MAKING IT STRAIGHT

ACTIVITY ONE

Part A. The base of the Great Pyramid at Giza covers 13 acres and is level to within less than one inch! In *Building the Great Pyramid*, we saw that a building and measuring device called a plumb bob was used. A plumb bob is simply a weight that comes to a point on its bottom and is suspended on a long string. The term plumb comes from *plumbum*, the ancient word for lead. The modern chemical symbol for lead is Pb from this ancient name.

Follow your teacher's directions for making a plumb bob.

Now, here are a few things to figure out with your plumb bob.

1.What makes the plumb bob seem to be attracted to the floor?

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2. Keeping the plumb slightly above the floor and using the protractor, what is the angle the bob makes with the floor?

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3. Move your plumb bob to other parts of the room and measure the angle it makes with the floor in at least two other places. What are the angles there?

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4. Choose any wall. Using the plumb bob and protractor, what is the angle the wall makes with the floor?

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5. Now go to a corner. What is the angle there?

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6. Why do you think the Egyptians used the plumb bob in the construction of houses, temples and pyramids?

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Khufu's priest uses a pendulum to align the pyramid site with the stars.

The conscripts strategically position the pyramid's capstone.

Part B. In *Building the Great Pyramid*, we learn that the Egyptians measured everything by the motion of the stars—the setting of their calendars, the flooding of the Nile—and they did so by noticing that all the stars moved. Everything in the night sky was in motion, except for one dark still point. Around that point two stars turned in a constant circle. Today we call those stars *circumpolar stars* but to Egyptians they were *The Indestructibles*, the location of heaven itself. On one particular night each year, one star was directly above the other. A plumb line held up against the two stars at that moment passed exactly through the point, fixing it with perfect accuracy. It was to this point that the Great Pyramid was aligned.

Your teacher will place large dots on the board. Stand about three meters away and follow your teacher's directions to determine which is in a straight line. What are your findings?

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In *Building the Great Pyramid*, we learn that the night sky appeared to move around an empty point in space around which the two stars revolved yearly. If you were to observe the night sky in 2003, you would notice that the sky appears to move around a star called Polaris or the North Star. What do you think might account for this difference?

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MAKE YOUR OWN PYRAMID

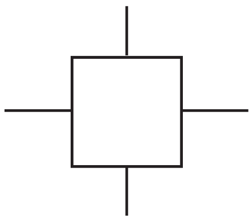
ACTIVITY TWO

Part A. As seen in *Building the Great Pyramid*, the Great Pyramid at Giza began with a square base. In fact, if you take a horizontal cross-section of the Great Pyramid at any level, you'd find a square.

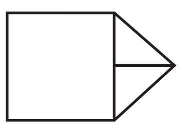
Now, you're going to construct a scale model of the Great Pyramid. The Great Pyramid is 3,000 times larger than your scale model. Therefore, the scale 1cm = 30m is needed to complete the construction.

1. Draw a square on a piece of oak tag with each side measuring 7.7cm in length.

2. Now, mark off the midpoint of each side. From the midpoint of each side, draw a 6.2cm length line outward, as you see below. Use a protractor to draw the line, making sure it is at a 90° angle.



3. Then, connect the end of your outward line to the corner of the square, forming two right triangles on each side. Draw the triangles on each of the four sides of the square.



Using the Pythagorean theorem ($a^2 + b^2 = c^2$), determine the length of the hypotenuse. What's your answer?

4. Cut out the template. Fold each triangle side along the edges of the square toward the center of the square base.

5. Align the sides of triangles and tape into place. Repeat until the pyramid is complete.

Part B. Using the dimensions of your scale model, determine the following.

1. What is the area of the base of the scale model pyramid?
   Formula:
   Area = (length of sides)^2

2. What is the area of each of the large triangles (each face of the pyramid)? Formula: Area = 1/2 base x height.

3. Calculate the total surface area of the scale model.
   Formula: 4(area of the large triangles) + area of the base = total surface area

Part C. As we discussed above, our scale is 1cm = 30m. In the chart below, fill in the blanks to show actual heights, scaled heights and other objects that represent the scaled-down heights.

