College Physics I: 1511 Mechanics & Thermodynamics

Professor Jasper Halekas
Van Allen Lecture Room 1
MWF 8:30-9:20 Lecture

Announcements

- Sample Midterm #1 Questions now available on the "Notes" tab on the main class web page
  - Solutions will be posted next week
- Remember your other resources for studying:
  - Me, your TAs, the TAs in the 3rd floor Tile Room
  - The book, class notes, Wiley Plus (including Orion)
- If anyone plans to ask for a makeup and has not yet done so please tell me ASAP!

Announcements II

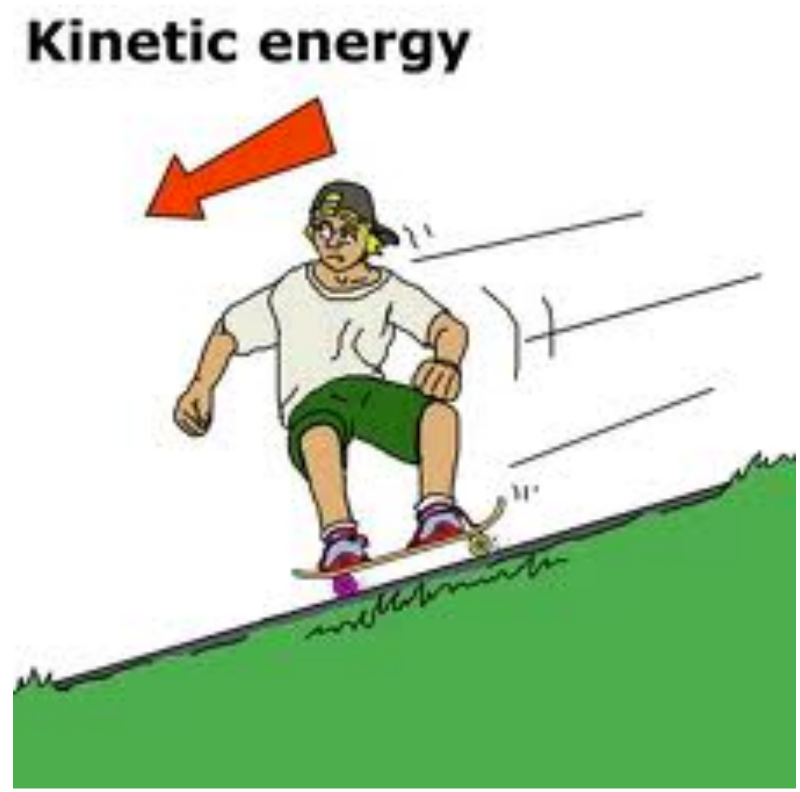
- Final Exam is now officially scheduled for Monday December 12 at 8:00-10:00 pm in this room
- If you have qualified exam conflicts and intend to take advantage of the opportunity to request a different exam time please let me know sooner rather than later
  - October 1 is the official deadline to do so

Conservation of Mechanical Energy

- $W_{net} = KE_f - KE_o$ $W_{cons} = PE_o - Pe_f$
- $KE_f - KE_o = PE_o - PE_f$ $\Delta KE = -\Delta PE$
  - (only true for conservative forces with $W_{net} = W_{cons}$)
- $KE_f + PE_f = KE_o + PE_o = E$
  - (constant for conservative forces)

