



Solar Altitude & Module Tilt Angles

Solar cells and modules provide the most electricity when oriented (or facing) at a 90° angle toward the sun. You can use the Sun Angle Quadrant (p. 87) to find the sun's altitude (elevation angle above the horizon). Then use simple geometry to find the correct tilt angle for a solar cell or module. Finally test your calculations by measuring the module's output at various angles with multimeter.

Finding the Best Module Tilt Angle

1. Measure and record the sun's altitude angle using the Sun Angle Quadrant.
2. Determine the angle at which a solar module must be tilted up from the ground plane to be perpendicular to the sun's rays.

- **a** = the sun's altitude
- **b** = 90° module angle to the sun
- **c** = module tilt angle from ground plane

The earth's surface for our purposes is a level plane, so the sum of the three angles equals a line, or 180°. We know that the optimum module angle to the sun is 90°, and we've measured the sun's angle up from the ground (altitude). So the equation for the module's best tilt angle from the ground plane is calculated as follows:

$$a \text{ [the sun's altitude]} + b \text{ [90° module angle to the sun]} + c \text{ [module tilt angle from ground plane]} = 180°$$

Thus: $c = 90° - a$

Example:

The sun's altitude as measured by the Sun Angle Quadrant is 47°.

$$c = 90° - 47°$$

The best module tilt angle for this solar altitude = 43°

Exercise:

Use a Sun Angle Quadrant to measure the sun's altitude and calculate the best module tilt angle for that altitude.

Date: _____ **Time:** _____

Sun's altitude: _____ **Best module tilt angle:** _____

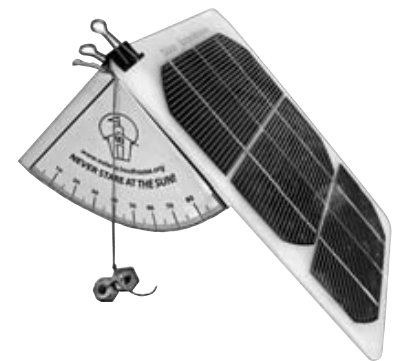
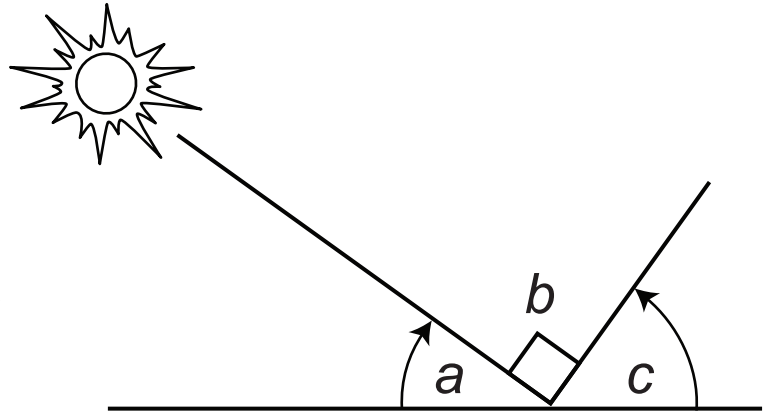
Testing the Calculation

1. Connect a solar module to a digital multimeter.
2. Attach a Sun Angle quadrant to the module with a small binder clip, or removable tape, as shown. Use this to hold the module at the tilt angle found in the above equation.
3. Record the voltage and amperage output by the module.
4. Repeat for higher and lower tilt angles.

The tilt angle at which maximum power is produced should match the one found by the above calculation.

For Extra Credit:

Check sun angle chart for your location to confirm the sun's altitude at the current date & time.



A Sun Angle Quadrant clipped to a module to measure tilt angle.