Teaching scenario 'Bolos Murcianos' in physics

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1. Teaching scenario identity

Thematic field: Spanish traditional games in physics

Thematic Unit: Bolos Murcianos in physics

Class: secondary school, 2nd grade (15-16 years old)

Competence level: students need a certain competence in basic mathematics

Profile of target group: students with a scientific orientation

Teaching scenario aim: students learn the physical principles behind holding/rolling/throwing a ball

Teaching scenario objectives: students are able to understand the physical principles of mass, force, work and displacement

Duration: 40 minutes

Teacher's role: presenter, facilitator and guide

Method of students' work: discussion, teamwork, making exercises

Required materials: calculator

2. Brief description of the teaching scenario

In this lesson students learn the principles of the Spanish game Bolos Murcianos. We use the game in a scientific context (physics). Students will learn the formula of gravity, work and kinetic energy. They need to make some calculations.

3. Worksheets and their keys

1. <u>How much force is needed to hold a bolos?</u>

When you lift an object from the ground, gravity is pulling it down. Therefore you need the muscles in your arm to hold a bolos, so the bolos doens't fall on your feet!

The formula to calculatie the gravity is:

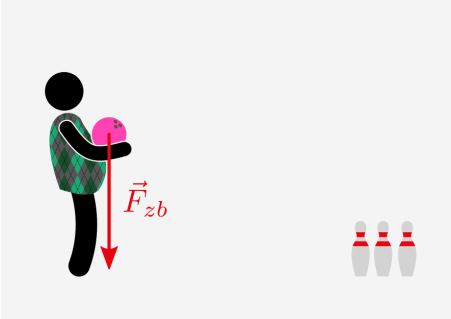
$$Fz = m \cdot g$$

- m is the international symbol for ……
- g is the gravitational constant: 9,81 N/kg
- Note: the z in Fz comes from the Dutch word 'zwaartekracht' and it means gravity

Now, let's calculate the gravity force on a bolos! Therefore you need to know the mass of the bolos. The bolos weighs approximate 1,10 kg.

Fz bolos =

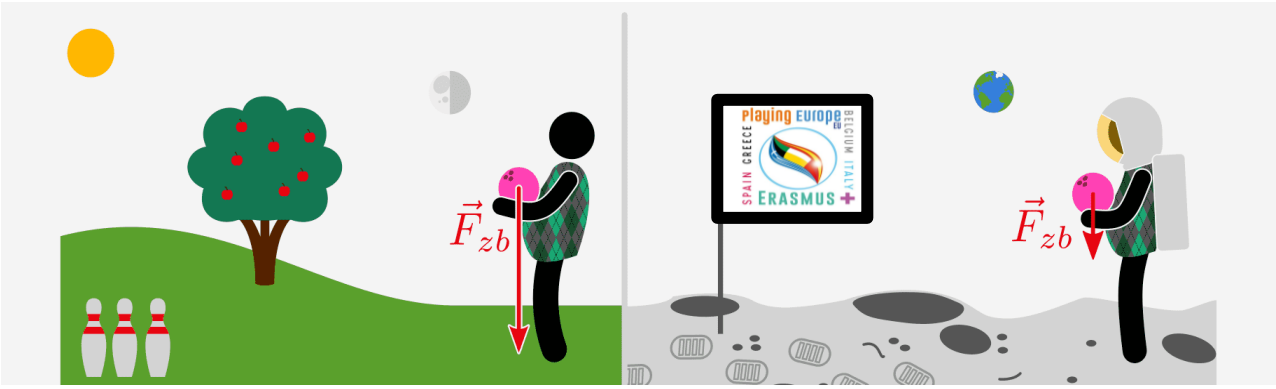
To hold the bolos, your force has to just slightly exceed the force of the gravity.



Picture: https://hoezithet.nu/lessen/fysica/krachten_1/zwaartekracht/

Want to play bolos Murcianos **on the moon**? The gravitational constant on the moon is six times smaller than on earth, it is 1,62 N/kg. It would be a lot easier to carry a bolos on the moon? How much force is needed to hold a bolos on the moon?

