Physics 32

Gravity & Kepler's Laws:

$$F_g = G\frac{M_a M_b}{r^2}, \qquad U_g = -G\frac{M_a M_b}{r}$$

$G = 6.67x10^{-11}$

First Law: Elliptical orbits
Second Law: Equal areas swept over equal times (conservation of angular momentum)
Third Law: Law of Periods: $T^2 \propto R^3$

Oscillations:

$$F_k = -kX \qquad U_k = \frac{1}{2}kx^2$$

$$x(t) = x_{max}\cos(\omega t + \Phi)$$

$$\frac{\mathrm{d}^2x}{\mathrm{d}t^2} = -\omega^2 x \qquad T = \frac{2\pi}{\omega_0}$$

Spring: $T = 2\pi\sqrt{\frac{m}{k}}$

Pendulum: $T = 2\pi\sqrt{\frac{\ell}{g}}$

$$x_{damped}(t) = x_{max}e^{-bt/2m}\cos(\omega' + \Phi)$$

$$\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$$

Fluid Dynamics:

Pascal's Principle: $\Delta P = \frac{F}{A}, \quad \frac{F_1}{A_1} = \frac{F_2}{A_2}$

$$P_2 - P_1 = \rho g(h_2 - h_1) \Rightarrow dP = \rho g dh$$

$$F_{buoyant} = m_{fluid}g = \rho_{fluid}V_{displaced}g$$

Continuity Eq: $A_1V_1 = A_2V_2 = \frac{Vol}{t}$

Bernoulli's Eq: $P + \rho gh + \frac{1}{2}\rho V^2 = Const$

Waves:

$$v = \lambda f, \quad T = \frac{1}{f}, \quad \omega = \frac{2\pi}{T}, \quad k = \frac{2\pi}{\lambda}$$

$$V = \frac{\lambda}{T} = \lambda f = \boxed{\frac{\omega}{k}} \quad Secret\ Equation!$$

$$v_{string} = \sqrt{\frac{F_T}{\mu}}, \quad F_T = Tension, \quad \mu = \frac{m}{\ell}$$

$$v_{fluid} = \sqrt{\frac{Bs}{\rho}}, \quad v_{solid} = \sqrt{\frac{E}{\rho}}$$

E/B = Elastic/Bulk Moduli.

$$E_{wave} = 2\pi^2 f^2 \rho(vtArea){x_{max}}^2$$

$$I_{intensity} = \frac{Power}{Area}$$

$$y_{traveling}(x,t) = y_{max}\sin(kx \mp \omega t)$$

(Minus for +x, plus for -x propagation)

Wave Equation: $\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\left(\frac{\partial^2 y}{\partial t^2}\right)$

Sound:

$$f_{beat} = |f_1 - f_2|$$

$$\beta = 10\log\left(\frac{I}{I_0}\right), \qquad I_0 = 10^{-12}\frac{w}{m^2}$$

$$\boxed{\beta = 20\log\left(\frac{y_{max}}{I_0}\right)} \quad Secret\ Equation!$$

$$f_{observer} = f_{source}\left(\frac{v_{sound} \pm v_{obs}}{v_{sound} \mp v_{source}}\right)$$

$$Pick \quad +v_{obs} = Towards, \quad -v_{obs} = Away$$

Light and Optics:

$$Reflection: \quad \theta_i = \theta_f$$

$$Refraction\,(Snell's): \; n_0\sin\theta_0 = n_f\sin\theta_f$$

Double Slit: $d\sin\theta = m\lambda$

$$m_{bright} = 1, 2, 3..., \quad m_{dark} = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}...$$

$$(Use\ small\ angle\ approx: \quad \tan\theta = \frac{y}{D})$$

$$2d = (m + \frac{1}{2})\lambda' + (m + \frac{1}{2})\frac{\lambda}{n'}$$