

# Study Guide for Midterm 1

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## 1 Memory Bank

- Unit conversions: 1 km = 1000 m, 1 m = 100 cm, 1 hr = 3600 s, 1 year =  $\pi \times 10^7$  s, 1 g/cm<sup>3</sup> = 1000 kg/m<sup>3</sup>.
- $\vec{x} = a\hat{i} + b\hat{j}$  ... Component form of a two-dimensional vector.
- $|\vec{x}| = \sqrt{a^2 + b^2}$  ... Pythagorean theorem for obtaining vector magnitude.
- $\theta = \tan^{-1}(b/a)$  ... Obtaining the angle between vector and x-axis.
- $a = |\vec{x}| \cos(\theta)$  ... Obtaining the x-component with trigonometry.
- $b = |\vec{x}| \sin(\theta)$  ... Obtaining the y-component with trigonometry.
- $\Delta x = \vec{x}_f - \vec{x}_i$  ... Definition of displacement.
- $\vec{v} = \frac{\Delta \vec{x}}{\Delta t} = \frac{\vec{x}_f - \vec{x}_i}{t_f - t_i}$  ... Definition of velocity.
- $\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{t_f - t_i}$  ... Definition of acceleration.
- $x(t) = x_i + vt$  ... Velocity is the slope of position versus time.
- $x(t) = \frac{1}{2}at^2 + v_it + x_i$  ... With constant acceleration, position is quadratic. If  $a = 0$  this becomes the prior function.
- $v(t) = v_i + at$  ... With constant acceleration, acceleration is the slope of velocity.
- $v^2 = v_i^2 + 2a\Delta x$  ... The kinematic equation without time, assuming constant acceleration.
- $\vec{v}(t) = \frac{d\vec{x}}{dt}$  ... General calculus-based definition of velocity.
- $\vec{a}(t) = \frac{d\vec{v}}{dt}$  ... General calculus-based definition of acceleration.
- General set of 2D kinematic equations, assuming gravity provides constant vertical negative acceleration.

$$\vec{x}(t) = (x_i + v_{x,i}t)\hat{i} \quad (1)$$

$$\vec{y}(t) = (-\frac{1}{2}gt^2 + v_{i,y}t + y_i)\hat{j} \quad (2)$$

$$\vec{v}_y = (v_{i,y} - gt)\hat{j} \quad (3)$$

$$\vec{a} = -g\hat{j} \quad (4)$$

$$T_{tof} = \frac{2v_0 \sin(\theta_0)}{g} \quad (5)$$

$$R = \frac{v_0^2 \sin(\theta_0)}{g} \quad (6)$$

$$v_{x,i} = v_0 \cos(\theta) \quad (7)$$

$$v_{y,i} = v_0 \sin(\theta) \quad (8)$$

## 2 Chapter 1: Estimations and Unit Analysis

1. Nerve fibers are often observed to make nerve signals propagate at a speed of 100 m/s. Estimate the reaction time of a person, if they touch something hot. That is, the signal must travel from their finger touching a hot surface, to the spinal chord, and back to the finger to make it move.
2. A distance of 1 AU is the distance from the Earth to the Sun, and is equal to  $\approx 1.5 \times 10^8$  km. Jupiter is about 5 AU from the Sun. How many kilometers between Jupiter and the Sun?
3. The speed of sound is measured to be 342 m/s on a certain day. What is this measurement in kilometers per hour?
4. A two *liter* bottle of water has a volume of 2000 cm<sup>3</sup>. What is this volume in m<sup>3</sup>? *Should it be a large or small number?*