Summary of critical formulas and important facts

Physics 298 – Test 3

Density, Pressure and Buoyancy

- Density:

$$\rho = m/V$$

- Pressure:

$$P = F/A$$

- Pressure due to depth h, of fluid:

$$P = P_{atm} + h\rho g$$

- Archimedes Principle:

F_B = weight of fluid displaced

Oscillations and SHM

- Hooke's Law (SHM):

$$F_R = -kx$$

- Displacement:

$$x = A\cos(\omega t + \phi) \qquad where \qquad \omega = \sqrt{k/m}$$

- Period:

$$T = 1/f = 2\pi/\omega$$

- Energy:

$$PE = \tfrac{1}{2}kx^2 \qquad KE = \tfrac{1}{2}mv^2$$

$$E_{Total} = \tfrac{1}{2}kA^2 = \tfrac{1}{2}mv_{\max}^2 = \tfrac{1}{2}kx^2 + \tfrac{1}{2}mv^2$$

- Simple pendulum:

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

- Damping, forced oscillations and resonance
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Traveling Waves

- Displacement

$$y(x,t) = A\sin(kx - \omega t)$$

- Wave number and angular frequency

$$k = \frac{2\pi}{\lambda} \qquad\qquad \omega = 2\pi f$$

- Wave velocity

$$v = f\lambda = \omega/k$$

- Stretched string velocity

$$v = \sqrt{\frac{T}{m/L}}$$

Standing Waves

- Superposition and interference, definition and application
- Displacement

$$y(x,t) = A\sin kx \sin \omega t$$

- Frequencies allowed, string fixed at both ends or closed pipe (n integer)

$$f = \frac{v}{2L}n$$

- Definition of nodes and antinodes
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Beats

- Interference in time, beat frequency

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

Doppler Effect

- Observed frequency

$$f' = f\frac{(v \pm v_o)}{(v \pm v_s)}$$

Temperature and Thermal Expansion

- Temperature scales

$$T_F = 32 + \tfrac{9}{5} T_C \qquad\qquad T_K = T_C + 273$$

- Thermal expansion

$$\Delta L = L_0 \alpha \Delta T$$

$$\Delta V = V_0 \beta \Delta T \qquad (\beta = 3\alpha)$$

Heat

- Calorimetry, method of mixtures, specific heat, heat capacity
- Quantity of heat

$$Q = mc\Delta T$$

- Change of phase, latent heats of fusion and vapourisation

$$Q = mL_F \qquad\qquad Q = mL_V$$

- Heat conduction (steady state)

$$\frac{dQ}{dt} = kA\frac{(T_H - T_C)}{L}$$

First Law of Thermodynamics

- Q positive for heat entering, W work done ***by*** gas

$$\Delta U = Q - W$$

$$\Delta U = 0 \quad \textit{closed cycle}$$

- Work done during gas expansion/compression

$$W = \int p\,dV$$

Second Law of Thermodynamics

- Heat engines and refrigerators

- Efficiency of heat engine

$$e = W / Q_H$$

- Coefficient of performance of refrigerator

$$\kappa = \frac{Q_C}{W}$$

- Kelvin and Clausius statements of 2nd law

- Carnot cycle and reversible processes (T in degrees Kelvin)

$$\frac{Q_H}{Q_C} = \frac{T_H}{T_C}$$

- Entropy

$$dS = \frac{dQ}{T}$$

- In all processes the net entropy of the Universe increases or remains unchanged. When there is no entropy change the process is reversible