

Experiment #6 Work and Energy Pre-lab Questions

Hints

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1. Lift a book from the floor to the table. Did you do work? To answer this question, consider whether you applied a force parallel to the displacement of the book.

Work is defined by applying a force parallel to the displacement of an object or applying a displacement parallel to an acting force.

$$W = F \cdot \Delta l \cos(\theta)$$

If we draw a free body diagram of the book:

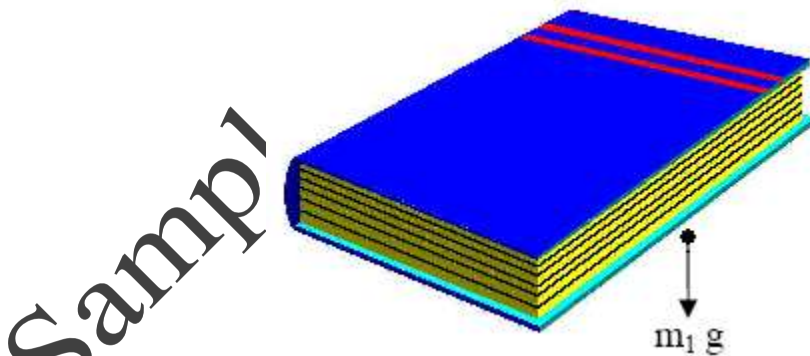


Figure 1: Free body diagram of a book under the influence of gravity.

Notice there is always force acting on the book, due to the acceleration due to gravity. This is in the “down” direction. Hence, according to the definition for work, the only way to do work is by moving the book in a direction parallel to the acting force of gravity. This means directly “up” or directly “down”. Any displacement (movement) of the book perpendicular to the acting force does not do any work. This means “side-to-side”.

Now, let's consider the movement of a book from the floor to a table (see the figure below).

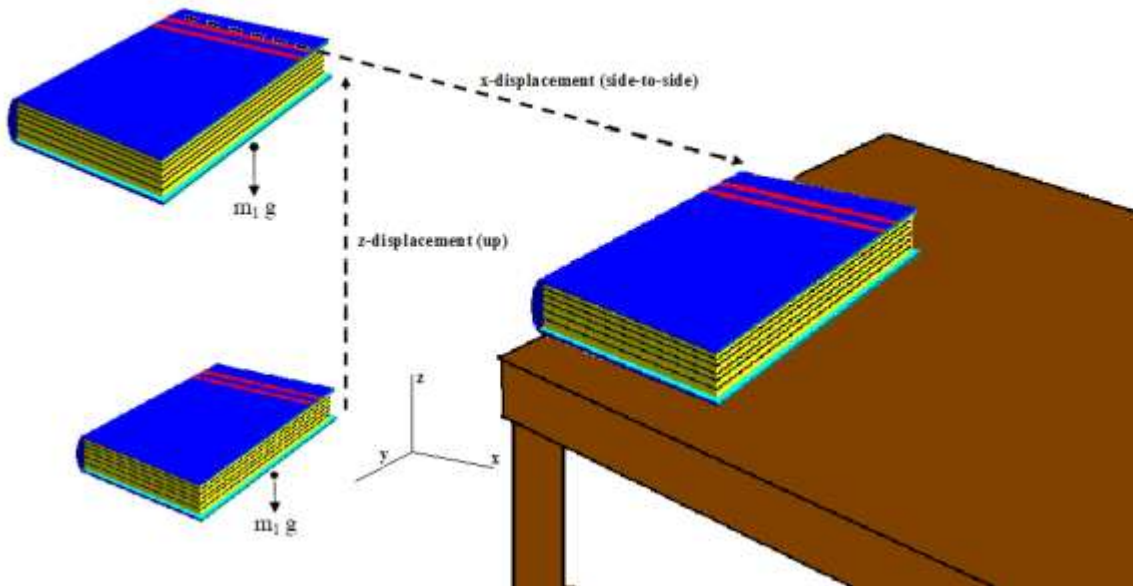


Figure 2: Displacement of a book from the Floor to a Table.

Now, use the logic above and the image to determine if there is any work being done, and where.

- The following graph shows how a constant force, in this case gravity, acts over distance: Lifting a mass (m) up against gravity.