OBJECT	ACTUAL HEIGHT	SCALED HEIGHT (1CM=30M)	OBJECT TO REPRESENT SCALED-DOWN HEIGHT
Great Pyramid	145.75m	4.9cm	Paper pyramid
Statue of Liberty	92m	3cm	Paper clip
Sears Building	443m	14.8cm	
Average person	1.7m	.05m	
Eiffel Tower			
Leaning Tower of Pisa			
Empire State Building			

The laborers haul stone blocks into the King's burial chamber using an A-frame and ropes.

RAISING THE BLOCKS

ACTIVITY THREE

Part A. It took more than 20,000 people more than 20 years to build the Great Pyramid at Giza for King Khufu. The pyramid's large square base covers about 13 acres and is aligned to the four points of the compass in near-perfect precision.

If 2,300,000 blocks of stone were used to build the Great Pyramid and 70% were used in the bottom third, how many stone blocks were dragged there?

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Why do you think a majority (70%) of the building materials were used on the lower level?

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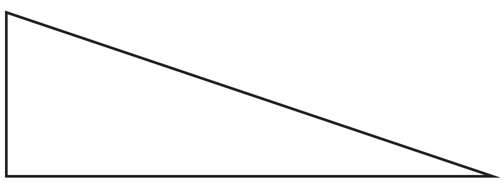
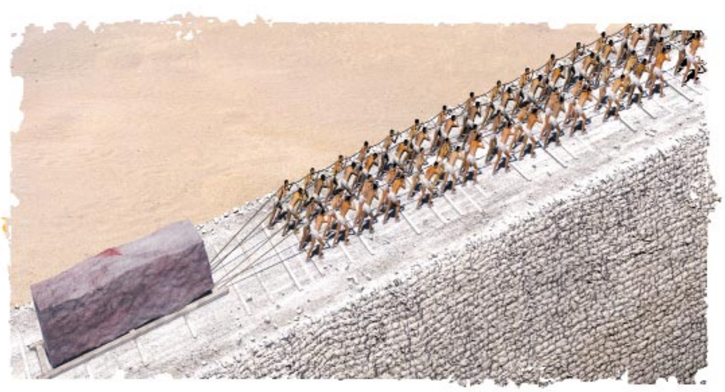
Part B. The simple machine that enabled the Egyptians to build such tall structures is the inclined plane. As some people were building the base of the pyramid, others were constructing ramps (inclined planes of sand, dirt and scrap building material that enabled the builders to push the stones to the next level). As the pyramid grew, so did the height of these ramps.



INCLINED PLANE

You can make an inclined plane in your classroom or at home.

1. You will need a rubber band, a paper clip, a metric ruler and a textbook.
2. Make two dots on the rubber band that are two centimeters apart.
3. Choose an object such as a small weight, a metal pen, keys or any object that will cause the rubber band to stretch. Attach the weight to the rubber band using the paper clip.
4. Hold the rubber band vertically so it can stretch, and measure the distance between the dots you drew on the rubber band.



The conscripts pull a 50-ton block of stone up a ramp to the King's burial chamber.

The conscripts cut the stone in the Khufu Quarry.

5. Record your findings below.
6. Lay your textbook flat on your desk and have your partner raise one end of the book off of the surface of the desk. This book will serve as a ramp.
7. Place an object such as another book under the raised end of the book. Measure the height of your "ramp."
8. Gently pull the object up the ramp, measuring the distance between the dots on the rubber band. You may do your measuring while pulling the object vertically and calculating the distance between the dots, just before it moves. Record both the height of the ramp and the distance between the dots below.
9. Repeat four more times, at four different heights. Record in the data table.

Vertical height (cm) of ramp	Distance between dots (cm)
1. __________	1. __________
2. __________	2. __________
3. __________	3. __________
4. __________	4. __________
5. __________	5. __________

What advantage does using the inclined planes have over lifting an object?

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How do you think the Egyptians used the inclined plane in building the Pyramid?

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