**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 $\rho_0$, 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 ;) )