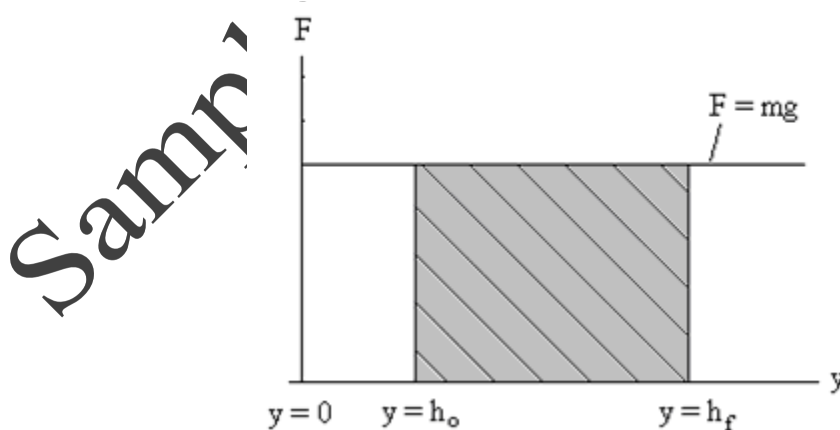


Figure 3: Graph of force versus displacement for a mass under the influence of gravity

Show that the indicated area under the force curve is just the potential energy stored in the object by the force, $\Delta U = mg\Delta h$. What units does the “length” of the

rectangle have? What units does the “height” of the rectangle have? What units does the area under the curve have?

The area under the force line (the shaded area) is simply a rectangle. Determine the equation for the area of a rectangle.

The height and width of the rectangle can be found from the difference of the final value and initial values (sides of the box).

Height:

$$\Delta F = F_{final} - F_{initial} = mg - 0 = mg$$

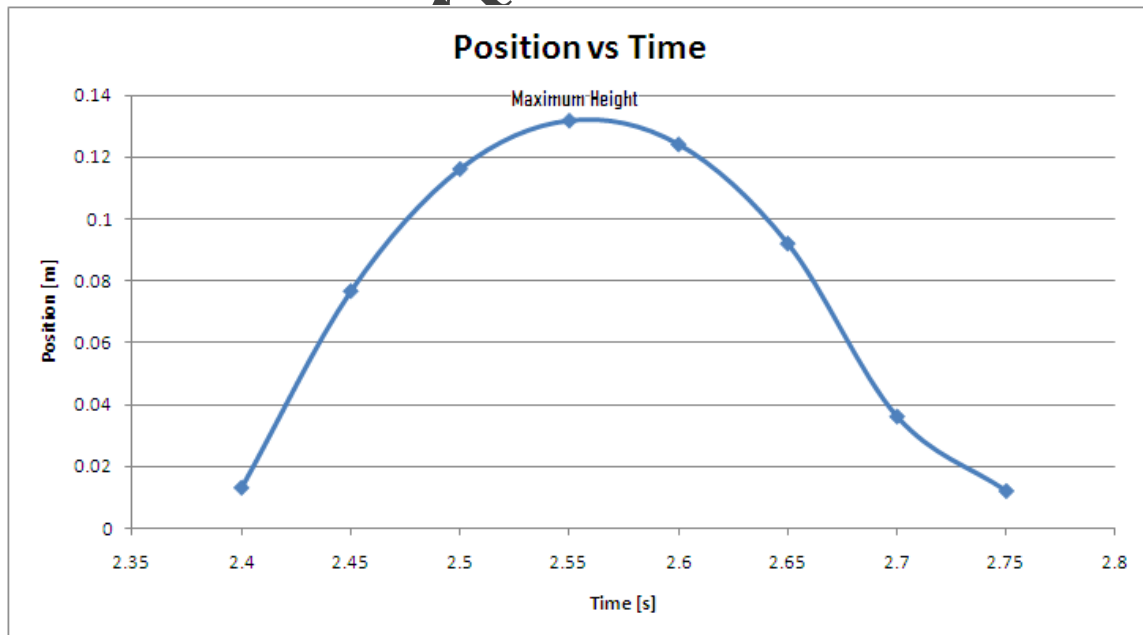
Width:

$$\Delta h = h_{final} - h_{initial} = h_f - h_o$$

Use the values above to get a relationship for Potential based on the area calculation.

You can figure out the units by determining what physical quantity is plotted where in the figure.

3. Think about the physics behind tossing a ball into the air and catching it. Sketch out a plot of the ball's position (height) vs. time and indicate the maximum height.



