ANSWERS TO THE QUESTIONS FOR STUDENTS:

1) If you were hired to find the height of the tower without climbing to the top to measure it, what suggestions would you give the mayor to figure it out?

Use very long measuring tape?!?
Suggestions might be hard to come by. There is a mathematical solution that will work. Hint: the answer involves using comparisons. Measure the length of your shadow and your height. Measure the shadow of the tower. Set up a proportion and solve the equation comparing the ratios.

$$\frac{\textbf{your height}}{\textbf{your shadow length}} = \frac{\textbf{height of tower (x)}}{\textbf{shadow length of tower}}$$

Solve the following.

2) $\frac{2}{5} = \frac{x}{10}$

x = 4

3) $\frac{7}{28} = \frac{4}{x}$

x = 16

The following are two examples of ratios that can be used to compare the differences between two skateboards.

A) $\frac{\text{Wheel size of } 1^{st} \text{ skateboard}}{\text{Length of } 1^{st} \text{ skateboard}} = \frac{\text{Wheel size of } 2^{nd} \text{ skateboard}}{\text{Length of } 2^{nd} \text{ skateboard}}$

B) $\frac{\text{Wheel size of } 1^{st} \text{ skateboard}}{\text{Wheel size of } 2^{nd} \text{ skateboard}} = \frac{\text{Length of } 1^{st} \text{ skateboard}}{\text{Length of } 2^{nd} \text{ skateboard}}$

3) What two things could you compare to figure out the height of the tower? (Hint: one was given to you in the wording of this problem)

You could compare the height of the tower and the shadow length of the tower.

4) The man who solved this problem for the mayor compared the height of the tower and the height of himself and the length of his shadow to the shadow of the tower. Using the skateboard example from above, can you write an equation that would compare the length and shadow?

A) $\frac{\text{Height of Tower}}{\text{Height of Man}} = \frac{\text{Length of Tower Shadow}}{\text{Length of Man's Shadow}}$

B) $\frac{\text{Height of Tower}}{\text{Tower's Shadow}} = \frac{\text{Height of Man}}{\text{Man's Shadow}}$

Which of the four parts of the equation is the unknown? Or, which one of these four parts cannot be measured without leaving the ground?

The height of the tower cannot be measured without leaving the ground.

How can we solve the part of the equation that we do not know (i.e. the height of the tower?)
We can write a proportion like those in A or B above.

What is the height of the tower if:
height of man = 6 feet
shadow of man = 18 feet long
shadow of tower = 36 feet long

