Mechanical Energy Conservation

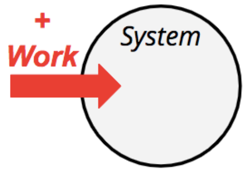
Lesson Notes

Learning Outcomes

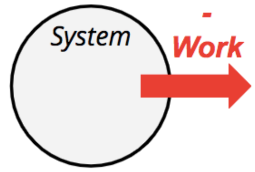
- Under what conditions is mechanical energy conserved?
- What is meant by saying that mechanical energy is conserved?

Work-Energy Relationship

When objects outside the system exert **non-conservative forces** on the system to do *net work*, causing a change in mechanical energy of the system. Such forces transfer energy across the system boundary.



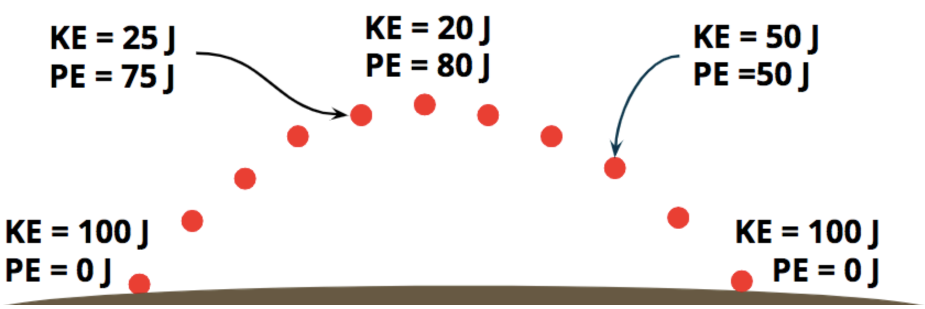
Positive work adds energy to the system and negative work removes energy.



$$KE_i + PE_i + W_{nc} = KE_f + PE_f$$

What if W_{nc} = 0 J?

When conservative forces are the only forces doing *net work* on an object, then the total amount of mechanical energy is conserved. Potential energy (PE) is converted to kinetic energy (KE) or vice versa, but the total of KE+ PE remains constant.



Mechanical Energy Conservation

If mechanical energy is conserved, then the total amount of mechanical energy (TME) is constant.

$$KE_i + PE_i + \cancel{W_{nc}} = KE_f + PE_f$$

$$KE_i + PE_i = KE_f + PE_f$$

As the skier skis up the hill, KE is lost and PE is gained.

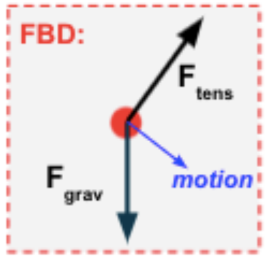
$$KE_i + PE_i = KE_f + PE_f$$

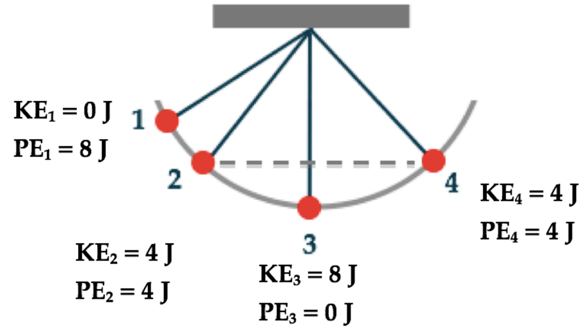
As the skier skis down the hill, PE is lost and KE is gained.

$$KE_i + PE_i = KE_f + PE_f$$

Energy of a Pendulum

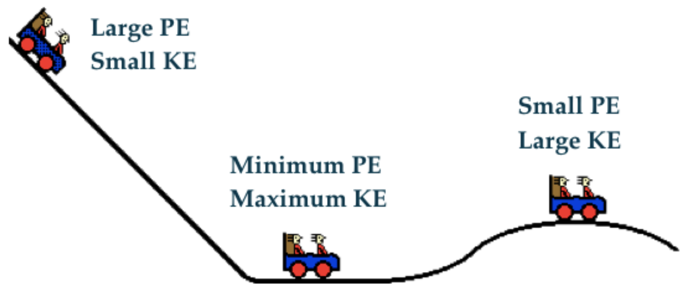
The tension force on a pendulum is directed perpendicular to the motion; as such, it does not do work on the pendulum bob. The mechanical energy of a pendulum bob is conserved since the only force doing work is F_{grav} (a conservative force).





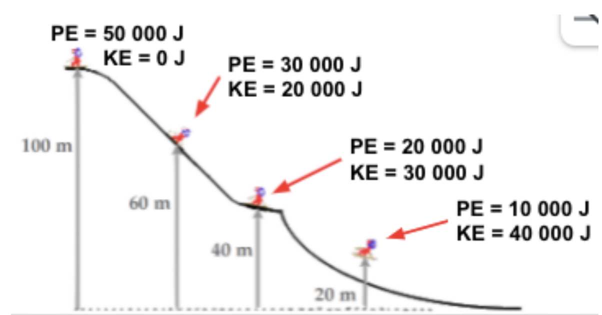
Roller Coasters and Energy

The up and down motion of a roller coaster car demonstrates the conversion of PE to KE (and vice versa). As the car moves downward, PE is lost and KE is gained. As the car rises, the KE is lost and the PE is gained.



Ski Jumper

Normal forces from the surface do not do work upon a ski jumper since they are ⊥ to motion. As gravity does work upon a ski jumper, the TME is conserved. The PE is transformed into KE but the sum remains the same.



Let's Get Real

Mechanical energy conservation assumes negligible losses of energy due to dissipative forces like F_{air} and F_{frict}. This is an idealization or approximation of reality. The fact is, friction and air resistance do exist and do serve to change mechanical energy into dissipative forms of energy like thermal energy and vibrational energy.

Ht (m)	PE (J)	Ideal KE (J)	Real KE (J)
100	50 000	0	0
60	30 000	20 000	16 000
40	20 000	30 000	24 000
20	10 000	40 000	30 000
0	0	50 000	38 000