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ABSTRACT

This booklet was designed as a reference for teachers and students of physics on various types of data. Included are: (1) formulas for various constants involved in the study of gravity, electricity, magnetism, atomic physics, particles, and trigonometry; (2) a chart containing values of trigometric functions; (3) equations used in the study of kinematics, dynamics, momentum and energy, waves and light, electricity and magnetism, atomic physics, and relativity and quantum physics; and (4) a periodic chart of the elements. (TW)

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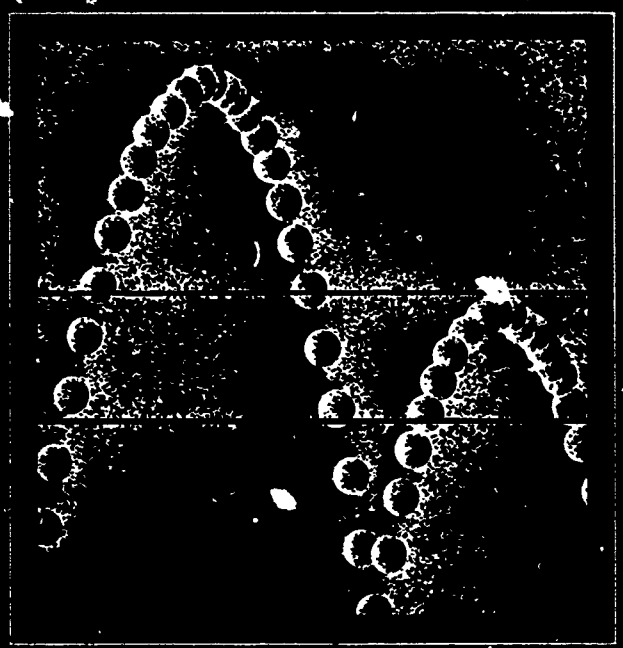

# PHYSICS DATA BOOKLET

(Revised 1987)

Alberta

# PHYSICS

## CONSTANTS

### GRAVITY, ELECTRICITY, AND MAGNETISM

| | |
|---|---|
| Acceleration Due to Gravity or Gravitation Field Near Earth | $g$ or $a_g = 9.81$ m/s$^2$ or 9.81 N/kg |
| Gravitational Constant | $G = 6.67 \times 10^{-11}$ N•m$^2$/kg$^2$ |
| Mass of Earth | $M_e = 5.98 \times 10^{24}$ kg |
| Radius of Earth | $R_e = 6.37 \times 10^{6}$ m |
| Coulomb's Constant | $k = 8.99 \times 10^{9}$ N•m$^2$/C$^2$ |
| Electron Volt | 1 eV $= 1.60 \times 10^{-19}$ J |
| Elementary Charge | $e = 1.60 \times 10^{-19}$ C |
| Faraday's Constant | $\mathcal{F} = 9.65 \times 10^{4}$ C/mol |
| Index of Refraction of Air | $n = 1.00$ |
| Speed of Light in Vacuum | $c = 3.00 \times 10^{8}$ m/s |

### ATOMIC PHYSICS

| | |
|---|---|
| Energy of an Electron in the 1st Bohr Orbit of Hydrogen | $E_1 = -2.18 \times 10^{-18}$ J or $-13.6$ eV |
| Planck's Constant | $h = 6.63 \times 10^{-34}$ J•s |
| Radius of 1st Bohr Orbit of Hydrogen | $r_1 = 5.29 \times 10^{-11}$ m |
| Rydberg's Constant | $R_H = 1.10 \times 10^{7}$/m |

## PARTICLES

| | Rest Mass | Charge |
|---|---|---|
| Alpha Particle | $m_\alpha = 6.65 \times 10^{-27}$ kg | $\alpha^{2+}$ |
| Electron | $m_e = 9.11 \times 10^{-31}$ kg | $e^-$ |
| Neutron | $m_n = 1.67 \times 10^{-27}$ kg | $n^0$ |
| Proton | $m_p = 1.67 \times 10^{-27}$ kg | $p^+$ |

## TRIGONOMETRY

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}} \qquad \cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}} \qquad \tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \qquad c^2 = a^2 + b^2 - 2ab\cos C$$

