Brinkley: Physics 1401
Formula Sheet

Chapter 2: One Dimensional Kinematics

- $\Delta x \equiv x_f - x_i \equiv x - x_0$
- $\text{average speed} \equiv \dfrac{\text{total distance traveled}}{\text{total time}}$

  $v_{av} \equiv \dfrac{\Delta x}{\Delta t} = \dfrac{x_f - x_i}{t_f - t_i}$
- $v \equiv \lim\limits_{\Delta t \to 0} v_{av} = \lim\limits_{\Delta t \to 0} \dfrac{\Delta x}{\Delta t}$
- $a_{av} \equiv \dfrac{\Delta v}{\Delta t} = \dfrac{v_f - v_i}{t_f - t_i}$
- Constant linear acceleration
  - $a = a_{av}$
  - $v = v_0 + at$
  - $\Delta x = \dfrac{1}{2}(v_0 + v)t$
  - $\Delta x = v_0 t + \dfrac{1}{2}at^2$
  - $v^2 = v_0^2 + 2a(\Delta x)$

Chapter 5: Newton's Laws of Motion

- $\sum \vec{F} = m\vec{a}$
- $F_g = mg$
- $\vec{F}_N \equiv$ Normal Force

Chapter 6: Applications of Newton's Laws

- $f_k = \mu_k F_N$
- $f_s \le \mu_s F_N$
- $\vec{F} = -k\vec{x}$.
- $a_{cp} = \dfrac{v^2}{r}$

Chapter 7: Work and Kinetic Energy

- $W \equiv \vec{F} \cdot \vec{d} = Fd\cos\theta$
- $K \equiv \dfrac{1}{2}mv^2$
- $W_{net} = \Delta K$
- $P = \dfrac{W}{t} = Fv$

Chapter 8: Potential Energy and Conservation of Energy

- $W_c = -\Delta U$,
- $U_{grav} \equiv mgy$
- $\Delta E \equiv \Delta K + \Delta U$
- $U_{spring} \equiv \dfrac{1}{2}kx^2$
- $W_{nc} = \Delta E$

Chapter 9: Linear Momentum and Collisions

- $\vec{p} \equiv m\vec{v}$
- $\sum \vec{F} = \lim\limits_{\Delta t \to 0} \dfrac{\Delta \vec{p}}{\Delta t}$
- $\left(\sum \vec{F}\right)_{av} = \dfrac{\Delta \vec{p}}{\Delta t}$
- $\vec{I} \equiv \left(\sum \vec{F}\right)_{av} \Delta t = \Delta \vec{p}$
- $\vec{X}_{cm} = \dfrac{\sum\limits_{i=1}^{N} m_i \vec{x}_i}{M_{total}} = \dfrac{m_1\vec{x}_1 + m_2\vec{x}_2 + \ldots + m_N\vec{x}_N}{m_1 + m_2 + \ldots + m_N}$

(1-D elastic)

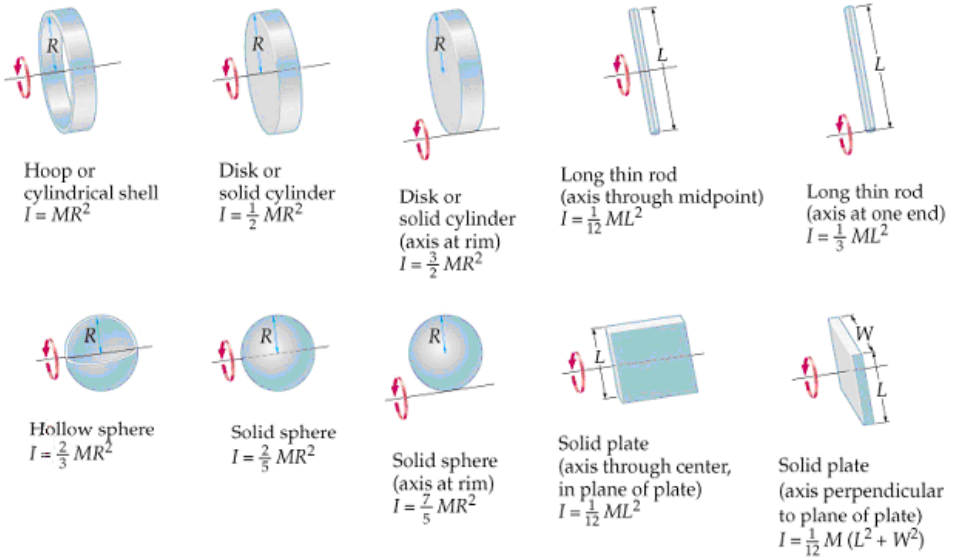
- $v_{1i} + v_{1f} = v_{2i} + v_{2f}$
- $m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$

