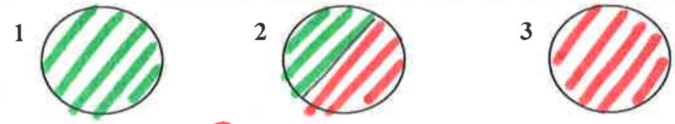
4. A moving bus screeches to a halt as the driver slams on the brakes.

a) Complete the energy pie charts.



- KE - Q

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?

$KE_i \rightarrow Q_f$

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

$\frac{1}{2}(5000\,Kg)(27\,\frac{m}{s})^2 = \boxed{1.8 \times 10^6\,J}$

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5. a) If the archer pulls back the bowstring 25 centimeters (0.25 m), 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.

$\cancel{KE_i} + PE_{s_i} = KE_f + \cancel{PE_{s_f}}$

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

$V = \sqrt{\frac{Kx^2}{m}} = \boxed{22\,\frac{m}{s}}$

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

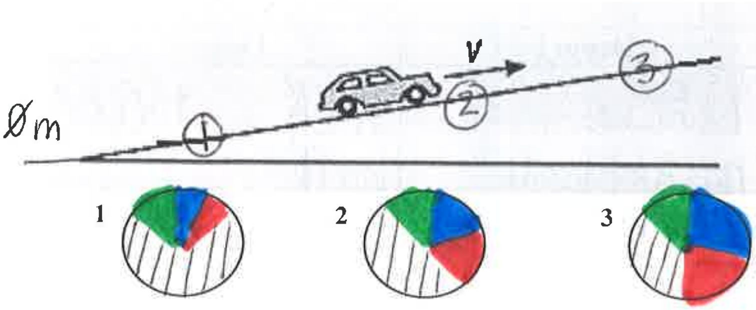
$PE_{s_i} = mgh \overset{or}{=} (PE_{g_f})$ $\quad g = 9.81\,\frac{m}{s^2}$

$\frac{1}{2}Kx^2 = mgh$

$h = \frac{1}{2}\frac{Kx^2}{mg} = \boxed{24\,m}$

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

KE Q
PE_g chemical PE



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?

$$PE_{g_i} + KE_i = \cancel{PE_{g_f}}^{0} + KE_f + Q$$

i: m = 60. kg v_i = 5.0 m/s h = 45 m
f: m = 60. kg v_f = 20. m/s h = Ø m

$$mgh + \frac{1}{2}mv_i^2 - \left(\frac{1}{2}mv_f^2\right) = Q = \boxed{1.5 \times 10^4 \text{ J}}$$

$$(60\,\text{kg})(9.8\,\tfrac{m}{s^2})(45\,\text{m})$$

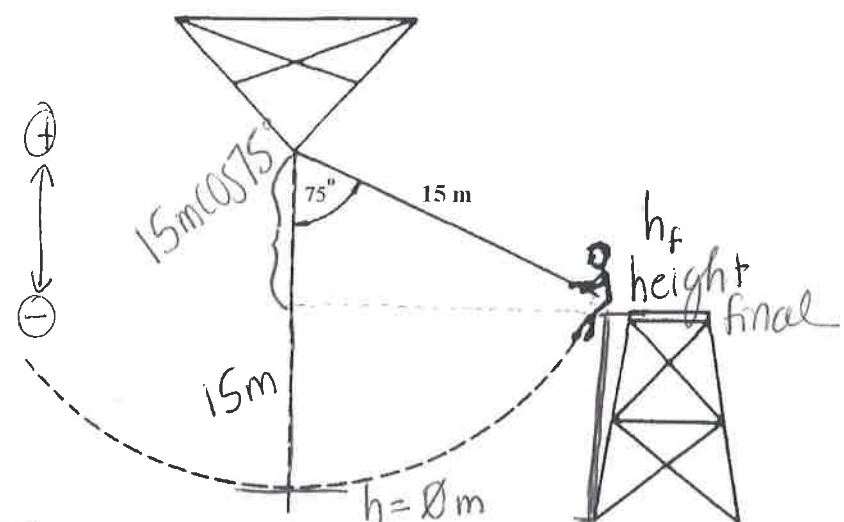
8. A daredevil student ~~jumps off a~~ leaves platform as shown. Determine the speed of the student at the lowest point in the swing.

$$PE_{g_T} = KE_B$$

$$mgh_T = \frac{1}{2}mv_B^2$$

$$\Delta h = h_f - h_i$$

$$\Delta h = 15\,\text{m} - 15\cos 75° - Ø\,\text{m}$$



$$v = \sqrt{2gh} = \boxed{15\,\text{m/s}}$$

Demo 1	Demo 2	Demo 3	Demo 4
Lift a basketball. $W_g = \Delta PE_g$ Work done against gravity.	Kick a soccer ball. Work done by a force. $W = \Delta KE$	Shoot an arrow. Work done against a spring. $W_s = \Delta PE_s$	Shove a box ($v_f = 0 \frac{m}{s}$) Work done by friction. $W_f = \Delta Q$

Was energy created in each of the demos above? Explain.