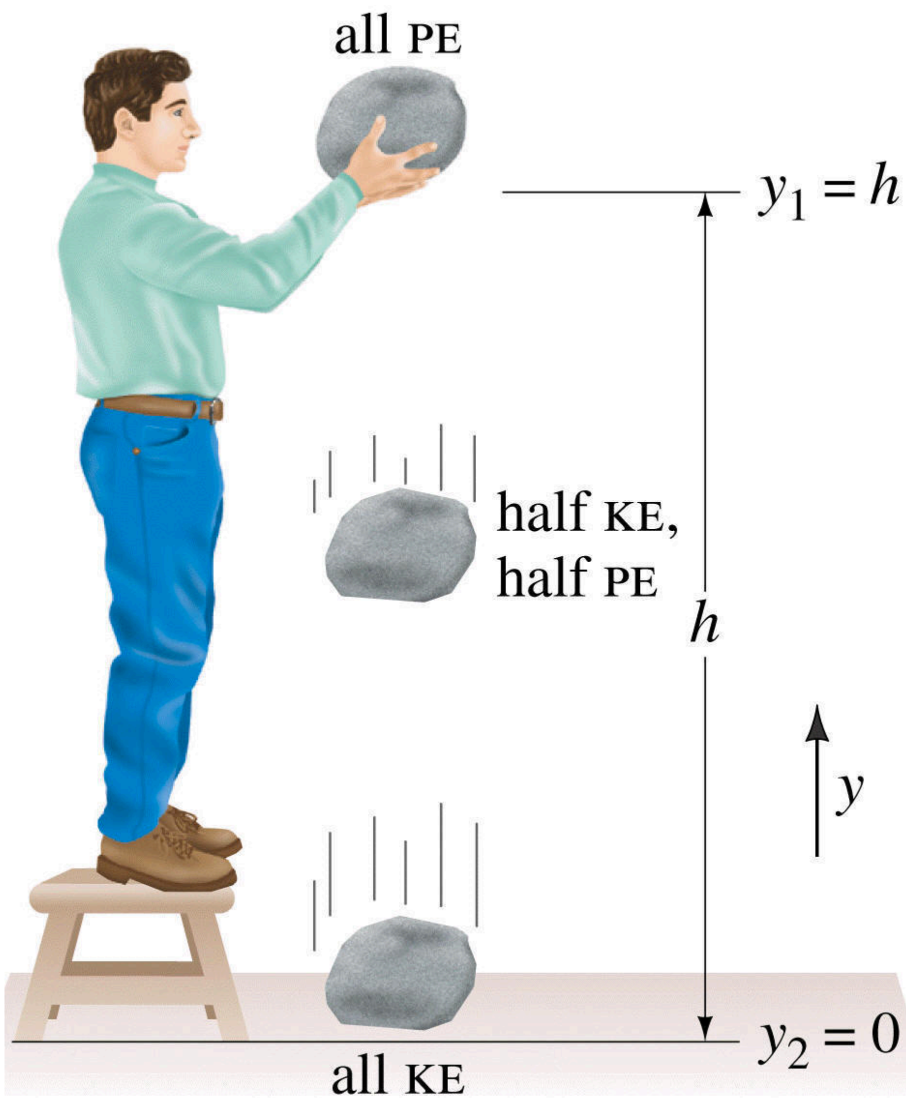
Kinetic Energy

- Kinetic energy = $1/2\ m\ v^2$

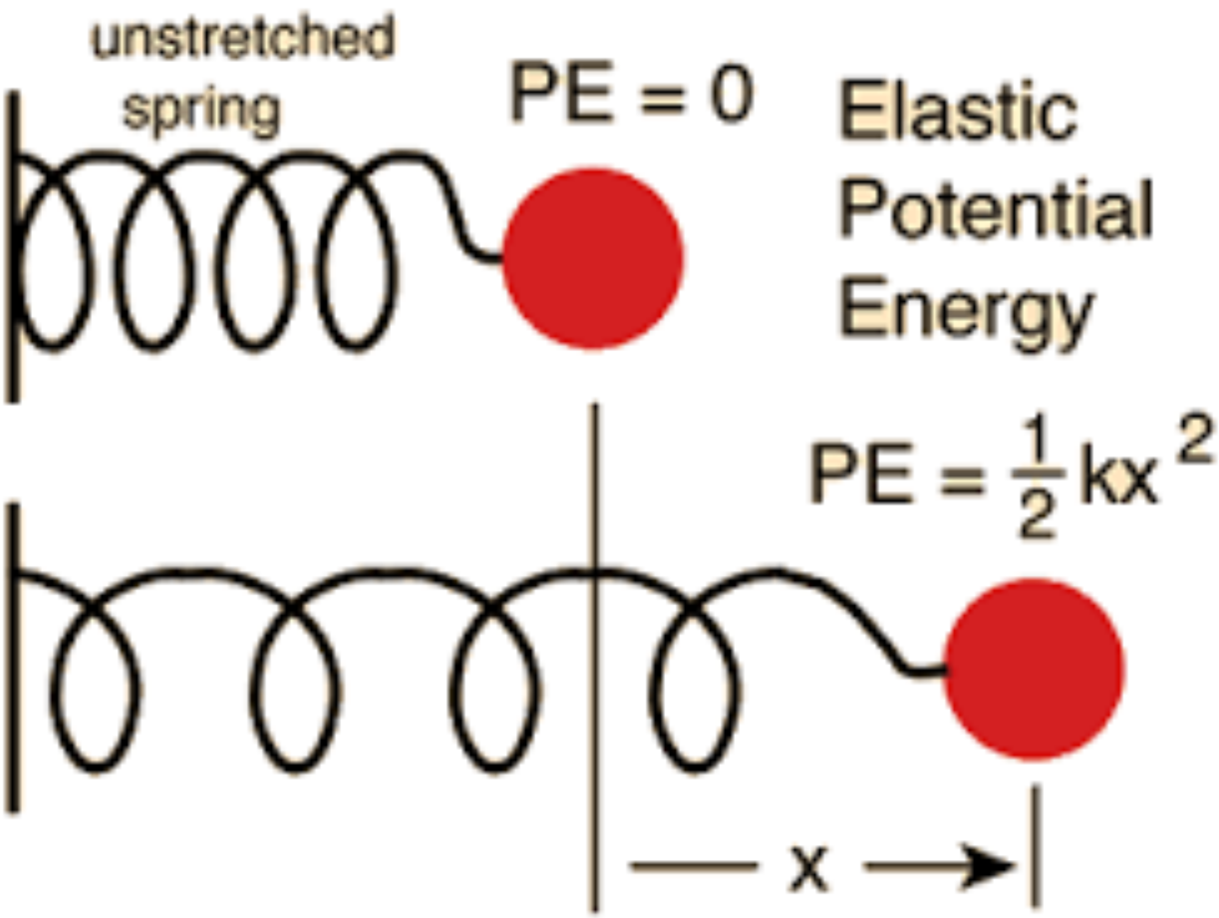


Gravitational Potential Energy

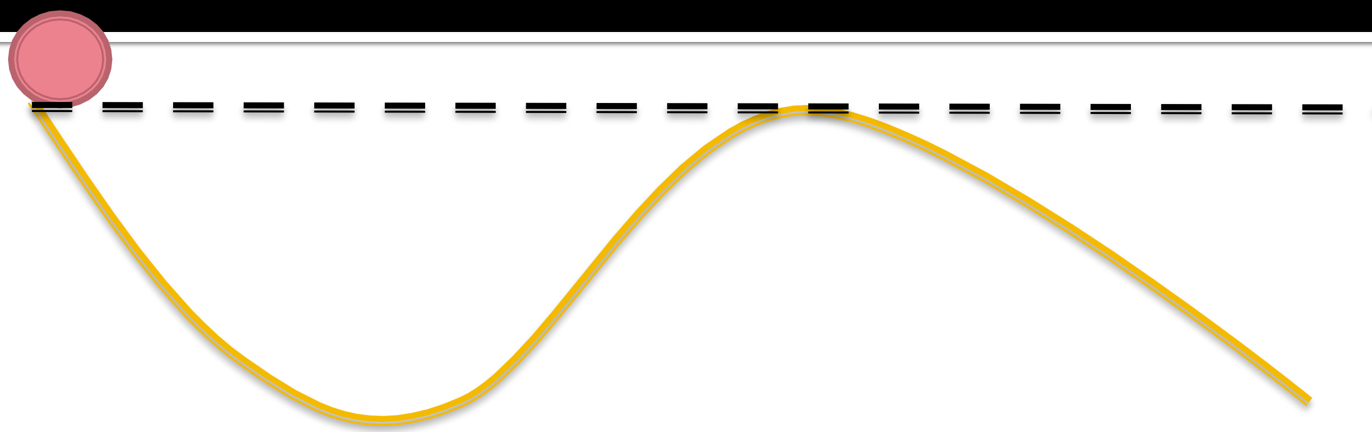
- W = -mgh = -ΔPE
  - ΔPE_g = mgh



Spring Potential Energy



