Today: PHY131H1F - Class 14

- MUTINY!!! First Mate Harlow makes Captain Harrison walk the plank!
- Harlow is the new captain of the good ship PHY131!
- Conservation of Energy
- Kinetic Energy
- Gravitational Potential Energy

Pre-class Reading Quiz. (Chapter 10)

According to Knight, energy is a physical quantity with properties somewhat similar to

A. money.
B. heat.
C. a liquid.
D. work.
E. momentum.

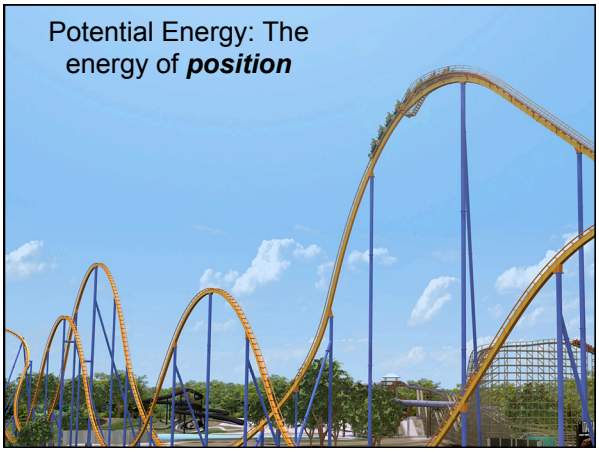
- We made it up! It isn't "real", but it's very useful!
- Keeping track of "credits" and "debits" can be interesting, since it doesn't come from nowhere.
- You can't just create it from nothing (it doesn't grow on trees!).

What is "energy"?

- Energy is a scalar quantity
- Energy is a property of an object, like age or height or mass
- Every object that is moving has some **kinetic energy**
- Objects in a gravitational or electric field may also have **potential energy**
- Energy has units, and can be measured
- Energy is *relative*; kinetic energy of car is different for an observer in the car than it is for an observer standing on the side of the road

Kinetic Energy: The energy of ***motion***

Potential Energy: The energy of ***position***



Thermal Energy: The energy of ***microscopic vibrations***

Kinetic and Potential Energy

Work is a form of energy which gets transferred to an object when a force is acted upon it over a certain distance.

There are many other forms of energy. For examples:

Kinetic energy K is an energy of ***motion***:

$$K = \frac{1}{2}mv^2 \qquad \text{(kinetic energy)}$$

Gravitational potential energy U_g is an energy of ***position***:

$$U_g = mgy \qquad \text{(gravitational potential energy)}$$

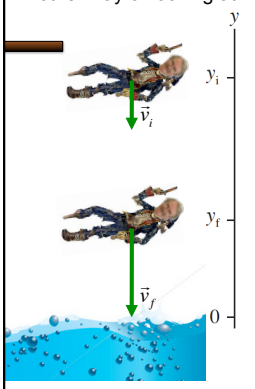
Chapter 10 big idea: "Conservation of Energy"

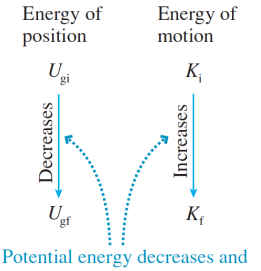
- A system of particles has a total energy, E
- If the system is isolated, meaning that there is no work or heat being added or removed from the system, then:

$$E_f = E_i$$

- This means the energy is "conserved"; it doesn't change over time
- This is a very useful equation for solving problems!

Another way of looking at freefall:





Potential energy decreases and kinetic energy increases as the object falls, but the sum $K + U_g$ doesn't change. We say that potential energy is *transformed* into kinetic energy.