Throwing a ball into the air will follow the kinematic ballistic motion (we can refer to labs 3 and 4 to see this action). Above is my diagram I drew for this question. It's fairly obvious where the maximum height is. ☺

4. Now let's see if you know what a graph of the potential energy should look like. Plot the potential energy vs. time. Sketch the potential energy curve on the same graph as the position vs. time sketch. When will the potential energy be the greatest? When will the potential energy be the least?

The mathematical equation for potential energy is given as:

$$U = mgh$$

Also note that the potential energy is a function of mass of the object (constant), the acceleration due to gravity (constant), and the relative height of the object (see above). Use that information to draw a potential energy versus time graph.

5. Now for the tricky one. Sketch the kinetic energy vs. time. Use the same graph as the one above. When will the kinetic energy be a maximum (velocity be the greatest)? When will the kinetic energy be zero?

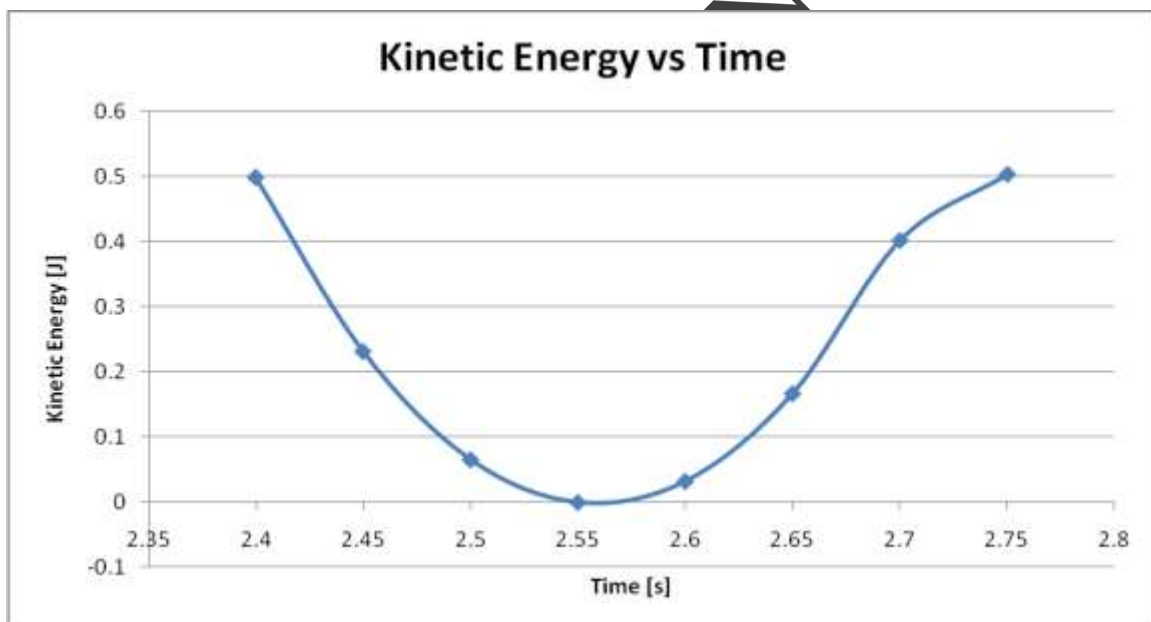
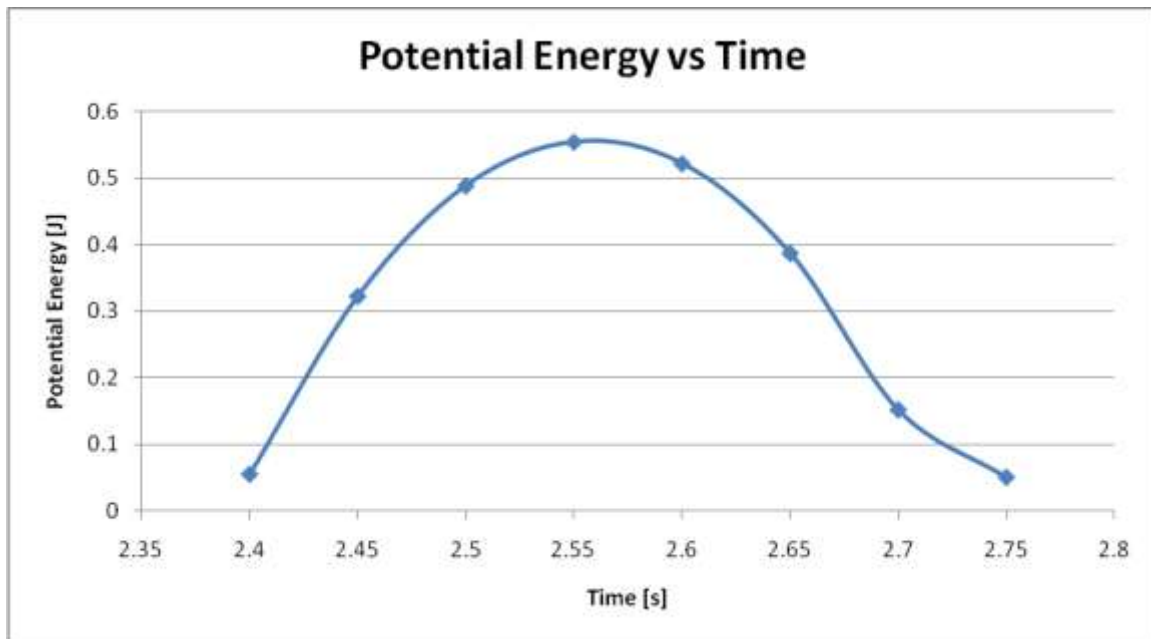
The mathematical equation for kinetic energy is given as:

