1. Forces:

$\Sigma \vec{F} = m\vec{a}$

$\Sigma F_x = ma_x$
$\Sigma F_y = ma_y$

$F = mg$

$f_{s\,max} = \mu_s n$

$f_k = \mu_k n$

$F = -k\Delta x$

2. Rotational Dynamics:

$L = I\omega$
$K_{rot} = {}^1\!/_2\, I\omega^2$

$\tau = r_\perp F = rF_\perp = rF\sin\phi$

$\sum \tau = I\alpha = \Delta L/\Delta t$

3. Rotational Inertia:

$I = \sum_i m_i R_i^2$

solid cylinder:	$I_{CM} = \frac{1}{2}MR^2$
hoop:	$I_{CM} = MR^2$
solid sphere:	$I_{CM} = \frac{2}{5}MR^2$
hollow sphere:	$I_{CM} = \frac{2}{3}MR^2$
rod ($\perp$ to length):	$I_{CM} = \frac{1}{12}ML^2$
rod (through end):	$I_{END} = \frac{1}{3}ML^2$

4. Impulse & Momentum:

$\left(\Sigma \bar{\vec{\mathbf{F}}}\right)\Delta t = m\vec{\mathbf{v}}_f - m\vec{\mathbf{v}}_i$

$m_1\vec{\mathbf{v}}_{f1} + m_2\vec{\mathbf{v}}_{f2} = m_1\vec{\mathbf{v}}_{i1} + m_2\vec{\mathbf{v}}_{i2}$

$v_{cm} = \frac{m_1v_1 + m_2v_2}{m_1+m_2}$

$v_{f1} = \frac{m_1 - m_2}{m_1+m_2}v_{i1}, \quad v_{f2} = \frac{2m_1}{m_1+m_2}v_{i1}$

5. Work; Energy; Power:

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

$K = {}^1\!/_2\, mv^2$

$U_g = mgy$

Linear ($F = -kx$) spring:
$U_s = {}^1\!/_2\, kx^2$

$E = K + U_g + U_s + E_{th} + E_{chem} + ...$

$\Delta E = \Delta K + \Delta U_g + \Delta U_s + \Delta E_{th} + \Delta E_{chem} + ... = W$

$P = \Delta E/\Delta t = W/\Delta t = Fv$

6. Using Energy:

$e = \frac{\text{What you get}}{\text{What you have to pay}} = COP$

1^{st} Law of Thermodynamics:
$\Delta E_{th} = Q + W$

2^{nd} Law of Thermodynamics:
The entropy of an isolated system always increases

$e_{max} = 1 - \frac{T_C}{T_H}$

$COP_{max,cooling} = \frac{T_C}{T_H - T_C}$

$COP_{max,heating} = \frac{T_H}{T_H - T_C}$

7. Heat & Temperature

Temperature Scales:
$T_C = {}^5\!/_9\,(T_F - 32.0)$
$T_F = {}^9\!/_5\,T_C + 32.0$
$T_K = T_C + 273.15$

Heat Capacity: $Q = Mc\Delta T$

Latent Heat of Transformation:
$Q = \pm ML_f$ or $Q = \pm ML_v$

Molar specific Heat (of an ideal Gas):
$Q = nC_V\Delta T$ or $Q = nC_P\Delta T$

8. Ideal Gases & Kinetic Theory

Mole, Mass, Avogadro's Number:
$n = N/N_A$
$n = m/(\text{mass per mole})$
$m_{particle} = (\text{mass per mole})/N_A$

Ideal Gas Law:
$pV = nRT = Nk_BT$

Kinetic Theory of Gases:
$K_{avg} = \frac{1}{2}mv_{rms}^2 = \frac{3}{2}k_BT$
$v_{rms} = \sqrt{\frac{3k_BT}{m}}$
$E_{th} = \frac{3}{2}nRT$

9. Constants:

$N_A = 6.02 \times 10^{23}$

$R = 8.31 \;\; J/(mol \cdot K)$

$k_B = R/N_A = 1.38 \times 10^{-23} \;\; J/K$

$g = 9.80 \; m/s^2$