Mech. 2.

You are to perform an experiment investigating the conservation of mechanical energy involving a transformation from initial gravitational potential energy to translational kinetic energy.

(a) You are given the equipment listed below, all the supports required to hold the equipment, and a lab table. On the list below, indicate each piece of equipment you would use by checking the line next to each item.

____ Track	____ Meterstick	____ Set of objects of different masses
____ Cart	____ Electronic balance	____ Lightweight low-friction pulley
____ String	____ Stopwatch	

(b) Outline a procedure for performing the experiment. Include a diagram of your experimental setup. Label the equipment in your diagram. Also include a description of the measurements you would make and a symbol for each measurement.

(c) Give a detailed account of the calculations of gravitational potential energy and translational kinetic energy both before and after the transformation, in terms of the quantities measured in part (b).

(d) After your first trial, your calculations show that the energy increased during the experiment. Assuming you made no mathematical errors, give a reasonable explanation for this result.

(e) On all other trials, your calculations show that the energy decreased during the experiment. Assuming you made no mathematical errors, give a reasonable physical explanation for the fact that the average energy you determined decreased. Include references to conservative and nonconservative forces, as appropriate.

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Question 2

15 points total | **Distribution of points**

(a) 1 point

For choosing the meterstick and stopwatch, regardless of what else is checked — 1 point

(b) 4 points

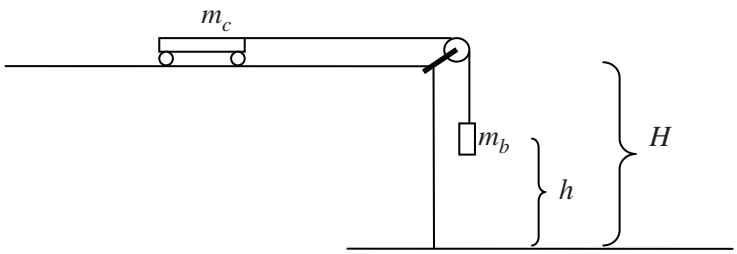
For a procedure that indicates the height needed to calculate gravitational potential energy — 1 point

For a procedure that indicates distance and time measurements to calculate velocity — 1 point

For a diagram and a clear indication of the height measurement — 1 point

For a diagram and a clear indication of the distance measurement — 1 point

Example #1



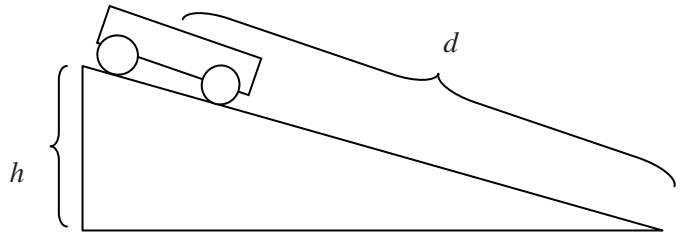
- Use the electronic balance to determine the mass m_c of the cart and the mass m_b of one object.
- Attach the object to the cart using the string.
- Place the cart on the track and hang the object so that the string passes through the pulley.
- Allow the object to fall a distance h from its initial position to the floor, using the meterstick to measure the distance fallen.
- Use the stopwatch to measure the time t it takes the object to fall the distance h.
- Measure the height H of the table.

Question 2 (continued)

Distribution of points

(b) continued

Example #2



- Use the electronic balance to determine the mass m of the cart.
- Set the track at an incline, and measure the height h of the incline.
- Place the cart at the top of the incline, and release from rest.
- Using the stopwatch, measure the time t it takes for the cart to move down the incline.
- Measure the distance d that the cart moves down the incline.

(c) 6 points

For a clear indication of the initial potential energy of the system	1 point
For a clear indication of the final potential energy of the system	1 point
For a clear indication of the initial kinetic energy of the system	1 point
For a clear indication of the final kinetic energy of the system	1 point
For a correct calculation of the instantaneous velocity of the system	2 points

Example #1

Initial gravitational potential energy: $U_{g0} = m_c gH + m_b gh$

Final gravitational potential energy: $U_{gf} = m_c gH$

Initial kinetic energy: $K_0 = 0$

Final kinetic energy: $K_f = \frac{1}{2}(m_c + m_b)v_f^2$

Acceleration is constant, so $d = \frac{1}{2}(v_0 + v_f)t$, where d is the distance along the track.

$v_f = \frac{2h}{t}$

Question 2 (continued)

Distribution of points

(c) continued

Example #2

Initial gravitational potential energy: $U_{g0} = mgh$

Final gravitational potential energy $U_{gf} = 0$

Initial kinetic energy $K_0 = 0$

Final kinetic energy $K_f = \frac{1}{2}mv_f^2$

Acceleration is constant, so $d = \frac{1}{2}(v_0 + v_f)t$.

$v_f = \frac{2d}{t}$

(d) 2 points

For identifying a reasonable cause for the increase in energy — 1 point

For a reasonable explanation related to the cause identified — 1 point

Example
An unintentional push was applied to the cart, thus increasing the initial energy.

(e) 2 points

For identifying a reasonable cause for the decrease in energy related to the nonconservative forces acting on the system — 1 point

For a reasonable explanation related to the cause identified — 1 point

Example
Friction acting on the object decreases the speed, thereby decreasing the energy.