Physics 131- Fundamentals of Physics for Biologists I

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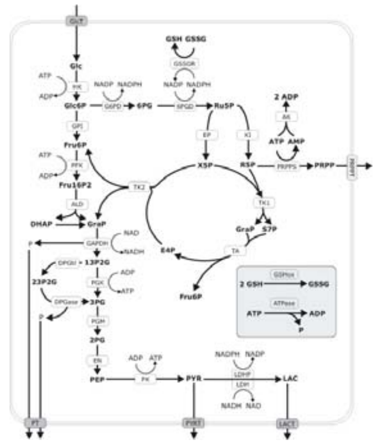


Metabolism

A biological example of energy transfer

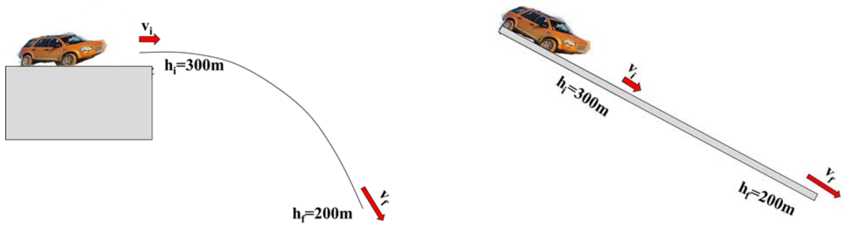
http://www.youtube.com/watch?v=1KgDXDLZNJI&feature=related

Quiz 9

Mechanical Energy Conservation

Types of Potential Energies

Review from Wed: Mechanical Energy Conservation



- Total of kinetic and potential energy are conserved
- normal forces do no work

$$\Delta(\tfrac{1}{2}mv^2) = mg\Delta h$$

$$\Delta(\tfrac{1}{2}mv^2 + mgh) = 0$$

$$\tfrac{1}{2}mv_i^2 + mgh_i = \tfrac{1}{2}mv_f^2 + mgh_f$$

Dimensions and Units of Energy

- $[1/2\ mv^2] = M\,(L/T)^2 = ML^2/T^2$
- 1 kg m^2/s^2 = 1 N m = 1 Joule
- Other units of energy are common (and will be discussed later)
  - Calorie
  - eV (electron Volt)

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Power

An interesting question about work and energy is the rate at which energy is changed or work is done. This is called *power.*

$$\text{Power} = \frac{\text{Energy change}}{\text{time to make the change}}$$

$$= \frac{\Delta W}{\Delta t} = \vec{F}^{net} \cdot \frac{\Delta \vec{r}}{\Delta t} = \vec{F}^{net} \cdot \vec{v} \quad \text{(for mechanical work)}$$

Unit of power: 1 Joule/sec = 1 Watt

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Foothold ideas: Potential Energy

- For some forces work only depends on the change in position. Then the work done can be written $\vec{F} \cdot \Delta\vec{r} = -\Delta U$

  U is called a *potential energy*.

- For gravity, $U_{gravity} = mgh$

  For a spring, $U_{spring} = ½ kx^2$

  For electric force, $U_{electric} = k_C Q_1 Q_2 / r_{12}$

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Foothold Ideas:
Conservation of Mechanical Energy

- Total of kinetic plus potential energy are conserved if resistive forces can be ignored

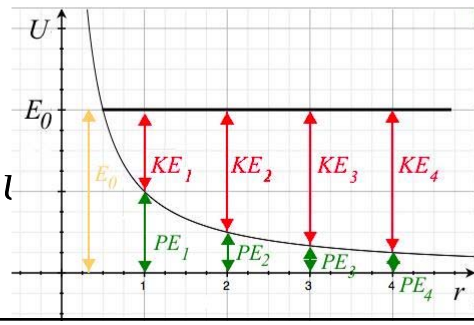
Mathematical Representation

$$\Delta(\tfrac{1}{2}mv^2) = \Delta U$$

$$\Delta(\tfrac{1}{2}mv^2 + U) = 0$$

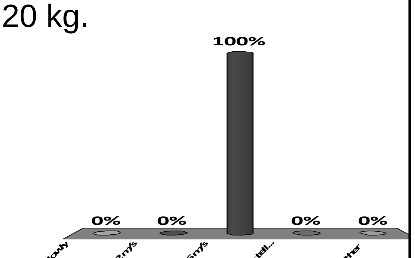
$$\tfrac{1}{2}mv_{initial}^2 + U_{initial} = \tfrac{1}{2}mv_{final}^2 + U$$

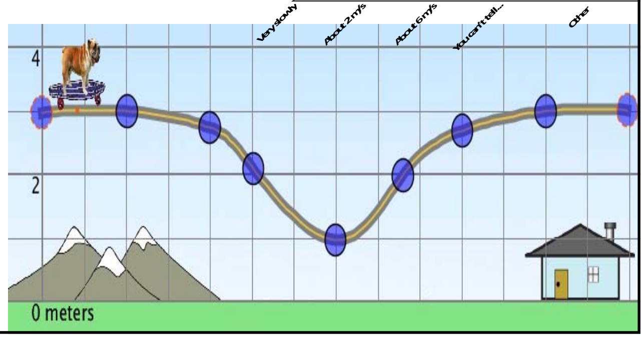
Graphical Representation



A bulldog on a skateboard is moving very slowly when he encounters a 2 m dip. How fast will be be going when he is at the bottom of the dip? The bulldog and skateboard combined have a mass of 20 kg. Friction and air drag can be ignored.

