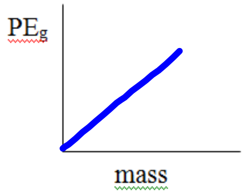
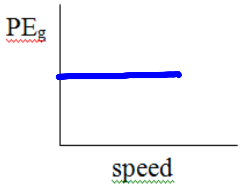
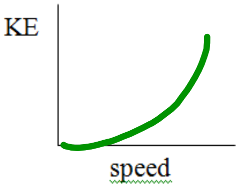
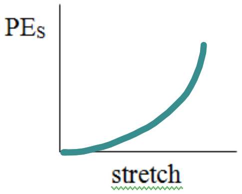






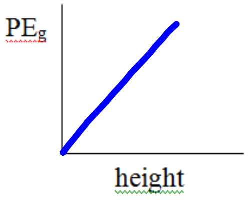


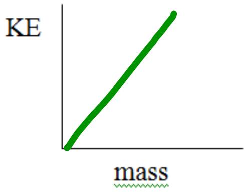
$PE_g = mgh$

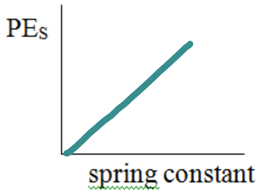
$KE = \frac{1}{2}mv^2$

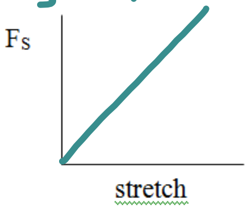
$PE_s = \frac{1}{2}kx^2$

$F_s = kx$









Conservation of Energy

Transformation:

conversion of energy from one type to another type

Transfer:

passing of energy from one object to another object

1) Basketball is dropped

Transformation:

$PE_g \rightarrow KE$

Transfer:

Grav field → ball

2) Arrow is shot by archer

Transformation:

$PE_s \rightarrow KE$

Transfer:

Bow → arrow

3) Bus skids to a halt

Transformation:

KE → Q

Transfer:

bus → tires/road

4) Light bulb is lit

Transformation:

Chem Pot E → electric E
→ light, heat

Transfer:

battery → wires → bulb

Conservation of Energy Principle

The total energy of an isolated system remains constant.

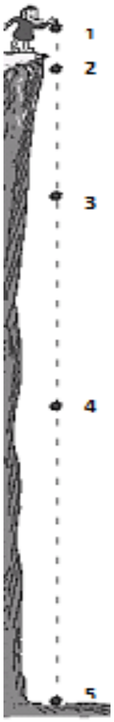
Meaning:

Energy is neither created nor destroyed, only transferred from one object to another object or transformed from one type to another type.

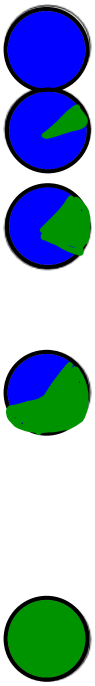
Isolated system:

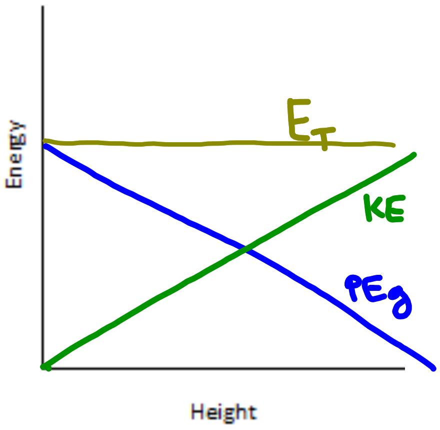
no external forces

Conservation of Energy



Free fall





c) Make a statement about the gravitational potential energy and the kinetic energy of the ball as it falls.

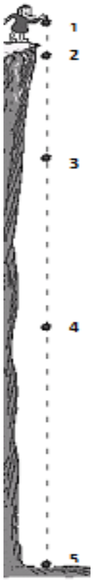
GPE is transformed into KE

d) Make a statement about the total energy of the ball as it falls.

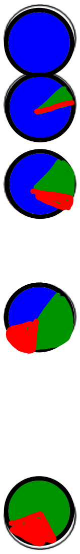
Total energy is conserved AND total mechanical energy is conserved

e) Discuss the energy of the ball if air resistance is not neglected.

Total energy of the ball is NOT conserved. Total energy is conserved for ball-air system. Total mechanical energy is NOT conserved. Some mechanical energy transformed to internal energy – some transferred to air.



