



# **Blue Pelican**

## **15 Minute MathLabs Answers**

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## MathLab Answers to in depth questions

### MathLab 01

1. A centimeter ruler was used for this lab. There are 10 subdivisions between the centimeter marks. What is the length of each of these small subdivisions?  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. The two similar triangles used in this particular lab were right triangles. Do all similar triangles have to be right triangles?  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. The proportion equation from which we solved for x in this problem was:  
*Free answers to only Labs 5, 9, 18, 21, 23*
4. Would the result have been the same if the positions of .5D1 and H1 + X had been interchanged?  
*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 02

1. What is the general formula for the volume of a non circular cone (pyramid)?  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. If any other liquid with a different density than that of water had been used, would the results for the final volume have been the same?  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. From the formula for the volume,  $(1/3)\pi R^2 H$ , explain why the dimensions for our volume came out in  $\text{cm}^3$ ?  
*Free answers to only Labs 5, 9, 18, 21, 23*
4. In the medical field, the amount of an injection is often given in cc's. How does that relate to the units of volume, ml and  $\text{cm}^3$ , used in this lab? **(Research needed)**  
*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 03

1. What error might result from weighing the full sheet and then waiting several days to cut out Texas and weigh that part?  
*Free answers to only Labs 5, 9, 18, 21, 23*

2. Suppose the 11" X 8.5" sheet with the picture of Texas is photocopied onto another 11" X 8.5" sheet with the picture enlarged. If the lab is done with this new paper, would the result for the area of Texas be different?

*Free answers to only Labs 5, 9, 18, 21, 23*

3. Instead of  $\frac{\text{area of Texas}}{\text{area of sheet}} = \frac{\text{weight of cutout}}{\text{weight of sheet}}$  suppose the equation was the following:  $\frac{\text{area of Texas}}{\text{weight of cutout}} = \frac{\text{area of sheet}}{\text{weight of sheet}}$

Would the result for the final area have been any different?

*Free answers to only Labs 5, 9, 18, 21, 23*

4. If the scales weighed everything 1gm in excess of the correct value, would the final area have been different?

*Free answers to only Labs 5, 9, 18, 21, 23*

#### MathLab 04

1. Suppose the proportion

$$\frac{8.5''}{889.24mi} = \frac{7.75''}{d}$$

had been written as:

$$\frac{d}{889.24mi} = \frac{7.75''}{8.5''}$$

Would the solution for  $d$  have been different?

*Free answers to only Labs 5, 9, 18, 21, 23*

2. The diagonal measurement was done on a flat piece of paper. The “line” from corner to corner in Texas is not an actual line. Realizing that Texas is on a sphere (the earth) what is the name of the actual geometric shape of this “line”?

*Free answers to only Labs 5, 9, 18, 21, 23*

3. On a globe instead of a traditional x-y coordinate system what is the coordinate system used to locate points on that sphere? (**Research needed**)

*Free answers to only Labs 5, 9, 18, 21, 23*

4. What portion of a map usually indicates how to measure distance on the map? (**Research needed**)

*Free answers to only Labs 5, 9, 18, 21, 23*

#### MathLab 05

1. In the equation we have developed for  $C$  as a function of  $F$ , which is independent and which is the dependent variable?

*$F$  is the independent variable and  $C$  is the dependent variable.*

2. What is the “y intercept” for the graph we have developed (actually, it’s the “C intercept”)?

$$-(5/9)32$$

3. From the equation  $C = (5/9)(F - 32)$ , solve for F so that it becomes a function of C.

$$F = (9/5)C + 32$$

4. Suppose  $(F_F, C_F)$  &  $(F_B, C_B)$  are respectively the freezing and boiling points of the liquid benzene. If we had used these two points in the development of our relationship between C & F, would the final result have been different?

*No, it would be the same. Any two points on the line would work.*

### MathLab 06

1. Of the two variables (time and temperature) which is the **independent** variable and which is the **dependent** variable?

