

Chapter 7 Momentum

Example Problems

7.1 Momentum

E1. A monkey throws a “hail marry” pass on the last play of the big football game. The 0.43 kg football leaves the monkey’s hand at a speed of 59 mph (26.38 m/s), calculate the magnitude of the footballs momentum.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$\rho =$

$m =$

$v =$

a) _____ ← units

E2. Suppose that your mass is 50.0 kg. How fast would you have to be running in order to have the same momentum as a 1,500 kg car traveling at 60 mph (26.82 m/s)?

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

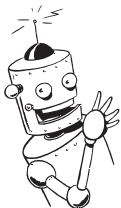
$\rho =$

$m =$

$v =$

a) _____ ← units

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E3. A runner has a mass of 45 kg. Calculate the change in momentum of the runner as he speeds up from an initial speed of 5 m/s to final speed of 11 m/s.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$\Delta p =$

$\Delta v =$

$m =$

a) _____ ← units

E4. A 0.095 kg tennis ball is thrown at a wall. The tennis ball is originally traveling 40 m/s when it hits the wall then bounces back at a speed of 30 m/s in the opposite direction. Calculate the change in momentum of the tennis ball.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

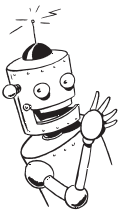
$\Delta p =$

$\Delta v =$

$m =$

a) _____ ← units

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Example Problems

7.2 Impulse

E1. A hockey puck has a mass of 0.115 kg and is at rest on the ice. A hockey player takes a slap-shot applying a constant force of 30.0 N on the puck for 0.16 seconds. Calculate the size of the impulse applied to the puck and the pucks change in momentum.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$J =$

$F =$

$t =$

a) _____ ← units b) _____ ← units

E2. In throwing a coconut a monkey applies an impulse of 32 Ns for 0.25 seconds. Calculate the magnitude of the average force applied to the coconut by the monkey.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

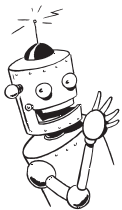
$J =$

$F =$

$t =$

a) _____ ← units

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E3. A baseball pitcher throws a fastball towards home plate applying an impulse of 6.48 Ns. If the average force applied to the ball by the pitcher as he threw the ball was 43.21 N, calculate how long the ball was in the pitcher’s hand.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$J =$

$F =$

$t =$

a) _____ ← units

E4. A goalie blocks a player’s slap shot changing the speed of the puck from 41.74 m/s to 29.31 m/s. If the puck has a mass of 0.115 kg, calculate the magnitude of the impulse the goalie applies to the puck and the change in momentum for the puck.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$J =$

$\Delta p =$

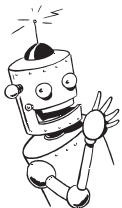
$m =$

$\Delta v =$

a) _____ ← units

b) _____ ← units

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Example Problems

7.3 Impulse and Momentum Theorem (FAT-MAV)

- E1. A 1000 kg monkey-mobile is driven by a crazy monkey. The monkey sees an armadillo crossing the road and applies the brakes in order to avoid hitting the armadillo. The car changes speed from 30 m/s to 20 m/s in 0.87 seconds.
- Calculate the force the brakes apply to the car to slow it down.
 - Calculate the impulse delivered to the car by the brakes.
 - Calculate the change in momentum of the car.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$F =$

$t =$

$m =$

$\Delta v =$

- E2. A 0.05 kg ball is dropped and strikes the floor with a speed of 10 m/s. It rebounds vertically with a speed of -7 m/s after being in contact with the floor for 0.01 seconds.
- Calculate the force the floor applies to the ball.
 - Calculate the impulse on the ball by the floor.
 - Calculate the change in momentum of the ball.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

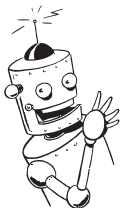
$F =$

$t =$

$m =$

$\Delta v =$

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E3. A 0.144 kg baseball is thrown towards home plate with a speed of 38.0 m/s. The batter hits the ball and the ball flies off the bat in the opposite direction at 55.0 m/s. The bat applies an average force of -13,680 N to the ball during the contact.

