Gravitational Potential Energy

Energy stored in an object based on its height.

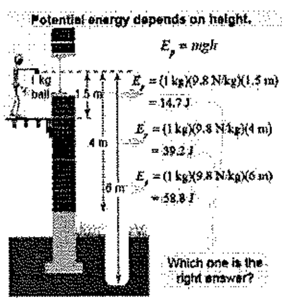
All objects affected by gravity that have a height above h=0 have gravitational potential energy defined by:

$$E_G = mgh$$

Frame of Reference (defining h=0)

When solving energy problems you want to define your reference height of h=0 to be what makes the problem easiest or what makes the most sense for the scenario.

Eg: If I drop something in the classroom, how would you define h=0?



Potential Energy (from gravity)

The potential energy of an object can be represented by the equation:

$$E_P = mgh$$

Example 1

What is the Potential Energy of a 70kg mountain biker at the top of a 500m high hill?

Looking for	Solution
Given	
Relationships/Formula	

= 70kg (9.8m/s²)(500m)
= 343,000J

Example 2

At the top of the first drop, a roller coaster has a potential energy of 3,000,000 joules. If it has a mass of 3,000 kg, how high is the drop?

Looking for	Solution
Given	
Relationships/Formula	

3,000,000 J = 3000 kg (9.8m/s²)(h)
3,000,000 J = 29400 kg·m/s² (h)
3,000,000 ~~kg m/s²~~ / 29400 ~~kg·m/s²~~ = ~~29400 kg·m/s²~~ (h) / ~~29400 kg·m/s²~~
102.04 m = h

Kinetic Energy

The Energy of Motion

All objects in motion have energy inherent to them. It can be calculated by the equation:

$$E_K = \frac{1}{2}mv^2$$

Example 3

What is the kinetic energy of a 800 kg Camaro traveling down rt. 114 at 20 m/s?

Looking for	Solution
Given	
Relationships/Formula	

$= \frac{1}{2}(800 kg)(20 m/s)^2$

$400 kg (400 m^2/s^2)$

$= 160000 J$

Review

In this class we are looking at 2 types of energy:

Kinetic Energy (the energy of motion)

$$E_K = \frac{1}{2}mv^2$$

Potential Energy (stored energy)

$$E_P = mgh$$

Total Energy

Systems can have multiple forms of energy happening at the same time.

To determine the total energy, we can simply add together the different types of energy that are occurring at the same time.

Example: $E_{Total} = E_K + E_P$

Warm-up

A 900kg car crests the top of a hill traveling at 32 m/s. The hill has a height of 120 meters. What is the **total** energy of the car?

Ask yourself:

- Does the object have kinetic energy?
  velocity
- Does the object have potential energy?
  height

Calculate each individually, and add them together

$E_k = \frac{1}{2}(900kg)(32m/s)^2$
$= 450kg(1024\ m^2/s^2)$
$= 460800\ J$

$E_p = 900kg(9.8m/s^2)(120m)$
$= 1058400\ J$

Looking for	Solution
Given	
Relationships/Formula	

Looking for	Solution
Given	
Relationships/Formula	

$E_p + E_k = E_T$
$1058400\ J + 460800\ J =$
$1519200\ J$

Conservation of Energy

The Law of Conservation of Energy states that energy can never be created or destroyed, only converted from one form into another.

This means that the total energy in an isolated system remains constant.

What does an "isolated system" mean?

No energy is added to or leaves the system

Conservation of Energy

Total Energy = Total Energy

Before change After change

Remember:

Total Energy = $E_K + E_P$

Example: Applying CoE

A 90kg go-cart crests the top of a hill traveling at 32 m/s. The hill has a height of 40 meters. What is the **total** energy of the car?

If there is no energy lost from the system, what is the speed of the car when it reaches the bottom of the hill?

We know the energy at the top of the hill must equal the energy at the bottom of the hill!

Ask yourself, at the bottom of the hill:
- Does the object have kinetic energy? (velocity)
- Does the object have potential energy? (height)

90kg (9.8m/s²)(40m)
= 35280 J

½ (90 kg)(32m/s)²
45kg (1024m²/s²)
46080 J

Set the total energy of the system at the top of the hill (before) equal to the total energy of the system at the bottom of the hill (after).

E_{Before} =

E_{After} =

Looking for	Solution
Given	
Relationships/Formula	

35280J + 46080J = 81360J

CoE problem

- A 35 kg skier starts from rest at the top of a long jump ramp that is 30 m high. Assume the snow applies no friction.
  - Determine the potential energy at the top of the hill
  - What is the skiers velocity at the bottom of the hill?

$35\,kg(9.8\,m/s^2)(30\,m)$

$= 10290\,J$

$10290\,J = \frac{1}{2}(35\,kg)(v^2)$

$10290\,kg \cdot m^2/s^2 = 17.5\,kg\,(v^2)$

$\div 17.5\,kg$

$\sqrt{588\,m^2/s^2} = \sqrt{v^2}$

$24.25\,m/s = v$

Conservation of Energy Lab Activity

Mass of car | Height of Track | Times

How do we calculate velocity if we know the amount of time it took an object to travel a known distance?

You should now quietly work on the 3 analysis questions and the 4 conclusion questions.