The conservation of momentum theorem with Cobra DigiCart

Physics > Mechanics > Dynamics & Motion

Difficulty level	Group size	Preparation time	Execution time
medium	2	20 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/60f939c5690ba70004c4506c

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Teacher information

Application

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Cannon

At a freight station, wagons roll down a hump and collide with stationary wagons. Afterwards, all wagons roll on slowly together: The speed can be calculated with the law of conservation of momentum.

The recoil of a cannon when firing the bullet can also be explained and calculated with the law of conservation of momentum.

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Teacher information (1/2)

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Learning

In this experiment, students learn about the physical concept of conservation of momentum and energy. They can perform the elastic as well as the inelastic collision.

Task

1. Carry out an elastic impact with the two DigiCarts. Analyze the change in momentum and energy of the system before and after the impact.
2. Carry out an inelastic impact with the two DigiCarts. Analyze the change in momentum and energy of the system before and after the impact.

Previous

This experiment requires prior knowledge of momentum and Newton's second law. The students should also have understood the concept of a closed system.

Teacher information (2/2)

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Principle

Impulse p

$p = m \cdot v$ For a body with mass m and the speed v

Conservation of momentum

$\dot{p} = \frac{dp}{dt} = F$ Newton's second law, constant at all times.

Shock variants or shock processes

1. **Elastic impact -none** Conversion of energy into heat. Energy constant.
2. **Inelastic impact -** Conversion of energy into heat. Energy not constant.

Without external forces the total momentum of the system is constant before and after impact $p_{vorher} = p_{nacher}$

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

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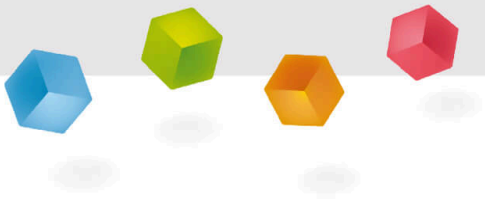

Student Information

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Motivation

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Billiards

What is an impulse in physics?

In billiards, you try to sink a colored ball with the help of a white ball. Physically, this situation represents a shot.

But how are all these variables related?

In this experiment you will learn about the physical concept of conservation of momentum and energy. You can perform elastic and inelastic

Tasks

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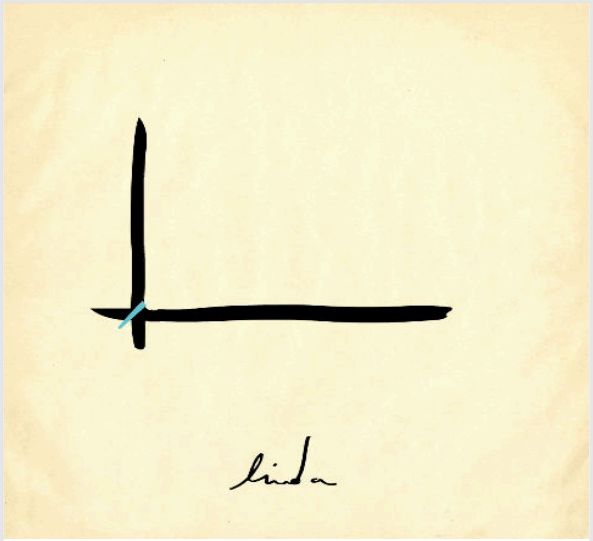

https://giphy.com/

1. Perform an elastic impact with the two DigiCarts. Analyze the change in momentum and energy of the system before and after the impact.
2. Perform an inelastic collision with the two DigiCarts. Analyze the change in momentum and energy of the system before and after the impact.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra DigiCartAPP	14582-61	1
2	Cobra DigiCart Expert Set	12940-88	1

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Set-up (1/3)

