

PHY 1122 Exam Formula Sheet

Fluid Dynamics

Buoyancy: $B = m_{fluid} \cdot g = \rho_{fluid} \cdot V \cdot g$

Continuity: $A_1 \cdot V_1 = A_2 \cdot V_2$

Bernoulli's: $P_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2$

$P = P_o + \rho g h$; $P + \rho g y_1 = P_o + \rho g y_2$; $P - P_o = \rho g (y_2 - y_1)$

Constant T & n; **Boyle's law:** $P \propto \frac{1}{V}$ $P_1 \cdot V_1 = P_2 \cdot V_2$

Constant V & n; **Amontons's law:** $P \propto T$ $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Constant P & n; **Charles's law:** $V \propto T$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Constant T & P; **Avogadro's law:** $V \propto n$ $\frac{V_1}{n_1} = \frac{V_2}{n_2}$ **Avogadro** $A_N = 6.0221 \times 10^{23} \text{ atoms/mol}$

Thermodynamics

Root mean speed: $v_{rms} = \sqrt{\frac{3KT}{m}}$; $\sqrt{\frac{v_1^2 + v_2^2 + \dots + v_n^2}{n}} = \sqrt{v_{av}}$;

Average speed: $v_{av} = \frac{1}{n} \cdot (v_1 + v_2 + \dots + v_n)$ $T_F = \frac{9}{5} T_C + 32^\circ$ $T_C = \frac{5}{9} \zeta$

Linear expansion: $\Delta L = \alpha \cdot L_o \cdot \Delta T$
 $T_k = T_c + 273.15^\circ$

$\Delta V = \beta \cdot V_o \cdot \Delta T = 3 L^2 \alpha \cdot L_o \cdot dT = \frac{3\alpha}{\beta} \cdot V_o \cdot dT$

Heat: $Q = mc \Delta T = nC \Delta T$ $Q = mL$ $PV = nRT$ $1 \text{ hp} = 0.735499 \text{ kW}$

Conduction: $H = kA \frac{(Th - Tc)}{L}$ $H = A \frac{(Th - Tc)}{R}$ $R = \frac{L}{k}$ $k = \frac{L \cdot H}{A(Th - Tc)}$ **Heat Capacity**

Radiation: $H = Ae\sigma T^4$ e = emissivity $\sigma = \zeta \text{ Stefan's c } \zeta 5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4$ Diatomic gas: $C_V = \frac{5}{2} R$; $C_P = \frac{7}{2} R$

Volumes of Objects

sphere: $V = \frac{4}{3} \pi r^3$

cylinder: $V = \pi r^2 h$

pyramid: $V = \frac{1}{3} l \cdot w \cdot h$

cone: $V = \frac{1}{3} \pi r^2 h$

Constants/Conversions

Ideal Gas $R = 8.314 \frac{\text{J}}{\text{mol} \cdot \text{K}}$

Boltzmann $k = 1.38066 \times 10^{-23} \frac{\text{J}}{\text{molecule} \cdot \text{K}}$

$P_{atm} = 1 \text{ atm} = 1.013 \times 10^5 \text{ Pa}$

$T_c = T_k - 273.15^\circ$

$\rho_{water} = 1000 \text{ kg/m}^3$

Heat Capacity

Vander waals: $\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$

Solid: $C_v = 3R$

$k_{tr} = \frac{3}{2}nRT$ (For moles) $k_{tr} = \frac{1}{2}m v_{av}^2 = \frac{3}{2}kT$ (Per molecule)
 $\gamma = \frac{5}{3}$

Monoatomic gas: $v = \frac{3}{2}R$; $C_p = \frac{5}{2}R$;

Free mean path: $\lambda = v t_{mean} = \frac{V}{4\pi\sqrt{2}r^2N}$ $t_{mean} = \frac{V}{4\pi\sqrt{2}r^2vN}$

Change in momentum: $\Delta p = 2m|\vec{v}_x|$

Number of collisions: $\frac{1}{2}\left(\frac{N}{V}\right)(A \cdot v_x \cdot dt)$; $N = \#$ of particles

Internal energy: $\Delta U = Q - W$ or $Q = \Delta U + W$

Adiabatic -> constant heat; $Q = 0$; $U_2 - U_1 = -W$; $P_1V_1^\gamma = P_2V_2^\gamma$; $TV^{(\gamma-1)} = cst$ $PV^\gamma = cst$

Isochoric -> constant volume; $W = 0$

Isobaric -> constant pressure; $W = p(V_2 - V_1)$ Isothermal -> constant temperature

Engine: $W = |Q_h| - |Q_c|$ Thermal efficiency: $e = \frac{W}{Q_h} = 1 - \frac{T_2}{T_1}$ power: $P = \frac{W}{\Delta t}$ power output:

$W \times cy/s$