Sections in OpenStax Physics that may be covered in the Finals:

(a) **7.1 to 7.6** (7.7 to 7.9 will not be on the Final)
(b) **8.1 to 8.5** (8.6 to 8.7 will not be on the Final)
(c) **10.4 to 10.5** (10.1 to 10.3 and 10.6 to 10.7 will not be on the Final)
(d) **11.1 to 11.5 and 11.7** (11.6 and 11.8 to 11.9 will not be on the Final)
(e) **13.1 to 13.4** (13.5 to 13.6 will not be on the Final)
(f) **14.1 to 14.3** (14.4 to 14.7 will not be on the Final)
(g) **15.1 to 15.4** (15.5 to 15.7 will not be on the Final, entropy will not be on the final)

Equations you can use for the Final

It is ok to write/print-out your own equation sheet or use this

(a) $v_t = \omega r$

(b) $a_t = \alpha r$

(c) Conversion factor: 2π radians=1 rev=360° (rev=revolutions)

(d) $W = Fx\cos\theta$

(e) $\Delta U = -W$

(f) $K_E = \frac{1}{2}mv^2$

(g) $U_g = mgh$

(h) Hooke's Law: $F = -kx$

(i) $U_s = \frac{1}{2}kx^2$

(j) $\vec{\boldsymbol{p}} = m\vec{\boldsymbol{v}}$

(k) $R_{CM} = \dfrac{\sum_{i=1}^{N} m_i r_i}{M_{Total}} = \dfrac{m_1 r_1 + m_2 r_2 + \cdots + m_N r_N}{m_1 + m_2 + \cdots + m_N}$

(l) $I = \sum m_i r_i^2$ (for a ***point*** particle)

(m) $K_E = \frac{1}{2} I_z \omega^2 = \frac{1}{2} I_{CM} \omega^2 + \frac{1}{2} M v_{CM}^2$

(n) $L = I\omega$

(o) Conservation of angular momentum: $\vec{\boldsymbol{L}}_{Total}^{initial} = \vec{\boldsymbol{L}}_{Total}^{final}$