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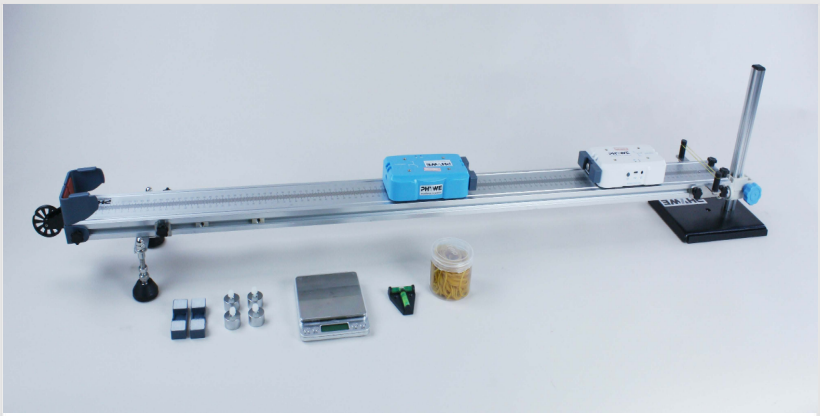

Overview of experimental setup

- Bring the track into a horizontal position with the help of the spirit level. Then tighten a rubber band at the end of the track on the black cylinders provided for this purpose.
- Place two 50 gram extra weights on each DigiCart and fix them with the plastic screws. Then weigh both cars and note the weight.
- Mount a magnetic bumper on each of the two DigiCarts and fix it in place using the screws.

Set-up (2/3)

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Overview of experimental setup

- Place both DigiCarts on the track so that the bumpers are facing each other and north pole meets north pole and south pole meets south pole.

  (the cars are supposed to repel each other when they get close).
- Launch the DigiCart app.
- Select test 10 from the overview. The measurement window opens.
- Connect both DigiCart with the app

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Set-up (3/3)

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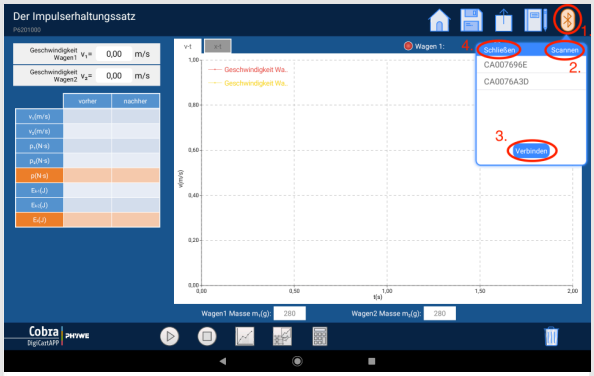

Connection to the DigiCart

- Two steps are required to do this. First, the ON switch on the DigiCart must be pressed for at least 3 seconds.
- Then open the connection window in the app via the Bluetooth symbol (1.). Both DigiCarts should now be displayed there. If not, you can update the list by clicking on Scan (2.).
- Now tap a DigiCart from the list once and establish the connection via the Connect button (3.).
- Proceed in the same way with the other DigiCart.
- The window can now be hidden again by clicking the close button (4.).

Implementation Part 1 (1/4)

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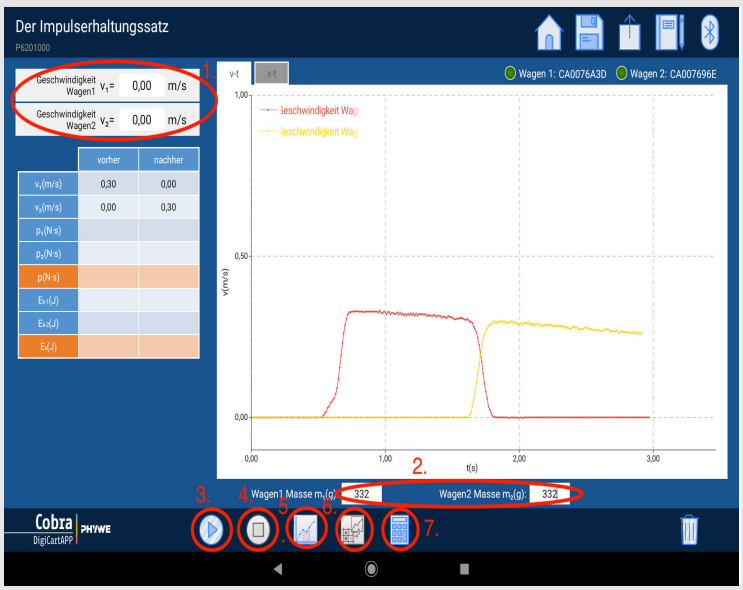

