PC1431 Midterms Cheatsheet v1.0 (2020-10-07)
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1 Position, velocity, & accel of a particle in 1D

1.1 x, v_x, a_x

- $x = x(t)$
- $v_x(t) = \frac{d}{dt}x(t)$
- $a_x(t) = \frac{d}{dt}v_x(t) = \frac{d^2}{dt^2}x(t)$

1.2 A particle at rest at x_0

$x(t) = x_0$, $v_x = 0$, $a_x = 0$

1.3 A particle moving with constant velocity v_{0x}

$x(t) = x_0 + v_{0x}t$, $v_x = v_{0x}$, $a_x = 0$

1.4 A particle moving with constant acceleration a_{0x}

- $x(t) = x_0 + v_{0x}t + \frac{1}{2}a_{0x}t^2$
- $v_x = v_{0x} + a_{0x}t$
- $a_x = a_{0x}$
- Freely-falling, $a_{0y} = -g$, $g = 9.80\ m/s^2$
- $2a_{0x}(x - x_0) = v_x^2 - v_{0x}^2$ AKA $2as = v^2 - u^2$

1.5 Sinusoidal functions of time

- $x(t) = r_0\cos(\theta_0 + \omega_0 t)$ AND $x(0) = r_0\cos\theta_0$
- $v_x = -\omega_0 r_0\sin(\theta_0 + \omega_0 t)$ AND $v_x(0) = -r_0\omega_0\sin\theta_0$
- $a_x = -\omega_0^2 r_0\cos(\theta_0 + \omega_0 t) = \omega_0^2 x(t)$

1.6 Exponential function of time

- $y(t) = y_0 - \frac{g}{\gamma}[1 - \exp(-\gamma t)] + \frac{g}{\gamma^2}[1 - \exp(-\gamma t)]$
- $y(0) = y_0$
- $v_y(t) = -\frac{g}{\gamma} + v_{0y}\exp(-\gamma t) + \frac{g}{\gamma}\exp(-\gamma t)$
- $v_y(0) = v_{0y}$ AND as $t \to \infty$, $v_y \to -\frac{g}{\gamma} = v_{terminal}$
- $a_y(t) = -\gamma v_{0y}\exp(-\gamma t) - g\exp(-\gamma t)$
- $a_y(0) = -\gamma v_{0y} - g$ AND as $t \to \infty$, $a_y \to 0$
- $a_y(t) = -\gamma v_y(t) - g$

1.7 a_x, v_x, x

- $v_x(t) = v_{0x} + \int_0^t a_x(t')dt'$
- $x(t) = x_0 + \int_0^t v_x(t')dt'$

2 Position, velocity, & accel of a particle in 2D

- $x = x(t), y = y(t)$
- $v = \sqrt{v_x^2 + v_y^2}$, $a = \sqrt{a_x^2 + a_y^2}$

2.1 Projectile motion

- $y(t) = -\frac{g}{2v_{0x}^2}(x - x_0) + \frac{v_{0y}}{v_{0x}}(x - x_0) + y_0$