Physics 131 Spring 2006 -- Equations you should know for the final exam
Chapters 14, 15, 17, 18, 19, and 20

Wave velocity v – string tension is F	$v = \sqrt{F/\mu}$ (μ is mass/length)
Wave length λ, wave-vector k	$k = 2\pi/\lambda$
Frequency f, angular frequency ω,period T	$\omega = 2\pi f = 2\pi/T$ **and** $v = \lambda f$
Standing wave – separate factors for x and t	$y(x,t) = A\ sin(kx)\sin(\omega t)$
Traveling wave – sign determines direction	$y(x,t) = A\sin(kx \pm \omega t)$ - for left, + for right
Normal modes – string fixed at both ends (0,L)	$\lambda_n = 2L/n$ n^{th} harmonic has $n-1$ nodes
Fluids – buoyant force – density ρ	$F_B = W$ (weight of displaced fluid)$=\rho V$
Pressure = F/A; p *vs* depth – if y increases	Upward, then $p=p_0-\rho g y$
Bernouilli equation – fluid in laminar flow	Av = constant; $p + \rho g y + ½\rho v^2$ = constant
Work $W = \int p dV$	
Heat, work ,energy W = work done **by** system	$\Delta U = Q - W$ **1st Law** Q = heat added **to** system
Specific heat capacity $Q = mc\Delta T$	c in joules/kg degree K or C
Molar heat capacity $Q = nC\Delta T$	C in Joules/mole degree K or C
Heat at constant p = heat at constant $V + W$	$C_p = C_V + R$ (ideal gases)
Ideal gas law $pV = nRT = Nk_BT$	T in Kelvin = T in Celsius + 273.15
$N/n = N_A$ (Avogadro's number = # molecules	per mole) $n = m$ (in g)/M (in amu) = # moles in a sample of mass m; M is "atomic" mass
Water: $\rho = 10^3$ kg/m^3 $T_{freeze} = 0^oC$=273.15K	$T_{boil} = 100^oC$ = 373.15K
heat flow $H = dQ/dt = kA\Delta T/L$ k = thermal	conductivity (W/mK) (A,L) = (area,thickness)
Rate of radiative heat transfer (medium 1 to 2)	$H = dQ/dt = e\sigma A(T_1^4-T_2^4)$ (σ in W/m^{2}K^4)
Thermal expansion $\Delta L = \alpha L_0\Delta T$ $\Delta V=\beta V_0\Delta T$	Heat of fusion, vaporization: $Q = mL$
Molecular model of gas $\overline{KE}_{trans} = \frac{3}{2}Nk_BT$	Diatomic molecules also have rotational KE $\overline{KE_{trans} + KE_{rot}} = \frac{5}{2}Nk_BT$ (neglect vibrational)
Molar specific heat $C_V = \frac{3}{2}Nk_B = \frac{3}{2}nR$ (monatomic as in He, Ne) $\gamma = C_p/C_v = 5/3$	$C_V = \frac{5}{2}Nk_B = \frac{5}{2}nR$ (diatomic as in O_2, N_2) $\gamma = C_p/C_v = 7/5$
Adiabatic process means **no heat.** Ideal gas	pV^γ = constant
Second ideal gas law: $\Delta U = nC_V\Delta T$	$U=U(T$ **only**$)$
Cyclic process W = area in p-V plane = $Q_{in}-Q_{out}$	Efficiency of heat engine $e = W/Q_{in}=1-Q_{in}/Q_{out}$
Carnot cycle – heat in at T_h, heat out at T_c	No heat (adiabats) in between
2nd Law all heat engines reject heat Q_c	**Or** heat never flows from T_c to T_h
Or no heat engine is more efficient than Carnot	**Carnot** efficiency = $1 - Q_c/Q_h = 1 - T_c/T_h$
Or entropy S depends on state, not path	$dS = dQ/T$ $S = \int dQ/T$ (reversible process)