Discussion Introduction
P212, Week 1
The Scientist's Sixth Sense

As a scientist or engineer, much of your job will be performing calculations, and using calculations performed by others. You'll be doing plenty of that in your classes. But here's the difference: in classroom exercises, the correct answer is known … in the real world, it isn't! It's your responsibility to make sure your work is correct (the consequences may be dire indeed if it isn't). Today we'll work on developing that sixth sense that experienced scientists possess: they are constantly (almost subconsciously) checking their work against their physical intuition. Here's the secret:

Knowing what the answer will look like before you start.

And here are three guidelines that become second nature to any scientist:

- **Draw a sketch** You should *never* start work on a problem without sketching the situation first. A good sketch engages your physical intuition and often allows you to figure out 90% of the answer before you write down a single formula.

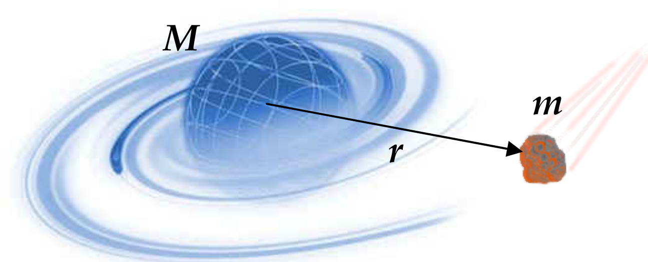
- **Check your units** If you're calculating a force and you get a result that comes out in meters, you know you made a mistake. If any part of your calculation contains an expression like $m+v$ where m is a mass and v is a velocity, you know you made a mistake. That's *mixed units* -- you can't add apples and oranges, or make them equal to each other.

- **Check limiting cases** All problems have limiting cases where you *know* what the solution should be. E.g., run the masses or distances in your problem to zero or infinity and make sure your solution gives the correct result.

Let's try it out! Here are two simple examples to illustrate:

(a) You're a structural engineer hired by an architectural firm to assist on the design of a museum. In the plans is a decorative corridor of length L whose roof will be supported by N columns. More columns cost more money, but you have to make sure there are enough of them to support the roof safely. You ask your assistant to calculate the mass M that each column will have to support, depending on the design parameters N and L. Your assistant comes up with this formula: $M = C N^2 / L$ where $C = 3478.7$ kg •m.

Do you believe it?



(b) You're an astrophysicist studying the motion of a meteor in the gravitational field of a distant planet. The meteor has mass m, the planet has mass M, and the distance between their centers is denoted r. The planet has a complex ring structure … your graduate student runs a computer simulation and comes up with this formula for the force experienced by the meteor: $F = G (36.7 M + 16.1 m) / r^3$ where G is the good old gravitational constant.

Do you believe it?