PHYS 1050 Tutorial 4: Formula Sheet

Mathematics

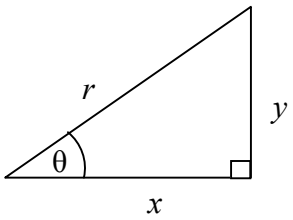
Quadratic equation:

$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Trigonometry:

$$x^2 + y^2 = r^2$$



$$\sin\theta = y/r$$
$$\cos\theta = x/r$$
$$\tan\theta = y/x$$

Calculus:

$$\frac{d}{dt}\left(t^n\right) = nt^{n-1}$$

$$\int x^n\,dx = \frac{x^{n+1}}{n+1}$$

Constants and Units

$k = 10^3$, $\mu = 10^{-6}$, $n = 10^{-9}$

$g = 9.80\ \text{m/s}^2$
$1\ \text{N} = 1\ \text{kg m/s}^2$
$1\ \text{J} = 1\ \text{kg m}^2/\text{s}^2$
$1\ \text{W} = 1\ \text{J/s}$

Particle Dynamics

$$\vec{F} = m\vec{a}$$

$W = mg$ weight

$f_s \le \mu_s F_N$ static friction
$f_k = \mu_k F_N$ kinetic friction

Kinetic energy, Work, and Potential Energy

$K = \frac{1}{2}mv^2$ kinetic energy
$W = \vec{F}\cdot\vec{d} = \vec{F}\cdot\Delta\vec{x}$ work by constant force
$\Delta K = K_f - K_i = W$

$$W = \int_{x_i}^{x_f} F(x)\,dx$$ work by variable force

$W = -mg\Delta y$ work by gravitational force

$F_s = -kx$ spring force (Hooke's Law)
$W_s = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$

$$\Delta U = -W = -\int_{x_i}^{x_f} F(x)\,dx$$ potential energy

$$F(x) = -\frac{dU(x)}{dx}$$

$U(y) = mgy$ gravitational PE

$U(x) = \frac{1}{2}kx^2$ spring PE

$$P = \frac{dW}{dt} = \vec{F}\cdot\vec{v}$$ power supplied by force $\vec{F}$

$E_{\text{mec}} = K + U$ mechanical energy
$\Delta E_{\text{mec}} = \Delta K + \Delta U = W_{\text{NC}}$ work by NC forces

Momentum and Collisions

$$\vec{p} = m\vec{v} \qquad \vec{F} = \frac{d\vec{p}}{dt}$$

$$\Delta\vec{p} = \vec{J} = \int_i^f \vec{F}(t)\,dt = \vec{F}_{avg}\Delta t$$

$$\vec{r}_{\text{com}} = \frac{1}{M}\sum_{i=1}^{n} m_i\vec{r}_i \qquad \vec{P} = \sum_{i=1}^{n}\vec{p}_i = M\vec{v}_{\text{com}}$$

$$\vec{F}_{\text{ext}} = \frac{d\vec{P}}{dt}$$