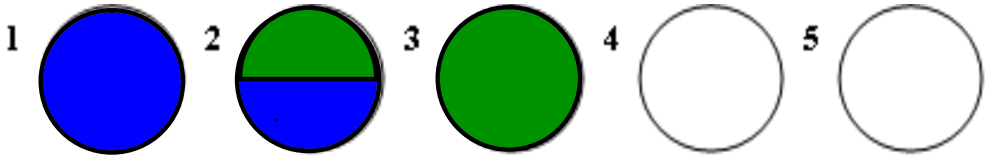
Air resistance

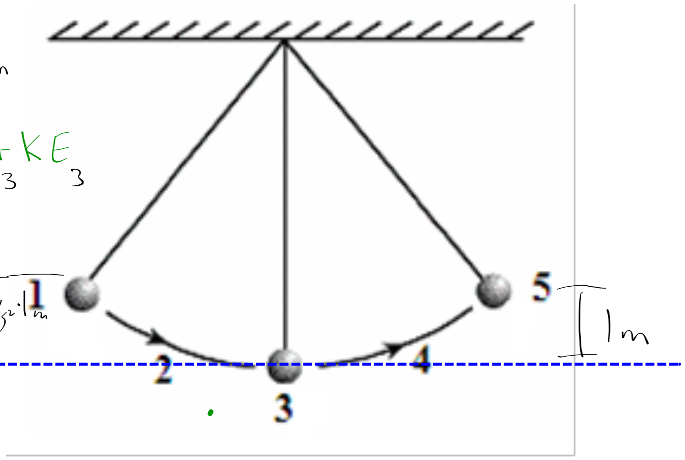


Conservation of Energy Formula:

$$PE_{g_0} + KE_0 + PE_{s_0} + Q_0 = PE_{g_f} + KE_f + PE_{s_f} + Q_f$$

2. A pendulum starts from rest at position 1 and swings freely back and forth.





h= 1m

1m

$PE_{g_1} + \cancel{KE_1} = \cancel{PE_{g_3}} + KE_3$

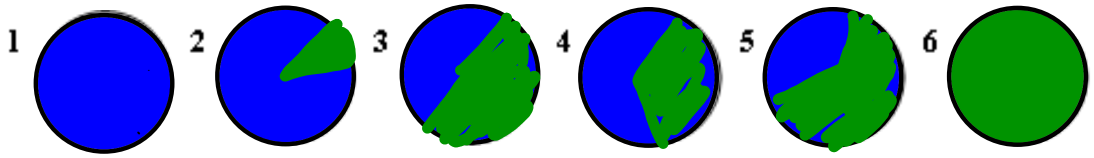
$mgh_1 = \frac{1}{2}mv^2$

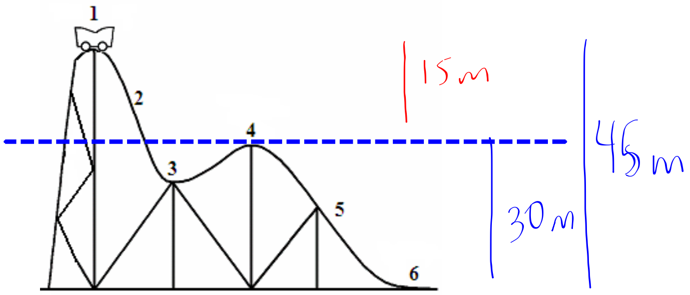
$v = \sqrt{2gh} = \sqrt{2 \cdot 9.8\,m/s^2 \cdot 1\,m}$

$= 3.5\,m/s$

b) A student braves the "bowling ball of death" by releasing it at their nose level. Estimate the speed of the ball at its lowest level.

3. A rollercoaster starts from rest and rolls freely downhill, neglecting friction.





b) A 750. kg car starts at the top of the 45 meter high first hill and rolls downhill. Calculate how fast it is traveling at position 4 which is 30 meters high..