# VALUES OF TRIGONOMETRIC FUNCTIONS

| Angle | Sin | Cos | Tan | Angle | Sin | Cos | Tan |
|---|---|---|---|---|---|---|---|
| 1° | 0.0175 | 0.9998 | 0.0175 | 46° | 0.7193 | 0.6947 | 1.0355 |
| 2° | 0.0349 | 0.9994 | 0.0349 | 47° | 0.7314 | 0.6820 | 1.0724 |
| 3° | 0.0523 | 0.9986 | 0.0524 | 48° | 0.7431 | 0.6691 | 1.1106 |
| 4° | 0.0698 | 0.9976 | 0.0699 | 49° | 0.7547 | 0.6561 | 1.1504 |
| 5° | 0.0872 | 0.9962 | 0.0875 | 50° | 0.7660 | 0.6428 | 1.1918 |
| 6° | 0.1045 | 0.9945 | 0.1051 | 51° | 0.7771 | 0.6293 | 1.2349 |
| 7° | 0.1219 | 0.9925 | 0.1228 | 52° | 0.7880 | 0.6157 | 1.2799 |
| 8° | 0.1392 | 0.9903 | 0.1405 | 53° | 0.7986 | 0.6018 | 1.3270 |
| 9° | 0.1564 | 0.9877 | 0.1584 | 54° | 0.8090 | 0.5878 | 1.3764 |
| 10° | 0.1736 | 0.9848 | 0.1763 | 55° | 0.8192 | 0.5736 | 1.4281 |
| 11° | 0.1908 | 0.9816 | 0.1944 | 56° | 0.8290 | 0.5592 | 1.4826 |
| 12° | 0.2079 | 0.9781 | 0.2126 | 57° | 0.8387 | 0.5446 | 1.5399 |
| 13° | 0.2250 | 0.9744 | 0.2309 | 58° | 0.8480 | 0.5299 | 1.6003 |
| 14° | 0.2419 | 0.9703 | 0.2493 | 59° | 0.8572 | 0.5150 | 1.6643 |
| 15° | 0.2588 | 0.9659 | 0.2679 | 60° | 0.8660 | 0.5000 | 1.7321 |
| 16° | 0.2756 | 0.9613 | 0.2867 | 61° | 0.8746 | 0.4848 | 1.8040 |
| 17° | 0.2924 | 0.9563 | 0.3057 | 62° | 0.8829 | 0.4695 | 1.8807 |
| 18° | 0.3090 | 0.9511 | 0.3249 | 63° | 0.8910 | 0.4540 | 1.9626 |
| 19° | 0.3256 | 0.9455 | 0.3443 | 64° | 0.8988 | 0.4384 | 2.0503 |
| 20° | 0.3420 | 0.9397 | 0.3640 | 65° | 0.9063 | 0.4226 | 2.1445 |
| 21° | 0.3584 | 0.9336 | 0.3839 | 66° | 0.9135 | 0.4067 | 2.2460 |
| 22° | 0.3746 | 0.9272 | 0.4040 | 67° | 0.9205 | 0.3907 | 2.3559 |
| 23° | 0.3907 | 0.9205 | 0.4245 | 68° | 0.9272 | 0.3746 | 2.4751 |
| 24° | 0.4067 | 0.9135 | 0.4452 | 69° | 0.9336 | 0.3584 | 2.6051 |
| 25° | 0.4226 | 0.9063 | 0.4663 | 70° | 0.9397 | 0.3420 | 2.7475 |
| 26° | 0.4384 | 0.8988 | 0.4877 | 71° | 0.9455 | 0.3256 | 2.9042 |
| 27° | 0.4540 | 0.8910 | 0.5095 | 72° | 0.9511 | 0.3090 | 3.0777 |
| 28° | 0.4695 | 0.8829 | 0.5317 | 73° | 0.9563 | 0.2924 | 3.2709 |
| 29° | 0.4848 | 0.8746 | 0.5543 | 74° | 0.9613 | 0.2756 | 3.4874 |
| 30° | 0.5000 | 0.8660 | 0.5774 | 75° | 0.9659 | 0.2588 | 3.7321 |
| 31° | 0.5150 | 0.8572 | 0.6009 | 76° | 0.9703 | 0.2419 | 4.0108 |
| 32° | 0.5299 | 0.8480 | 0.6249 | 77° | 0.9744 | 0.2250 | 4.3315 |
| 33° | 0.5446 | 0.8387 | 0.6494 | 78° | 0.9781 | 0.2079 | 4.7046 |
| 34° | 0.5592 | 0.8290 | 0.6745 | 79° | 0.9816 | 0.1908 | 5.1446 |
| 35° | 0.5736 | 0.8192 | 0.7002 | 80° | 0.9848 | 0.1736 | 5.6713 |
| 36° | 0.5878 | 0.8090 | 0.7265 | 81° | 0.9877 | 0.1564 | 6.3138 |
| 37° | 0.6018 | 0.7986 | 0.7536 | 82° | 0.9903 | 0.1392 | 7.1154 |
| 38° | 0.6157 | 0.7880 | 0.7813 | 83° | 0.9925 | 0.1219 | 8.1443 |
| 39° | 0.6293 | 0.7771 | 0.8098 | 84° | 0.9945 | 0.1045 | 9.5144 |
| 40° | 0.6428 | 0.7660 | 0.8391 | 85° | 0.9962 | 0.0872 | 11.4301 |
| 41° | 0.6561 | 0.7547 | 0.8693 | 86° | 0.9976 | 0.0698 | 14.3007 |
| 42° | 0.6691 | 0.7431 | 0.9004 | 87° | 0.9986 | 0.0523 | 19.0811 |
| 43° | 0.6820 | 0.7314 | 0.9325 | 88° | 0.9994 | 0.0349 | 28.6363 |
| 44° | 0.6947 | 0.7193 | 0.9657 | 89° | 0.9998 | 0.0175 | 57.2900 |
| 45° | 0.7071 | 0.7071 | 1.0000 | 90° | 1.0000 | 0.0000 | |

