

**Practice**

- What impulse is exerted in each of the following cases?
  - a force of 25 N pushing on a cart for 3.2 s (80 N·s)
  - a tennis racquet exerting a force of 60 N on a tennis ball during the 0.04 s they are in contact (2.4 N·s)
  - the Earth pulling down on a 12 kg rock during the 3.0 s it takes to fall from a cliff. (3.6 × 10<sup>2</sup> N·s)
- A billiard ball of mass 200 g is rolling towards the right-hand cushion of a billiard table at 2.0 m/s and rebounds straight back at 2.0 m/s.
  - What is its change in momentum as a result of the collision? (-0.8 kg·m/s)
  - What impulse is exerted on the ball? (-0.8 N·s)
- A puck of mass 0.20 kg is sliding along a smooth flat section of ice at 18 m/s when it encounters some snow. After 2.5 s of sliding through the snow, it returns to smooth ice, continuing at a speed of 10 m/s.
  - What is the change in momentum of the puck? (-1.6 kg·m/s)
  - What impulse is exerted on the puck by the snow? (-1.6 N·s)
  - What average force does the snow exert on the puck? (-0.64 N)
- A frictionless disc of mass 0.50 kg is moving in a straight line across an air table at a speed of 2.4 m/s when it bumps into an elastic band stretched between two fixed posts. If the elastic band exerts an average opposing force of 1.2 N on the disc for 1.5 s, what will be the final velocity of the disc? (-1.2 m/s)
- A skateboard of mass 2.0 kg is rolling along a smooth flat floor when a small girl pushes it, causing it to speed up to 4.5 m/s in 0.5 s. If the force exerted by the girl on the skateboard, in its direction of motion, was 6.0 N, with what initial velocity was it moving? (3.0 m/s)

**Practice**

- A 5000 kg boxcar runs into a stationary 8000 kg tank car at 5.2 m/s. They hook together and move off down the track. How fast will they be going? (2.0 m/s)
- A large compressed spring is placed between a 4000 kg railway car and a 6000 kg boxcar at rest. The spring is released and the two cars move off in opposite directions. If the heavier car moves at 2.4 m/s, how fast will the other move? (-3.6 m/s)
- A 0.20 kg golf ball, moving at 80 m/s, hits a watermelon of 10 kg mass at rest on a frictionless table, and sticks in it. How fast does the watermelon move? (1.6 m/s)

**Practice**

- What impulse is exerted in each of the following cases?
  - a force of 25 N pushing on a cart for 3.2 s (80 N·s)
  - a tennis racquet exerting a force of 60 N on a tennis ball during the 0.04 s they are in contact (2.4 N·s)
  - the Earth pulling down on a 12 kg rock during the 3.0 s it takes to fall from a cliff. (3.6 × 10<sup>2</sup> N·s)
- A billiard ball of mass 200 g is rolling towards the right-hand cushion of a billiard table at 2.0 m/s and rebounds straight back at 2.0 m/s.
  - What is its change in momentum as a result of the collision? (-0.8 kg·m/s)
  - What impulse is exerted on the ball? (-0.8 N·s)
- A puck of mass 0.20 kg is sliding along a smooth flat section of ice at 18 m/s when it encounters some snow. After 2.5 s of sliding through the snow, it returns to smooth ice, continuing at a speed of 10 m/s.
  - What is the change in momentum of the puck? (-1.6 kg·m/s)
  - What impulse is exerted on the puck by the snow? (-1.6 N·s)
  - What average force does the snow exert on the puck? (-0.64 N)
- A frictionless disc of mass 0.50 kg is moving in a straight line across an air table at a speed of 2.4 m/s when it bumps into an elastic band stretched between two fixed posts. If the elastic band exerts an average opposing force of 1.2 N on the disc for 1.5 s, what will be the final velocity of the disc? (-1.2 m/s)
- A skateboard of mass 2.0 kg is rolling along a smooth flat floor when a small girl pushes it, causing it to speed up to 4.5 m/s in 0.5 s. If the force exerted by the girl on the skateboard, in its direction of motion, was 6.0 N, with what initial velocity was it moving? (3.0 m/s)

**Practice**

- A 5000 kg boxcar runs into a stationary 8000 kg tank car at 5.2 m/s. They hook together and move off down the track. How fast will they be going? (2.0 m/s)
- A large compressed spring is placed between a 4000 kg railway car and a 6000 kg boxcar at rest. The spring is released and the two cars move off in opposite directions. If the heavier car moves at 2.4 m/s, how fast will the other move? (-3.6 m/s)
- A 0.20 kg golf ball, moving at 80 m/s, hits a watermelon of 10 kg mass at rest on a frictionless table, and sticks in it. How fast does the watermelon move? (1.6 m/s)

**Practice**

- A 5000 kg boxcar runs into a stationary 8000 kg tank car at 5.2 m/s. They hook together and move off down the track. How fast will they be going? (2.0 m/s)
- A large compressed spring is placed between a 4000 kg railway car and a 6000 kg boxcar at rest. The spring is released and the two cars move off in opposite directions. If the heavier car moves at 2.4 m/s, how fast will the other move? (-3.6 m/s)
- A 0.20 kg golf ball, moving at 80 m/s, hits a watermelon of 10 kg mass at rest on a frictionless table, and sticks in it. How fast does the watermelon move? (1.6 m/s)

**Practice**

- A 5000 kg boxcar runs into a stationary 8000 kg tank car at 5.2 m/s. They hook together and move off down the track. How fast will they be going? (2.0 m/s)
- A large compressed spring is placed between a 4000 kg railway car and a 6000 kg boxcar at rest. The spring is released and the two cars move off in opposite directions. If the heavier car moves at 2.4 m/s, how fast will the other move? (-3.6 m/s)
- A 0.20 kg golf ball, moving at 80 m/s, hits a watermelon of 10 kg mass at rest on a frictionless table, and sticks in it. How fast does the watermelon move? (1.6 m/s)

**Practice**

- What impulse is exerted in each of the following cases?
  - a force of 25 N pushing on a cart for 3.2 s (80 N·s)
  - a tennis racquet exerting a force of 60 N on a tennis ball during the 0.04 s they are in contact (2.4 N·s)
  - the Earth pulling down on a 12 kg rock during the 3.0 s it takes to fall from a cliff. (3.6 × 10<sup>2</sup> N·s)
- A billiard ball of mass 200 g is rolling towards the right-hand cushion of a billiard table at 2.0 m/s and rebounds straight back at 2.0 m/s.
  - What is its change in momentum as a result of the collision? (-0.8 kg·m/s)
  - What impulse is exerted on the ball? (-0.8 N·s)
- A puck of mass 0.20 kg is sliding along a smooth flat section of ice at 18 m/s when it encounters some snow. After 2.5 s of sliding through the snow, it returns to smooth ice, continuing at a speed of 10 m/s.
  - What is the change in momentum of the puck? (-1.6 kg·m/s)
  - What impulse is exerted on the puck by the snow? (-1.6 N·s)
  - What average force does the snow exert on the puck? (-0.64 N)
- A frictionless disc of mass 0.50 kg is moving in a straight line across an air table at a speed of 2.4 m/s when it bumps into an elastic band stretched between two fixed posts. If the elastic band exerts an average opposing force of 1.2 N on the disc for 1.5 s, what will be the final velocity of the disc? (-1.2 m/s)
- A skateboard of mass 2.0 kg is rolling along a smooth flat floor when a small girl pushes it, causing it to speed up to 4.5 m/s in 0.5 s. If the force exerted by the girl on the skateboard, in its direction of motion, was 6.0 N, with what initial velocity was it moving? (3.0 m/s)