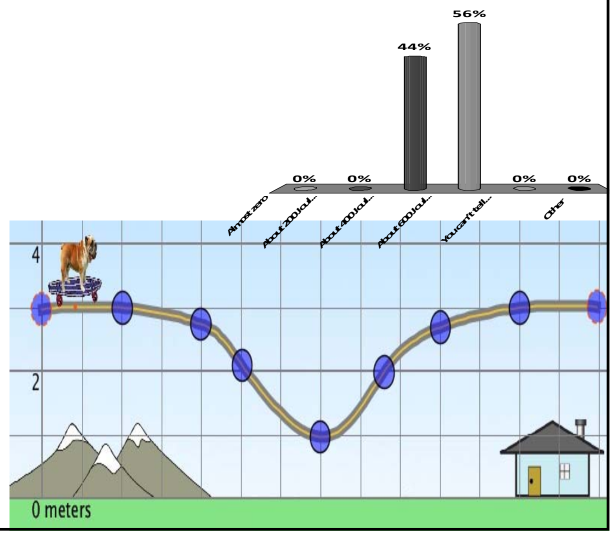
1. Very slowly
2. About 2 m/s
3. About 6 m/s
4. You can't tell from the information given.
5. Other





A bulldog on a skateboard is moving very slowly when he encounters a 2 m dip. The bulldog and skateboard combined have a mass of 20 kg. What is their total mechanical energy?

1. Almost zero
2. About 200 Joules
3. About 400 Joules
4. About 600 Joules
5. You can't tell from the information given.
6. Other



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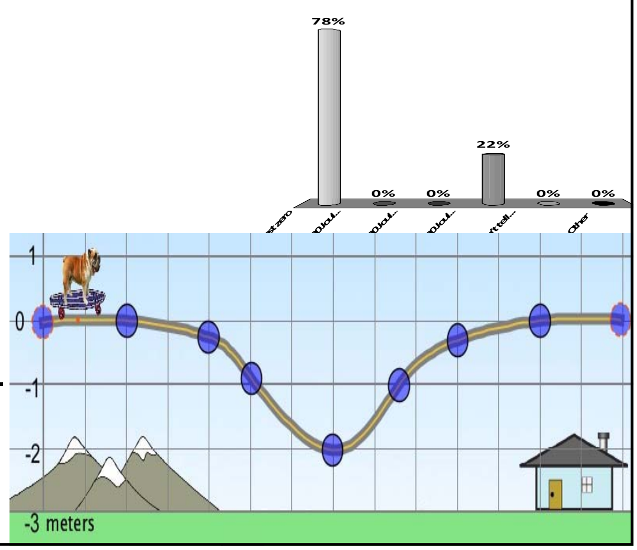
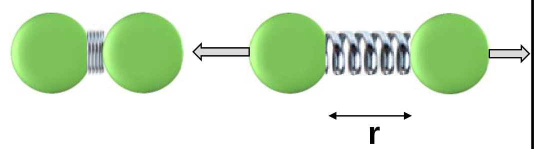
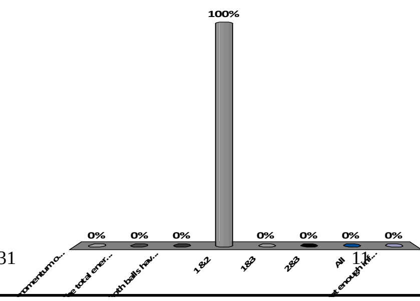


Comparing the "before" state at rest with a compressed spring and the "after" state with moving balls, which of the following is true

1. The momentum of the system is the same before and after
2. The total energy of the system is the same before and after
3. Both balls have the same momentum and energy in the "after" state
4. 1 &2
5. 1&3
6. 2&3
7. All





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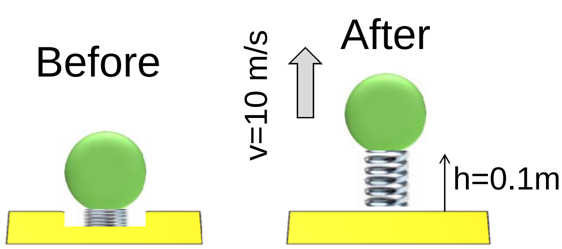
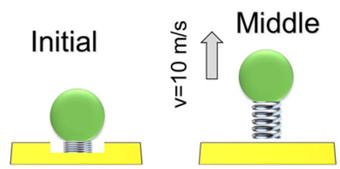
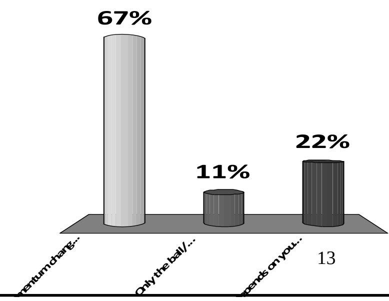
1. Draw System Schema for Before and After state
2. Identify main Energies in System Schema
3. Define a system boundary so that mechanical energy is conserved in the system



Comparing the before and after state, the spring pushes on both the ball and the earth giving them energy and momentum

1. Momentum change of ball/spring and earth is the same
2. Only the ball/spring changes momentum
3. Depends on your choice of system





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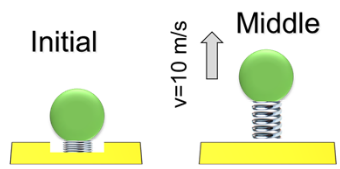
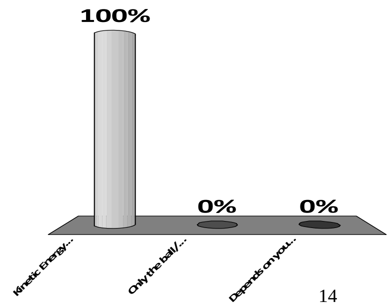
Comparing the before and after state, the spring pushes on both the ball and the earth giving them kinetic energy and momentum

1. Kinetic Energy change of ball/spring and earth is the same
2. Only the ball/spring changes Energy
3. Depends on your choice of system





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