Elastic impact

- The figure shows the steps for the measurement process.
- The instantaneous speed of the two DigiCarts is shown in the speed display (1.).
- Enter the masses of both DigiCart in the fields provided (2.).
- Place one DigiCart in the middle of the track (cart 2). Press the other DigiCart into the taut rubber band so that it tightens and holds it in place (cart 1).

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Implementation Part 1 (2/4)

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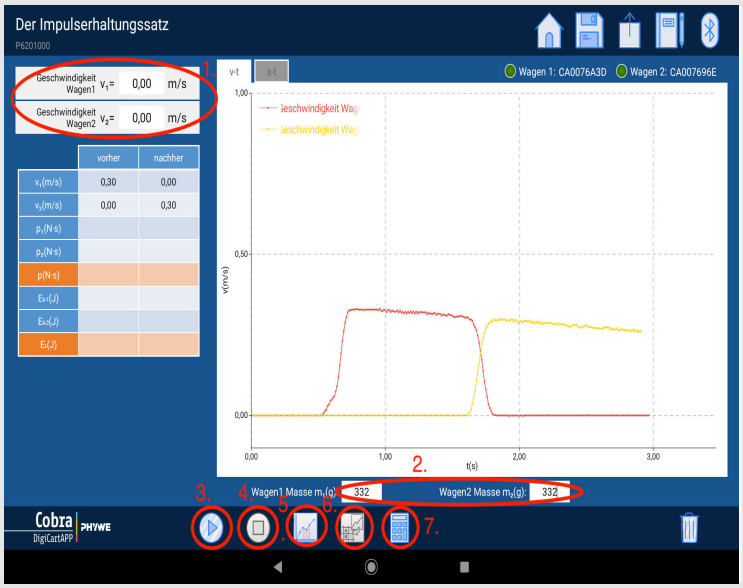

Important: The bumpers are still facing each other so that north points to north pole and south points to south pole.

- Start the measurement by clicking on "Start measurement". (3.).
- Release car 1 so that it moves towards car 2.
- The measurement can be stopped by clicking on "Stop measurement" (4.) as soon as car 2 reaches the end of the track.

Implementation Part 1 (3/4)

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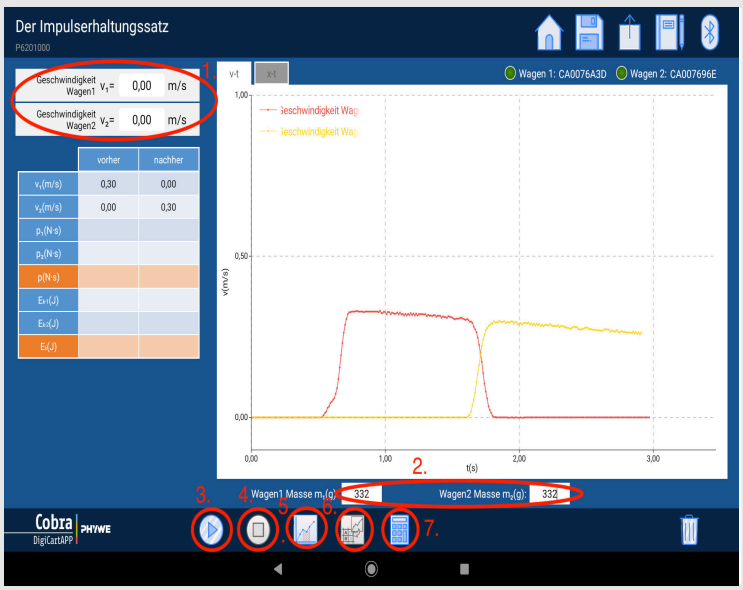