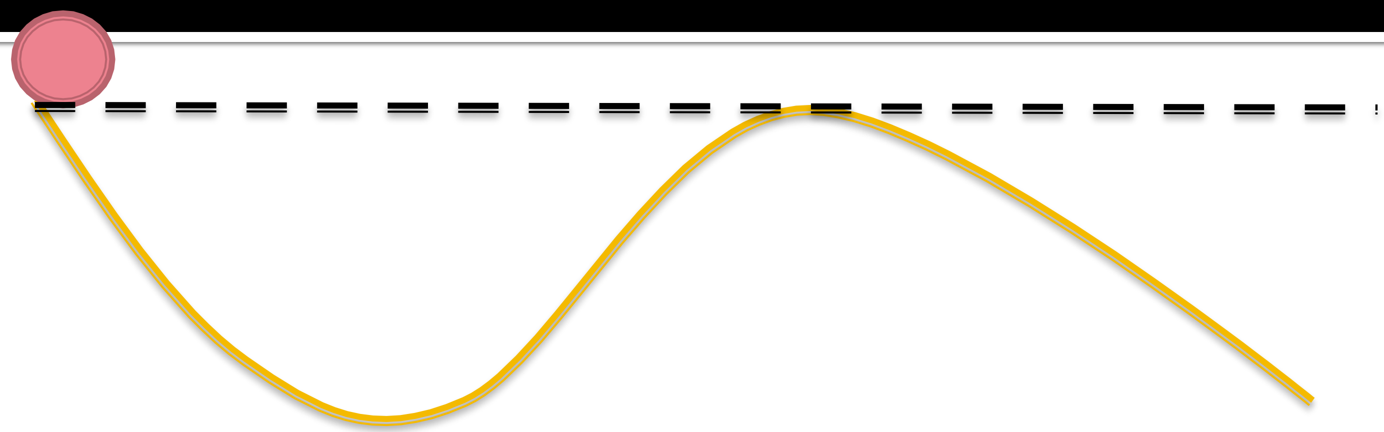
Concept Check



- Imagine a ball launched from rest at the top of a ramp of height h. Assuming no friction, will the ball make it to the top of a bump of height h?

- A. Yes
- B. No
- C. Depends on mass
- D. Depends on how much coffee I've had this morning

Concept Check



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Concept Check

- A spring is depressed a distance d and used to launch a ball of mass m vertically upward. How much gravitational potential energy does it gain at the top of its flight (a vertical displacement h)?

