Physics 302K Formula Sheet

Ch.1: sin=opposite/hypotenuse, cos=adjacent/hypotenuse, tan=opposite/adjacent

Ch.2: one dimensional motion
velocity $v = \frac{\Delta x}{\Delta t}$, acceleration $a = \frac{\Delta v}{\Delta t}$
kinematic equation 1 $\rightarrow$ $v = v_0 + at$
kinematic equation 2 $\rightarrow$ $v^2 = v_0^2 + 2a\Delta x$
kinematic equation 3 $\rightarrow$ $\Delta x = v_0 t + \frac{1}{2}at^2$

Ch.3: projectile motion
kinematic equation 1 $\rightarrow$ $\Delta x = v_{x0}t$
kinematic equation 2 $\rightarrow$ $v_y = v_{y0} - gt$
kinematic equation 3 $\rightarrow$ $v_y^2 = v_{y0}^2 - 2g\Delta y$
kinematic equation 4 $\rightarrow$ $\Delta y = v_{y0}t - \frac{1}{2}gt^2$

Ch.4: laws of motion
Force $F = ma$, Weight $W = mg$
equilibrium conditions $\rightarrow$ $\Sigma F_x=0$, $\Sigma F_y=0$
non-equilibrium conditions $\rightarrow$ $\Sigma F_x=ma_x$, $\Sigma F_y=ma_y$
static friction force $f_s \leq \mu_s n$, kinetic friction force $f_k = \mu_k n$

Ch.5: work and energy
work: $W = F \cos\theta \, \Delta x$, work $\theta=0$: $W = F \, \Delta x$
potential energy: $PE = mgy$
elastic potential energy stored in a spring: $PE_s = \frac{1}{2}kx^2$
kinetic energy: $KE = \frac{1}{2}mv^2$
work energy theorem: $W_{net} = KE_f - KE_i$
energy conservation: $KE_i + PE_i = KE_f + PE_f$
non-conservative work: $W_{nc} = (KE_f + PE_f) - (KE_i + PE_i)$
power: $P = \frac{E}{t} = Fv$

Ch.6: momentum conservation and collisions
momentum: $p = mv$, impulse $= F \, \Delta t$
impulse-momentum theorem: $F \, \Delta t = \Delta p = mv_f - mv_i$
conservation of momentum in collisions: $\Sigma(mv)_{initial} = \Sigma(mv)_{final}$

Ch.7: rotational motion
rotational equation 1: $\omega = \omega_0 + \alpha t$
rotational equation 2: $\Delta\Theta = \omega_0 t + \frac{1}{2}\alpha t^2$
rotational equation 3: $\omega^2 = \omega_0^2 + 2\,\alpha\Delta\Theta$
tangential velocity: $v_t = \omega\, r$
tangential acceleration: $a_t = \alpha\, r$
centripetal acceleration: $a_c = \frac{v^2}{r} = \omega^2\, r$
total linear acceleration: $a = \sqrt{(a_r^2 + a_t^2)}$
centripetal force: $F_c = m\,\frac{v^2}{r}$

Ch.8: rotational equilibrium and dynamics
rotational kinetic energy: $KE_r = \frac{1}{2}I\,\omega^2$
moment of inertia: $I = \Sigma\, m_i r_i^2$
torque: $\tau = Fd$ ($d=r \sin\theta$), torque: $\tau = I\,\alpha$
equilibrium conditions $\rightarrow$ $\Sigma F_x=0$, $\Sigma F_y=0$, $\Sigma \tau=0$
angular momentum: $L = I\,\omega$
angular momentum conservation: $I_i\omega_i = I_f\omega_f$

Ch.9: solids and liquids
tensile strain and shear strain: $\frac{F}{A}$ = Y $\frac{\Delta L}{L_0}$, $\frac{F}{A}$ = S $\frac{\Delta x}{h}$
density: $\rho = \frac{m}{V}$, pressure: P = $\frac{F}{A}$
buoyant force: B = ρ_f V_f g
pressure variation with depth : P = P_0 + ρ g h
pressure variation with velocity : P = P_0 + $\frac{1}{2}$ ρ v^2
Bernoulli's equation: P + ρ g y + $\frac{1}{2}$ ρ v^2 = constant
fluid in motion: A_1 v_1 = A_2 v_2

Ch.10: thermal physics
Celsius to Fahrenheit conversion: T_F = $\frac{9}{5}T_C$ + 32
thermal expansion: $\Delta L = \alpha\ L_0\ \Delta$T
$PV = nRT$ (ideal gas law)

Ch.11: heat
heat energy: Q = m c ΔT (c = specific heat)
latent heat: Q = ± m L (L = latent heat)
calorimetry: $Q_{cold} = -Q_{hot}$

Ch.12: laws of thermodynamics
change in internal energy: ΔU = Q + W
work done on a gas in isobaric process: W = -P ΔV
thermal efficiency of heat engine: e = $\frac{W}{Q_h}$ = 1 - $\frac{Q_c}{Q_h}$
thermal efficiency of Carnot engine: e_c = 1 - $\frac{T_c}{T_h}$
entropy: Δ S = $\frac{\Delta Q}{T}$

Ch.13: vibrations and waves
spring force: F_s = -kx
elastic potential energy: PE_s = $\frac{1}{2}$ k x^2
velocity as a function of position: v = ± $\sqrt{(\frac{k}{m}(A^2 - x^2))}$
period: T = $2\pi/\omega$
angular frequency: ω = 2πf, ω= $\sqrt{\frac{k}{m}}$
position in simple harmonic motion: x = A cos(ωt)
velocity in simple harmonic motion: v = -A ω sin(ωt)
pendulum period: T = 2 π $\sqrt{\frac{L}{g}}$
wave velocity: v = f λ

Ch.14: sound
speed of sound: v = 331 $\sqrt{1 + \frac{T}{273}}$
doppler effect: f_{ob} = f_s $\frac{v+v_{ob}}{v-v_s}$
intensity: I = $\frac{power}{area}$ = $\frac{P}{A}$
intensity level: β = 10 log ($\frac{I}{I_0}$), $I_0 = 1.0 \times 10^{-12} W/m^2$

conversion factors and constants:
gravitational acceleration a = -g = -9.8 [m/s^2]
1 atm = 1.013*10^5 Pa
0 degree Celsius = 273 K
gas constant R = 8.31451 [J/mol K]
volume of a sphere V = $\frac{4}{3}$ πr^3
1 gallon = 3.786 l = 0.003786 m^3
1 rot = 1 rev = 6.28 rad = 360 degrees
1 rpm = 1 rotation per minute
density of water = 1000 kg/m^3