

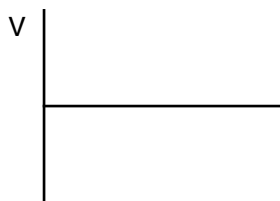
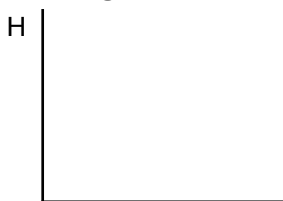
### Lab 8-3: Energy of a Tossed Ball

- Purpose:**
1. To examine graphs of kinetic and potential energy for a toy ball that is tossed up in the air.
  2. To see how the total energy of a ball changes as it goes up and down after tossing it in the air.

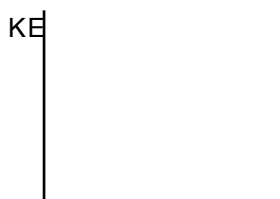
**Preliminary Questions:**

*In the following questions, imagine tossing a ball over a motion detector and catching it when it comes back down. Only consider the motion of the ball while it is in the air.*

1. What form or forms of energy does the ball have while momentarily at rest at the top of the path?
2. What form or forms of energy does the ball have while in motion near the bottom of the path?
3. What does a height of zero mean to the motion detector?
4. Sketch graphs of position vs time and velocity vs. time for the ball while it is in the air. Identify the portions that correspond to the release of the ball, at its maximum height, and when you catch it again.



5. Sketch graphs of potential energy vs. time and kinetic energy vs time for the ball while it is in the air.



6. If there are no frictional forces acting on the ball, how is the change in the ball's potential energy related to the change in kinetic energy?

**Procedure:**

1. Start Logger Pro and open up the file called "16 Energy of a Tossed Ball."
2. Enter the mass of the ball in the box in the lower right portion of the screen. Place the motion detector pointing up, and toss the ball up in the air a couple times. With a little luck, one of the tosses will show a "nice" set of graphs. Zoom in on a nice toss (or just ignore the messy ones.)
3. Click on the Examine tool and move the mouse across the distance or velocity graphs of the motion of the ball to answer these questions:
  - a. Identify the portion of each graph where the ball had just left your hands and was in free fall. Determine the height and velocity of the ball at this time. Enter your values in the data table.
  - b. Identify the point on each graph where the ball was at the top of its path. Determine the time, height, and velocity of the ball at this point. Enter your values in the data table.

**Lab 8-3: Energy of a Tossed Ball**

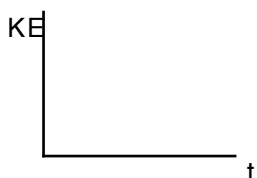
- c. Find a time where the ball was moving downward, but a short time before it was caught. Measure and record the height and velocity of the ball at that time.
- d. For each of the three points in the data table, calculate the Potential Energy (PE), Kinetic Energy (KE), and Total Energy (TE). Use the position of the Motion Detector as the zero of your gravitational potential energy. Show your calculations below, and record the answers in the data table.

**Data:**

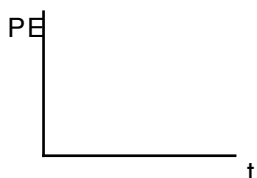
<i>Position</i>	<i>Height (m)</i>	<i>Velocity (m/s)</i>	<i>PE (J)</i>	<i>KE (J)</i>	<i>TE (J)</i>
After release					
Top of path					
Before catch					

**Conclusions:**

1. How well do the calculations show conservation of energy? Explain.
2. Click on the top graph's vertical axis label and change the display to Kinetic Energy, *KE*. Inspect your kinetic energy vs. time graph for the toss of the ball. Sketch the shape of the graph while the ball was in the air and explain what happens to the kinetic energy of the ball while it is in the air.



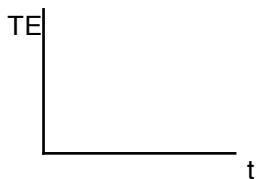
3. Click on the bottom graph's vertical axis and change the display to the Potential Energy, *PE*. Inspect your potential energy vs. time graph for the toss of the ball. Sketch the shape of the graph while the ball was in the air and explain what happens to the potential energy of the ball while it is in the air.



4. Compare your energy graphs predictions (from the Preliminary Questions) to the real data for the ball toss.

### Lab 8-3: Energy of a Tossed Ball

5. Click on the vertical axis of the KE graph and choose “More” then check Potential energy and click ok. You should now have both the KE and PE graphs on the same graph (rescale if needed). Notice that when  $KE=0$  PE is at a maximum. Why is PE not equal to zero when KE is at a maximum?
6. Logger Pro will also calculate Total Energy, the sum of KE and PE. Click on the top graph’s vertical axis label, choose “More” and add the Total Energy to the graph. Sketch the shape of the graph of Total Energy vs time and explain what happens to it while the ball was in the air.



7. What do you conclude from this graph about the total energy of the ball as it moved up and down in free fall? Was energy conserved?
8. Would the shapes of the graphs you made change if you had entered the wrong mass for the ball? Explain.

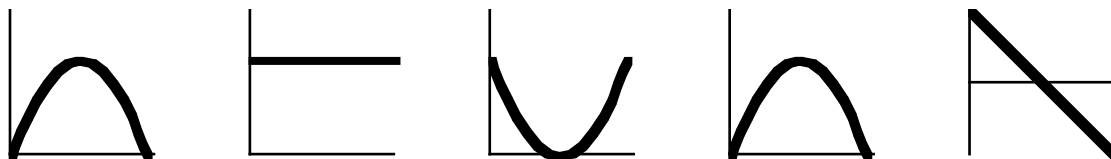
#### Follow-Up Questions:

1. A ball is tossed up in the air with 50 J of kinetic energy. Its initial height is 0 meters.
  - a. What is its potential energy? How about its total energy?
  - b. As it goes up in the air, what happens to its kinetic energy?
  - c. As it goes up in the air, what happens to its total mechanical energy?
  - d. At its maximum height, what is its kinetic energy? potential energy? total energy?
  - e. At some point, the balls kinetic energy is 30 J. What is its potential energy? total energy?
  - f. At some point, the balls potential energy is 40 J. What is its kinetic energy? total energy?
  - g. Where is it when:
    - i) its potential energy equals its kinetic energy?
    - ii) its total energy equals its kinetic energy?

**Lab 8-3: Energy of a Tossed Ball**

iii) its total energy equals its potential energy?

2. The following graphs all came from this lab. Label them correctly (include units.)



3. Some other students did the same lab with a 0.25 kg ball. They recorded the initial height and velocity of the ball as shown in the table. Fill in the rest of the table, but here are some hints:  
*What is the kinetic energy of the ball at its maximum height?*  
*What number stays constant even though the ball is going up and down and changing speeds?*

<i>(mass = 0.25 kg)</i>	<i>Height (m)</i>	<i>Velocity (m/s)</i>	<i>PE (J)</i>	<i>KE (J)</i>	<i>TE (J)</i>
Initial Data	0.75	3.70			
Top of Path					
Random Position		-2.3			