Work & Energy

- So far this year, we have used Newton's laws to analyze the motion of objects.
- In this unit, an entirely different model will be used to analyze the motion of objects. Motion will be approached from the perspective of work and energy.

Work

- When a force acts upon an object to cause a displacement of the object, it is said that work was done upon the object.

$$W = F * d$$

W = work [J]
F = force [N]
d = displacement [m]

- Work is measured in units if Joules [J].

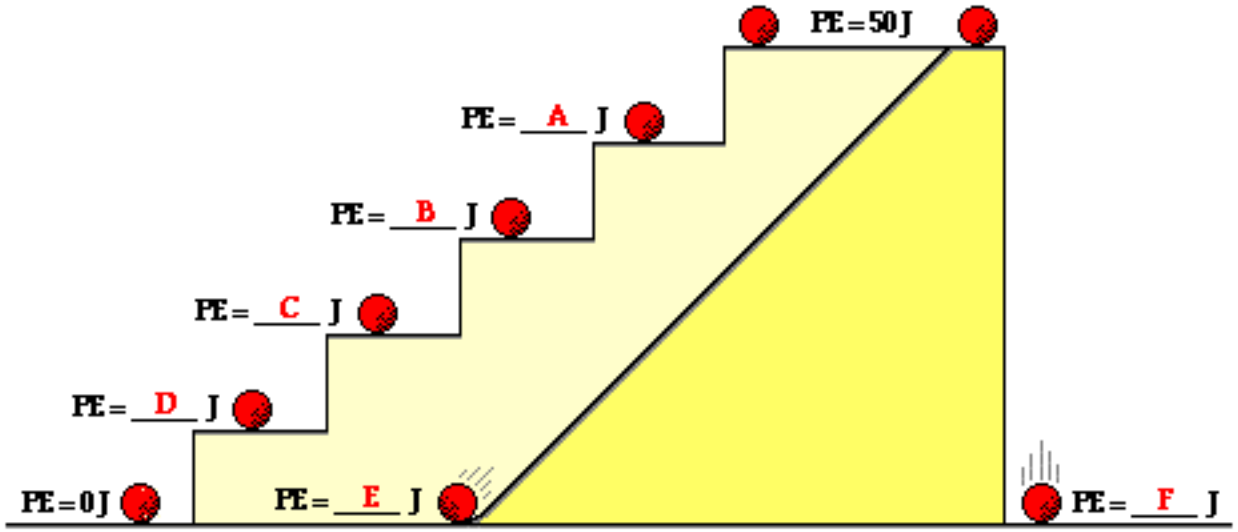
Ex: A brick has a mass of 7 kg. Bob lifts the brick from the ground to a height of 2.5 m. How much work does he do?

- The work Bob does in lifting this brick is now equal to the **energy** of the brick at its new, higher location.

Energy = ability to do work

Potential Energy (PE)	Kinetic Energy (KE)
Energy an object has because of its <u>height off the ground.</u>	Energy an object has because it is <u>moving.</u>
$PE = mgh$	$KE = \frac{1}{2}mv^2$
m = mass [kg] g = 10 m/s^2 (on earth) h = height above the ground [m]	m = mass [kg] v = velocity [m/s]
Measured in Joules [J]	Measured in Joules [J]

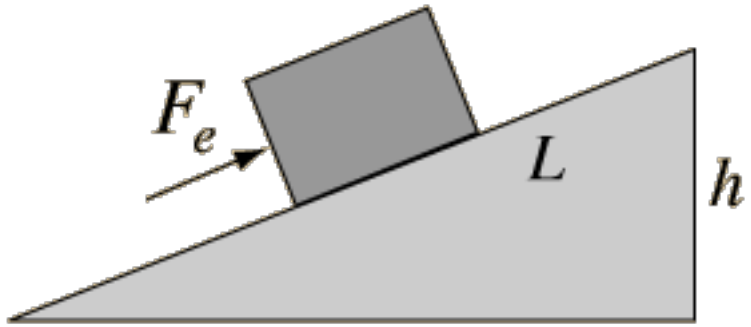
Ex: Find the potential energy of the 1 kg ball at each location.



Ex: Determine the kinetic energy of a 625-kg roller coaster car that is moving with a speed of 18.3 m/s.

Mechanical Advantage

- An **Inclined plane** or a **ramp** is one of the most basic machines.
- Ramps are used because they reduce the force necessary to move a load a certain distance up. By moving the load a longer total distance, we lessen the force needed, but the amount of work stays the same.
- We call the ratio of the total distance traveled to the vertical height of the ramp the **mechanical advantage** of that ramp.



Incline $IMA = \frac{L}{h}$

$$Mechanical\ Advantage = \frac{Length\ of\ Ramp}{Height\ of\ Ramp}$$

Ex: We want to lift a 2 kg mass to a height of 4 m.

a) How much work is required if we were to lift the mass straight up?
b) How much potential energy does the mass have at a height of 4 m?
c) If we used a ramp of length 6 m to push the mass up to the same height, how much force would we have to apply?
d) What is the mechanical advantage of the ramp?