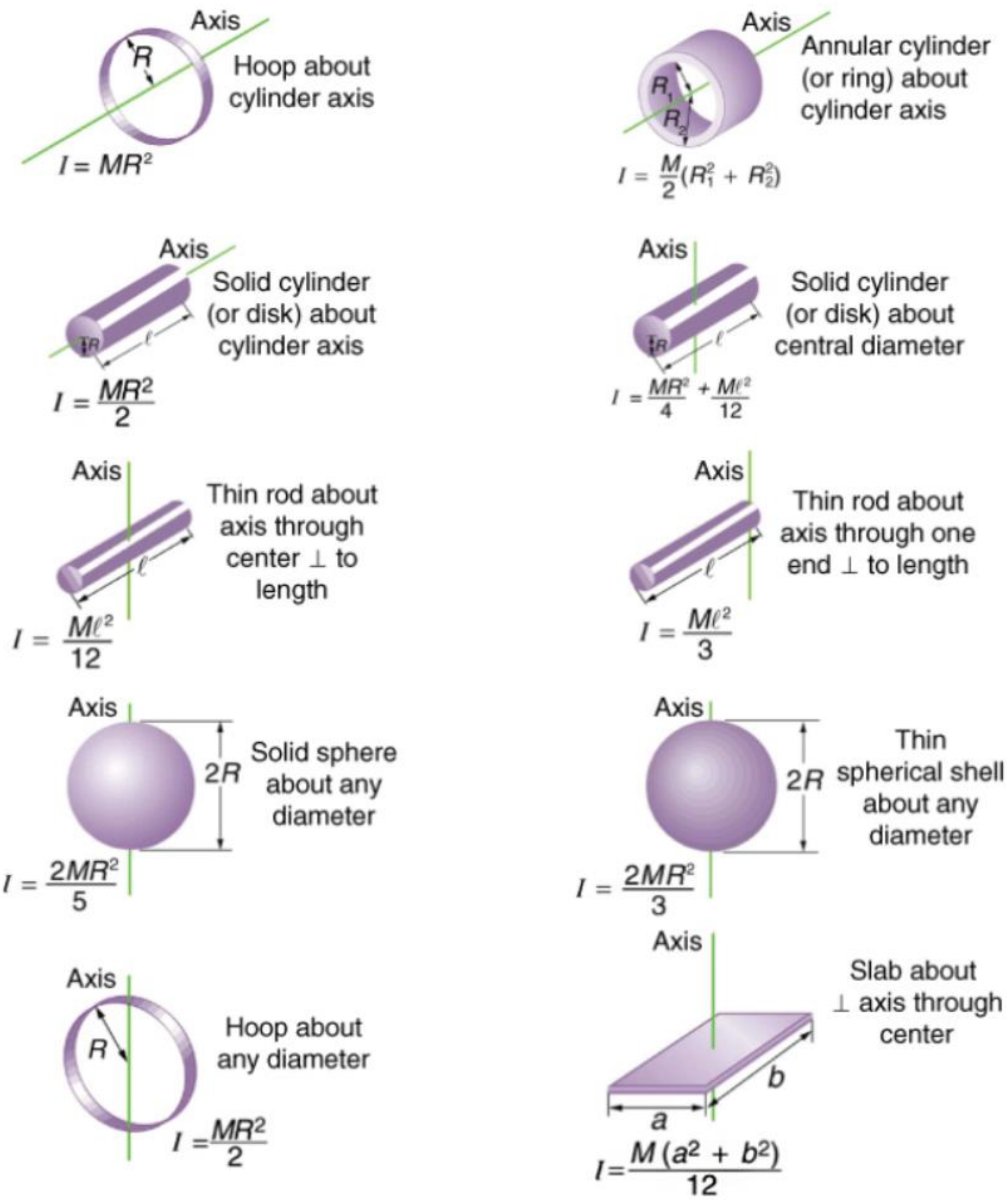

Figure 10.12 Some rotational inertias.

(p) $\rho = \frac{m}{V}$

(q) $P = \frac{F}{A}$

(r) $P_{bottom} = P_{Top} + \rho g d$

(s) $F_{buoyant} = \rho g V$

(t) Density of water = 1000 kg/m^3

(u) $°C = \frac{5}{9}(°F - 32)$; $°K = °C + 273.15$

(v) $\frac{\Delta L}{L_0} = \alpha \Delta T$

(w) $\frac{\Delta V}{V_0} = \beta \Delta T$

Table 10.1 Average Coefficients of Expansion for Some Materials Near Room Temperature

Material	Average Coefficient of Linear Expansion $[(°C)^{-1}]$	Material	Average Coefficient of Volume Expansion $[(°C)^{-1}]$
Aluminum	24×10^{-6}	Acetone	1.5×10^{-4}
Brass and bronze	19×10^{-6}	Benzene	1.24×10^{-4}
Concrete	12×10^{-6}	Ethyl alcohol	1.12×10^{-4}
Copper	17×10^{-6}	Gasoline	9.6×10^{-4}
Glass (ordinary)	9×10^{-6}	Glycerin	4.85×10^{-4}
Glass (Pyrex)	3.2×10^{-6}	Mercury	1.82×10^{-4}
Invar (Ni–Fe alloy)	0.9×10^{-6}	Turpentine	9.0×10^{-4}
Lead	29×10^{-6}	Air[a] at 0°C	3.67×10^{-3}
Steel	11×10^{-6}	Helium	3.665×10^{-3}

[a] Gases do not have a specific value for the volume expansion coefficient because the amount of expansion depends on the type of process through which the gas is taken. The values given here assume the gas undergoes an expansion at constant pressure.

(x) $PV = Nk_B T = nRT$

(y) $Q = mc\Delta T$

(z) melting: $Q = m\ell_F$

(aa) vaporization: $Q = m\ell_V$

Table 11.1 Specific Heats of Some Materials at Atmospheric Pressure

Substance	J/kg · °C	cal/g · °C
Aluminum	900	0.215
Beryllium	1 820	0.436
Cadmium	230	0.055
Copper	387	0.092 4
Ethyl alcohol	2 430	0.581
Germanium	322	0.077
Glass	837	0.200
Gold	129	0.030 8
Human tissue	3 470	0.829
Ice	2 090	0.500
Iron	448	0.107
Lead	128	0.030 5
Mercury	138	0.033
Silicon	703	0.168
Silver	234	0.056
Steam	2 010	0.480
Tin	227	0.054 2
Water	4 186	1.00

