Straight Up Physics V4

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Energy

[Flipping Physics- Energy]

Formulas:

Kinetic Energy- $K = \frac{1}{2}mv^2$ where v is the *velocity*

Gravitational Potential Energy- $U_g = mgh$ where h is the *distance* between the object and the *zero line*
Spring Potential Energy- $U_s = \frac{1}{2}kx^2$ where x is the *spring constant* and x is the *displacement*

Work/Change in Energy- $W = F_{\parallel} d = Fd\cos\theta = \Delta E$ where work is ***independent*** of the path and cos is between the force and displacement vector

Law of Conservation of Mechanical Energy- $K_i + U_{gi} + U_{si} \pm W = K_f + U_{gf} + U_{sf}$
Work Energy Theorem: $W = \Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ **-** a subset of the Law of Conservation where potential energy is constant
Power- $P = \frac{W}{t} = \frac{\Delta E}{t} = \frac{Fd\cos\theta}{t} = Fv\cos\theta$ where P is *(average) power* in *joules per second/watts* or the amount of energy transferred over a period of time.

In the last equation (not on equation sheet), I substituted d/t for *velocity*.

Concepts:

- **Zero Line:** Height at which the gravitational potential energy is **zero**. You can choose where this "line" is, but you must be **consistent**.
  - It is suggested to use key situations such as water level or the floor
- Kinetic energy is a **scalar** and can **never** be negative (v is squared)**.** This means that direction does **not** play a role in the kinetic energy.
  - Potential energy, both Gravitational and Spring, **can** be negative

Open and Closed Systems:

- Open System: external forces/work means mechanical energy is not conserved

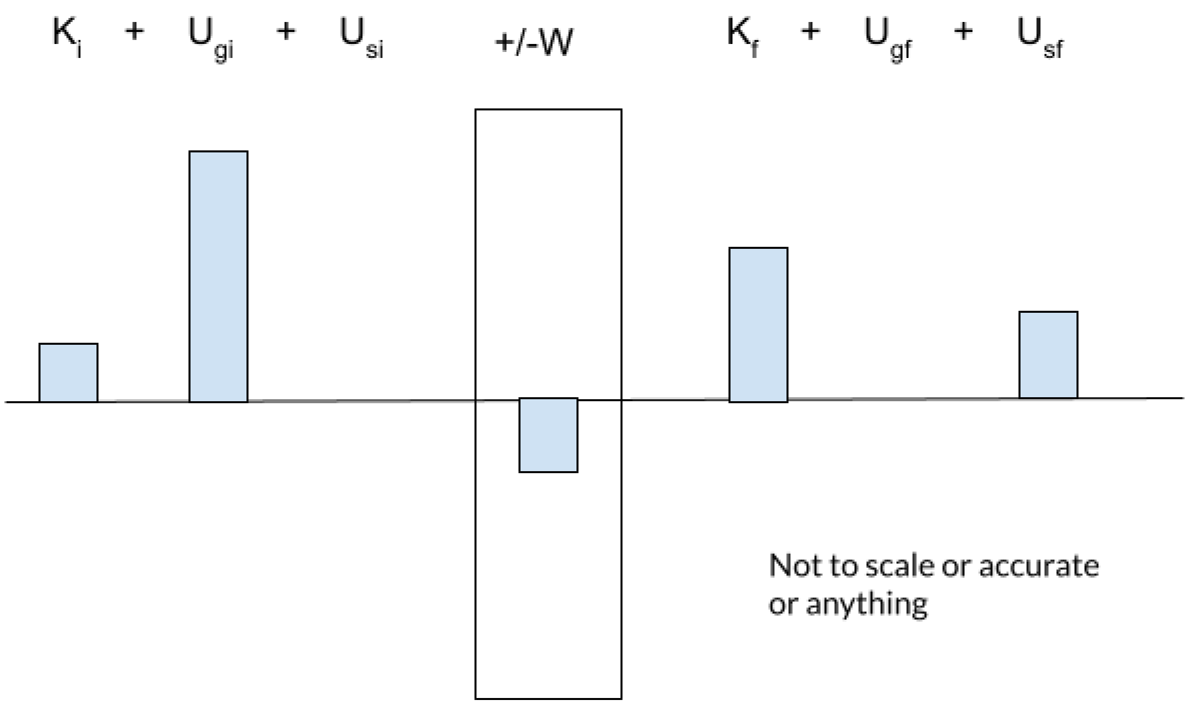
    - Meteorite hits the earth with the meteorite being the system. The meteorite stops once it's hit, losing all kinetic energy
- Closed System: no external forces/work means mechanical energy is conserved
    - Meteorite hits the earth with the meteorite and earth being the system. Once the meteorite hits, it loses all its kinetic energy but transfers it on to the earth (also in the system).

Graphs:

Fd graphs: area = F*d = Work/Change in Energy
Potential or Kinetic Energy over Time or Displacement

