090	81°	.9877	.1564
37°	.6018	.7986	82°	.9903	.1392
38°	.6157	.7880	83°	.9925	.1219
39°	.6293	.7771	84°	.9945	.1045
40°	.6428	.7660	85°	.9962	.0872
41°	.6561	.7547	86°	.9976	.0698
42°	.6691	.7431	87°	.9986	.0523
43°	.6820	.7314	88°	.9994	.0349
44°	.6947	.7193	89°	.9998	.0175
45°	.7071	.7071	90°	1.0000	.0000

### URANIUM DISINTEGRATION SERIES

Atomic Number and Chemical Symbol



## SUMMARY OF EQUATIONS

### MECHANICS

$$\bar{v} = \frac{\Delta s}{\Delta t}$$

$$\bar{v} = \frac{v_f + v_i}{2}$$

$$\bar{a} = \frac{\Delta v}{\Delta t}$$

$$\Delta s = v_i \Delta t + \frac{1}{2} a (\Delta t)^2$$

$$v_f^2 = v_i^2 + 2a\Delta s$$

$$F = ma$$

$$w = mg$$

$$F = \frac{Gm_1m_2}{r^2}$$

$$p = mv$$

$$J = F\Delta t$$

$$F\Delta t = m\Delta v$$

$a$  = acceleration

$r$  = distance between centers

$F$  = force

$g$  = acceleration due to gravity

$G$  = universal gravitation constant

$J$  = impulse

$m$  = mass

$p$  = momentum

$\Delta s$  = displacement

$t$  = time

$v$  = velocity

$w$  = weight

### ELECTRICITY AND MAGNETISM

$$F = \frac{kq_1q_2}{r^2}$$

$$E = \frac{F}{q}$$

$$V = \frac{W}{q}$$

$$E = \frac{V}{d}$$

$$I = \frac{\Delta q}{\Delta t}$$

$$R = \frac{V}{I}$$

$$P = VI = I^2R = \frac{V^2}{R}$$

$$W = Pt = VIt = I^2Rt$$

*Series Circuits:*

$$I_t = I_1 = I_2 = I_3 = \dots$$

$$V_t = V_1 + V_2 + V_3 + \dots$$

$$R_t = R_1 + R_2 + R_3 + \dots$$

*Parallel Circuits:*

$$I_t = I_1 + I_2 + I_3 + \dots$$

$$V_t = V_1 = V_2 = V_3 = \dots$$

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

### ENERGY

$$W = F\Delta s$$

$$P = \frac{W}{\Delta t} = \frac{F\Delta s}{\Delta t} = F\bar{v}$$

$$\Delta PE = mg\Delta h$$

$$KE = \frac{1}{2}mv^2$$

$$F = kx$$

$$PE_s = \frac{1}{2}kx^2$$

$F$  = force

$g$  = acceleration due to gravity

$h$  = height

$k$  = spring constant

KE = kinetic energy

$m$  = mass

$P$  = power

PE = potential energy

PE<sub>s</sub> = potential energy stored in a spring

$\Delta s$  = displacement

$t$  = time

$v$  = velocity

$W$  = work

$x$  = change in spring length from the equilibrium position

### INTERNAL ENERGY

$$Q = mc\Delta T_c$$

$$Q_f = mH_f$$

$$Q_v = mH_v$$

$c$  = specific heat

$H_f$  = heat of fusion

$H_v$  = heat of vaporization

$m$  = mass

$Q$  = amount of heat

$T_c$  = Celsius temperature

**WAVE PHENOMENA**

$T = \frac{1}{f}$   
 $v = f\lambda$   
 $n = \frac{c}{v}$   
 $\sin \theta_c = \frac{1}{n}$   
 $n_1 \sin \theta_1 = n_2 \sin \theta_2$   
 $n_1 v_1 = n_2 v_2$   
 $\frac{\lambda}{d} = \frac{x}{L}$

*c* = speed of light in a vacuum  
*d* = distance between slits  
*f* = frequency  
*L* = distance from slit to screen  
*n* = index of absolute refraction  
*T* = period  
*v* = speed  
*x* = distance from central maximum to first-order maximum  
*λ* = wavelength  
*θ* = angle  
*θ<sub>c</sub>* = critical angle of incidence relative to air

**MODERN PHYSICS**

$W_o = hf_o$   
 $E_{\text{photon}} = hf$   
 $KE_{\text{max}} = hf - W_o$   
 $p = \frac{h}{\lambda}$   
 $E_{\text{photon}} = E_i - E_f$

*c* = speed of light in a vacuum  
*E* = energy  
*f* = frequency  
*f<sub>o</sub>* = threshold frequency  
*h* = Planck's constant  
*KE* = kinetic energy  
*p* = momentum  
*W<sub>o</sub>* = work function  
*λ* = wavelength

**MOTION IN A PLANE**

$v_{iy} = v_i \sin \theta$   
 $v_{ix} = v_i \cos \theta$   
 $a_c = \frac{v^2}{r}$   
 $F_c = \frac{mv^2}{r}$

*a<sub>c</sub>* = centripetal acceleration  
*F<sub>c</sub>* = centripetal force  
*m* = mass  
*r* = radius  
*v* = velocity  
*θ* = angle

**ELECTROMAGNETIC APPLICATIONS**

$F = qvB$   
 $\frac{N_p}{N_s} = \frac{V_p}{V_s}$   
 $V_p I_p = V_s I_s$  (ideal)  
 % Efficiency =  $\frac{V_s I_s}{V_p I_p} \times 100$   
 $V = Blv$

*B* = flux density  
*F* = force  
*I<sub>p</sub>* = current in primary coil  
*I<sub>s</sub>* = current in secondary coil  
*N<sub>p</sub>* = number of turns of primary coil  
*N<sub>s</sub>* = number of turns of secondary coil  
*q* = charge  
*v* = velocity  
*V<sub>p</sub>* = voltage of primary coil  
*V<sub>s</sub>* = voltage of secondary coil  
*ℓ* = length of conductor  
*V* = electric potential difference

**GEOMETRIC OPTICS**

$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$   
 $\frac{S_o}{S_i} = \frac{d_o}{d_i}$

*d<sub>i</sub>* = image distance  
*d<sub>o</sub>* = object distance  
*f* = focal length  
*S<sub>i</sub>* = image size  
*S<sub>o</sub>* = object size

**NUCLEAR ENERGY**

$E = mc^2$   
 $m_f = \frac{m_i}{2^n}$

*c* = speed of light in a vacuum  
*E* = energy  
*m* = mass  
*n* = number of half-lives