PHYSICS

Physics Lab Instructions

Read and follow the steps to complete the investigation.

Pendulums and Energy Online Lab

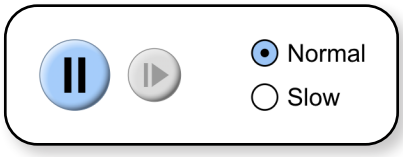
Potential Energy During the Swing of a Pendulum

For this first part of the investigation, click on the "Intro" mode of the simulation.

You will see a pendulum bob hanging on a string in the middle of the screen, with a ruler at the left side of the screen and variables that can be changed on the right of the screen. Keep the variables at the default setting, with the length at 0.70 m, the mass at 1.00 kg, the gravity of Earth, and friction at none.

Calculate the potential energy at different points of the pendulum's swing using the directions in this slideshow.

1. At the bottom of the screen, click on Slow. Also click on the pause button. Clicking on the pause button allows you to pull the pendulum bob back and have it stay there until you are ready for it to swing.

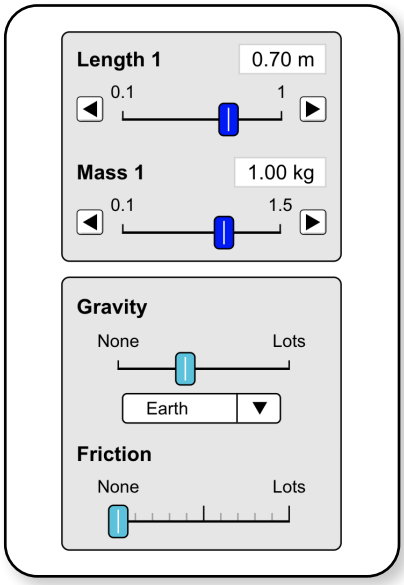


2. To find the potential energy of the pendulum bob at its start position, first grab the ruler and use it to measure the length of the string from the blue circle at the top to the bottom of the bob when it hangs straight down. Record this length on the data table in Question 1 on your assignment worksheet.

3. This measurement will be considered a height of 0 cm. Record that height in the column on the data table labeled "Height of bob compared to the lowest point of swing (cm)." Since 0 cm is also 0 m, record that in the data table under the column labeled "Height of bob compared to the lowest point of swing (m)."

4. From the information at the right-hand side of the screen, record the mass and acceleration due to gravity on the data table in Question 1 on your assignment worksheet. The acceleration due to gravity for Earth is 9.81 m/s^2.

5. Use the height of the bob at 0 m, the mass of the pendulum bob, and the acceleration due to gravity to



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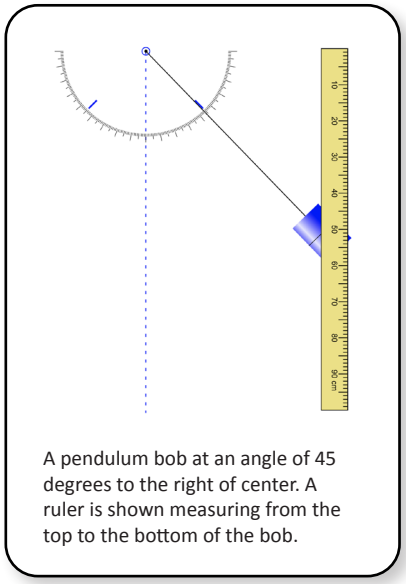
determine the potential energy of the pendulum bob when it is hanging straight down. Use the following equation to calculate potential energy.

$$PE = mgh$$

Show the work for this calculation on Question 2 on your assignment sheet and enter the answer in the data table in Question 1 under "Potential Energy (J)."

6. Next, pull the bob to the right until it reaches a 45° angle. You may need to move the ruler out of the way in order to see the angle measurement. Move the ruler over to measure the new height of the bob, measuring from the top (in line with the blue circle, but directly above the bob, down to the center of the bottom of the pendulum bob as shown in this image). Record this number on the data table in Question 1 on your assignment worksheet under the column "Distance from the top to the bottom of the bob."



A pendulum bob at an angle of 45 degrees to the right of center. A ruler is shown measuring from the top to the bottom of the bob.

7. You will use the first measurement as the base and then determine how high the other points are from that base. To determine the height at the starting position, subtract the measurement when it is pulled back to a 45° angle from the length when the bob is straight down. Record this on the data table in Question 1 on your assignment worksheet under "Height of bob compared to the lowest point of swing."

8. The height of the bob is in centimeters. To calculate the potential energy, the height must be converted to meters. To convert centimeters to meters, divide the measurement in centimeters by 100. Convert the height and record it on the data table in Question 1 on your assignment worksheet.

9. The mass and the acceleration due to gravity are the same as when the pendulum was straight down. Record these values in the data table in Question 1 on your assignment worksheet.

10. Use the height of the bob at a 45° angle, the mass of the pendulum bob, and the acceleration due to gravity to determine the potential energy of the pendulum bob at 45°. Use the equation given previously. Show the work for this calculation on Question 3 on your assignment sheet and enter the answer on the data table on Question 1.