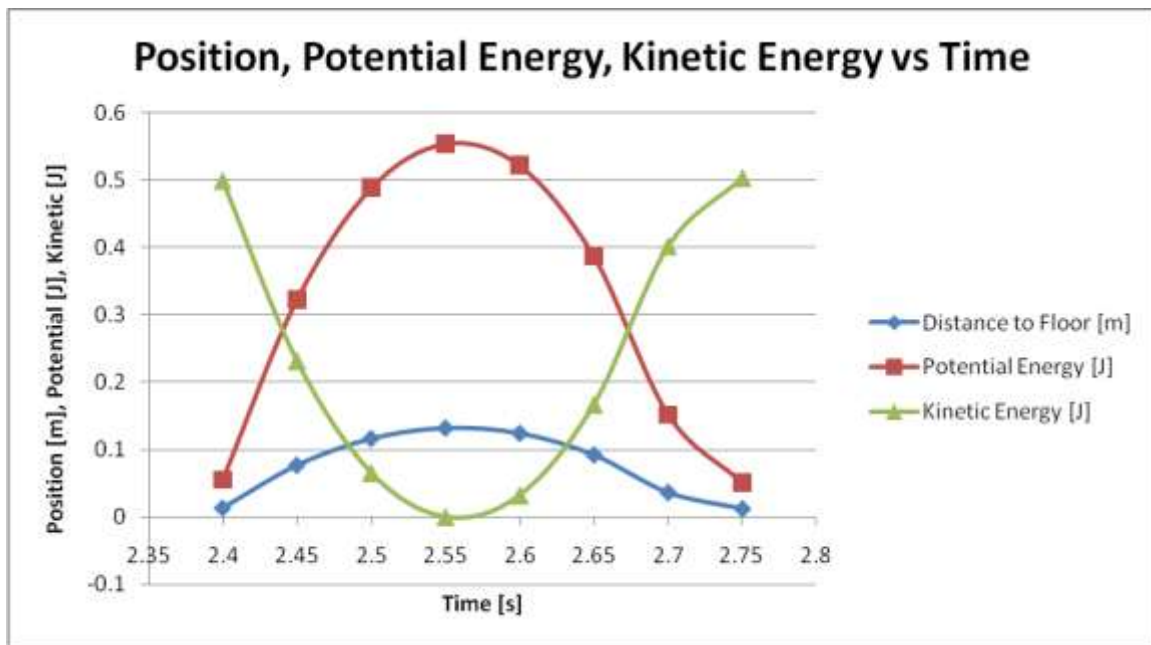
$$K = \frac{1}{2}mv^2 \text{ or } U + K = E (\text{constant})$$

Draw a figure based on this kinetic energy versus time.

Have your instructor check your sketches before starting the experiment.

The following are my diagrams I made when doing my prelab for questions 4 and 5 (for comparison only). [Consider this your "check".]





Sample Only Do Not