TABLE 20.2 Latent Heats of Fusion and Vaporization

Substance	Melting Point (°C)	Latent Heat of Fusion (J/kg)	Boiling Point (°C)	Latent Heat of Vaporization (J/kg)
Helium	−269.65	5.23×10^3	−268.93	2.09×10^4
Nitrogen	−209.97	2.55×10^4	−195.81	2.01×10^5
Oxygen	−218.79	1.38×10^4	−182.97	2.13×10^5
Ethyl alcohol	−114	1.04×10^5	78	8.54×10^5
Water	0.00	3.33×10^5	100.00	2.26×10^6
Sulfur	119	3.81×10^4	444.60	3.26×10^5
Lead	327.3	2.45×10^4	1 750	8.70×10^5
Aluminum	660	3.97×10^5	2 450	1.14×10^7
Silver	960.80	8.82×10^4	2 193	2.33×10^6
Gold	1 063.00	6.44×10^4	2 660	1.58×10^6
Copper	1 083	1.34×10^5	1 187	5.06×10^6

(bb) $U = \frac{3}{2} N k_B T = \frac{3}{2} nRT$

(cc) $C_V = \frac{3}{2} R$ and $C_P = \frac{5}{2} R$ (monatomic gas)

Table 12.2 The First Law and Thermodynamic Processes (Ideal Gases)

Process	ΔU	Q	W
Isobaric	$nC_v \Delta T$	$nC_p \Delta T$	$-P\Delta V$
Adiabatic	$nC_v \Delta T$	0	ΔU
Isovolumetric	$nC_v \Delta T$	ΔU	0
Isothermal	0	$-W$	$-nRT \ln\left(\frac{V_f}{V_i}\right)$
General	$nC_v \Delta T$	$\Delta U - W$	(PV Area)

(dd) $\Delta U = Q + W$ where W = work done on the system (on the gas)

(ee) $W = -P\Delta V$ (for work done on the system) (on the gas)

(ff) $e = \frac{W}{Q_{in}} = 1 - \frac{Q_{out}}{Q_{in}}$

(gg) $e = 1 - \frac{T_C}{T_H}$

(hh) Avogadro's number $= N_A = 6.022 \times 10^{-23}$ / mole

(ii) Boltzmann constant $= k_B = 1.38 \times 10^{-23}$ J/°K

(jj) Universal gas constant $= R = 8.31$ J/(°K · mole)

(kk) 1000 liter $= 1\,\text{m}^3$

(ll) 1 atm $= 1.013 \times 10^5$ Pa

Midterm Exam Equations

(a) $a_x = constant$

(b) $v_x = v_{x0} + a_x t$

(c) $x = x_0 + v_{x0} t + \frac{1}{2} a_x t^2$

(d) $x = x_0 + \dfrac{v_x^2 - v_{x0}^2}{2a_x}$

(e) For motion under gravity: $a_y = -g$

(e) $g = 9.8$ m/sec^2

(f) $\vec{\boldsymbol{F}} = m\vec{\boldsymbol{a}}$

(g) $W = mg$

(h) $N = normal\,force \quad , \quad T = tension$
$f_k = \mu_k N = kinetic\,friction$
$f_s \leq \mu_s N = static\,friction$

(i) $s = r\theta$

(j) $v_t = \omega r$

(k) $a_t = \alpha r$

(l) $a_r = -\omega^2 r = -\dfrac{v_t^2}{r}$

(m) $\omega = \omega_0 + \alpha t$

(n) $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$

(o) $\theta = \theta_0 + \dfrac{\omega^2 - \omega_0^2}{2\alpha}$

(p) $F_{Total,r} = -m\dfrac{v_t^2}{r}$
$F_{Total,\theta} = mr\alpha$

(q) $I = \sum m_i r_i^2$

(r) $\tau_{Total} = \pm r_\perp F = \pm r F_\perp = I\alpha$

(s) Conversion factor: 2π radians=1 rev=360° (rev=revolutions)