Energy – Part 3

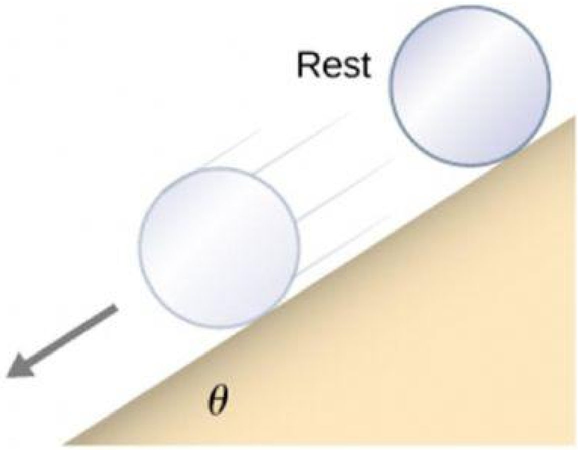
3. Slope

In this example, a ball is rolling DOWN a slope from rest ($v = 0 m.s^{-1}$).
If there is no friction from the surface of the slope then:

$$E_{mech}(top) = E_{mech}(bottom)$$

$$E_k + E_p(top) = E_k + E_p(bottom)$$

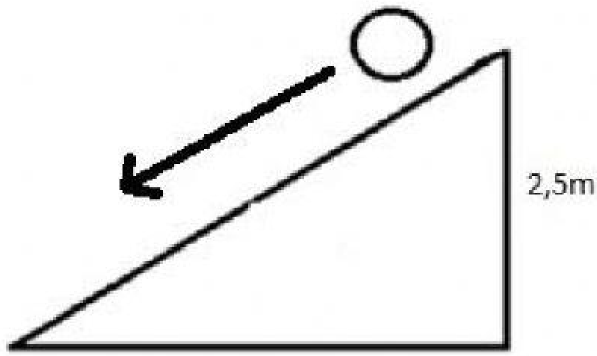
$$0 + E_p(top) = E_k(bottom) + 0$$



(Picture from https://courses.lumenlearning.com/suny-osuniversityphysics/chapter/11-1-rolling-motion)

Example 1:

A 0,5 kg ball rolls down a slope from rest.
Assume there is no friction.



Calculate:

1. **The E_p of the ball at the top of the slope:**

Ep = mgh

= x 9,8 x

= J

Hint: Look at the diagram to see what height the ball was at when it was at the top of the slope.

2. The E_{mech} of the ball at the top of the slope:

Hint: Remember the ball was AT REST at the top of the slope.

Emech (top) = Ep + Ek (top)

= +

= J

3. The E_{mech} of the ball at the bottom of the slope:

Emech (bottom) = Emech (top) = J

4. The velocity of the ball at the bottom of the slope:

Emech (bottom) = Ep + Ek (bottom)

Hint: Remember Ep at the bottom is zero…..no height!

Emech (bottom) = 0 + $\frac{1}{2} mv^2$

= $\frac{1}{2}$ x x v^2

__________ x 2 = v^2

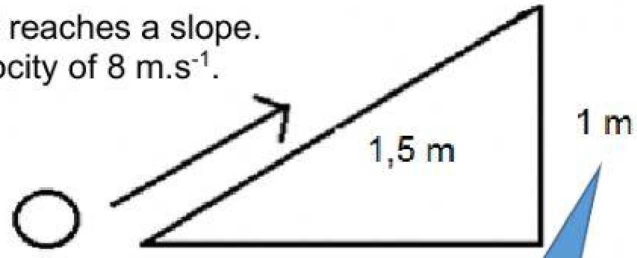
v^2 =

v = $m.s^{-1}$

Example 2:

It is also possible to use Conservation of Energy principles if a ball rolls UP a slope, as long as there is NO FRICTION on the slope.

A 0,2 kg ball is rolling along the floor when it reaches a slope. At the bottom of the slope the ball has a velocity of 8 $m.s^{-1}$.



Hint: Use the HEIGHT of the slope (1m) not the length of the slope (1,5m)

Calculate:

1. **The E_k of the ball at the bottom of the slope:**

Ek = ½ mv^2

= ½ x   x ^{2}

=   J

2. **the E_{mech} of the ball at the bottom of the slope:**

Emech (bottom) = Ek + Ep

=   + 0

=   J

3. **the E_{mech} of the ball at the top of the slope:**

Emech (top) =   J

4. **the velocity of the ball at the top of the slope:**

Emech (top) = Ep + Ek (top)

Emech (top) = mgh + $\frac{1}{2}mv^2$

= (x 9,8 x) + ($\frac{1}{2}$ x x v^2)

v^2 =

v = $m.s^{-1}$

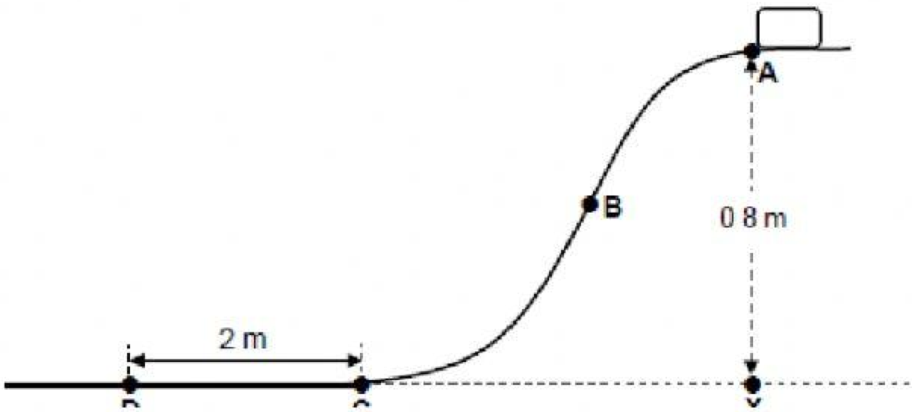
Write this problem out in your books and solve for v^2!

