ABRHS PHYSICS NAME: KEY

Conservation of Energy 1

1. A highdiver (m = 75 kg) is standing atop a 60 meter tall tower and then jumps to a pool below.
   a. How much potential energy does the diver have at the top of the tower?

m = 75 kg
g = 10 m/s²
h = 60 m

$U = mgh$ $U = (75)(10)(60)$

$U = 45{,}000\ J$

   b. How much potential energy does the diver have when they hit the water?

$U = mgh$ $U = (75)(10)(0)$

h = 0 m

$U = 0\ J$

   c. How much kinetic energy does the diver have at the top of the tower?

v = 0 m/s

$K = \frac{1}{2}mv^2$ $K = \frac{1}{2}(75)(0)^2$

$K = 0\ J$

   d. How much kinetic energy does the diver have when they hit the water?

$\Sigma E_i = \Sigma E_f$

$U_i + K_i = U_f + K_f$ $0 + 45{,}000 = K_f + 0$

$K_f = 45{,}000\ J$

   e. How much total energy did the diver have as they fell?

$45{,}000\ J$

   f. When the diver was halfway down, how much potential and ~~kinetic energy did~~ the diver have?

$\frac{1}{2}$ way means $\frac{1}{2}$ the U, so and so $U = 22{,}500\ J$, $K = 22{,}500\ J$ (because they have to add up to 45,000)

   g. How fast was the diver going just as they hit the water?

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

$45{,}000 = \frac{1}{2}(75)v^2$ $v^2 = 1200$ $v = 34.6\ m/s$

2. Charlene has a mass of 70 kg and is jumping on a trampoline. The trampoline gives her an initial velocity of 12 m/s straight up.
   a. How much kinetic energy does she have as she leaves the trampoline?

m = 70 kg
v = 12 m/s

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

$K = \frac{1}{2}(70)(12)^2$ $K = 5040\ J$

   b. How much kinetic energy does she have at her highest point?

v = 0 @ highest point, so $K = 0\ J$

   c. How much potential energy does she have as she leaves the trampoline?

h = 0 @ lowest point, so $U = 0\ J$

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d. How much potential energy does she have at her highest point?

The K turned into U, so U = 5040 J

e. How high up does she go?

$U = mgh$ $5040 = (70)(10)h$ $h = 7.2$ m

f. When she is one meter above the trampoline, what is her total energy?

5040 J Always the same total!

3. Yusi tosses her 7 kg backpack straight up in the air, giving it a kinetic energy of 120 J.
   a. How fast did she throw it?

$K = \frac{1}{2}mv^2$ $120 = \frac{1}{2}(7)v^2$ $v^2 = 34.3$ $v = 5.86$ m/s

   b. How high does the backpack go?

It stops at its max height - so its energy is all U. So U = 120 J. Then $U = mgh$, $120 = (7)(10)h$, $h = 1.71$ m

4. A 72 kg skier is at the top a frictionless hill with a vertical drop of 95 meters.
   a. How much potential energy does the skier have at the top of the hill?

$m = 72$ kg, $h_i = 95$ m, $v_i = 0$ m/s

$U = mgh$ $U = (72)(10)(95)$ $U = 68{,}400$ J

   b. How fast is the skier going at the bottom of the hill?

$h_f = 0$ m, $v_f = ?$

All that U turns into K, so @ bottom, K = 68,400 J. Then $K = \frac{1}{2}mv^2$, $68{,}400 = \frac{1}{2}(72)v^2$, $v^2 = 1900$, $v = 43.6$ m/s

5. A 1500 kg car is stopped on a hill when the brakes fail (i.e. no friction) and it rolls down the hill. The car rolls until it has speed of 3 m/s.
   a. How much kinetic energy does the car have at the bottom?

$m = 1500$ kg, $h_i = ?$, $h_f = 0$ m, $v_i = 0$ m/s, $v_f = 3$ m/s

$K = \frac{1}{2}mv^2$ $K = \frac{1}{2}(1500)(3)^2$ $K = 6750$ J

   b. What was the vertical drop of the car on the hill?

That K started off as U, so U = 6750 J. Then $U = mgh$, $6750 = (1500)(10)h$, $h = 0.45$ m

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6. A frustrated painter throws his brush (m = 0.04 kg) straight up in the air with an initial velocity of 23 m/s. How high does the brush go?

$m = 0.04$ kg
$v_i = 23$ m/s
$h_i = 0$ m
$v_f = 0$ m/s
$h_f = ?$

$\Sigma E_i = \Sigma E_f$

$K_i + U_i = K_f + U_f$

$\frac{1}{2}mv_i^2 + 0 = 0 + mgh_f$

So $\frac{1}{2}(.04)(23)^2 = (.04)(10)h$

$10.58 = (.4)h$

$h = 26.5$ m

7. A 32 kg child is having fun at the playground on a Super Slide. It is 4.5 meters high and absolutely frictionless. How fast is the child going at the bottom of the slide? (*Note that this is a law suit waiting to happen.*)

$m = 32$ kg
$h_i = 4.5$ m
$v_i = 0$ m/s
$h_f = 0$ m
$v_f = ?$

$\Sigma E_i = \Sigma E_f$

$K_i + U_i = K_f + U_f$

$=0!$ $=0!$

So $(32)(10)(4.5) = \frac{1}{2}(32)v^2$

$90 = v^2$

$v = 9.49$ m/s

Notice you can cancel out the "1300" from all 3 terms if you like :)

8. A 1300 kg roller coaster car is 45 meters high in the air. It rolls down a frictionless hill, and "falls" a vertical distance of 25 meters to the bottom of the first hill. How fast is the roller coaster car traveling at the bottom of the first hill?

$m = 1300$ kg
$h_i = 45$ m
$v_i = 0$ m/s
$h_f = 45 - 25 = 20$m
$v_f = ?$

$\Sigma E_i = \Sigma E_f$

$K_i + U_i = K_f + U_f$

$0 + (1300)(10)(45) = \frac{1}{2}(1300)v^2 + (1300)(10)(20)$

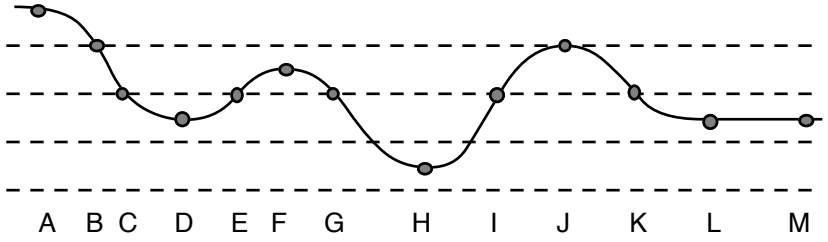
$585{,}000 = 650v^2 + 260{,}000$

$650v^2 = 325{,}000$

$v^2 = 500$

$v = 22.4$ m/s

9. The drawing below represents a frictionless hill, with lines of equal height shown. A ball is given an initial kinetic energy at point A, and then the position of the ball is shown at several positions later.



For each of the questions below, rank the position from greatest to least

a. Where is the ball going the fastest?

At the lowest point – so H

b. Where does the ball have the most potential energy?

At the highest point - so A

c. Where does the ball have the most total energy?

All the same! Potential + kinetic will always add up to the same total number.