*Free answers to only Labs 5, 9, 18, 21, 23*

2. What would have been the effect of not drying the thermometer and allowing cold water to remain in the hollow surrounding the bulb?

*Free answers to only Labs 5, 9, 18, 21, 23.*

3. If the thermometer is not completely accurate, would the curve look substantially the same?

*Free answers to only Labs 5, 9, 18, 21, 23*

4. Our curve has a horizontal asymptote. Are there functions that have vertical asymptotes? If so, give a simple example of what one would look like. (**Research required**)

*Free answers to only Labs 5, 9, 18, 21, 23.*

### MathLab 07

1. Why are the volumes determined above really just “average” volumes of the beans?

*Free answers to only Labs 5, 9, 18, 21, 23*

2. What could have been done to obtain an even more accurate average volume of the beans and reduce the error caused by inaccurate reading of the graduated cylinder?

*Free answers to only Labs 5, 9, 18, 21, 23*

3. How would you solve the problem of having to measure the volume of an object that won't sink in water?

*Free answers to only Labs 5, 9, 18, 21, 23*

4. Instead of a 25 ml graduated cylinder, what would have been the result if the 14 beans had been dropped in a large 500 ml graduated cylinder and the difference in volume noted there?

*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 08

1. Could you determine the density of something by just weighing it?

*Free answers to only Labs 5, 9, 18, 21, 23*

2. Which has the greatest density, an 8000 lb elephant or 8000 lbs of feathers?

*Free answers to only Labs 5, 9, 18, 21, 23*

3. What makes the best bullet: a high density or a low density bullet?

*Free answers to only Labs 5, 9, 18, 21, 23*

4. From what material does the military make its “special density” bullets?  
(Research required)

*Free answers to only Labs 5, 9, 18, 21, 23*

5. In this lab we found the density of a kidney bean which is given in  $\text{gm}/\text{cm}^3$ . Suppose that you know this number to be 1.05. What mathematical operation will quickly give you  $\text{cm}^3/\text{gm}$ ?

*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 09

1. Why might we not always get integer answers for L and K?  
*If we used different beans in Lab 7 (where the volume was determined) than here, then because of the variation in the size of beans the volume readings may be in error. Also, all of the volume readings are just estimates.*

2. How could the accuracy of the lab results be improved?  
*Choose beans that are more uniform in size. Use a cylinder with finer graduations for more accurate volumes.*

3. For a small diameter cylinder the meniscus formed by the water becomes more apparent and affects the readings. What is a meniscus? (Research required)  
*It is the curved shape of the top of the liquid as it hugs the walls of the cylinder.*

4. What would be the result of leaving the beans in the water for an extended period of time and then trying to use them for a lab in a class later in the day?

*The beans would swell and their volumes would be different from that determined in MathLab 07 thus making that data invalid for use in a later lab.*



**MathLab 10**

1. Write out in words exactly how to say “grains/in<sup>3</sup>”.  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. Notice when looking at the sand with a magnifier, some of the grains of sand are relatively large while some are tiny. Does this adversely affect our estimates in any significant way?  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. Suppose when weighing the graduated cylinder with 16.38 ml of sand, we forgot to subtract the weight of the empty cylinder. How would this affect the estimated total number of grains in one cubic inch?  
*Free answers to only Labs 5, 9, 18, 21, 23*
4. Suppose wet sand had been used. In what ways might this affect our results?  
*Free answers to only Labs 5, 9, 18, 21, 23*

**MathLab 11**

1. What is the number of atoms in a mole of the “compound making up sand”?  
(Research required)  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. Search online and find out what astronomers currently think is the number of galaxies in the universe? (Research required)  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. With what arithmetic operation is it appropriate to subtract exponents when using scientific notation?  
*Free answers to only Labs 5, 9, 18, 21, 23*
4. Convert  $3,718 \times 10^5$  into “true” scientific notation where the “number in front” is between 1 and 10.  
*Free answers to only Labs 5, 9, 18, 21, 23*