Fz bolos =

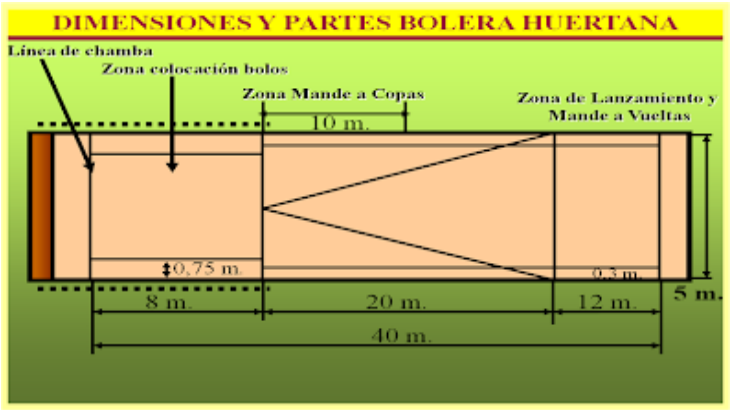


2. <u>How much work is needed to roll a bolos over a distance of 18 meters?</u>

When we want to roll a bolos on the ground in a straight line over a distance of 18 meters (to hit the bowling pins!), we need to give the bolos some energy. We can do that by applying a force on the bolos.

In physics, work (**W**) is the energy transferred to or from an object via the application of force along a displacement. In its simplest form, it is often represented as the product of force and displacement. A force is said to do positive work if it has a component in the direction of the displacement of the point of application. A force does negative work if it has a component opposite to the direction of the displacement at the point of application of the force.

When we want to calculate the work, we must keep in mind that there will be soms friction between the bolos and the ground. That friction on a sandy surface is represented by the greek letter mu (**μ**) and has a estimated value of 0,550.



The formula for work is

$$W = F \cdot d$$

- W is the international symbol for work
- F is the international symbol for force
- d is the international symbol for distance

We must keep in mind that there will be some friction, and therefore the formula becomes:

$$W = \mu \cdot F \cdot d$$

Now, we can replace the F in the formula. What is the formula for calculating the force?

So, the formula for work becomes: **W** =

So, let's calculate the work needed to roll a bolos over a distance of 18 meters (as played in the 'vueltas' variation of Bolos Murcianos).

W =

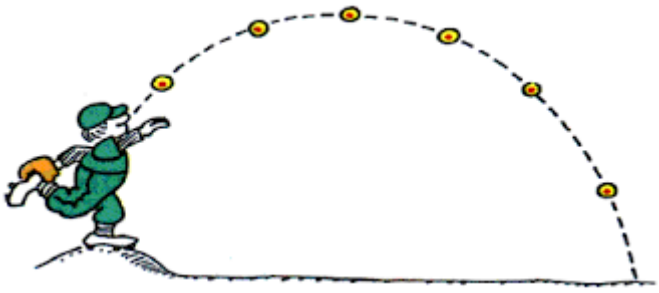
3. How much energy is needed to throw a bolos to the bowling pins?

Off course, we want to hit the bowling pins! What energy needs the bolos to reach the bowling pins, located 18 meters away? The energy that the bolos needs is called 'kinetic energy'. The kinetic energy (E_k) of an object is the energy that it possesses due to its motion.

The formula of kinetic energy is

$$E_k = \frac{1}{2} . m . v^2$$

- m stands for the mass
- v stands for velocity



We can replace v^2 by another formula: $v^2 = d . g$

So the formula for E_k becomes:

$$E_k = \frac{1}{2} . m . d . g$$

Now we can calculate the amount of kinetic energy needed to throw the bolos towards the bowling pins.

$E_k =$

KEY

1. How much force is needed to hold a bolos?

When you lift an object from the ground, gravity is pulling it down. Therefore you need the muscles in your arm to hold a bolos, so the bolos doens't fall on your feet!

The formula to calculatie the gravity is:

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- g is the gravitational constant: 9,81 N/kg
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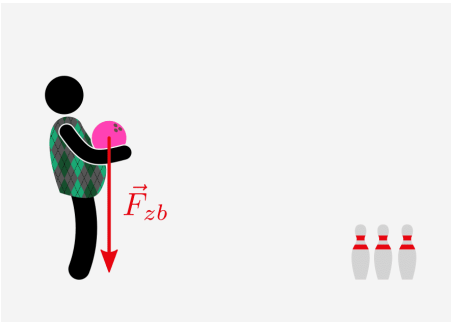
Now, let's calculate the gravity force on a bolos! Therefore you need to know the mass of the bolos. The bolos weighs approximate 1,10 kg.

***Fz bolos* = *m* bolos · *g* =1,10 kg · 9,81 N/kg = 10,8 N**

To hold the bolos, your force has to just slightly exceed the force of the gravity.



