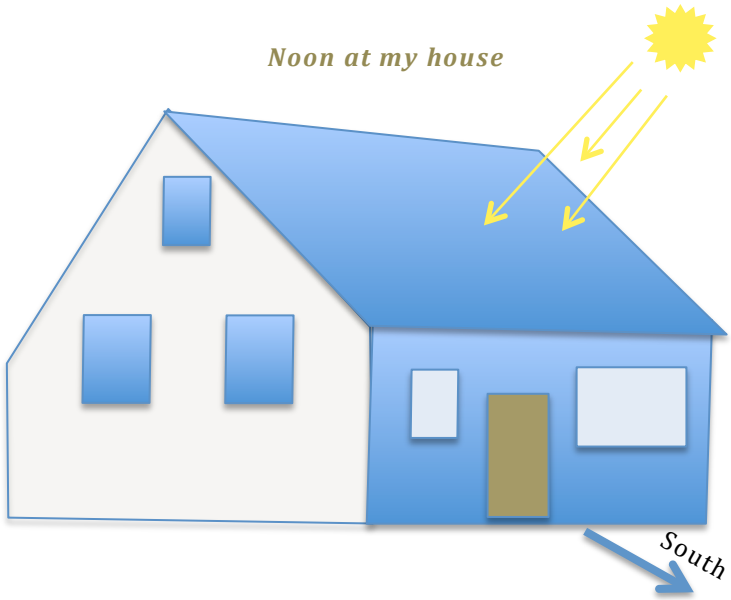
What's my angle?

I'm going to save energy and the planet by adding solar panels to my roof. When I started researching what my set up should be like, I found that I would have to make a lot of decisions.



1. What are some things that you think that I might have to consider?

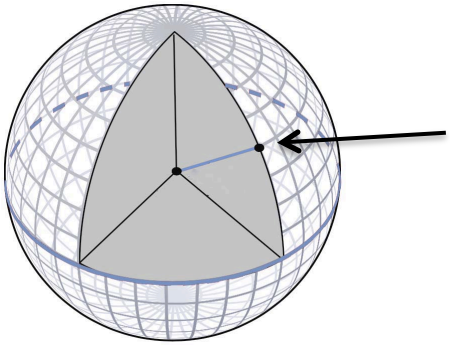
My solar panels could lay flat on my roof or I could mount them on a tilted support on my roof. There are even mounting systems that let you adjust the slant of your panels for winter and summer Sun angles. There are even mounting devices that let your panel tilt and rotate in order to directly follow the Sun throughout the day.

I'm going to stick to just mounting them at one angle on my roof.

2. How do you think that you could calculate the best tilt for mounting the panels?

The Sun's rays, on the spring and fall equinoxes, aim directly at our equator. If you lived on the Equator, you could just allow your panels to be horizontal, facing straight up. But, alas, most of us don't live on the Equator.