A. $U_g = mgh$
B. $U_g = 1/2kd^2$
C. Neither is correct
D. Both are correct

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Spring Gun

$E = PE_{spring} + PE_g + KE$

E @ launch

$= PE_{spring\_max}$

$+ PE_{g\_min} = \frac{1}{2} k d^2 + m g y_0$

E @ top

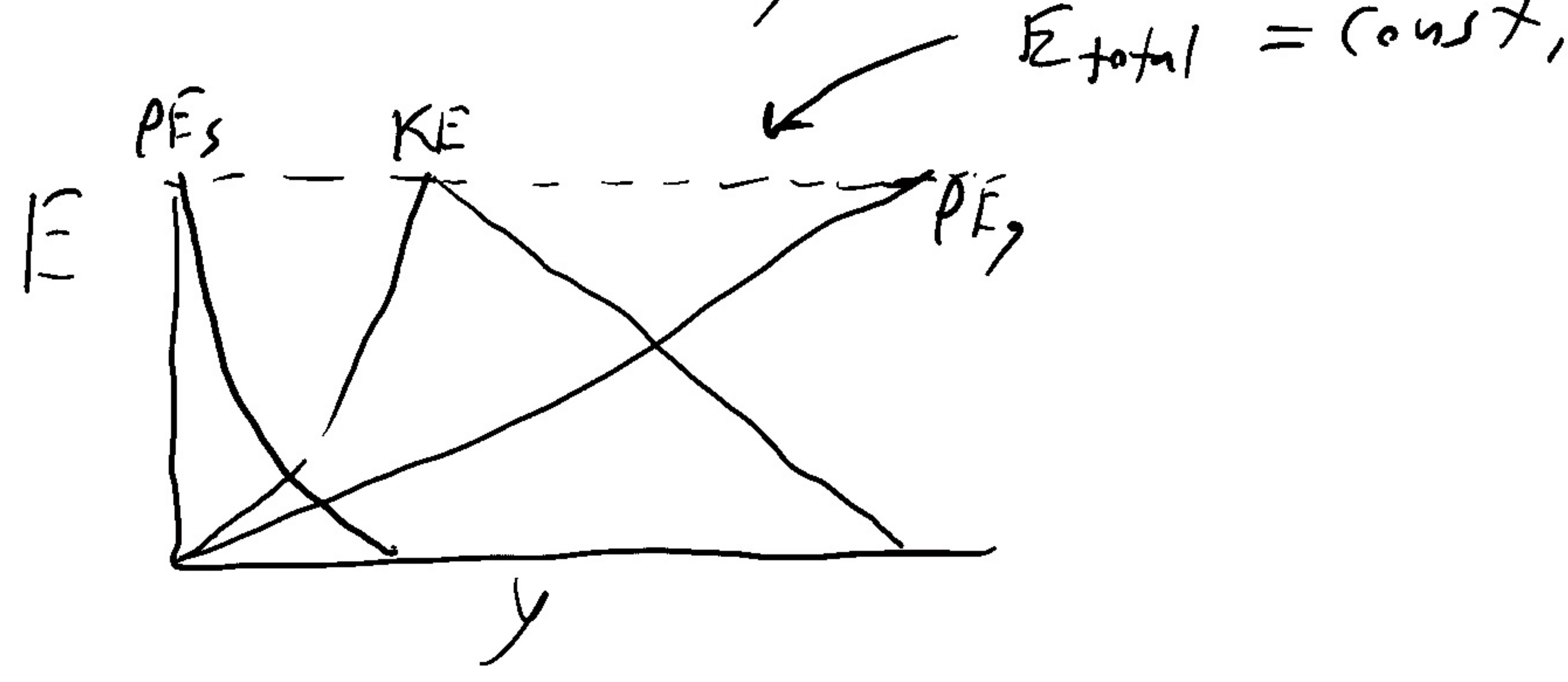
$= PE_{g\_min} = m g y_f$

$E_{top} = E_{launch}$

$\frac{1}{2} k d^2 + m g y_0 = m g y_f$

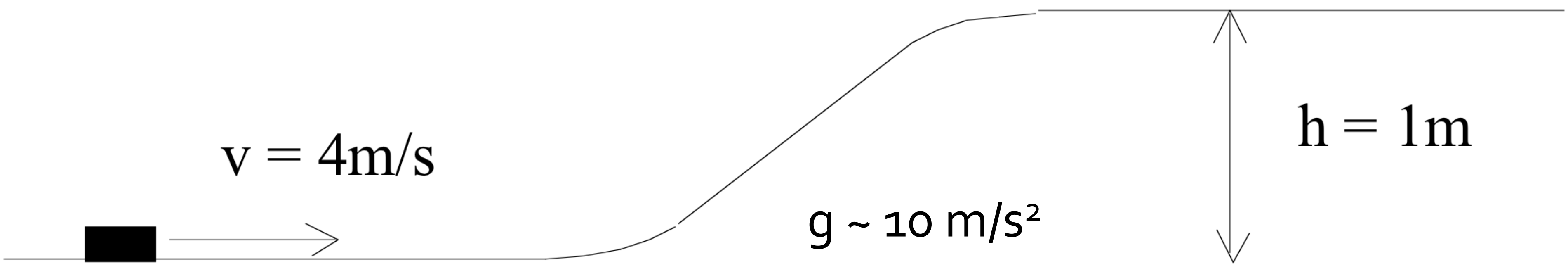
$\frac{1}{2} k d^2 = m g (y_f - y_0)$

$= m g h$



Concept Check

A hockey puck slides without friction along a frozen lake toward an ice ramp and plateau as shown. The speed of the puck is 4m/s and the height of the plateau is 1m. Will the puck make it all the way up the ramp?



A: Yes **B:** No

C: impossible to determine without knowing the mass of the puck.

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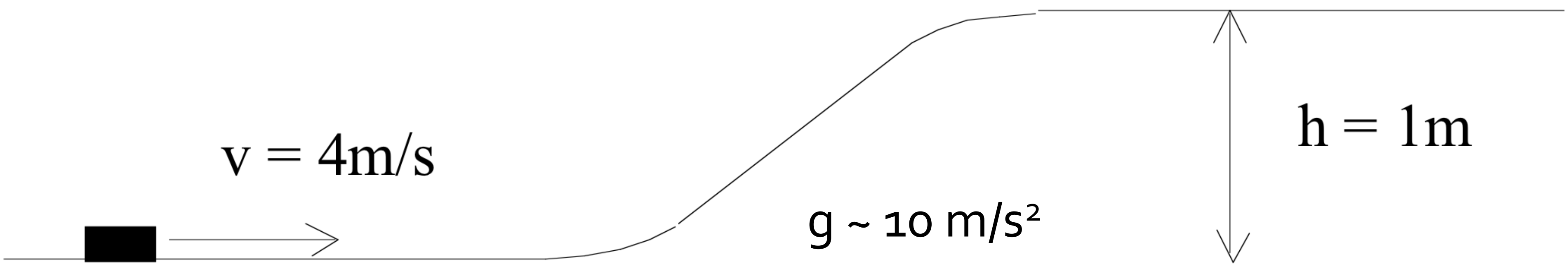

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Hockey Puck

$E_0 = \frac{1}{2} m v_0^2 + m g y_0$

to get to top must

have $E_f > m g y_f$

but $E_f = E_0$

so $\frac{1}{2} m v_0^2 + m g y_0 > m g y_f$

or $\frac{1}{2} m v_0^2 > m g (y_f - y_0)$

$= m g h$

$\frac{1}{2} m v_0^2 = \frac{1}{2} m \cdot 4^2$

$= 8 m$

$m g h = m \cdot 10 \cdot 1$

$= 10 m$

Won't make it!

Non-Conservative Forces

- Forces that are not reversible, or whose work depends on the path that you take, are termed "non-conservative"
- Non-conservative does not mean that the total energy in the universe is not conserved
  - It means that the energy is going somewhere else other than kinetic or potential energy of the body in question
  - In the case of friction or air resistance, the energy goes into heat (thermal energy)