Clicker Question

A cart rolls up a frictionless incline. It starts with speed v_i, but stops near the top. As it rolls up the ramp, its kinetic energy is transformed to

A. stopping energy.
B. gravitational potential energy.
C. energy of motion.
D. thermal energy.
E. energy of rest.

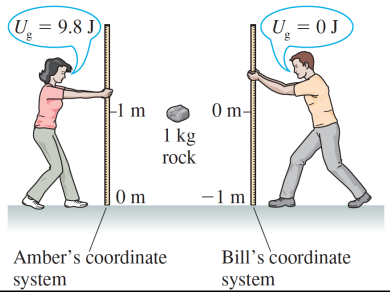
Clicker Question

A car starts with speed v_i, but the driver puts on the brakes and the car slows to a stop. As the car is slowing down, its kinetic energy is transformed to

A. stopping energy.
B. gravitational potential energy.
C. energy of motion.
D. thermal energy.
E. energy of rest.

NOTE: The Zero of Potential Energy

- You can place the origin of your coordinate system, and thus the "zero of potential energy," wherever you choose and be assured of getting the correct answer to a problem.
- The reason is that only ΔU has physical significance, not U_g itself.

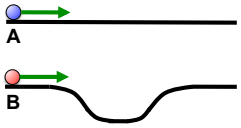


EXAMPLE 1: The speed of a sled

QUESTION:
Zainab runs forward with her sled at 2.0 m/s. She hops at the top of a very slippery slope. The slope is 7.0° below the horizontal, and extends down a total vertical distance of 5.0 m. What is her speed at the bottom?

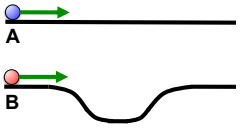
EXAMPLE 2: The speed of a sled

QUESTION:
Zainab runs forward with her sled at 2.0 m/s. She hops at the top of a very slippery valley. The valley goes down to 5.0 m below her starting position, then back up to the same initial height. What is her speed when she reaches the other side of the valley? [neglect friction]



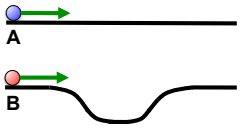
Two balls are launched along a pair of tracks with equal velocities, as shown. Both balls reach the end of the track. *Predict*: Which ball will reach the end of the track first?

- A
- B
- C: They will reach the end of the track at the same time



Demo: Two balls were launched along a pair of tracks with equal velocities. Both balls reached the end of the track. *Observe*: Which ball reached the end of the track first?

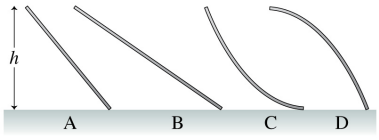
- A
- B
- C: They reached the end of the track at the same time



Explanation: *Why* does ball B reach the end of the track first?

A. Ball B is always traveling faster than ball A, so it reaches the end of the track first.
B. Balls A and B start and end with the same speed. But while ball B is on the lower part, it is going faster than ball A because gravity has sped it up. Its *average* speed is greater, so it gets there first.
C. Ball B travels a shorter distance than ball A.
D. Ball B travels a longer distance, but is pulled faster by an extra force we cannot know about.
E. The observation is flawed – ball B should not reach the end first.

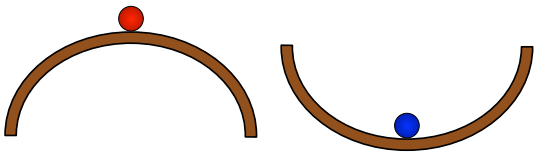
A small child slides down the four frictionless slides A–D. Each has the same height, and the child always starts from rest. Rank in order, from largest to smallest, her speeds v_A to v_D at the bottom.



A. $v_C > v_A = v_B > v_D$
B. $v_C > v_B > v_A > v_D$
C. $v_D > v_A > v_B > v_C$
D. $v_A = v_B = v_C = v_D$
E. $v_D > v_A = v_B > v_C$

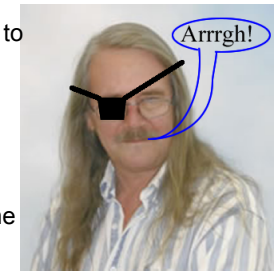
Before Class 15 on Wednesday

- Please read the Knight **Chapter 10, Sections 10.4 through 10.7**
- Something to think about:
- A red marble is balanced on the top of a smooth hill. A blue marble sits at the bottom of a smooth valley. Which marble is in equilibrium? What is the difference between these two situations?



As Captain Harlow Sails the Good Ship PHY131 Into Uncharted Waters …

- I am slowly sinking down to Davey Jones' Locker
- The Locker is not in Toronto, and I won't be either
- At the end of February, I expect to surface to do the last half of PHY132



Until then … So Long and Thanks for All the Fish!