

The scenario

Subject	Mechanics / Action and Reaction
Length	2:02
Main objectives	Action and reaction
Detailed objectives	Force
Structure and description of experiments:	
1. Introduction	Description: Collision of two different carts with different weights. Measurement of the magnitude of the acting forces.
2. Main subject	Description: To show that when two bodies collide, they exert the same force on each other, regardless of their mass.
Part 1	Collision of two carts with different weights
(0:54)	Tools: track, carts, weights, force meter Description: A cart with a smaller mass (0.8 kg) collides with a cart with a larger mass (1.52 kg). We see that after the collision, the heavier one is reflected in the direction of movement and the lighter one is reflected slowly back. From the time course of the forces acting during the collision, we clearly see that the carts act on each other with the same force, the maximum of which reaches approximately 2.8 N. We also see from the course that the forces act only during the collision. The force first increases until the cart with the smaller weight stops, the maximum force is reached, and then the carts move away from each other, corresponding to a decrease in force to zero.
(1:04)	In the second part, the situation is the opposite, the heavier cart collides with the lighter one. In this case, the heavier truck continues in the direction of movement after the collision, because only part of its energy was transferred during the collision with the lighter truck. In this case, the course of the force during the collision is like the previous case - that is, the acting forces are the same, but the maximum force was only 2.1 N smaller. This is due to the fact that in this case we acted on a lighter truck and its start less force is needed than for a heavier cart. Questions: Why is the maximum force different in the second case of collision? What would change in maximum strength if we used heavier/lighter carts?
Part 2	Collision of trucks moving against each other.
(1:20)	Tools: track, carts, weights, force meter Description:

	<p>In this video, two carts with different weights (0.8 kg and 2.52 kg) that are simultaneously moving towards each other collide. After the collision, the heavier cart stops and the lighter one bounces off and moves in the opposite direction. Again, we see that the acting forces are equal, so one cart exerts the same force on the other regardless of its weight. The maximum force reaches a value of around 4.3 N, because we have heavier carts and they move against each other.</p> <p>Questions: What is next reason for the increase in the force applied when two carts collide.</p>
<p>Part 3</p>	<p>Reflecting carts on an inclined plane.</p>
<p>Part 3 (1:29)</p>	<p>Tools: track, mat, carts, weights, force meter</p> <p>Description: Let's prepare an inclined plane where the angle is $\alpha = \arcsin(0.065/0.8) = 4.7^\circ$. On the inclined plane, we have a cart (the center of the cart with the force meter at the distance of 65 cm from the end of the track) with a mass of 520 g, and at the end is a second cart with a mass of 753 g. When moving on an inclined plane, the cart accelerates until it hits the cart at the end of the track. A collision occurs and after the bounce the cart moves up, not returning to its original position, but a little lower, only up to the distance of 42 cm. This is due to the energy lost in the collision and also the energy that caused the book to shift slightly. Subsequently, the cart moves down again and bounces again. After each bounce, it travels a smaller distance, due to the loss of energy in the collision, the energy needed to deform the spring and friction in motion. During the first and then subsequent collisions, we see that the acting forces are the same, they increase to a maximum and then decrease to zero. With each rebound, the maximum force is smaller and smaller.</p> <p>Questions: Why does the cart move upwards after the collision?</p> <p>Conclusions: The action/reaction force is always the same regardless of the weight of the objects and type of movement.</p>
<p>3. Summary, evaluation and notes</p>	<p>In a collision, bodies applies the same force on each other regardless of their mass and state of motion. The mutual force action does not depend on the inclination of the pad.</p> <p>ISCED 3 – 2 Force and movement - Force as a measure of interaction. Newton's third law of motion</p>