Prefixes

a=10^{-18}, f=10^{-15}, p=10^{-12}, n=10^{-9}, $\mu = 10^{-6}$, m=10^{-3}, c=10^{-2}, k=10^{3}, M=10^{6}, G=10^{9}, T=10^{12}, P=10^{15}

Physical Constants

$g = 9.80$ m/s^2 (gravitational acceleration)
$M_E = 5.98 \times 10^{24}$ kg (mass of Earth)
$m_e = 9.11 \times 10^{-31}$ kg (electron mass)
$c = 299792458$ m/s (speed of light)
$u = 1.6605 \times 10^{-27}$ kg (atomic mass unit)
$R = 8.314$ J/mol·K (gas constant)

$G = 6.67 \times 10^{-11}$ N·m^2/kg^2 (Gravitational constant)
$R_E = 6380$ km (mean radius of Earth)
$m_p = 1.67 \times 10^{-27}$ kg (proton mass)
$\sigma = 5.67 \times 10^{-8}$ W/m^2·K^4 (Stefan-Boltzmann constant)
$N_A = 6.022 \times 10^{23}$/mol (Avogadro's number)
$k = 1.38 \times 10^{-23}$ J/K (Boltzmann's constant)

Units and Conversions

1 inch = 1 in = 2.54 cm (exactly)
1 mile = 5280 ft
1 m/s = 3.6 km/hour
1 acre = 43560 ft^2 = (1 mile)^2/640

1 foot = 1 ft = 12 in = 30.48 cm (exactly)
1 mile = 1609.344 m = 1.609344 km
1 ft/s = 0.6818 mile/hour
1 hectare = 10^4 m^2

Some Elemental Properties

symbol	element	atomic number	mass number
H	hydrogen	1	1.00794
He	helium	2	4.00260
C	carbon	6	12.0107
N	nitrogen	7	14.0067
O	oxygen	8	15.9994
Ne	neon	10	20.180
Ar	argon	18	39.948
Fe	iron	26	55.845
Ni	nickel	28	58.693
Cu	copper	29	63.546
Au	gold	79	196.97
U	uranium	92	238.03

Mass numbers are atomic masses in units of "u" where 1 u = 1.6605×10^{-27} kg, or, molar masses for the element (1 mole = 6.02×10^{23} atoms), measured in grams. ($N_A \times 1$ u = 1 gram)

Trig summary

$\sin\theta = \frac{\text{(opp)}}{\text{(hyp)}}$, $\cos\theta = \frac{\text{(adj)}}{\text{(hyp)}}$, $\tan\theta = \frac{\text{(opp)}}{\text{(adj)}}$, $\text{(opp)}^2 + \text{(adj)}^2 = \text{(hyp)}^2$.
$\sin\theta = \sin(180^\circ - \theta)$, $\cos\theta = \cos(-\theta)$, $\tan\theta = \tan(180^\circ + \theta)$, $\sin^2\theta + \cos^2\theta = 1$.

Vectors

Written $\vec{V}$ or **V**, described by magnitude=V, direction=θ or by components (V_x, V_y).
$V_x = V\cos\theta$, $V_y = V\sin\theta$,
$V = \sqrt{V_x^2 + V_y^2}$, $\tan\theta = \frac{V_y}{V_x}$. θ is the angle from $\vec{V}$ to x-axis.
Addition: $\mathbf{A} + \mathbf{B}$, head to tail. Subtraction: $\mathbf{A} - \mathbf{B}$ is $\mathbf{A} + (-\mathbf{B})$, $-\mathbf{B}$ is **B** reversed.

Energy, Force, Power

Work & Kinetic & Potential Energies:
$W = Fd\cos\theta$, $\text{KE} = \frac{1}{2}mv^2$, $\text{PE}_{\text{gravity}} = mgy$, $\text{PE}_{\text{spring}} = \frac{1}{2}kx^2$. θ = angle btwn $\vec{F}$ and $\vec{d}$.

Conservation or Transformation of Energy:

Work-KE theorem:
$\Delta\text{KE} = W_{\text{net}}$ = work of all forces.

General energy-conservation law:
$\Delta\text{KE} + \Delta\text{PE} = W_{\text{NC}}$ = work of non-conservative forces.

Power:
$P_{\text{ave}} = \frac{W}{t}$, or use $P_{\text{ave}} = \frac{\text{energy}}{\text{time}}$.

