Study Guide for Midterm 1

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1 Types of Problems on the Midterm

- There are three problems on estimation, approximation, and unit analyis. One of these involves kinematics, and another is multiple choice.
- There are two problems on kinematics with constant acceleration.
- There is one four-part problem on vectors.

2 Estimation, Approximation, and Unit Analysis

Remember our three techniques for establishing estimates:

- Choose the right *scale*. For example, don't work in meters if the distances are between planets. Work in AU or light-minutes.
- Obtain complex quantities from simpler ones. For example, estimate lengths first, and then multiply them to estimate volumes and areas.
- Constrain the unknown with upper and lower limits. For example, the height of a child should not be 10 meters, or 0.1 meters.

3 Displacement, Velocity, and Constant Acceleration Vectors

The definition of average velocity is

$$\bar{v} = \frac{x_f - x_i}{t_f - t_i} = \frac{\Delta x}{\Delta t} \tag{1}$$

If the velocity is constant, the average velocity and the instantaneous velocity are the same. The numerator of Eq. 1 is in general a vector called *the displacement*: $\Delta\vec{x}$, describing the change in position of something. If the velocity is constant, then

$$\Delta\vec{x} = \vec{v}\Delta t \tag{2}$$

If the velocity is not constant, but the acceleration is constant, we have a system of equations relating displacement, time, velocity, and acceleration:

$$x(t) = x_0 + v_0 t + \frac{1}{2}at^2 \tag{3}$$

$$v(t) = v_0 + at \tag{4}$$

$$a(t) = a \tag{5}$$

$$v^2 = v_0^2 + 2a\Delta x \tag{6}$$

4 Vectors

- Practice adding and subtracting vectors.
  1. Graphically
  2. As lists of numbers
- Practice breaking vectors into components: $\hat{x}\cdot\vec{v} = v\cos\theta$, $\hat{y}\cdot\vec{v} = v\sin\theta$ (if θ goes from x-axis to vector).
- Practice taking the magnitude of a vector: $\sqrt{\vec{v}\cdot\vec{v}}$, or Pythagorean theorem.