- Select the range in the speed-time diagram by clicking on "Select range". (5.) select the range in the velocity-time diagram, in which

  Which one of the shocks is taking place.
- The range should therefore start shortly before the impact and end shortly after the impact (see illustration). The selection is made by sweeping over the interval with the finger.
- Save the measurement by clicking on the "Save" button (6.). button (6.). The values are now written into the left table.

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Implementation Part 1 (4/4)

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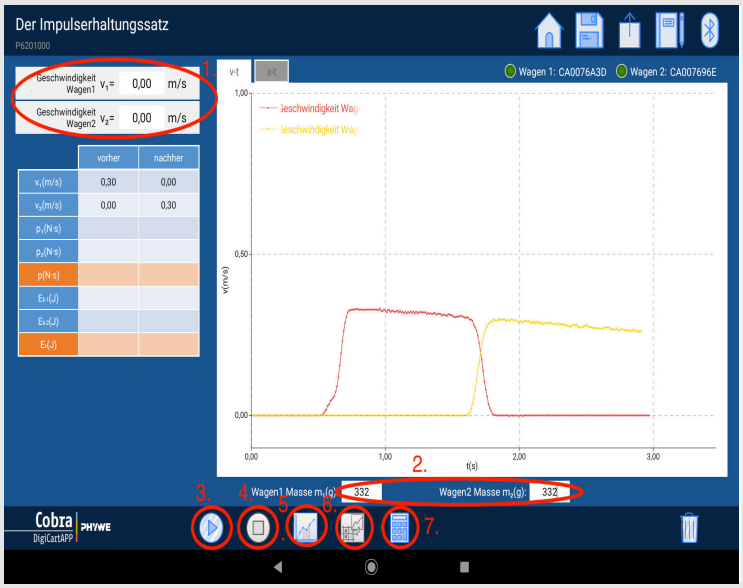

- The figure shows the steps for the evaluation.
- Click on the "Calculate" button (7.) to fill the table with values.
- The table shows the speeds v_1 and v_2 of both DigiCarts before and after the shock. In addition, their impulses are p_1 and p_2 calculated before and after the impact.
- This results in the value of the total impulse of the system of both cars before and after the impact, which is highlighted in red.

Implementation Part 2 (1/4)

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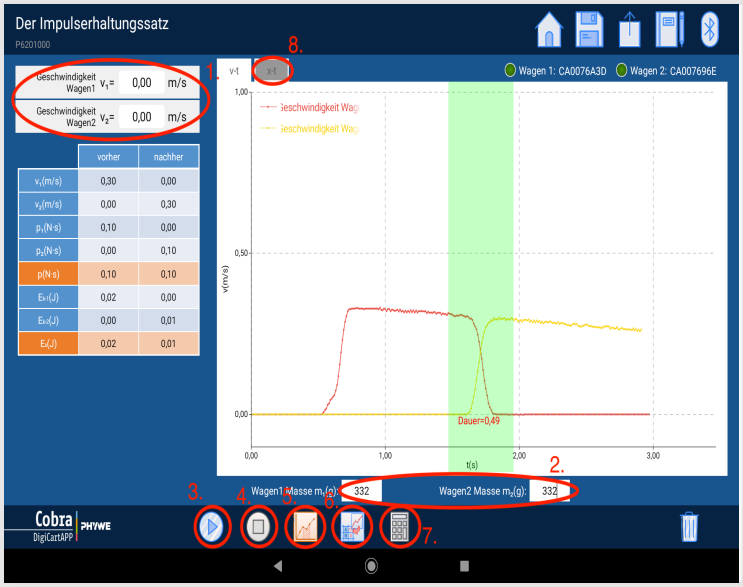

Inelastic impact

- Replace the magnetic bumpers on both cars with the Velcro bumpers.
- The instantaneous speed of the two DigiCarts is shown in the speed display (1.). Enter the masses of both DigiCarts in the fields provided (2.).
- Place one DigiCart in the middle of the track (cart 2). Press the other DigiCart into the taut rubber band so that it is held in place (cart 1).