Chapter 10: Rotational Kinematics and Energy

Linear Quantity	Angular Quantity
$\vec{x}$	$\vec{\theta}$
$\vec{v}$	$\vec{\omega}$
$\vec{a}$	$\vec{\alpha}$
m	I
$\vec{F}$	$\vec{\tau}$
$\vec{p}$	$\vec{L}$

- $\theta \equiv \dfrac{s}{r}$
- $T = \dfrac{2\pi}{\omega}$
- $v_t = r\omega$
- $a_t = r\alpha$
- $a_{cp} = r\omega^2$
- $I \equiv \sum_{i=1}^{N} m_i r_i^2 = m_1 r_1^2 + m_2 r_2^2 + \ldots + m_N r_N^2$ (N point masses)
- $K_{rot} \equiv \dfrac{1}{2} I\omega^2$
- $K_{total} = K_{trans} + K_{rot}$

Moments of Inertia for Uniform, Rigid Objects of Various Shapes



Chapter 11: Rotational Dynamics and Static Equilibrium

- $\tau \equiv \left|\vec{r} \times \vec{F}\right| \equiv rF\sin\theta$
- $\sum \tau = I\alpha$
- $L \equiv I\omega$
- $L = \left|\vec{r} \times \vec{p}\right| = rmv\sin\theta$
- $\sum \tau = \dfrac{\Delta L}{\Delta t}$
- $W = \tau\theta$
- $P = \dfrac{\tau\theta}{t} = \tau\omega$

Chapter 12: Gravity

- $F_g = G\dfrac{m_1 m_2}{r^2}$
- $U_{grav} = -G\dfrac{m_1 m_2}{r}$

A list of solar system data is located at the end of the formula sheet

- $T^2 = \dfrac{4\pi^2}{GM} r_g^2 r_{cp}$

($r_g \approx r_{cp}$ when M>>m i.e. Sun/earth system)

- $v_e = \sqrt{\dfrac{2GM}{R}}$

Chapter 13: Oscillations about Equilibrium

- $f = \frac{1}{T}$ & $\omega = 2\pi f$
- $T = \frac{2\pi}{\omega}$
- $x = A\cos(\omega t)$
- $v = -A\omega\sin(\omega t)$
- $a = -A\omega^2\cos(\omega t)$
- $T = 2\pi\sqrt{\frac{m}{k}}$
- $T = 2\pi\sqrt{\frac{L}{g}}$
- $T = 2\pi\sqrt{\frac{l}{g}}\left(\sqrt{\frac{I}{ml^2}}\right)$

Chapter 14: Waves and Sound

- $v = \lambda f = \frac{\omega}{k}$
- $v = \sqrt{\frac{F}{\mu}}$ (Wave on a string)
- $\mu = m/L$ (Mass per unit length)
- $y(x,t) = A\cos[kx - \omega t]$
- $k = \frac{2\pi}{\lambda}$ (Wave number)
- $\beta = 10\log\left(\frac{I}{I_0}\right)\text{dB}$
- $I = \frac{P}{A} = \frac{P}{4\pi r^2}$
- $f' = \left(\frac{1 \pm \frac{u_o}{v}}{1 \mp \frac{u_s}{v}}\right)f$
- $f_n = n\frac{v}{2L}$ Both ends open or closed
- $f_n = (2n-1)\frac{v}{4L}$ Mixed conditions
- $f_{beat} = |f_1 - f_2|$