- a) Calculate how long the bat was in contact with the ball.
- b) Calculate the impulse delivered by the bat to the ball.
- c) Calculate the change in momentum of the ball.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$F =$

$t =$

$m =$

$\Delta v =$

E4. A 0.06 kg tennis ball is hit with a force of -138 N in the opposite direction. The tennis ball is in contact with the racket for a total of 0.020 seconds

- a) Calculate the change in velocity of the ball.
- b) Calculate the impulse delivered by the racket to the ball.
- c) Calculate the change in momentum of the tennis ball.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$F =$

$t =$

$m =$

$\Delta v =$

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Student Problems

7.1 Momentum and Impulse

1. The worlds fastest human Usain Bolts has a mass of 207 pounds (94 kg) and can run at a top speed of 27.78 mph (12.4 m/s), calculate Usain Bolts momentum.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$$p =$$

$$m =$$

$$v =$$

a) _____ ← units b) _____ ← units

2. The cheetah is the fastest land mammal found today. An adult cheetah has an average mass of 160 pounds (72.57 kg) and can run at 70 mph (30 m/s), calculate the momentum of an adult cheetah running at top speed.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

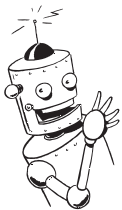
$$p =$$

$$m =$$

$$v =$$

a) _____ ← units

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3. Suppose that you have a mass of 150 pounds (68.03-kg). How fast would you have to run in order to have the same momentum as a 5,500 kg elephant traveling at a top speed of 15 mph (6.71 m/s)? Convert your answer to miles per hour.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$\rho =$

$m =$

$v =$

a) _____ ← units b) _____ ← units

4. The average person walks at a rate of 3.1 mph (1.39 m/s). Assuming the average person has a mass of 150 pounds (68.03-kg), how fast would you have to throw a 0.43 kg football in order to have the same momentum as a person walking? Convert to mph.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

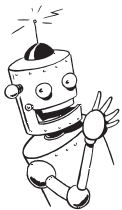
$\rho =$

$m =$

$v =$

a) _____ ← units b) _____ ← units

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5. A monkey hits a 0.04593 kg golf ball sitting at rest. The golf ball leaves the club traveling at 75 m/s. Calculate the size of the impulse by the club on the golf ball.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$J =$

$m =$

$\Delta v =$

a) _____ ← units

6. A 210 pounds (95-kg) football player is running with the ball and has a velocity of 4.2 m/s to. Calculate the magnitude of the impulse that is needed to stop the runner.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

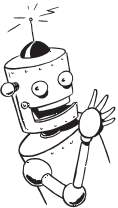
$J =$

$m =$

$\Delta v =$

a) _____ ← units

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7. The fastest drive of a golf ball was an unbelievable 217.1 mph (97.05 m/s). If a golf ball has a mass of 0.04593 kg and the time of contact between the golf ball and the club was 0.005 seconds, find the magnitude of the force exerted by the club on the ball.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$F =$

$t =$

$m =$

$\Delta v =$

a) _____ ← units

8. A top tennis player can hit a serve at 130 mph (58.12 m/s). A tennis ball has a mass of 0.055 kg. If the time of contact between the ball and the racket is 0.02 seconds, calculate the average force exerted by the racket on the ball.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$F =$

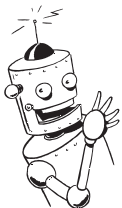
$t =$

$m =$

$\Delta v =$

a) _____ ← units

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9. A monkey is playing pool when he lines up a shot with the cue stick. While taking the shot the cue stick is in contact with the ball for 0.11 seconds and exerts an average force of 50 N. If the ball has a mass of 0.20 kg calculate the velocity of the ball after impact from the cue stick.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$F =$

$t =$

$m =$

$\Delta v =$

a) _____ ← units

10. Small rockets are used to make tiny adjustments to the speed of satellites in orbit. One such rocket has a thrust of 35 N. If the rocket is fired to change the velocity of a 72,000 kg spacecraft by 0.63 m/s, calculate how long the rocket should be fired.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$F =$

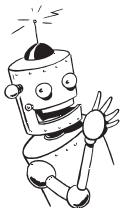
$t =$

$m =$

$\Delta v =$

a) _____ ← units

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11. A 0.05 kg rubber-ball is dropped from rest and strikes the floor with a speed of 10 m/s. The ball then bounces off the floor with a speed of -7 m/s. If the ball is in contact with the floor for 0.01 seconds, calculate the magnitude of the force exerted by the floor on the rubber-ball.

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$F =$

$t =$

$m =$

$\Delta v =$

a) _____ ← units

12. A 0.4 kg object is moving on a frictionless surface at a speed of 30 m/s. A force of -2 N is applied continually until the velocity of the object has been reversed to the same speed but in the opposite direction (-30 m/s). How long was this force applied?

Record all givens, draw a picture, arrow all vectors, write the formula, substitute and solve

$F =$

$t =$

$m =$

$\Delta v =$

a) _____ ← units

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