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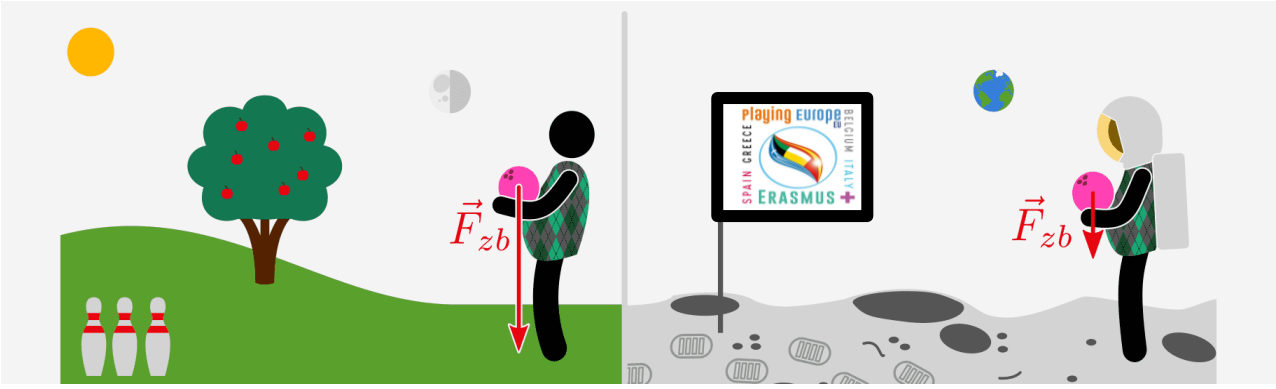
***Fz bolos* = *m* bolos · *g moon* = 1,10 kg · 1,62 N/kg = 1,78 N**



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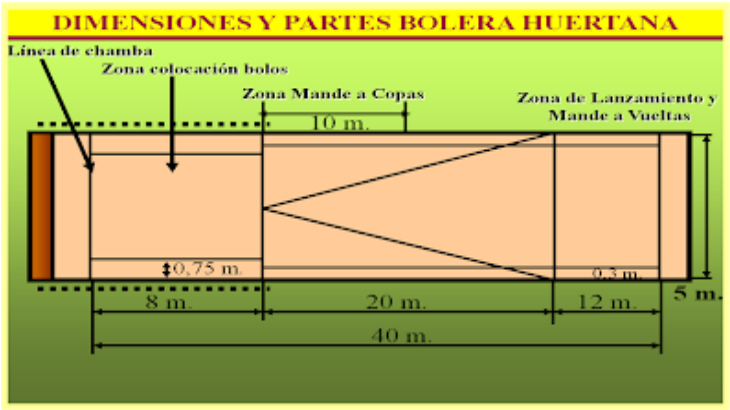

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- W is the international symbol for work
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We must keep in mind that there will be some friction, and therefore the formula becomes:

$$W = \mu \cdot F \cdot d$$

Now, we can replace the F in the formula. What is the formula for calculating the force? ***F = m. g***

So, the formula for work becomes: **W** = ***μ . m . g . d***

So, let's calculate the work needed to roll a bolos over a distance of 18 meters (as played in the 'vueltas' variation of Bolos Murcianos).

W = ***μ . m . g . d***

= 0,550 . 1,10 kg . 9,81 N/kg . 18,0 m

= 107 J

3. How much energy is needed to throw a bolos to the bowling pins?

Off course, we want to hit the bowling pins! What energy needs the bolos to reach the bowling pins, located 18 meters away? The energy that the bolos needs is called 'kinetic energy'. The kinetic energy (E_k) of an object is the energy that it possesses due to its motion.

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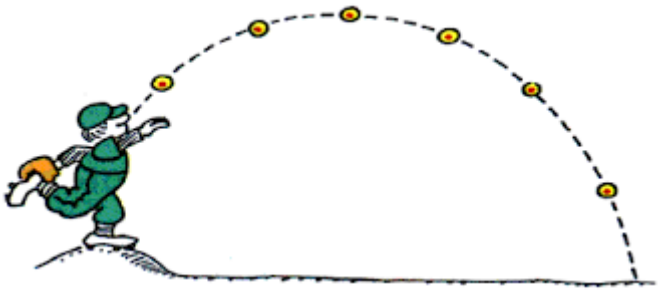

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So the formula for E_k becomes:

$$E_k = \frac{1}{2} . m . d . g$$

Now we can calculate the amount of kinetic energy needed to throw the bolos towards the bowling pins.

E_k = ***½ . 1,10 kg . 18,0 m . 9,81 N/kg***

= 97,1 J