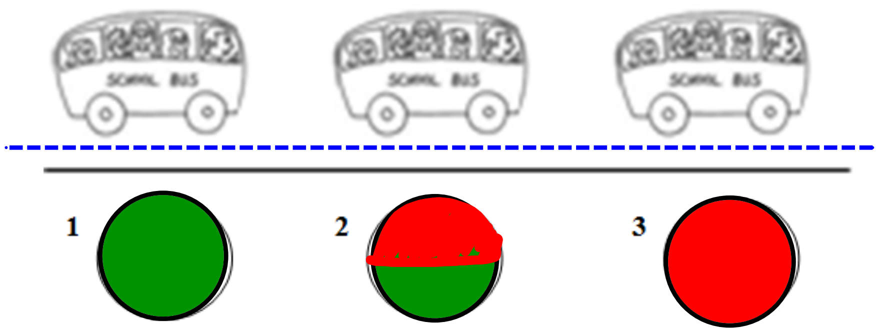
$$m g \underset{\substack{\uparrow\\45m}}{\overset{\substack{15m\\\downarrow}}{h_1}} + \cancel{\frac{1}{2} m v_1^2} = m g \underset{\substack{\uparrow\\30m}}{\overset{\substack{0\\\downarrow}}{h_4}} + \frac{1}{2} m v_4^2$$

$$v = \sqrt{2 g (h_1 - h_4)}$$

c) Where will the car be traveling the fastest? Why?

end of ride (6) - lost most PE, gained most KE

4. A moving bus screeches to a halt as the driver slams on the brakes.



b) A 5000 kilogram bus traveling at 27 meters per second skids to a stop. How much energy is transformed into internal energy due to friction?

$KE \rightarrow Q$

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

$\frac{1}{2}(5000kg)(27m/s)^2$

$1.8\times10^6 J = Q$

5. a) If the archer pulls back the bowstring 25 centimeters, how fast will the 0.020 kilogram arrow be traveling when it is shot? The bow has a spring constant of 150 newtons per meter.

$$PE_s \rightarrow KE \rightarrow PE_g$$

$$\underbrace{\frac{1}{2}kx^2 = \frac{1}{2}mv^2} = mgh$$

$$V = \sqrt{\frac{K}{m}}\,X$$

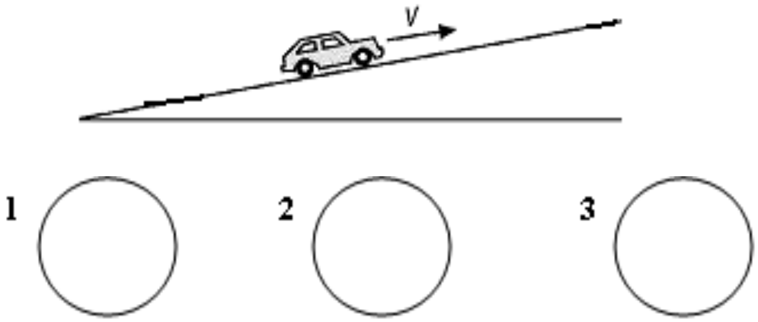
$$= \sqrt{\frac{150\,N/m}{.02\,kg}} \cdot .25\,m = 22\,m/s$$

$$\cancel{PE_g}+\cancel{KE}+PE_s+\cancel{Q} = \cancel{PE_g}+KE+\cancel{PE_s}+\cancel{Q} = PE_g+\cancel{KE}+\cancel{PE}$$

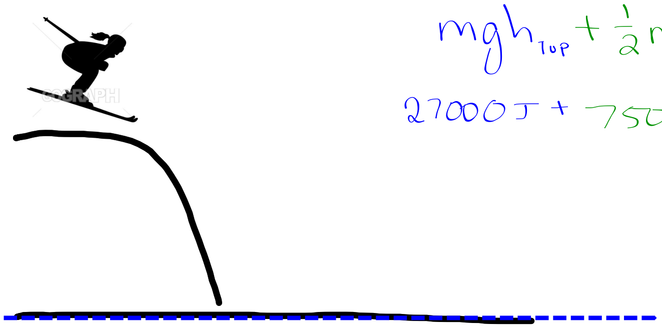
b) If the arrow were shot straight up, how high would it go?

24m

6. A car climbing a hill at a steady speed. Complete the energy pie charts.



7. A 60. kg skier moving at 5.0 meters per second skis down a hill 45 meters high. If her speed at the bottom of the hill is 20. meters per second, how much energy was lost due to friction? Where did this energy go?



$$mgh_{Top} + \frac{1}{2}mV_{Top}^2 = \cancel{mgh_B} + \frac{1}{2}mv_B^2 + Q$$

$$27000J + 750J = 12000J + \underline{16000J}$$