Try the following more challenging problems in the back of your Physics notebooks:

Past paper questions

QUESTION 6 (Start on a new page.)

An object of mass 0,2 kg is released at point **A** and moves along the frictionless section **AC** of a curved track. Along section **CD** it experiences friction and stops at point **D**. The vertical height of point **A** above point **X** on the ground is 0,8 m as shown below.



6.3 At point **B** the speed of the object is 3 $m\cdot s^{-1}$. Use the principle of conservation of mechanical energy to calculate the vertical height of point **B** above the ground. (6)

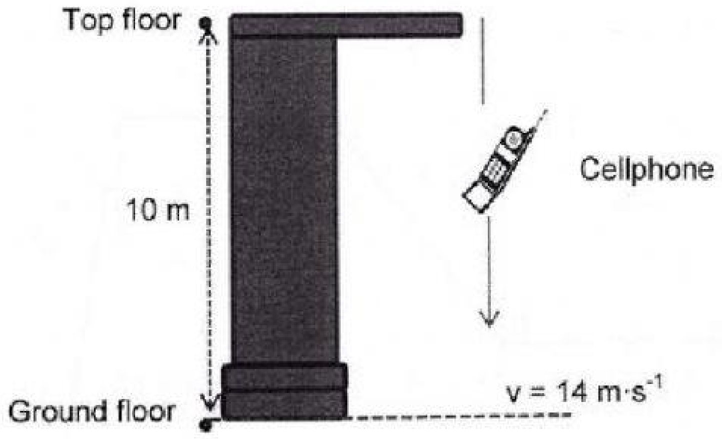
6.4 The object reaches point **C** at a velocity of 3,96 $m\cdot s^{-1}$.

6.4.1 Write down the energy conversion which takes place as the object moves from point **C** to **D**. (1)

6.4.2 Calculate the acceleration that the object experiences as it moves from point **C** to **D**. (5)

[17]

A woman is at the shopping mall 10 m above the ground. Her cellphone, with a mass of 0,01 kg, falls and hits the ground at a speed of 14 $m \cdot s^{-1}$. Ignore the effects of air resistance.



5.1 Convert 14 $m \cdot s^{-1}$ to $km \cdot h^{-1}$. (2)

5.2 Define the term *kinetic energy*. (2)

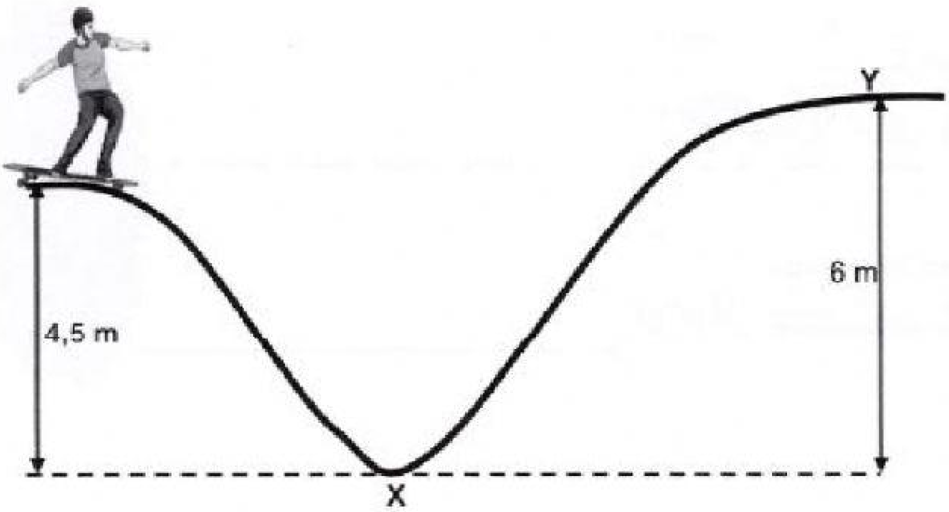
5.3 Calculate the gravitational potential energy of the cellphone at a height of 5 m above the ground. (3)

5.4 Calculate the velocity of the cellphone at a height of 5 m above the ground. (4)

5.5 Will the value of the cellphone's mechanical energy just before it hits the ground be GREATER THAN, LESS THAN or EQUAL TO the mechanical energy at a height of 5 m? Explain the answer. (3)

[14]

A skateboarder, starting from the top of a ramp 4,5 m above the ground, skates down the ramp, as shown in the diagram below. The mass of the skateboarder and his board is 65 kg. Ignore the effects of friction.



5.1 Define the term *gravitational potential energy* in words. (2)

5.2 Calculate the gravitational potential energy of the skater just before he skates down the ramp. (3)

5.3 State the *principle of conservation of mechanical energy* in words. (2)

5.4 Use the principle stated in QUESTION 5.3 to calculate the magnitude of the velocity of the skateboarder when he reaches the ground at point **X**. (4)

5.5 Will the skateboarder be able to reach point **Y** if he were to remain on his skateboard? Write YES or NO and support the answer with a relevant calculation. (5)

[16]