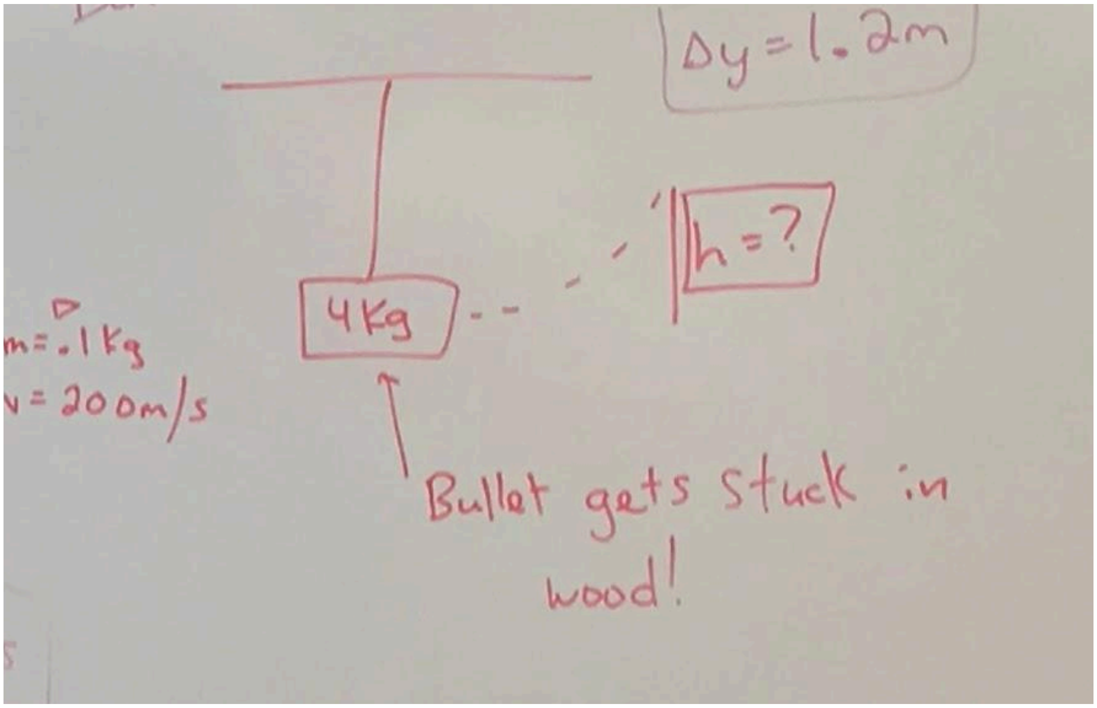
Energy Bar Chart:

Similar to the momentum bar chart



Problems:

Ballistic Pendulum:



Mixes momentum (collision) and energy (swing)

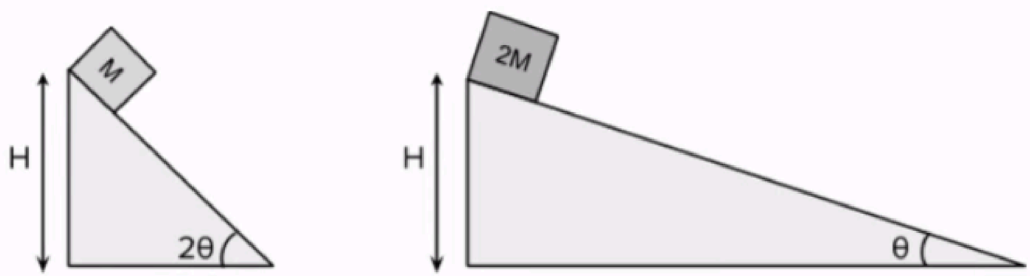
Work:

An object of mass 2kg travels 10m/s to the right. It encounters a wall and collides and is sent back traveling 10m/s to the left. What is the work done on the object by the wall assuming right is positive?

-200N 200N 0N 100N

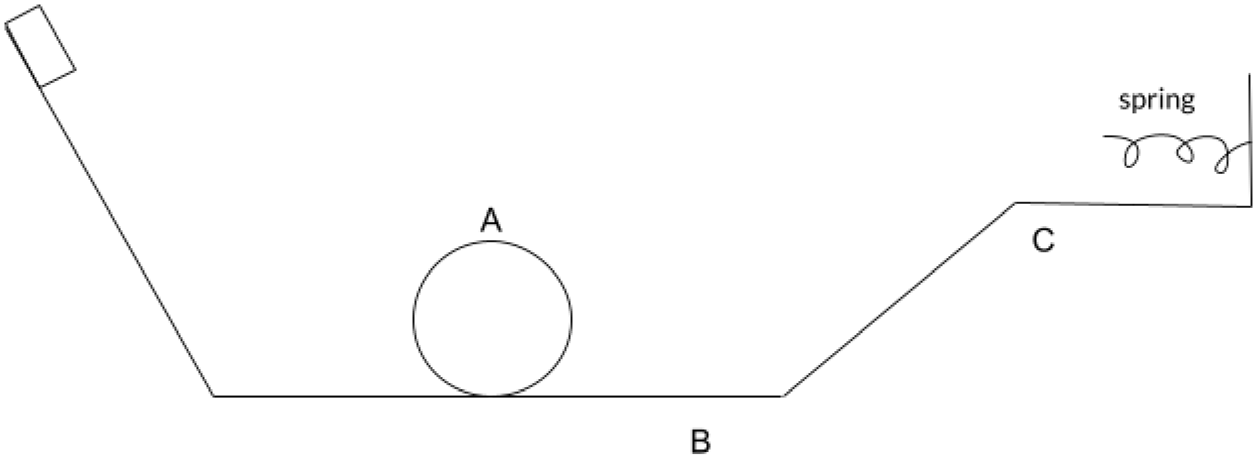
Question: A box of mass M slides down a frictionless ramp of height H and angle 2θ and a separate box of mass 2M slides down a frictionless ramp of height H and angle θ as seen below. How does the work done on the boxes by Earth compare?

A. Earth does more work on box M
B. Earth does more work on box 2M
C. Earth does equal positive work on both boxes
D. Earth does equal negative work on both boxes



Track:

An object initially at rest slides on a frictionless track with a loop shown below. Label kinetic energy at points A, B, C and how far will the spring compress.



If the track right before and after is now covered in carpet, will the cart make it up to the spring?