Fluids

Density:

$\rho = m/V$, SG=$\rho/\rho_{\rm H_2O}$, $\rho_{\rm H_2O} = 1000$ kg/m^3 = 1.00 g/cm^3 (at 4°C).

Static Fluids:

$P = F/A$, $P_2 = P_1 + \rho g h$, $\Delta P = \rho g h$, $P = P_{\rm atm.} + P_G$, $B = \rho g V$ or $F_B = \rho g V$.

Pressure Units:

1 Pa = 1 N/m^2, 1 bar = 10^5 Pa = 100 kPa, 1 mm-Hg = 133.3 Pa.

1.00 atm = 101.3 kPa = 1.013 bar = 760 torr = 760 mm-Hg =14.7 lb/in^2.

Moving Fluids:

$A_1 v_1 = A_2 v_2$ = a constant, $P + \frac{1}{2}\rho v^2 + \rho g y$ = a constant.

Chapter 13 Equations

Atomic Theory & Moles:

$n = \frac{N}{N_A}$, $n = \frac{m}{M_A}$, $N_A = 6.022 \times 10^{23}$/mol, 1 u = $\frac{1 \text{ gram}}{N_A} = 1.6605 \times 10^{-27}$ kg.

Temperature scales:

T(°C) = $\frac{5}{9}$[T(°F)-32], T(°F)=$\frac{9}{5}$ T(°C)+32, T(K)=T(°C)+273.15

Thermal Expansion:

$\Delta L = \alpha L_0 \Delta T$, $\Delta V = \beta V_0 \Delta T$.

Ideal Gas Law:

$PV = nRT$, or $PV = NkT$, $R = 8.314$ J/mol·K, $k = \frac{R}{N_A} = 1.38 \times 10^{-23}$ J/K.

Kinetic Theory:

$\overline{\rm KE} = \frac{1}{2} m v_{\rm rms}^2 = \frac{3}{2} kT$, $v_{\rm rms} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M_A}}$, $m = M_A/N_A$.

Chapter 14 Equations

Internal Energy:

$U = \frac{3}{2} NkT = \frac{3}{2} nRT$, for ideal monatomic gases.

Mechanical Equivalent of Heat, Specific Heat, Latent Heat:

1 cal = 4.186 J, $Q = mc\Delta T$, $Q = mL_F$, $Q = mL_V$.

For water, $c = 1.00$ cal/g·C° = 4.186 kJ/kg ·C°, $c_{\rm ice} = 0.50$ cal/g·C° = 2.1 kJ/kg ·C°.

$L_F = 79.7$ kcal/kg = 333 kJ/kg, $L_V = 539$ kcal/kg = 2260 kJ/kg.

Heat Transfer:

Conduction: $P = \frac{Q}{t} = kA\frac{\Delta T}{l}$.

Radiation: $P = \frac{\Delta Q}{\Delta t} = e\sigma A T^4$, $P = \frac{\Delta Q}{\Delta t} = e\sigma A(T_1^4 - T_2^4)$, $\sigma = 5.67 \times 10^{-8}$ W/m^2· K^4.

Solar Energy: $P = \frac{\Delta Q}{\Delta t} \approx (1000 \text{ W/m}^2)\, eA\cos\theta$

Chapter 15 Equations

First Law of Thermodynamics (U = internal energy):

$\Delta U = Q - W$ or $\Delta KE + \Delta PE + \Delta U = Q - W$

work = W = area under $P(V)$ curve. $W = P\Delta V$ for isobaric processes.

heat = Q = heat absorbed by the system. $Q = 0$ for adiabatic processes.

Heat Engines:

$W = Q_H - Q_L$, efficiency $e = \frac{W}{Q_H} = 1 - \frac{Q_L}{Q_H}$, $\frac{Q_L}{Q_H} = \frac{T_L}{T_H}$ for ideal Carnot cycle.

Cooling Machines, Heat Pumps:

$W = Q_H - Q_L$, refrigerators: COP = $\frac{Q_L}{W}$, heat pumps: COP = $\frac{Q_H}{W}$, $\frac{Q_L}{Q_H} = \frac{T_L}{T_H}$ for ideal Carnot.

Power:

$P_{\rm ave} = \frac{W}{t}$, or use $P_{\rm ave} = \frac{\text{energy}}{\text{time}}$.