PHYS 111-01 STARTING EQUATIONS - WAVES, SOUND, THERMAL PHYSICS

The equations given below may be used as starting points for solving problems on the final.

WAVES AND SOUND

Waves:

$v_W = \lambda f$ $\quad f = (1/T) = \omega/2\pi$

$v_W = \sqrt{\dfrac{F}{m/L}}$ (stretched string)

Sound:

$f_n = (n/2L)v$ normal modes - stretched string or open tube

$f_n = (n/4L)v$ normal modes - tube with only one end open

$I = P/A$ $\quad I(r) = P/4\pi r^2$ (spherical sound wave)

Doppler Shift – Easy versions

$f' = f[v_W/(v_W \mp u_S)]$ moving source $\quad f' = f[(v_W \pm u_0)/v_W]$ moving observer (Top signs, approaching)

Doppler Shift – Textbook versions

$f' = \left(1 \pm \dfrac{u_o}{v_w}\right) f$ Moving Observer $\qquad f' = \left(\dfrac{1}{1 \mp \dfrac{u_s}{v_w}}\right) f$ Moving Source (Top signs, approaching)

TEMPERATURE AND HEAT

$\Delta L = \alpha L_0 \Delta T$ $\quad \Delta V = \beta V_0 \Delta T$ $\quad Q = mc\Delta T$ $\quad Q = mL$

Ideal Gas

$PV = NkT = nRT$ $\quad U = (3/2)\,NkT = (3/2)nRT$ Monatomic Ideal Gas

Thermodynamics, Thermal Conduction, Thermal Radiation:

$Q = kAt(\Delta T/L)$ $\quad P = eA\sigma T^4$

$\Delta U = Q_{in} - W_{by}$ $\quad W = P\Delta V$ $\quad \Delta S = Q/T$ $\quad \Delta S_{universe} \geq 0$

Heat Engines

$e = W/Q_h$ $\quad e_{max} = 1 - (T_C/T_h)$

QUANTITY	SYMBOL	UNIT OR VALUE	COMMENTS
Period	T	s	
Frequency	f	Hz	Hz = sec^{-1}
Wavelength	λ	m	
Wave velocity	v or v_W	m/s	v_W = 343 m/s, sound in 20°C air
Intensity	I	W/m^2	
Temperature	T	K or °C	
Linear expansion coefficient	α	K^{-1} or $°C^{-1}$	
Volume expansion coefficient	β	K^{-1} or $°C^{-1}$	
Specific Heat	c	J/(kg-K) or J/(kg-°C)	
Heat	Q	J	
Latent Heat	L	J/kg	
Thermal Conductivity	k	J/(s-m-C°)	
Stefan-Boltzmann Constant	σ	5.67×10^{-8} $W/(m^2\text{-}K^4)$	
Boltzmann Constant	k	1.38×10^{-23} J/K	
Gas Constant	R	8.31 J/(mol-K)	
Number of moles	n		
Entropy	S	J/K	
Internal Energy	U	J	