The scenario

Subject	**Dynamics/Centrifugal force**
Length	3:41
Main objectives	Centrifugal force
Detailed objectives	Force, Gravitational force, Frictional force, Centrifugal force
Structure and description of experiments:	
1. Introduction	Description: Centrifugal force is encountered during rotating motion, and its magnitude increases with the square of the speed and decreases with the radius of the circular path.
2. Main subject	Description: Determine the speed of the car to go through the looping. Determine the maximum speed at which the car can go through a classic and a banked turn.
Part 1	**Movement in a plane and in a curve**
(0:39)	**Tools:** Track, scale, weight, controller, car
	Description:
(0:55)	First, we weigh the car and the weight used in the test. We place the weight on the car.
(1:10)	We place the toy car on a simple car track with four 90o turns, two of which are tilted (15o) and two normal and set it in motion. At a speed of 1.3 m/s, we can see that the toy car moves along the track without any problems or flying out of the corner. As the speed increases to 1.7 m/s, we can see that the transition through the tilted turn is still without problems, but in a classic turn, the car flies out. In a classic corner, only friction keeps the car in curved motion, while in a banked track it is also the normal component of gravity.
(1:31)	We will weigh the car and the weight used in the test. We place the weight on the car.
(2:13)	When the weight is increased, we see that it goes through a tilted turn at a speed of 1.6 m/s without any problems, while it takes off almost immediately in a classic turn. **Questions:** What is the relationship for gravity, friction, and centrifugal force? When will the toy car pass safely through loping? Why is a tilted turn safer? **Conclusions:** In a banked turn, we can go at a higher speed, because the normal weight component helps us.
Part 2	**Movement after loping**

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(2:32) **(3:01)** **(3:21)**	**Tools:** Loping track, scale, controller, cars (36g and 48g) **Description:** Place the car at the beginning of the looping track. We press the controller fully and observe whether the car passes through the loop. When moving up, we observe a slight deceleration of speed, due to the increase of potential energy at the expense of kinetic energy (blue from 2.2 m/s to 1.5 m/s, gray from 2.5 m/s to 2 m/s). Both cars pass without problems at full power. When moving through a loping, we consider two forces, centrifugal Fc and gravitational G. If Fc is greater than G, the car passes through the loping without falling. When the controller is pressed less, the cars move slower (1.8 m/s and 2.2 m/s) and when going up, the gravitational force prevails over the centrifugal force (1 m/s), which pressed them to the track, and the cars fall from different heights. **Questions:** How to determine the minimum speed to pass a loping? Does this speed depend on the weight of the car? **Conclusions:** Centrifugal force increases quadratically with velocity and decreases with radius.
3. Summary, evaluation and notes	**Application:** Movement on a carousel or in a bus in a curve. Example of a non-inertial system. Centrifugal force is applied during circular motion, carousel or when driving around a curve. When loading the car, it is better to put the weight inside so that the resulting center of gravity is as low as possible. The movement of the toy car on the track is held by a guide pin, so the friction-only calculations may not match. When setting the correct speed, which is still sufficient to drive through loping, more attempts are needed. **Level:** gymnasiums, secondary vocational schools (1st year, ISCED 3)

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