**MathLab 12**

1. Suppose the total error in any one time measurement with the stop watch is .1 sec. When obtaining the total time for 30 swings, what is the total timing error?  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. Suppose the total error in any one time measurement with the stop watch is .2 sec. When obtaining the total time for 30 swings, what is the total timing error per swing?  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. What could we have done to have produced even greater accuracy in “time per swing”?  
*Free answers to only Labs 5, 9, 18, 21, 23*
4. Explain why getting the total time for 30 oscillations and then dividing by 30 is more accurate than timing 30 individual oscillations and then averaging these times?  
*Free answers to only Labs 5, 9, 18, 21, 23*
5. Research why it is important to use small angles of deflection of the pendulum. (Research required)  
*Free answers to only Labs 5, 9, 18, 21, 23*

**MathLab 13**

1. How could a pendulum be used to find the exact value of  $g$  (the acceleration of gravity) at various places on the earth?  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. Realizing that the acceleration of gravity ( $g$ ) on the moon is less than it is on the earth, how would this affect the period of a pendulum on the moon as compared to the period of the same pendulum on earth?  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. What happens when the quantity under the square root is negative? (Try it on your calculator.)  
*Free answers to only Labs 5, 9, 18, 21, 23*

4. Research “temperature compensated” pendulums? What does it mean?  
(Research required)  
*Free answers to only Labs 5, 9, 18, 21, 23*
5. What would L have to be in order for the period to be exactly  $2\pi$ . Try to reason through this by just looking at the equation and realizing that the square root needs to be 1 in order to get this answer.  
*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 14

1. Using a technique similar to that of Calculator Activity # 3, determine the time the pendulum bob is 3.6 cm to the left of center.  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. Using a technique similar to that of Calculator Activity # 4, determine the position of the pendulum bob at  $t = 1.02$  sec.  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. With a pendulum of length 700 cm, what is the greatest extent to both the left and right of center that the shadow (projection) of the bob could move?  
*Free answers to only Labs 5, 9, 18, 21, 23*
4. What would be the angle of deflection for the pendulum described in problem 3?  
*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 15

1. What is the minimum speed of a roller coaster in meters/sec traveling in a vertical circle of 10 meters?  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. Solve the equation  $v = \sqrt{rg}$  for r.  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. Write the equation  $v = \sqrt{rg}$  without using a radical.  
*Free answers to only Labs 5, 9, 18, 21, 23*
4. Would the graph of  $v = \sqrt{rg}$  be considered concave up or concave down? Assume that v is graphed on the vertical axis and r on the horizontal axis.

(Research required)

*Free answers to only Labs 5, 9, 18, 21, 23*

- For the problem described in problem 4, which (v or r) would be the dependent and which would be the independent variable?

*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 16

- What is the form of the equation of a catenary? (Research required)  
*Free answers to only Labs 5, 9, 18, 21, 23*
- With regard to the answer to question # 1 above, how is *cosh* pronounced? (Research required)  
*Free answers to only Labs 5, 9, 18, 21, 23*
- What is the equation of  $y = .001103x^2$  when reflected across the x axis?  
*Free answers to only Labs 5, 9, 18, 21, 23*
- What is the equation of  $y = .001103x^2$  when reflected across the y axis?  
*Free answers to only Labs 5, 9, 18, 21, 23*
- Is the parabola discussed in this lab an even or an odd function?  
*Free answers to only Labs 5, 9, 18, 21, 23*
- We have learned in this lab that a freely hanging cable is not exactly parabolic, yet the cables of a suspension bridge hang almost exactly in the shape of a parabola. Why? (Research required)  
*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 17