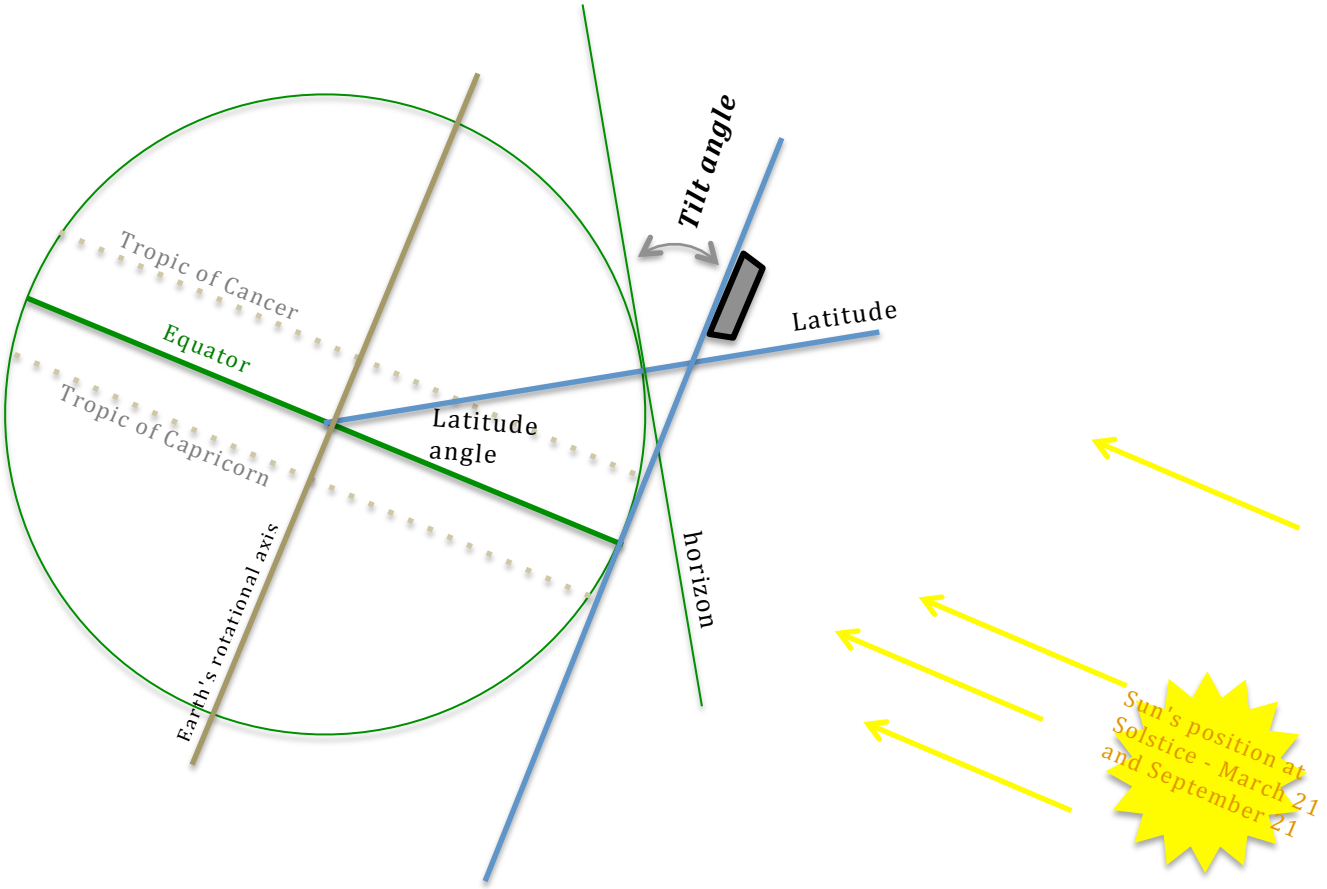
I was told to use my location's latitude to decide on the angle of the panel's tilt.



Your latitude shows at what central angle your location is relative to the equator.

The Sun's rays during the spring and fall equinoxes (March 21st and September 21st) aim directly at our Earth's equator. The Earth is tilted on its rotational axis at about 23.5° towards the Sun on June 21st (in the Northern Hemisphere) and tilted away from the Sun by that same amount on December 21st.

3. So how might you figure out the best tilt angle from your location on all of those days? … Summer solstice, spring and Fall Equinoxes and Winter solstice? You can use the following diagram to help consider your calculations.



Consider summer at 42° latitude. At noon on the summer solstice, June 21st, the Sun is 42° - 23.5° which is 18.5° from directly overhead (from the horizontal when you are standing on the Earth). To capture the most sun at that time you would tilt the panel 18.5° from horizontal to point it directly at the Sun.

4. Show on my diagram how we might have derived 18.5°.

5. But when it is not noon on June 21st the Sun won't seem to rise as high in the sky. So, should I increase or decrease the slant of my panel to accommodate for the less high elevation of the Sun in the sky?

6. What angle might you set your solar panel tilt at on the Winter solstice when the Sun reaches only a lower elevation in the sky?

7. If you wish to set the angle of your solar panel to one permanent angle, what might be a good angle to use that would aim towards the Sun at its lowest and highest elevations in the sky and everything in between? (Actually you would want to do some research, speak to experts, and find formulas online that help you realize several options.)

We found several formulas that you could use to set your panels at an optimal level from the horizontal. Here is just one of them.

If your latitude is below 25°, use the latitude times 0.87.
If your latitude is between 25° and 50°, use the latitude, times 0.76, plus 3.1 degrees.

8. Use these formulas to come up with another solution to question # 7.

Now lets look at the pitch angle of your roof and try to figure out if you could mount your solar panels flat to the roof.

9. What do you guess is the angle of pitch on your roof? How might you figure that out?

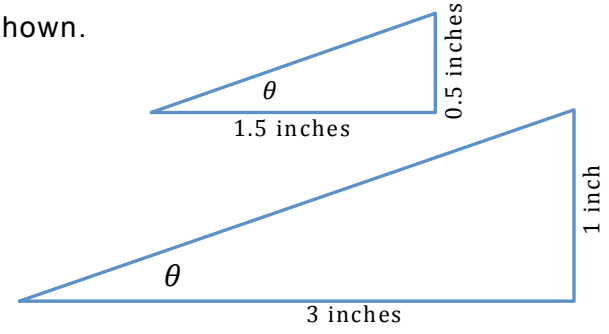
We've created some roof sketches with various pitches. Try to figure out the angle measure of their slants. You could either use a protractor to measure the pitch of the roof or do some simple trigonometry.

