# Physics 1090 Homework #5

*Due Thursday, October 15, 2:00 pm*

**Reading assignment**: Chapters 10 - 13 of the notes.

1. Some years ago, a very attractive photograph of the Rotunda *viewed from the middle of the Lawn* was on sale, it was night and the full Moon was visible quite close to the Rotunda, so the shape of the Rotunda echoed the Moon. How could you prove this photo was a fake?

2. Recreate al-Khwarizmi's argument to solve $x^2 = 10x + 39$, draw a diagram and explain your work.

3. Here is a picture of a sundial:

The rod is parallel to the Earth's axis. Describe carefully how the movement of the Sun through the sky shows the time on this sundial—in particular, it must read 12 one hour *after* it reads 11, right? Are you sure the sun's moving in the right direction for this thing to work?

4. Galileo showed off his new telescope to the Doge from the Campanile in Venice, pictured here:

Estimate the distance to the horizon as seen from the observation point on the Campanile.

(*How to do this*: first, come up with some reasonable estimate of the height (clearly not the full height of the Campanile).

Next, draw a diagram of the Earth, with the campanile and the horizon showing.

*Hint*: it might help to review Galileo's argument about how high the mountains are on the Moon.)

5. Galileo was sometimes on the wrong track. For example, consider the following quote from *Two New Sciences*. Read it carefully, try to summarize the argument, and critique it.

SAGR. Thanks to this discussion, I have learned the cause of a certain effect which I have long wondered at and despaired of understanding. I once saw a cistern which had been provided with a pump under the mistaken impression that the water might thus be drawn with less effort or in greater quantity than by means of the ordinary bucket. The stock of the pump carried its sucker and valve in the upper part so that the water was lifted by attraction and not by a push as is the case with pumps in which the sucker is placed lower down. This pump worked perfectly so long as the water in the cistern stood above a certain level; but below this level the pump failed to work. When I first noticed this phenomenon I thought the machine was out of order; but the workman whom I called in to repair it told me the defect was not in the pump but in the water which had fallen too low to be raised through such a height; and he added that it was not possible, either by a pump or by any other machine working on the principle of attraction, to lift water a hair's breadth above eighteen cubits; whether the pump be large or small this is the extreme limit of the lift. Up to this time I had been so thoughtless that, although I knew a rope, or rod of wood, or of iron, if sufficiently long, would break by its own weight when held by the upper end, it never occurred to me that the same thing would happen, only much more easily, to a column of water. And really is not that thing which is attracted in the pump a column of water attached at the upper end and stretched more and more until finally a point is reached where it breaks, like a rope, on account of its excessive weight?

SALV. That is precisely the way it works; this fixed elevation of eighteen cubits is true for any quantity of water whatever, be the pump large or small or even as fine as a straw. We may therefore say that, on weighing the water contained in a tube eighteen cubits long, no matter what the diameter, we shall obtain the value of the resistance of the vacuum in a cylinder of any solid material having a bore of this same diameter. And having gone so far, let us see how easy it is to find to what length cylinders of metal, stone, wood, glass, etc., of any diameter can be elongated without breaking by their own weight.