Work Done by Friction

$$W_F = -F_F|\Delta x|$$

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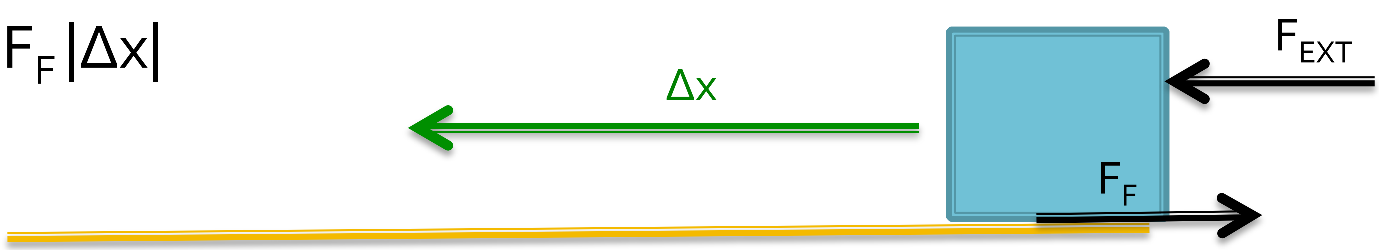


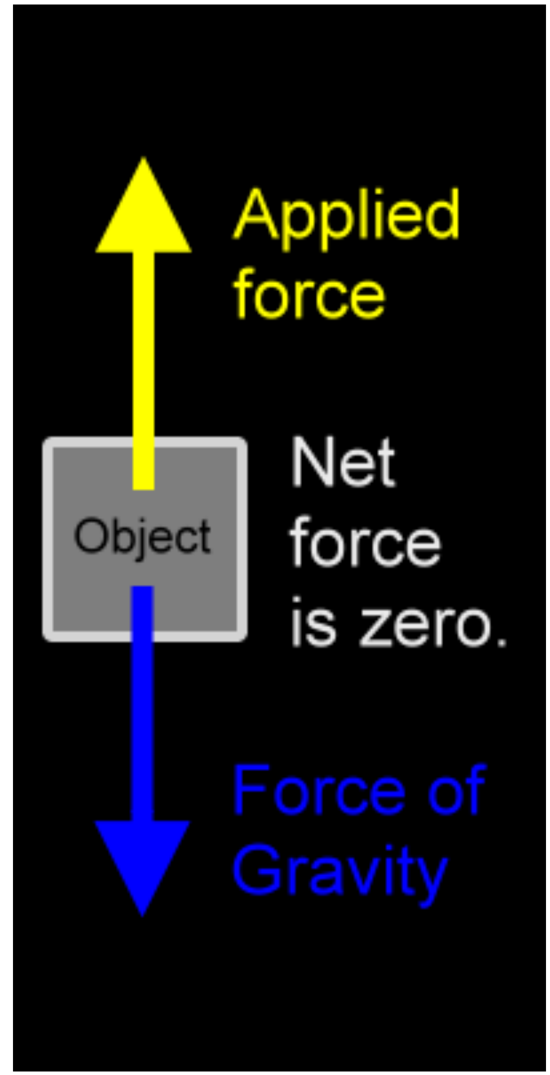
Change of Mechanical Energy

- For conservative force:
  - $\Delta E = \Delta KE + \Delta PE = 0$
  - $\Delta E = W - W = 0$

- For non-conservative forces, potential energy does not exist
  - $\Delta E = \Delta KE + \Delta PE$
  - $\Delta E = \Delta KE_{NC} + \Delta KE_{cons} + \Delta PE \neq 0$
  - $\Delta E = W_{NC} + W_{cons} - W_{cons}$
  - $\Delta E = W_{NC}$

Work Done to Lift an Object

- Work done by gravity when lifting a body to height h
  - $W_g = -mgh$
  - Work of gravity is conservative
- Work done by me to overcome gravity
  - $W_{applied} = mgh$
  - My work is non-conservative



Work Lifting an Object

$W_{app} = mgh$

$W_g = -mgh$

$W_{net} = 0$

$W_{net} = \Delta KE = 0$

$E_0 = \frac{1}{2}mv_0^2 + mgy_0$
$E_f = \frac{1}{2}mv_f^2 + mgy$

$E_f - E_0 = \Delta E$

$= \Delta KE + \Delta PE$

$= 0 + mg(y - y_0)$

$= mgh$

Where did energy come from?

From $W_{app} = W_{NC}$

$= mgh$

My work was non-conservative