- What are the reasons that fit of the parabola is not perfect?  
*Free answers to only Labs 5, 9, 18, 21, 23*
- What is the “vertex” form of the equation of a parabola? (Research required)  
*Free answers to only Labs 5, 9, 18, 21, 23*
- What is the root form of the equation of a parabola? (Research required)  
*Free answers to only Labs 5, 9, 18, 21, 23*

4. What is the general form of the equation of a parabola? **(Research required)**  
*Free answers to only Labs 5, 9, 18, 21, 23*
5. What is the minimum number of points generally needed to determine the equation for a parabola? **(Research required)**  
*Free answers to only Labs 5, 9, 18, 21, 23*
6. Is it possible to determine the exact equation of a parabola given only three non-collinear points? **(Research required)**  
*Free answers to only Labs 5, 9, 18, 21, 23*
7. Why possibly might the “droop” of a parabola look different on a calculator than the actual “droop” of the string taped to the board?  
*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 18

1. When we measured from the center to any of points A, B, or C to obtain the radius, were there other point to which we could have measured?  
*Yes, to any point on the arc*
2. Why would it be important for blacksmith to use a non stretchable string?  
*Depending on how much the string stretched each time, the radii of the arcs would be in question*
3. Would the perpendicular bisector of a fourth chord have passed through the intersection point of the first two?  
*Yes*
4. In choosing the three points on the arc, why is it important not to choose points that are near each other?  
*When aligning a straightedge to two points there is always some error in the alignment. This translates into a greater angular error when the two points are closer together.*
5. Is it always possible to find a circle that will pass through three noncollinear points?  
*Yes*
6. Is it always possible to find a circle that will pass through four noncollinear points?  
*No*

**MathLab 19**

1. Since a circular mirror's "focal point" is not perfect what advantage does such a mirror have over a parabolic mirror that has perfect focus?

*Free answers to only Labs 5, 9, 18, 21, 23*

2. Why is it not especially important for all reflected rays to go exactly through a common focal point when trying to concentrate the sun's rays on a pipe carrying water?

*Free answers to only Labs 5, 9, 18, 21, 23*

3. It is possible for a parabolic reflector to work in the reverse of what has been presented here in this lab. Rays emanating from the focus will strike the parabolic mirror and emerge in a collimated beam of parallel rays. Give an example of this encountered in everyday life.

*Free answers to only Labs 5, 9, 18, 21, 23*

4. To collect the sun's rays so as to heat a pipe at the focus, why is it important to aim the principle axis directly at the sun?

*Free answers to only Labs 5, 9, 18, 21, 23*

**MathLab 20**

1. Is the vertex of the parabola also equidistant from the focus and directrix?

*Free answers to only Labs 5, 9, 18, 21, 23*

2. State the "locus of points" definition for a parabola? **(Research required)**

*Free answers to only Labs 5, 9, 18, 21, 23*

3. Are there any mathematical curves that have more than one focal point. If so, what are their names? **(Research required)**

*Free answers to only Labs 5, 9, 18, 21, 23*

4. The parabola is just one of the four "conic sections"? What are the other three? **(Research required)**

*Free answers to only Labs 5, 9, 18, 21, 23*

5. In this lab the distance between two points was measured with a **compass**. Given two points  $(x_1, y_1)$  and  $(x_2, y_2)$ , what is the **algebraic** formula that gives the distance between them?

*Free answers to only Labs 5, 9, 18, 21, 23*

**MathLab 21**

1. Since probabilities can't exceed 1, how can the probability of rain be 25% since 25 is greater than 1.

*25% is the decimal equivalent of .25 which is less than 1*

2. Suppose in addition to the 4 and 5 color spinners we additionally have a 6 color spinner that also has just one red section. Spinning all three simultaneously, what would be the probability of at least one red?

$$1 - P_0 = 1 - \left(\frac{3}{4} \cdot \frac{4}{5} \cdot \frac{5}{6}\right) = 1 - \frac{1}{2} = \frac{1}{2}$$

3. For the 4-color spinner, would it be possible to spin a million times and never get a red?

*yes, but very unlikely*

4. For the 4-color spinner, would we be more likely to get 30,000 reds or 300,000 reds when spinning a million times? Why?