No - External force transferred energy to the objects by doing work on them.

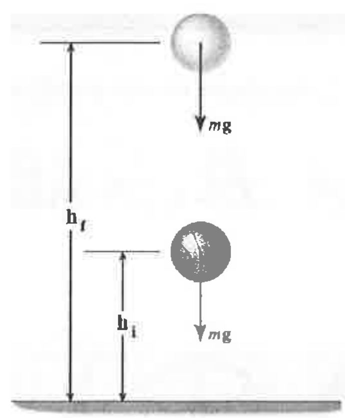
Work-Energy Theorem:

Work done by an external force is equal to the total energy change of the system.

Formula: $W_T \text{ (or } E_T) = \Delta PE + \Delta KE + \Delta Q$

Derivation of Energy Formulas

I. Gravitational Potential Energy



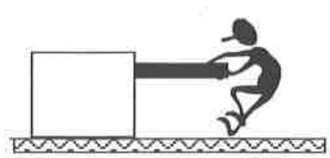
$W = Fd\cos\theta$

$W = mg\Delta h \cos(0°)$

$W = mgh_f - mgh_i$

$W = PE_g = mgh$

II. Kinetic Energy



$W = Fd\cos\theta \quad \theta = 0°$

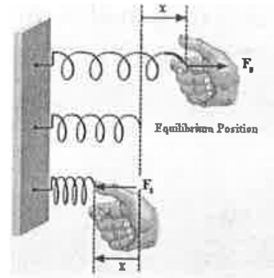
$W = m(ad)\cos(0°)$

$v_f^2 = v_i^2 + 2(ad)$

$ad = \frac{v_f^2 - v_i^2}{2}$

$W = \frac{m(v_f^2 - v_i^2)}{2}$

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



III. Elastic Potential Energy

$W = F \cdot d \cdot \cos\theta$

↑ avg. force

$\ominus \longleftrightarrow \oplus$

where $x_i = 0\,m$

$W = \frac{1}{2} F_{max}(x_f - x_i)\cos\theta$ $\theta = 180°$ $\cos(180°) = (-1)$

$W = \frac{1}{2}(Kx)(x_f) = \frac{1}{2}Kx^2 = PE_s$ $F = -Kx$

indicates restorative force

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1. A 25 kilogram object is accelerated from rest to a speed of 12 meters per second by a force of 65 newtons. How much work is done by the force?

work formula $W = \Delta KE = \frac{1}{2}mv^2$

$\frac{1}{2}(25\,Kg)(12\,\frac{m}{s})^2 = $ **1800 J**

Kinematics $W = Fd\cos\theta$

$F = ma$ $a = \frac{F}{m}$

$\frac{65\,N}{25\,Kg} = 2.6\,m/s^2 = a$

$V_f^2 = V_i^2 + 2ad$ ($V_i = 0\,m/s$)

$\frac{(12\,m/s)^2}{2(2.6\,m/s^2)} = 27.7\,m$

$W = (65\,N)(27.7\,m)(\cos 0°) = $ **1800 J**

2. A 5.0 kilogram block slides <u>from rest</u> down a hill with a rough surface. When it reaches the bottom, it has 150 J of kinetic energy. How much work was done overcoming friction as it slid?

$PE_g = KE + Q$

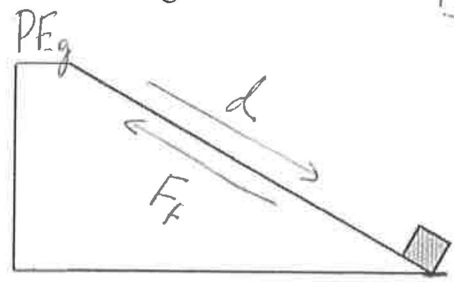
TOP BOTTOM

$mgh_T = \frac{1}{2}mv_B^2 + Q$

$mgh_T - \frac{1}{2}mv_B^2 = Q$

$(5.0\,Kg)(9.81\,\frac{m}{s^2})(4.5\,m) - 150\,J = $ **71 J** (W against friction)

4.5 m



↑ $h = 0\,m$

$W_f = -71\,J$

F + d are opposite directions