Measuring the Altitude of the Sun

By S. Grinstead

Subject: Gr. 10 Math - Measuring Angles
Time: 1 period 45-55mins. (outside group work)
Goal: identify date and season
identify latitude
identify sun's altitude (angle to ground)
Given Knowledge:

Shadows get shorter from December 21 to June 21. The angle of the sun's rays on the northern part of the earth is becoming more direct, thus the shadows are shrinking. The shortest shadow is cast on June 21st, the summer solstice.

Shadows become longer from June 22 to December 22. The angle of the sun's rays is becoming less direct, so the shadows are lengthening. The longest shadow cast is on December 22nd, the winter solstice.

This information is very important if you are planning to use solar energy to cook or heat your home or hot water. Shadows cast by a tree or a neighbour's home will affect the efficiency of the solar energy that you are trying to use.

Solar noon is when the sun is at its highest peak during the day. This is not always at 12 noon. In Thunder Bay, solar noon is at 1 pm Eastern Standard Time during autumn and winter and 2 pm Eastern Daylight Saving Time during spring and summer.

Hypothesis:

If the shadow cast by a 100 cm (1m) stick is measured, the altitude of the sun at solar noon for that day can be determined.

(Author's Note: The angle of the sun's altitude will change during the season and at different latitudes, so only local data is given here. This experiment is a fun way to confirm the gr. 10 math lesson on angles.)

Materials: bright sunny day at local solar noon
grid or regular paper pencils
100cm (1m) sticks tape measure
protractors

Method:

1. Place the metre stick 90˚ to the ground (Opposite side).
2. Mark the shadow length (Adjacent side). Do not stand in the shadow path.
3. Measure the distance accurately from the 1 metre stick (Opposite side) at the ground level to the end of the shadow path (Adjacent side).
4. Measure the length of the Hypotenuse side from the top of the metre stick to the end of the shadow path with the tape measure.

5. Measure the angle (>) between the Hypotenuse side and the shadow path with the protractor. This angle is the altitude of the sun.
6. Draw a simple diagram and mark all the measurements.
7. Do the math work to prove the protractor measurement.
8. State the altitude of the sun, the date, location, latitude and season in the concluding statement.
9. Formulas:

O = Opposite	A = Adjacent	H = Hypotenuse
Sine = $\frac{O}{H}$	Cosine = $\frac{A}{H}$	Tangent = $\frac{O}{A}$

Example # 1

O = 1 metre A = 2 m 8 cm or 2.08 m H = ? > = X

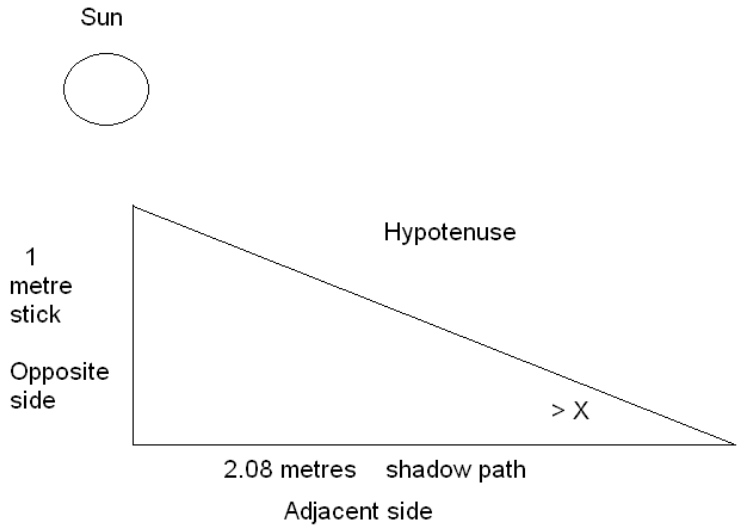
Tangent >X = $\frac{O}{A}$

Tangent >X = $\frac{1}{2.08}$

Tangent > X = 0.48

> X = Tangent -1 (0.48)

> X = 25.6˚ > X ~ 26˚



On Sunday, January 28, 2008, the altitude of the sun was 26˚ at solar noon (1pm EST) at Thunder Bay, ON at latitude 48.5˚ N. The season is winter.

Example # 2

O = 1 metre A = 0.5 metre H = 1.1 metres > = X

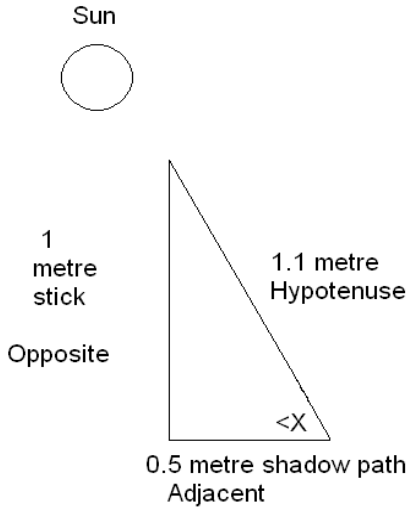
Tangent > X = $\frac{O}{A}$

Tangent > X = $\frac{1}{0.5}$

Tangent > X = 2

> X = Tangent – 1 (2)

> X = 63.4˚ > X ~ 63˚



On __(date and year)__ the sun's altitude was _63˚_ at __(city)_____ at solar noon at latitude_____˚ N (or S). The season is _____.

Example #3

O = 1 metre A = 1.5 metres H = 1.8 metres > = X

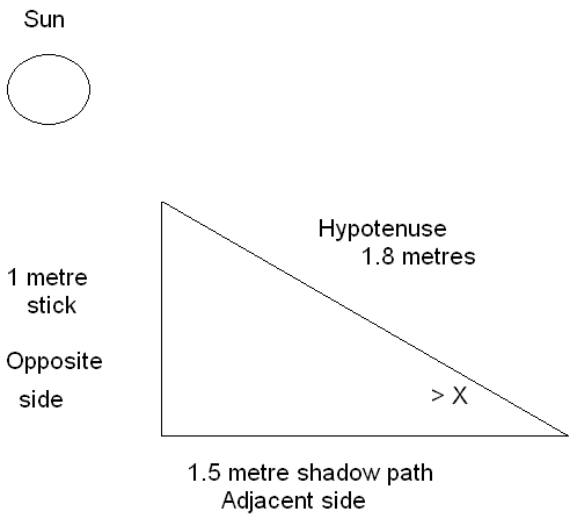
Tangent > X = $\frac{O}{A}$

Tangent > X = $\frac{1}{1.5}$

Tangent > X = 0.6667

> X = Tangent – 1 (0.6667)

> X = 33.7˚ > X ~ 34˚



O n _____ the sun's altitude was 34˚ at _____ at solar noon at latitude ___˚ N (or S). The season is _____.

Math Resource L. Bortolin