1. Dimensional Analysis

- There are four basic dimensions:

L	M	T	Q
length	mass	time	charge (don't worry about this one)

Everything can be represented in these dimentions. Ex. speed = meters/sec = L/T

acceleration = meters/sec^2 = L/T^2

Dimensional Analysis can be a huge help when solving MC problems because you can eliminate answers that are dimensionally incorrect.

Additionally the following rules exist:

- You can only add and subtract quantities that are dimensionally the same.
- Can multiply divide dimensions like fractions

Ex. What are the dimensions of

$2\pi\sqrt{\frac{l}{g}}$ where l = length
g = acceleration due to gravity

$$= 2\pi\sqrt{\frac{L}{L/T^2}} = 2\pi\sqrt{T^2} = \underbrace{2\pi}_{\text{constant doesn't change units}} \cdot T = T$$

1. Dimensional Analysis

1. A particle is thrown into the air from ground level height $h = 0$ with upward velocity v. Which of the following gives the height of the particle at time t from launch?
   a. $h(t) = v \cdot t - \frac{1}{2}gt$
   b. $h(t) = v \cdot t^2 - \frac{1}{2}gt$
   c. $h(t) = v \cdot t - \frac{1}{2}gt^2$
   d. $h(t) = v \cdot t^2 - \frac{1}{2}gt^2$
2. Newton's second law of motion states $F = ma$, what are the dimensions of F (force) in basic dimensions?

3. Challenge question! The universal law of gravitation states $F_{gravity} = G\frac{m_1 m_2}{R^2}$, where $F_{gravity}$ is a force, and m_1 and m_2 are masses, and R is a distance. What are the units of the gravitational constant G?

4. Super extra bonus challenge question! (From a past F=ma exam but it's really easy and you should be able to do it)

Inspired by a problem from the 2012 International Physics Olympiad, Estonia.

A very large number of small particles forms a spherical cloud. Initially they are at rest, have uniform mass density per unit volume ρ_0, and occupy a region of radius r_0. The cloud collapses due to gravitation; the particles do not interact with each other in any other way.

How much time passes until the cloud collapses fully? (The constant 0.5427 is actually $\sqrt{\frac{3\pi}{32}}$.)

(A) $\frac{0.5427}{{r_0}^2\sqrt{G\rho_0}}$
(B) $\frac{0.5427}{r_0\sqrt{G\rho_0}}$
(C) $\frac{0.5427}{\sqrt{r_0}\sqrt{G\rho_0}}$
(D) $\frac{0.5427}{\sqrt{G\rho_0}}$
(E) $\frac{0.5427}{\sqrt{G\rho_0}}r_0$

(Use the backside if you need to for this one ;))