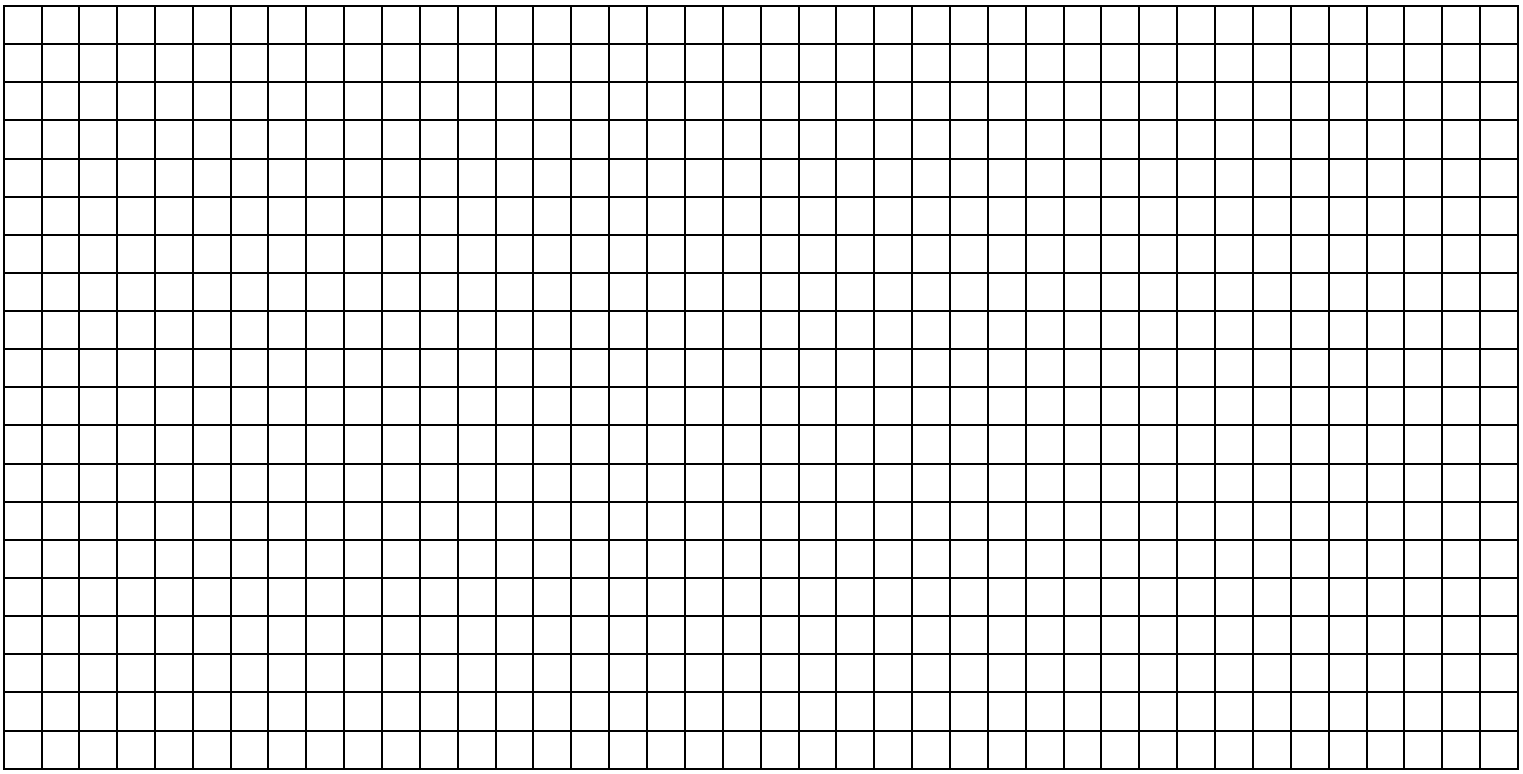
$$\frac{6}{18} = \frac{x}{36}$$

Can you reduce the $\frac{6}{18}$ before solving the equation and still get the correct result? **yes**

$$\frac{1}{3} = \frac{x}{36}$$ **The value of x is 12.**

Graphing:

On a piece of graph paper, create a graph where the x-axis is the shadow length and the y-axis is the height.



11) Plot the point that represents the length of the shadow of the man (18 feet), and the length of his height (6 feet). Draw the line from the origin (0,0) through this point (18,6). Extend the line through the point. Mark the shadow of the tower on the x-axis (36). With your pencil on 36, follow in a vertical line up to the point where it would intersect the line. What is the y-value or height at this point? **The "y" value at this point is 12.**

Using this line, predict the height of an object with a shadow of the following measurements:

A) 26 feet long **8.66 feet or 8 and 2/3 ft**

B) 30 feet long **10 feet**

C) 34 feet long **11.33 feet or 11 and 1/3 ft**

How is graphing and predicting similar to setting up an equation with ratios to solve for the height of the tower?

Each can be used to approximate an unknown. In others words, by knowing 3 other things, we can figure out something we do not know either by using a graph or ratios.

Now complete this process and find the height of your house.

ASSESSMENT OPTIONS (constructed response)

Suppose you own a hotel along a beachfront. You don't want your hotel to create a shadow over the beach and block the sun from your guests. If you knew the height of the hotel, how could you figure out how far the shadow reaches at a give time of the day without measuring the distance from the hotel to the end of the shadow?

If I were a hotel owner, I would first measure my height and then my own shadow. Then, I would measure the height of my hotel. By setting up ratios comparing the height and shadow length of both the hotel and myself, I could use a proportion to figure out how far the shadow would reach off the side of the hotel.

$$\frac{\text{my height}}{\text{my shadow}} = \frac{\text{height of hotel}}{\text{shadow of hotel (x)}}$$

EXTENSIONS:
If the man in the problem waited a day after measuring his shadow and the shadow of the tower, why would this be a bad idea?

The sun is constantly moving and the weather is changing. The positioning and angle of sunlight changing will cause the ratios to be different if we wait a long period of time in between measurements.

If a man waited 10 minutes instead of a day, why might his finding be a bit different?

Again, the angle of sunlight will change the outcome of the ratios.