1) I'm trying to weigh my pet dinosaur by placing a 10 foot long plank (weighing 50 pounds) across two scales, one under each end of the plank, and having my dinosaur stand on the plank—that way I should be able to just add the numbers on the scales and subtract the weight of the plank.

a) Why would this work? Include a free body diagram in your explanation.

b) Unfortunately, the dinosaur stands too close to one of the scales (just 2 feet away from one end, instead of exactly in the middle) and that scale breaks! However, I can at least see that the non-broken scale reads "850 pounds." How much does the dinosaur weigh? What would the broken scale read if it hadn't broken?

2) Let's investigate the orbit of the Earth around the Sun from a force perspective.

The force of gravity between two objects is $F_g = \frac{G m_1 m_2}{r^2}$, where m_1 and m_2 are the masses of the two objects (such as the Sun and the Earth) and $G = 6.67 \times 10^{-11} \frac{\mathrm{m}^3}{\mathrm{kg\,s}^2}$ (a constant).

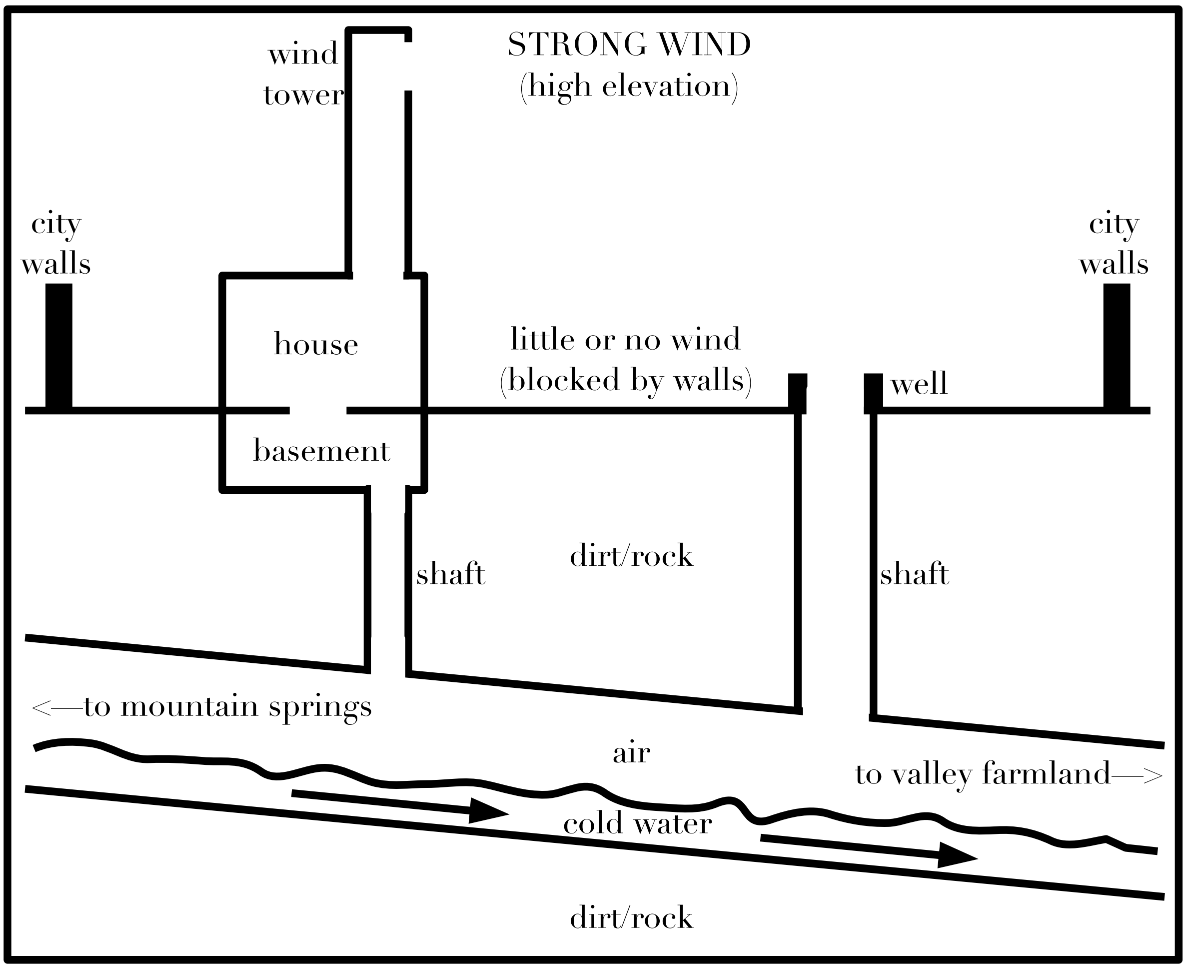
You may have learned earlier that the force required to keep an object moving on a circular path at constant speed (centripetal force) is $F_{cent} = \frac{m v^2}{r}$.

a) In this case, the gravity between the Sun and the Earth *is* what's keeping the Earth on a circular path, so what can you do with these two formulas? Do so, and solve for m_{Sun}.

b) You should now have a formula for the mass of the Sun in terms of a bunch of other variables... but you should be able to find values for all of those variables. The only one you might not already know is the distance (orbital radius) between the Sun and the Earth, which is about 150 billion meters. As for velocity... how far does the Earth travel in one year? Piece it together from that. Now find the mass of the Sun in kilograms!

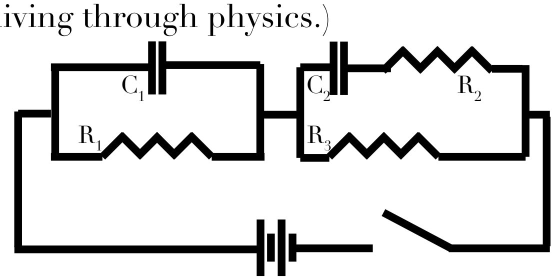
c) Jupiter is about 5.2 times as far from the Sun as Earth is. How long is one Jupiter year?

3) A few thousand years ago, the agricultural engineers of ancient Persia started digging tunnels called "qanat" to allow water to flow from springs in the mountains down to farms in the valleys. Villages could also dig wells down to the qanat to bring cold water up to the surface for drinking, washing, cooking, etc.
Some time later, they discovered another very useful application of the same tunnels: air conditioning! Here is a cross-section diagram of a typical layout:



Use what you know about fluid flow (including the Bernoulli Equation) to describe what will happen, and why this works as an air conditioning system.
(Apparently the qanat system, along with an underground evaporative cooling setup, was able to *freeze* water for use in frozen desserts! Better living through physics.)

4) In this circuit, each resistor are 1Ω, each capacitor is 2F, and the battery is 24V. The capacitors begin empty.



a) At the instant the switch is closed, what is the current through each resistor?
b) After a long period of time, what is the current through each resistor?
c) After a long period of time, how much charge is on each capacitor?