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Implementation Part 2 (2/4)

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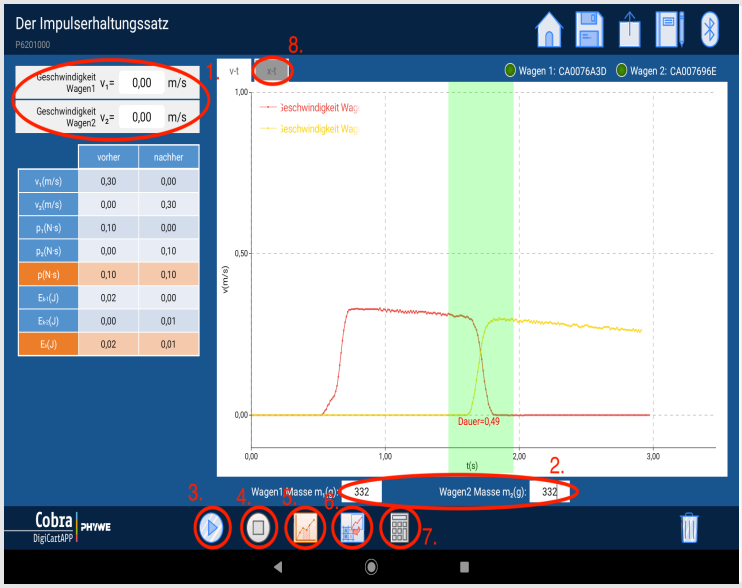

Important: The bumpers are still facing each other. In the collision, they hook together due to the Velcro.

- Start the measurement by clicking on "Start measurement". (3.).
- Release car 1 so that it moves towards car 2.
- The measurement can be stopped by clicking on "Stop measurement" (4.) as soon as car 2 reaches the end of the track.

Implementation Part 2 (3/4)

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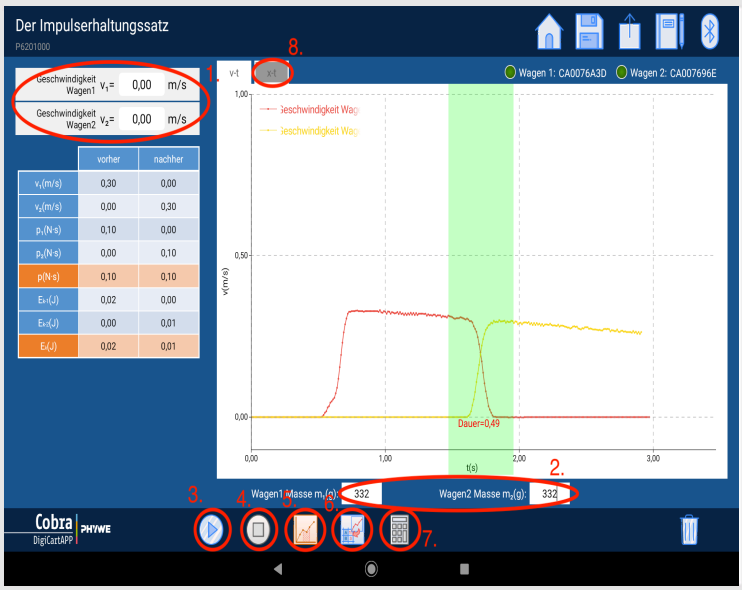

- Select the range in the velocity-time diagram by clicking on "Select range". (5.) select the range in the velocity-time diagram in which the impact takes place. The range should therefore start shortly before the impact and end shortly after the impact (see figure).
- Selection is made by swiping your finger over the interval.
- Save the measurement by clicking on the "Save" button (6.). button (6.).
- The values are now written to the left table.

