- Spherical shapes are used to ensure that the surface area of contact is the smallest possible.
- Hard metal spheres or glass marbles are used to reduce loss of energy.

Newton's cradle:
Take one ball and let it fall back. Paper pipe: Use a bent PVC pipe with a marble at the bottom.

4. What do you observe in terms of the height that the balls at the ends reach each time?

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5. During an elastic collision, the kinetic energy is conserved.
Do you think that the collisions in Newton's cradle are completely elastic?
Explain your answer.

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## Exercise 3 Date:

1. Two laboratory trolleys, P and Q, with masses 2 kg and 1 kg respectively, move toward each other in the same straight line on a horizontal surface, as shown in the diagram.


The trolleys collide head-on and proceed to move as a unit. Calculate the velocity with which they move after the collision.

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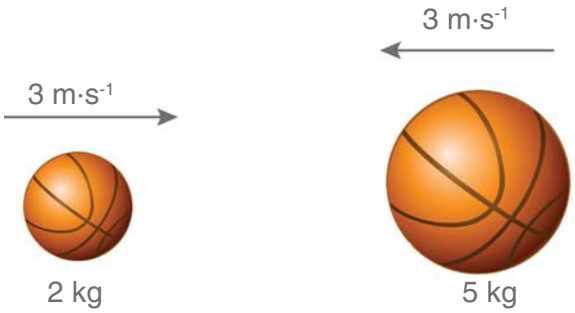
2




Two balls, with mass and velocity as indicated in the diagram, collide head-on. After the collision, the 2 kg ball bounces back with a velocity of 2,5 m·s$^{-1}$.

2.1 Name the law that applies to this event.

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2.2 Calculate the velocity of the 5 kg ball after the collision.

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2.3 Calculate the impulse that the 2 kg ball exerts on the 5 kg ball.

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2.4 If the time of contact between the balls is 0,5 s, calculate the force that the 5 kg ball exerts on the 2 kg ball.

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3 Two trolleys, P and Q, move toward each other on a straight track as indicated in the diagram.


The trolleys collide and P bounces back with a velocity of 1,5 m·s$^{-1}$.

3.1 Calculate the velocity of trolley Q after the collision.

3.2 State the principle that you used in words.

The time of contact between the trolleys during the collision is 0,02 seconds.

3.3 Calculate the force that trolley P exerts on trolley Q during the collision.

3.4 What is the force that trolley Q exerts on trolley P?

3.5 Why are cars manufactured with airbags and crumple zones? Explain your answer in short sentences using your knowledge of impulse, force, time and change in momentum.

4 A cannon, mass 700 kg, recoils at 4 $m \cdot s^{-1}$ when it shoots a cannon ball, mass 5 kg, horizontally.

4.1 Calculate the velocity of the cannon ball as it leaves the cannon.