## EQUATIONS

### Kinematics

$$\vec{v}_{ave} = \frac{\vec{d}}{t} \qquad \vec{d} = \left( \frac{\vec{v}_f + \vec{v}_i}{2} \right) t$$

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t} \qquad v_f^2 = v_i^2 + 2ad$$

$$\vec{d} = \vec{v}_i t + {}^1/_2 a t^2$$

### Dynamics

$$\vec{F} = m\vec{a} \qquad g = \frac{Gm_1}{R^2}$$

$$\vec{F}t = m\Delta\vec{v} \qquad F_c = \frac{mv^2}{R}$$

$$\vec{F}_g = m\vec{g} \qquad F_c = \frac{4\pi^2 mR}{T^2}$$

$$F_g = \frac{Gm_1 m_2}{R^2}$$

### Momentum & Energy

$$\vec{p} = m\vec{v} \qquad P = \frac{W}{t}$$

$$W = Fd \qquad E_k = {}^1/_2 mv^2$$

$$W = Fd \cos \Theta \qquad E_p = mgh$$

### Waves & Light

$$v = f\lambda \qquad \lambda = \frac{xd}{nl}$$

$$T = \frac{1}{f} \qquad \lambda = \frac{d \sin \Theta}{n}$$

$$\frac{\sin \Theta_1}{\sin \Theta_2} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1}$$

## EQUATIONS

### Electricity & Magnetism

$$F_e = \frac{kq_1q_2}{R^2}$$

$$|\vec{E}| = \frac{kq_1}{R^2}$$

$$|\vec{E}| = \frac{F_e}{q}$$

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

$$V = \frac{\Delta E}{q}$$

$$V = IR$$

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

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

$$F_m = IlB_\perp$$

$$F_m = qvB_\perp$$

### Atomic Physics

$$m = \frac{It}{9.65 \times 10^4 \text{ C/mol}} \cdot \frac{A}{v}$$

$$E_{k_{max}} = hf - W$$

$$W = hf_0$$

$$E_{k_{max}} = qV_{stop}$$

$$E = hf = \frac{hc}{\lambda}$$

$$\frac{1}{\lambda} = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$E_n = \frac{1}{n^2}E_1$$