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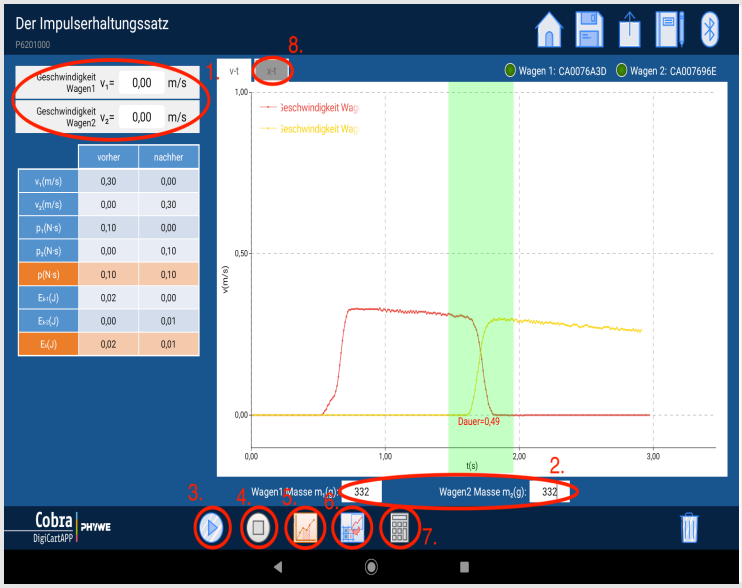
Implementation Part 2 (4/4)



- The kinetic energy of both DigiCarts before and after the impact is also calculated. This results in the value of the total energy of the system of both carts before and after the impact, highlighted in red.
- By clicking on the tab "x-t" above the diagram (8.) you can switch to the location-time diagram. Try to reconstruct the movements of the DigiCarts using the diagram.
- Repeat the elastic and inelastic impact also for different masses of the DigiCarts by distributing the additional weights differently on the carts.

Report

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Task 1

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Drag the correct words into the gaps! (Elastic push)

If one compares the values of the total momentum of the system before and after the impact, one finds that they _____ to a good approximation. The same can be seen with the _____ of the system. It has the same value before and after the impact. The momentum and energy are thus _____ in the elastic collision.

agree
conserved
total energy

Check

Task 2

PHYWE

Drag the correct words into the gaps! (Inelastic collision)

If we compare the values of the total momentum of the system before and after the impact, we find that they _____ to a good approximation. But this time, this does not apply to the _____ of the system. It has _____ values before and after the collision. The momentum is thus _____ in the inelastic collision, but the energy is not. There are _____.

match
total energy
losses
different
conserved

Check

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Task 3

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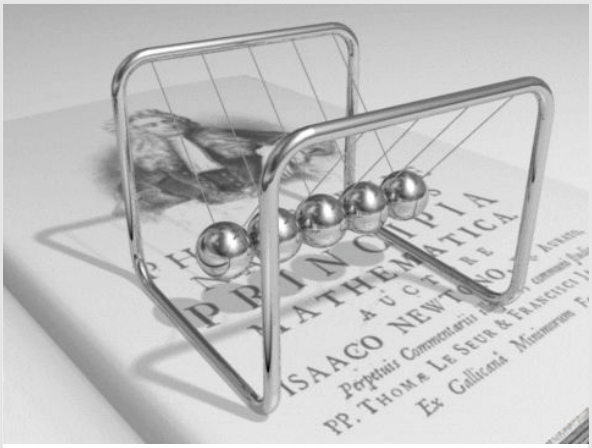

https://giphy.com/

How can you get the impulse p calculate?

- $p = m \cdot a$
- $p = m \cdot v$
- $p = a \cdot v$

Slide	Score / Total
Slide 22: Relationship elastic impact	**0/3**
Slide 23: Relationship inelastic impact	**0/5**
Slide 24: Pulse variants	**0/5**

Total Score **0 / 13**

Show solutions Retry

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