PHYS 1020 General Physics 1 - Formula Sheet for Final Exam (December 8, 2006) – Paper #11

Kinematics (for constant acceleration):

$v = v_0 + at$

$x = \frac{1}{2}(v_0 + v)t$

$x = v_0 t + \frac{1}{2} at^2$

$v^2 = v_0^2 + 2ax$

Forces:

Newton's second law: $\sum \vec{F} = m\vec{a}$

First condition for equilibrium: $\sum \vec{F} = 0$

Gravity:

near Earth: $F = mg$

Universal: $F = G\frac{m_1 m_2}{R^2}$

$g = 9.80 \text{ m/s}^2$

Friction:

Static: $0 \le f_s \le \mu_s F_N$ direction is always opposite to motion (or tendency to motion)

Kinetic: $f_K = \mu_K F_N$

Uniform Circular Motion and Gravitation

Period: $T = \frac{2\pi R}{v}$ where v is the speed of the particle and R is the radius of the circle

Frequency: $f = \frac{1}{T}$

$\theta \text{ (in radians)} = \frac{\text{Arc length}}{\text{radius}}$

Centripetal Acceleration: $a_c = \frac{v^2}{R}$

Centripetal Force: $F_c = \frac{mv^2}{R}$ directed towards the centre

Work, Energy, and Power:

Work: $W = (F\cos\theta)\, s$

Kinetic energy: $KE = \frac{1}{2} mv^2$

Potential energy:

Gravitational (near Earth): $PE = mgh$

Work-energy theorem: $W_{nc} = \Delta KE + \Delta PE = E_f - E_i$

Total mechanical energy: $E = KE + PE$

Conservation of mechanical energy: $E = KE + PE = \text{constant}; \; E_f = E_i$

Power (rate of doing work): $\overline{P} = \frac{W}{t}$

Linear Momentum

Impulse: $\overline{F}\Delta t = \Delta p = mv_f - mv_i$

Conservation of Momentum: $\mathbf{p}_i = \mathbf{p}_f$, if no external forces

Torque and Angular Momentum

Torque: $\tau = Fl = Fr\sin\theta$; l = (lever arm) = $r\sin\theta$

Second condition of equilibrium: $\sum \vec{\tau} = 0$

Angular momentum: $L = I\omega$ = conserved, in absence of external torques

Simple Harmonic Motion

Hooke's law: Restoring force = $F = -kx$

Elastic potential energy $= \frac{1}{2}kx^2$

Displacement: $x = A\cos(\omega t)$ (when $x = A$ at $t = 0$)

Velocity: $v = -A\omega\sin(\omega t)$ Acceleration: $a = -A\omega^2\cos(\omega t)$

frequency, period $\omega^2 = \frac{k}{m}$; $f = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$; $T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{k}}$

simple pendulum $T = 2\pi\sqrt{\frac{L}{g}}$

Energy $E = KE + PE = \frac{1}{2}mv^2 + \frac{1}{2}kx^2$

Heat

Linear thermal expansion: $\Delta L = \alpha L_0 \Delta T$

Volume thermal expansion: $\Delta V = \beta V_0 \Delta T$

Amount of heat and temperature change: $Q = Cm\Delta T$

Heat required for change of phase: $Q = mL$

Conduction of heat through a material: $Q = \frac{(kA\Delta T)t}{L}$

$n = \frac{N}{N_A} = \frac{m}{\text{mass per mole}}$ $N_A = 6.022\times10^{23}\ \text{mol}^{-1}$

$PV = nRT = \frac{2}{3}N(\overline{KE})$ $R = 8.314$ J/(mol.K)

$\overline{KE} = \frac{1}{2}mv^2_{rms} = \frac{3}{2}kT$

Fluids

Pressure: P = Force/Area,

Hydrostatic Pressure: $P = \rho gh$

Continuity Equation: $\rho_1 v_1 A_1 = \rho_2 v_2 A_2$

Bernoulli's Equation: $P + \rho gh + \frac{1}{2}\rho v^2 = \text{constant}$