Chapter 16: Temperature and Heat

- $T_C = \frac{5}{9}(T_F - 32)$
- $T_K = T_C + 273.15$
- $\Delta L = \alpha L_0 \Delta T$
- $\Delta A = 2\alpha A_0 \Delta T$
- $\Delta V = 3\alpha V_0 \Delta T = \beta V_0 \Delta T$
- $Q = mc\Delta T$
- $P = \frac{Q}{t} = kA\left(\frac{\Delta T}{L}\right)$
- $P = e\sigma A T^4$

Chapter 17: Ideal Gas Law

- $PV = Nk_BT$ or $PV = nRT$
- $Nk_B \equiv nR$ (molecules of moles)
- $Q = mL$
- $v_{rms} = \sqrt{\frac{3k_BT}{m}}$
- $U = \frac{3}{2}Nk_BT$
- $F = \text{Y}\left(\frac{\Delta L}{L_0}\right)A$
- $F = S\left(\frac{\Delta x}{L_0}\right)A$
- $\Delta P = -B\left(\frac{\Delta V}{V_0}\right)$

Chapter 18: The Laws of Thermodynamics

- $\Delta U = Q - W$
- $W = P\Delta V$
- $Q_v = nC_v\Delta T$

  $Q_p = nC_p\Delta T$

$C_v = \frac{3}{2}R \quad \& \quad C_p = \frac{5}{2}R$

- $PV^{\frac{5}{3}} = \text{constant}$
- $COP = \dfrac{Q_c}{W}$ (for refrigeration or A/C)
- $COP = \dfrac{Q_h}{W}$ (for HP)
- $e = 1 - \dfrac{Q_c}{Q_h}$
- $e_{\max} = 1 - \dfrac{T_c}{T_h}$
- $\Delta S = \dfrac{Q}{T}$

Solar System Data

- radius of Earth: $R_E = 6.37\times10^6$ m
- radius of Moon: $R_M = 1.74\times10^6$ m
- mass of Earth: $M_E = 5.97\times10^{24}$ kg
- mass of Moon: 7.35×10^{22} kg
- mass of Sun: 2.00×10^{30} kg
- Earth-Moon distance: 3.84×10^8 m
- Earth-Sun distance: 1.50×10^{11} m

TABLE 1–4 Common Prefixes

Power	Prefix	Abbreviation
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f

Conversion Factors

- 1 in = 2.54 cm
- 1 ft = 0.305 m
- 1 mph = 0.447 m/s
- 1 lb = 4.45 Newton
- 1 hp = 746 Watts
- 1 gallon = 3.785 liters
- 1 m^3 = 1000 liters
- 1 cal = 4.186 J
- 1 Btu = 1055 J

Constants

- G = 6.67 x 10^{-11} $N{\cdot}m^2/kg^2$ (Universal gravitational constant)
- v_s=343 m/s (speed of sound in air)
- I_o=10^{-12} W/m^2 (Threshold of Human Hearing)
- k_B=1.38x10^{-23} J/K (Boltzmann's constant)
- R=8.31 $J/_{mol\cdot K}$ (universal gas constant)
- σ = 5.67 x 10^{-8} $W/(m^2K^4)$
- $N_A = 6.022\times10^{23}$ $molecules/_{mol}$ (Avogadro's number)

TABLE 16–2 Specific Heats at Atmospheric Pressure

Substance	Specific heat, $c[J/(kg\cdot K)]$
Water	4186
Ice	2090
Steam	2010
Air	1004
Aluminum	900
Glass	837
Iron (steel)	448
Copper	387
Silver	234
Gold	129
Lead	128

TABLE 17–4 Latent Heats for Various Materials

Material	Latent heat of fusion, L_f(J/kg)	Latent heat of vaporization, L_v(J/kg)
Water	33.5×10^4	22.6×10^5
Ammonia	33.2×10^4	13.7×10^5
Copper	20.7×10^4	47.3×10^5
Benzene	12.6×10^4	3.94×10^5
Ethyl alcohol	10.8×10^4	8.55×10^5
Gold	6.28×10^4	17.2×10^5
Nitrogen	2.57×10^4	2.00×10^5
Lead	2.32×10^4	8.59×10^5
Oxygen	1.39×10^4	2.13×10^5