

Energy – Part 3

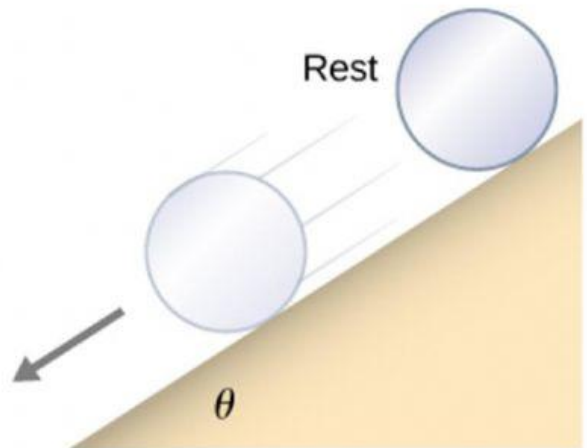
3. Slope

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

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

$$E_k + E_p(\text{top}) = E_k + E_p(\text{bottom})$$

$$0 + E_p(\text{top}) = E_k(\text{bottom}) + 0$$

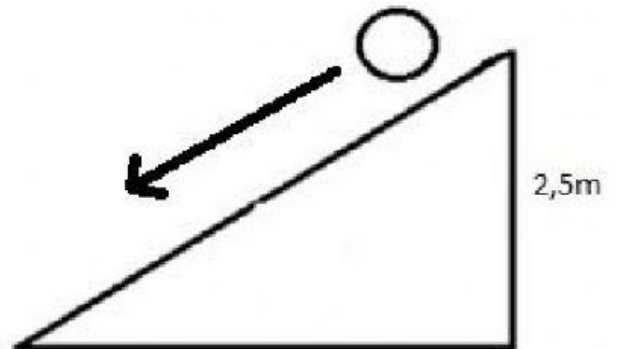


(Picture from <https://courses.lumenlearning.com/suny-osuniversityphysics/chapter/11-1-rolling-motion>)

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:

$$\begin{aligned} E_p &= mgh \\ &= \quad \times 9,8 \times \quad \\ &= \quad \text{J} \end{aligned}$$

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:

$$\begin{aligned} E_{\text{mech}} (\text{top}) &= E_p + E_k (\text{top}) \\ &= + \\ &= J \end{aligned}$$

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

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

$$E_{\text{mech}} (\text{bottom}) = E_{\text{mech}} (\text{top}) = J$$

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

$$E_{\text{mech}} (\text{bottom}) = E_p + E_k (\text{bottom})$$

$$E_{\text{mech}} (\text{bottom}) = 0 + \frac{1}{2} mv^2$$

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

$$\underline{\hspace{2cm}} \times 2 = v^2$$

$$v^2 =$$

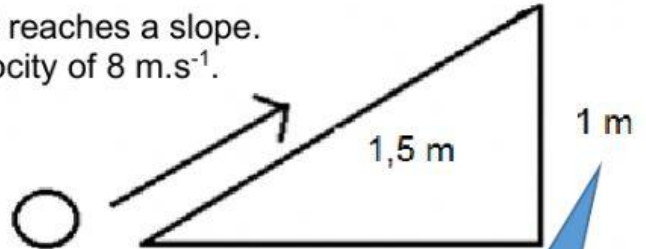
$$v = \text{m.s}^{-1}$$

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

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} .



Calculate:

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

$$\begin{aligned} E_k &= \frac{1}{2} mv^2 \\ &= \frac{1}{2} \times \quad \times \quad^2 \\ &= \quad \text{J} \end{aligned}$$

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

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

$$\begin{aligned} E_{\text{mech}} (\text{bottom}) &= E_k + E_p \\ &= \quad + 0 \\ &= \quad \text{J} \end{aligned}$$

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

$$E_{\text{mech}} (\text{top}) = \quad \text{J}$$

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

$$E_{\text{mech}} (\text{top}) = E_p + E_k (\text{top})$$

$$E_{\text{mech}}(\text{top}) = mgh + \frac{1}{2}mv^2$$

$$= (\quad \times 9,8 \times \quad) + \left(\frac{1}{2} \times \quad \times v^2 \right)$$

