Potential and Kinetic Energy Calcs 2018 Name: Key Per:

ENERGY DEFINITION AND UNITS

Energy is the ability to do work or cause change. Energy is measured in joules (J) or Newton-meters.

POTENTIAL ENERGY

Potential energy (PE) is stored energy. The formula for the PE of an object is: **GPE = mgh** where ***m*** equals mass in kg, ***g*** is the acceleration of gravity in m/s^2, and ***h*** equals the height of the object in m. The mass (*m*) of the object times the acceleration of gravity (*g*) is the same as the weight of the object in newtons. The acceleration of gravity is equal to 9.8 m/sec^2.

Sample Problem: What is the potential energy of a 10.0-newton book that is placed on a shelf that is 2.5 meters high?
Looking for: Gravitational Potential Energy
Given: W = 10.0 Newtons, h = 2.5 meters
Solution: The book's weight (10.0 N) is equal to its mass times the acceleration of gravity. (W = mg) Therefore, you can easily use this value in the potential energy formula: GPE = mgh
The GPE is 25 Joules (or 25 Newton-meters).

POTENTIAL ENERGY CALCS

1. The potential energy of an apple is 6.00 Joules. The apple is 3.00 meters high. What is the mass of the apple?

PE = 6.00 J
h = 3.00 m
m = ?

$6.00\,J = m(9.8\,m/s^2)(3.00\,m)$

$m = .204\,kg$

2. Determine the amount of potential energy of a 5.0-Newton book that is moved to three different shelves on a bookcase. The height of each shelf is 1.0 meter, 1.5 meters, and 2.0 meters.

$PE = (5.0\,N)(1.0\,m)$ $PE = 5.0\,J$

$PE = (5.0\,N)(1.5\,m)$ $PE = 7.5\,J$

$PE = (5.0\,N)(2.0\,m)$ $PE = 10.\,J$

3. You are on roller blades on top of a small hill. Your potential energy is equal to 1,000.0 Joules. The last time you checked your mass was 60.0 kilograms.

a. What is your weight in Newtons?

$W = mg$ $W = (60.0\,kg)(9.8\,m/s^2) = 588\,N$

b. What is the height of the hill?

$1{,}000.0\,J = (588\,N)(h)$ $h = 1.70\,m$

c. If you start skating down this hill, your potential energy will be converted to kinetic energy. At the bottom of the hill, your kinetic energy will be equal to your potential energy at the top. What will be your speed at the bottom of the hill?

max PE = max KE

$1{,}000.0\,J = \frac{1}{2}(60.0\,kg)(v^2)$

$v = 5.77\,m/s$

KINETIC ENERGY

Kinetic energy (KE) is energy of motion. The formula for the KE of an object is: **KE = ½ mv^2** where *m* equals mass in kilograms and *v* equals the velocity or speed of the object in meters per second. To do this calculation, square the velocity value. Next, multiply by the mass, and then, divide by 2.

Sample Problem: A 50.-kilogram boy and his 110-kilogram father went jogging. Both ran at a rate of 5.0 m/sec. Who had more kinetic energy?
Looking for: Who had more KE?
Given: boy's mass = 50. kg, father's mass = 110 kg, velocity for both = 5.0 m/s
Solution: Boy's KE = ½ (50. kg)(5 m/s)^2 = 625 → 630 J
Father's KE = ½ (110 kg)(5 m/s)^2 = 1,375 → 1,400 Joules

KINETIC ENERGY CALCS

4. What is the kinetic energy of a 2,000.0-kilogram boat moving at 5.00 m/sec?

$KE = \frac{1}{2}(2{,}000.0\ kg)(5.00\ m/s)^2 = 25{,}000 \rightarrow \boxed{2.50 \times 10^4\ J}$

5. What is the velocity of an 500.0-kilogram elevator that has 4,000.0 Joules of energy?

$4{,}000.0\ J = \frac{1}{2}(500.0\ kg)(v^2)$ $\boxed{v = 4.000\ m/s}$

6. What is the mass of an object that creates 33,750.0 Joules of energy by traveling at 30.0 m/sec?

$33{,}750.0\ J = \frac{1}{2}(m)(30.0\ m/s)^2$ $\boxed{m = 75.0\ kg}$

ENERGY CONSERVATION

The law of conservation of energy states that energy is never destroyed or created, only transferred. Therefore, you can assume that the energy in a system remains the same unless work is done. You can use the following equation in an energy conservation question. $\mathbf{KE_i + PE_i + W_{ext} = KE_f + PE_f}$

$W = F \cdot X$

Sample Problem: A 4768-kg roller coaster train full of riders approaches the loading dock at a speed of 17.1 m/s. It is abruptly decelerated to a speed of 2.2 m/s over a distance of 13.6 m. Determine the resisting force that acts upon the roller coaster cars.
Looking for: Resisting force on the roller coaster cars
Given: mass = 4768 kg, v_i = 17.1 m/s, v_f = 2.2 m/s, d = 13.6 m
Solution: ½ (4768 kg)(17.1 m/s)^2 - F (13.6 m) = ½ (4768 kg)(2.2 m/s)^2
697,105 J - F (13.6m) = 11538 J
F = 5.0 x 10^4 Newtons

(pile is not in motion & doesn't have h to begin with)

7. A physics teacher exerts a force upon a 3.29-kg pile of snow to both lift it and set it into motion. The snow leaves the shovel with a speed of 2.94 m/s at a height of 0.562 m. Determine the work done upon the pile of snow. ~~KE_i~~ + ~~PE_i~~ + W_{ext} = KE_f + PE_f

$W_{ext} = \frac{1}{2}(3.29\ kg)(2.94\ m/s)^2 + (3.29\ kg)(9.8\ m/s^2)(.562\ m)$

$W = 14.219 + 18.120 = \boxed{32.3\ J}$

8. A 250.-gram cart starts (NO KE_i) from rest and rolls down an inclined plane from a height of 0.541 m. Determine its speed at a height of 0.127 m above the bottom of the incline. NO work ext

~~KE_i~~ + PE_i + ~~W_{ext}~~ = KE_f + PE_f

$(.250\ kg)(9.8\ m/s^2)(.541\ m) = \frac{1}{2}(.250\ kg)(v^2) + (.250\ kg)(9.8\ m/s^2)(.127\ m)$

$1.325\ J = .125\ v^2 + .311$ $\boxed{v = 2.85\ m/s}$

9. A catcher's mitt recoils a distance of 12.9 cm in bringing a 142-gram baseball to a stop. If the applied force is 588 N, then what was the speed of the baseball at the moment of contact with the catcher's mitt?

KE_i + ~~PE_i~~ + W_{ext} = ~~KE_f~~ + ~~PE_f~~ (no KE_f, no PE_f bec no height)

$\frac{1}{2}(.142\ kg)(v^2) - (588\ N)(.129\ m) = 0\ J$

$(.071)v^2 = 75.852\ J$

$\boxed{v = 32.7\ m/s}$

* when something slows down or stops W is in opp direction