$$r_n = n^2r_1$$

### Relativity & Quantum Physics

$$E = mc^2$$

$$E_k = (m - m_0)c^2$$

$$m = \frac{m_0}{\sqrt{1 - v^2/c^2}}$$

$$p = \frac{h}{\lambda} = \frac{hf}{c}$$

$$\Delta x \Delta p \geq \frac{h}{4\pi}$$

$$2\pi r_n = n\lambda$$

# PERIODIC CHART OF THE ELEMENTS

| IA | IIA | IIIB | IVB | VB | VIB | VIIB | VIIIB | IB | IIB | IIIA | IVA | VA | VIA | VIIA | VIIIA or 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 Li 1.0 lithium 6.94 | 4 Be 1.5 beryllium 9.01 | | | | | | | | | 5 B 2.0 boron 10.81 | 6 C 2.5 carbon 12.01 | | | | |
| 11 Na 0.9 sodium 22.99 | 12 Mg 1.2 magnesium 24.31 | | | | | | | | | 13 Al 1.5 aluminum 26.98 | 14 Si 1.8 silicon 28.09 | 15 P 2.1 phosphorous 30.97 | 16 S 2.5 sulphur 32.06 | | |
| 19 K 0.8 potassium 39.10 | 20 Ca 1.0 calcium 40.08 | 21 Sc 1.3 scandium 44.96 | 22 Ti 1.5 titanium 47.90 | 23 V 1.6 vanadium 50.94 | 24 Cr 1.6 chromium 52.00 | 25 Mn 1.5 manganese 54.94 | 26 Fe 1.8 iron 55.85 | 27 Co 1.8 cobalt 58.93 | 28 Ni 1.8 nickel 58.71 | 29 Cu 1.9 copper 63.55 | 30 Zn 1.6 zinc 65.38 | 31 Ga 1.6 gallium 69.74 | 32 Ge 1.8 germanium 72.59 | 33 As 2.0 arsenic 74.92 | 34 Se 2.4 selenium 78.96 | | |
| 37 Rb 0.8 rubidium 85.47 | 38 Sr 1.0 strontium 87.62 | 39 Y 1.3 yttrium 88.91 | 40 Zr 1.4 zirconium 91.22 | 41 Nb 1.6 niobium 92.91 | 42 Mo 1.8 molybdenum 95.94 | 43 Tc 1.9 technetium 98.91 | 44 Ru 2.2 ruthenium 101.07 | 45 Rh 2.2 rhodium 102.91 | 46 Pd 2.2 palladium 106.40 | 47 Ag 1.9 silver 107.87 | 48 Cd 1.7 cadmium 112.41 | 49 In 1.7 indium 114.82 | 50 Sn 1.8 tin 118.69 | 51 Sb 1.9 antimony 121.75 | 52 Te 2.1 tellurium 127.60 | 53 I 2.5 iodine 126.90 | |
| 55 Cs 0.7 cesium 132.91 | 56 Ba 0.9 barium 137.33 | 57-71 | 72 Hf 1.3 hafnium 178.49 | 73 Ta 1.5 tantalum 180.95 | 74 W 1.7 tungsten 183.85 | 75 Re 1.9 rhenium 186.21 | 76 Os 2.2 osmium 190.20 | 77 Ir 2.2 iridium 192.22 | 78 Pt 2.2 platinum 195.09 | 79 Au 2.4 gold 196.97 | Hg | 81 Tl 1.8 thallium 204.37 | 82 Pb 1.8 lead 207.19 | 83 Bi 1.9 bismuth 208.98 | 84 Po 2.0 polonium (209) | 85 At 2.2 astatine (210) | |
| 87 Fr 0.7 francium (223) | 88 Ra 0.9 radium 226.03 | 89-103 | 104 Rf — rutherfordium (260) | 105 Ha — hahnium (260) | 106 — (263) | 107 — | | | | | | | | | | | |

KEY

ATOMIC NUMBER → 1 H ← SYMBOL OF THE ELEMENT
2.1 ← ELECTRONEGATIVITY
NAME OF THE ELEMENT → hydrogen
1.01 ← ATOMIC MASS

BASED ON $^{12}_{6}C$

( ) INDICATES MASS OF THE MOST STABLE ISOTOPE

NOTE: The Legend at right denotes the physical state of the elements at 101 kPa and 298 K (25°C)

LEGEND

SOLID

LIQUID

GAS

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 57 La 1.1 lanthanum 138.91 | 58 Ce 1.1 cerium 140.12 | 59 Pr 1.1 praseodymium 140.91 | 60 Nd 1.2 neodymium 144.24 | 61 Pm — promethium (145) | 62 Sm 1.2 samarium 150.35 | 63 Eu — europium 151.96 | 64 Gd 1.1 gadolinium 157.25 | 65 Tb 1.2 terbium 158.93 | 66 Dy — dysprosium 162.50 | 67 Ho 1.2 holmium 164.93 | 68 Er 1.2 erbium 167.26 | 69 Tm 1.2 thulium 168.93 | 70 Yb 1.1 ytterbium 173.04 | 71 Lu 1.2 lutetium 174.97 |
| 89 Ac 1.1 actinium (227) | 90 Th 1.3 thorium 232.04 | 91 Pa 1.5 protactinium 231.04 | 92 U 1.7 uranium 238.03 | 93 Np 1.3 neptunium 237.05 | 94 Pu 1.3 plutonium (244) | 95 Am 1.3 americium (243) | 96 Cm — curium (247) | 97 Bk — berkelium (247) | 98 Cf — californium (251) | 99 Es — einsteinium (254) | 100 Fm — fermium (257) | 101 Md — mendelevium (258) | 102 No — nobelium (259) | 103 Lr — lawrencium (260) |