*300,000 since that is closer to the 250,000 that probability theory predicts*

5. What is the probability for an event that is absolutely certain to happen?

*1*

6. What is the probability for an event that is absolutely certain not to happen?

*0*

7. Is it possible for a probability to be negative?

*no*

**Math Lab 22**

1. For the 3-color spinner used in this lab, what is the probability of getting either a yellow or blue?

*Free answers to only Labs 5, 9, 18, 21, 23*

2. On the "Wheel of Fortune" wheel the \$10,000 prize corresponds to a central angle of four degrees. What is the probability that a single spin will land on it?

*Free answers to only Labs 5, 9, 18, 21, 23*

3. On the "Wheel of Fortune" wheel the \$10,000 prize corresponds to a central angle of four degrees. What is the probability that after four spins that we would land on it at least once?

*Free answers to only Labs 5, 9, 18, 21, 23*

4. Assume that the green area of the spinner occupies a space corresponding to a central angle of x degrees. What is the probability of landing in the green area?

*Free answers to only Labs 5, 9, 18, 21, 23*

**MathLab 23**

- Using the equation for the number of nuts ( $N = .10989x$ ), what would be the number of nuts if the amount of stretch is 54.6 cm?

$$6$$

- From physics what is the name of the law that expresses  $F = kx$  where  $F$  is the force,  $k$  is the spring constant, and  $x$  is the amount of stretch. (Research needed)

*Hooke's Law*

- Rewrite the function  $N(x) = kx$  so that instead of  $N$  being a function of  $x$ ,  $x$  is a function of  $N$ .

$$x(N) = \frac{1}{k}N$$

- If we had nuts that weighed 1.5 times as much as those used in this lab, how much would 3 nuts stretch the spring?

$$1.5(3) = .10989x$$

.

.

.

$$x = 40.95cm$$

- When a linear regression is done on the calculator the  $N$ -intercept is  $-.00539721$  whereas it's theoretical value is 0. Why the difference?

*The value  $-.00539721$  is very close to 0. The points from which the regression was done were obtained experimentally and subject to some error. These errors propagate their way into the regression function.*

**MathLab 24**

- In this lab we used the equation  $N = 3.1383T^2 - 5.32769$ . For a given value of  $N$  how many solutions of  $T$  are there?

*Free answers to only Labs 5, 9, 18, 21, 23*

- Suppose that in the process of solving  $3.1383T^2 - 5.32769$ , a negative solution was produced for  $T$ . What would be the meaning of such a negative solution for the physical situation of this lab?

*Free answers to only Labs 5, 9, 18, 21, 23*

- If six nuts were hung on the end of the spring used in this lab, what would be the period?

*Free answers to only Labs 5, 9, 18, 21, 23*

- What is the **general** positive solution of  $N = 3.1383T^2 - 5.32769$  for  $T$ ?

*Free answers to only Labs 5, 9, 18, 21, 23*



- In this lab the slinky was stretched and then released to bob up and down while the time of 30 cycles was noted. Would the results have been the same if, instead of stretched, the slinky was compressed and then released?

*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 25

- Why is the function produced in Calculator Activity # 1 ( $N = 4.997x^2 - 5.7018x - .9788$ ) different from the theoretical function presented in MathLab 23 ( $N = 3.1383T^2 - 5.32769$ )?

*Free answers to only Labs 5, 9, 18, 21, 23*

- As can be seen from the scatter plot produced in this lab, the points are bunched together on a relatively small section of the parabola. How does this “tight bunching” affect the quality of the quadratic regression?

*Free answers to only Labs 5, 9, 18, 21, 23*

- What is the meaning of mathematical extrapolation as was mentioned in the last sentence of this lab? (**Research needed**)

*Free answers to only Labs 5, 9, 18, 21, 23*

- Does adding more weight on the end of a spring make it oscillate faster or slower?