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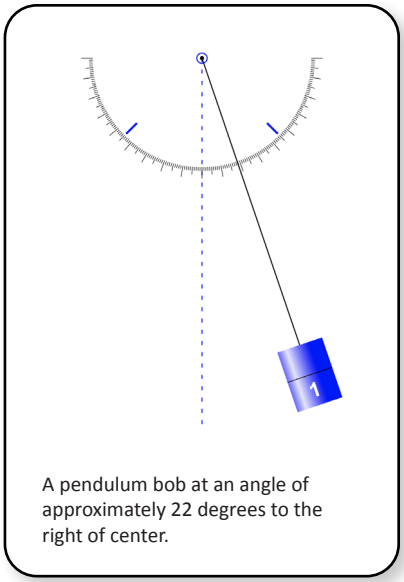
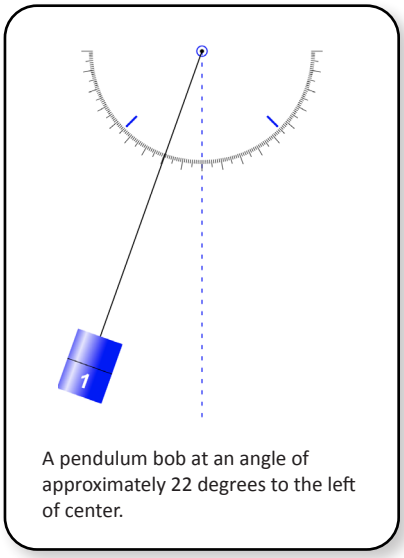
11. Let the pendulum bob start moving by clicking on the play button. Pause the bob when it is about halfway down to the bottom, as shown in this image. Determine the new height of the bob the same way you determined it at the 45° angle. Measure from the top down to the middle of the bottom of the bob. Record this number on the data table on Question 1, then subtract that measurement from the length of the bob at the bottom. Record this height on the data table in Question 1 on your assignment worksheet.



A pendulum bob at an angle of approximately 22 degrees to the right of center.

12. Convert the height to meters as you did for the previous angle and record the measurement. Also record the mass and the acceleration due to gravity. Then, use the height along with the mass of the pendulum and the acceleration due to gravity to determine the potential energy of the pendulum bob at this new angle. Show the work for this calculation on Question 4 on your assignment worksheet and put the answer in the data table on Question 1.

13. Let the pendulum bob start moving again by clicking on the play button. Pause it when it goes partway up the other side as shown in this image. Repeat Steps 11 and 12 at this new height. Show your work for the potential energy for this new height on Question 5 on your assignment worksheet and record all values on the data table on Question 1.



A pendulum bob at an angle of approximately 22 degrees to the left of center.

14. Let the pendulum bob start to move again by clicking on the play button. Pause it when it reaches its highest point on the left side. Repeat Steps 11 and 12 at this new height. Show your work for the potential energy for this new height on Question 6 on your assignment worksheet and record all values on the data table on Question 1.

15. Look at the potential energy for each point along the pendulum bob's path. Describe what happens to the potential energy of a pendulum during its swing on Question 7 on your assignment worksheet.

16. Predict what would happen to the kinetic energy at each point and record this on Question 8 on your assignment worksheet.

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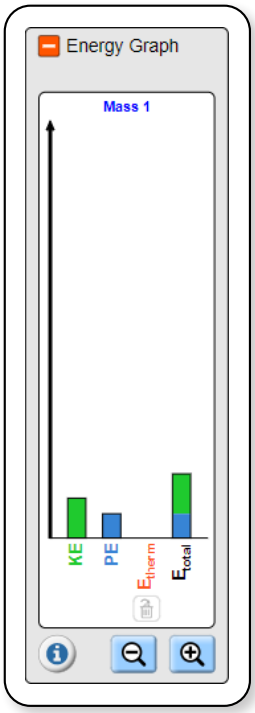
Relationship Between Potential Energy and Kinetic Energy

For this part of the investigation, click on the "Energy" mode located below the simulation window.

On the right are the variables that can be changed. Keep the default values on these variables. Length should stay at 0.70 m, mass at 1.00 kg, gravity of Earth, and friction at none.

On the left, there is a graph that records the kinetic energy (KE), the potential energy (PE), and the total energy (E_{total}). On this graph the kinetic energy is represented by a green bar, and the potential energy is represented by a blue bar. There is no thermal energy since there is no friction.



At the bottom of the screen, click on the pause button and the slow button. Keep the single blue bob.

Follow these instructions to explore the relationship between kinetic energy and potential energy and to relate that to the conservation of energy.

1. Drag the pendulum bob to the right to 45°. Look at the energy graph. On Question 9 of your assignment worksheet tell what type of energy the pendulum has at 45°.

2. Click on play to drop the pendulum. Click on pause when the bob is about halfway to the bottom. Look at the energy graphs. On Question 10 of your assignment worksheet, tell what type of energy the pendulum has at this location. How do the types of energy compare?

3. Click on play again and click on pause when the bob reaches the bottom. Look at the energy graphs. On Question 11 of your assignment worksheet, tell what type of energy the pendulum has at this location. How do the types of energy compare?

4. Click on play again and click on pause when the bob goes up halfway to its highest point on the left of its swing. Look at the energy graphs. On Question 12 of your assignment worksheet, tell what type of energy the pendulum has at this location. How do the types of energy compare?

5. Click on play again and click on pause when the bob is at its highest point on the left of its swing. Look at the energy graphs. On Question 13 of your assignment worksheet, tell what type of energy the pendulum has at this location. How do they compare?

6. Click on play again and allow the pendulum to swing back and forth several times, while watching the energy graphs on the left. Then answer Questions 14-16.