Here's a short lesson in trigonometric ratios.

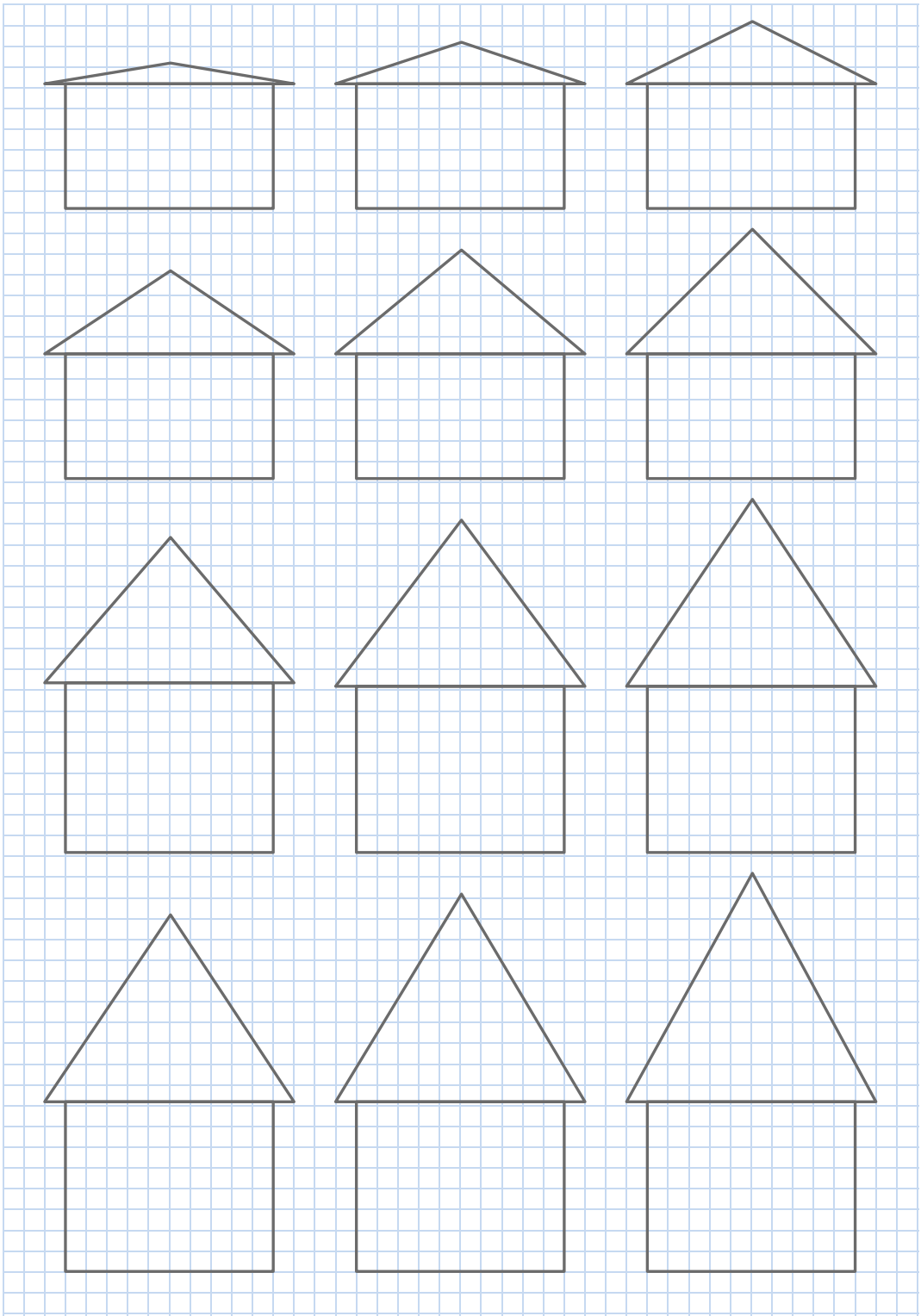
These are two similar triangles with the measurements shown.

There is a name for the ratio between the height measurement and the width measurement of two similar right triangles = Tangent ratio.

So in both of these cases the tangent of this angle, θ, = $\frac{1}{3}$ = 0.333 or the angle with tangent = 0.333 = 18.43°



10. Find the base angle of these 12 roof slants by either calculating the angle that has the correct tangent or measuring with your protractor.



11. Use what you have figured out to create a general plan for the roof of your home or for the roof of your school. Include the pitch of the roof and the desired angle for the solar panel. At what angle would you have to install your solar panel on this roof to get an optimal angle?

Sources: http://www.solarpaneltilt.com
http://physics.ucsd.edu/do-the-math/tag/solar/