$$v^2 =$$

$$v = \quad \text{m.s}^{-1}$$

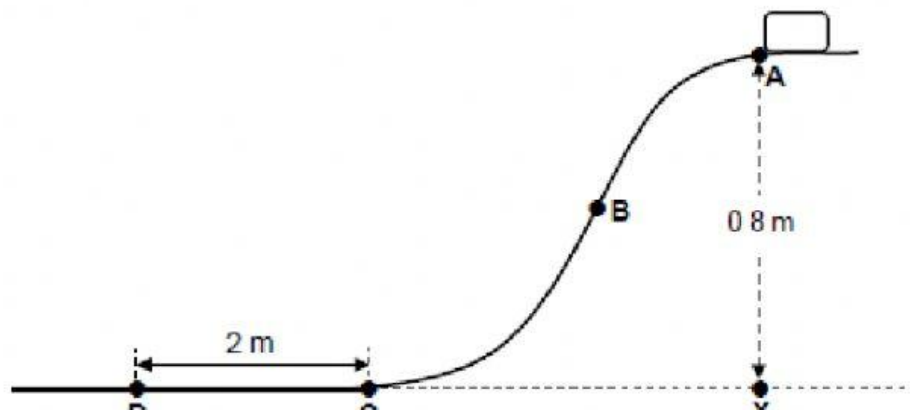
Write this problem out in your books and solve for v^2 !

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

Past paper questions

QUESTION 6 (Start on a new page.)

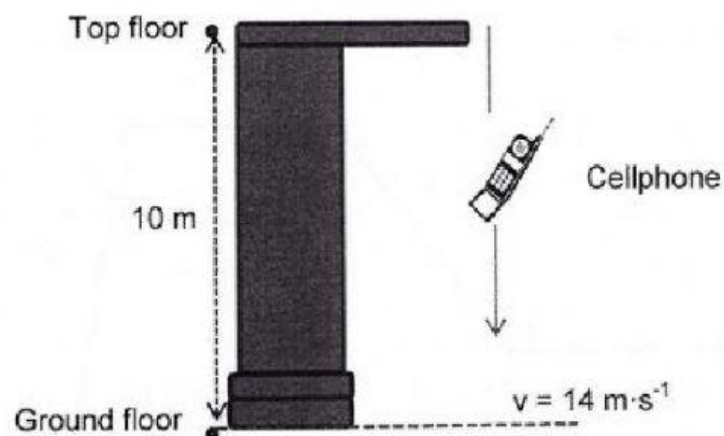
An object of mass 0,2 kg is released at point A and moves along the frictionless section AC of a curved track. Along section CD it experiences friction and stops at point D. The vertical height of point A above point X on the ground is 0,8 m as shown below.



- 6.3 At point B the speed of the object is 3 m.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 $3,96 \text{ m.s}^{-1}$.
- 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)

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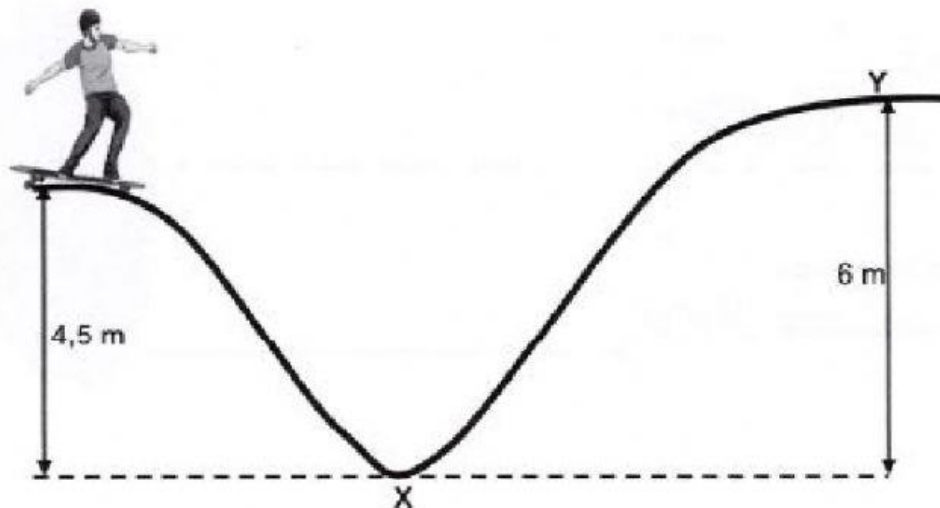
A woman is at the shopping mall 10 m above the ground. Her cellphone, with a mass of 0,01 kg, falls and hits the ground at a speed of $14 \text{ m}\cdot\text{s}^{-1}$. Ignore the effects of air resistance.



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

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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)
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