*Free answers to only Labs 5, 9, 18, 21, 23*

- What is meant by the “elastic limit” of a spring? (**Research needed**)

*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 26

- The process for estimating the time value corresponding to  $N = 5$  is not called interpolation. Rather, it is called what? (Note that the  $N$  values in the table on page 1 only have values 1, 2, 3, and 4.) (**Research needed**)

*Free answers to only Labs 5, 9, 18, 21, 23*

- Using the table from page 1, interpolate to find the  $N$  value corresponding to  $T = 1.58$ .

*Free answers to only Labs 5, 9, 18, 21, 23*

- Using the table from page 1, interpolate to find the  $T$  value corresponding to  $N = 1.85$ .

*Free answers to only Labs 5, 9, 18, 21, 23*

4. Why is the interpolation process used in this lab called **linear** interpolation?  
*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 27

1. If a concave semicircular molding of radius 10” has all points translated 3” perpendicular to the surface of the molding at each point, what will be the **diameter** of the new semicircle produced?  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. What is the new equation of  $f(x) = 5x^3 - 6$  when translated upward 2 units?  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. Modify the general function  $f(x)$  so that it is translated down  $t$  units.  
*Free answers to only Labs 5, 9, 18, 21, 23*
4. What is the new equation of  $f(x) = 5x^3 - 6$  when translated 7 units to the left?  
*Free answers to only Labs 5, 9, 18, 21, 23*
5. Modify the general function  $f(x)$  so that it is translated right  $t$  units.  
*Free answers to only Labs 5, 9, 18, 21, 23*
6. What is a synonym for “translate” as used in this lab?  
*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 28

1. Software can very quickly generate many random numbers that represent the positions of raindrops. Suppose that a particular program generates 1,000,000 points in the square (10 X 10) presented in this lab and 785,147 in the circle (radius 5). What is the estimate of  $\pi$  based on these numbers?  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. Does using 100,000 raindrops as opposed to 1000 raindrops guarantee better results when estimating  $\pi$  with the techniques of this lab?  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. Why is the technique used in this lab called the Monte Carlo technique?  
*Free answers to only Labs 5, 9, 18, 21, 23*

4. It turns out that when a computer generates random numbers that represent the random coordinates of raindrops, there is a point beyond which generating more points does not extend the precision of the estimate for  $\pi$ . What is a possible explanation for this since theoretically the precision for the estimate for  $\pi$  should increase as more and more raindrops are created? (**Research needed**)  
*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 29

1. What would have been the longest telephone pole that could be placed in a room that is a right circular cylinder of radius 30' and height 10'?  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. How high would a room of length 28' and width 20' need to be so that the longest diagonal would be 40'?  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. Suppose a box is 40' wide but infinitely long. Is it possible to say the diagonals of this box are longer than the length of the box?  
*Free answers to only Labs 5, 9, 18, 21, 23*
4. Consider the last drawing in this lab. What is the angle between the two lines labeled  $h1$  and  $h2$ ? (**Research needed**)  
*Free answers to only Labs 5, 9, 18, 21, 23*

### MathLab 30

1. In the last drawing above, calculate the angle between the side of length 278 and the hypotenuse.  
*Free answers to only Labs 5, 9, 18, 21, 23*
2. How many plane surfaces does the pyramid of this lab have?  
*Free answers to only Labs 5, 9, 18, 21, 23*
3. The sides of the Luxor and the great pyramid in Egypt both slope up with an angle of approximately  $52^\circ$ . This is not the answer that was obtained in problem #1. Why aren't they the same?  
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4. Show how to get the  $52^\circ$  (approximately) mentioned in problem #3? (**Research needed**)

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5. Of what type rock is the great pyramid in Egypt primarily built? (**Research needed**)

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