Ch 8 Supplemental [Edit]

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Ch 8 Supplemental

Due: 6:59pm on Wednesday, November 16, 2016

To understand how points are awarded, read the Grading Policy for this assignment.

Exercise 8.6

Description: The mass of a regulation tennis ball is 57 g (although it can vary slightly), and tests have shown that the ball is in contact with the tennis racket for 30 ms. (This number can also vary, depending on the racket and swing.) We shall assume a...

The mass of a regulation tennis ball is 57 g (although it can vary slightly), and tests have shown that the ball is in contact with the tennis racket for 30 ms. (This number can also vary, depending on the racket and swing.) We shall assume a 30.0-ms contact time. The fastest-known served tennis ball was served by “Big Bill” Tilden in 1931, and its speed was measured to be 73 $\mathrm{m/s}$.

Part A

What impulse did Big Bill exert on the tennis ball in his record serve? Assume that the positive direction is along the final direction of motion of the ball.

Express your answer with the appropriate units.

ANSWER:

$J =$ $4.2\,\mathrm{kg\cdot}\left(\frac{\mathrm{m}}{\mathrm{s}}\right)$

Also accepted: $4.16\,\mathrm{kg\cdot}\left(\frac{\mathrm{m}}{\mathrm{s}}\right)$, $4.2\,\mathrm{kg\cdot}\left(\frac{\mathrm{m}}{\mathrm{s}}\right)$

Part B

What force did Big Bill exert on the tennis ball in his record serve?

Express your answer with the appropriate units.

ANSWER:

$F_x =$ $140\,\mathrm{N}$

Also accepted: $139\,\mathrm{N}$, $140\,\mathrm{N}$

Part C

If Big Bill's opponent returned his serve with a speed of 55 $\mathrm{m/s}$, what impulse did he exert on the ball, assuming only horizontal motion? Assume that the positive direction is the direction the ball is traveling before it is hit by the opponent's racket.

Express your answer with the appropriate units.

ANSWER:

J = -7.3 $\mathrm{kg}\cdot\left(\frac{\mathrm{m}}{\mathrm{s}}\right)$

Also accepted: -7.30 $\mathrm{kg}\cdot\left(\frac{\mathrm{m}}{\mathrm{s}}\right)$, -7.3 $\mathrm{kg}\cdot\left(\frac{\mathrm{m}}{\mathrm{s}}\right)$

Part D

What force did he exert on the ball, assuming only horizontal motion?

Express your answer with the appropriate units.

ANSWER:

F_x = -240 N

Also accepted: -243 N, -240 N

Exercise 8.10

Description: A bat strikes a 0.145-kg baseball. Just before impact, the ball is traveling horizontally to the right at v1; when it leaves the bat, the ball is traveling to the left at an angle of theta above horizontal with a speed of v2 . The ...

A bat strikes a 0.145-kg baseball. Just before impact, the ball is traveling horizontally to the right at 43.0 $\mathrm{m/s}$; when it leaves the bat, the ball is traveling to the left at an angle of 31.0 $^\circ$ above horizontal with a speed of 58.0 $\mathrm{m/s}$. The ball and bat are in contact for 1.63 ms .

Part A

Find the horizontal and vertical components of the average force on the ball. Let $+x$ be to the right and $+y$ be upward

Express your answers using three significant figures separated by a comma.

ANSWER:

F_x, F_y = $\frac{-0.145\,(v1 + v2\cos(\theta))}{t}, \frac{0.145\,(v2\sin(\theta))}{t}$ = -8250, 2660 N

Exercise 8.17

Description: The expanding gases that leave the muzzle of a rifle also contribute to the recoil. A .30 caliber bullet has mass m1 and a speed of v1 relative to the muzzle when fired from a rifle that has mass m2. The loosely held rifle recoils at a speed of v...

The expanding gases that leave the muzzle of a rifle also contribute to the recoil. A .30 caliber bullet has mass 7.20×10^{-3} kg and a speed of 601 $\mathrm{m/s}$ relative to the muzzle when fired from a rifle that has mass 2.90 kg . The loosely held rifle recoils at a speed of 2.05 $\mathrm{m/s}$ relative to the earth.

Part A

Find the momentum of the propellant gases in a coordinate system attached to the earth as they leave the muzzle of the rifle.

ANSWER:

$p =$ $m2v2 - m1\,(v1 - v2)$ = 1.63 $\mathrm{kg \cdot m/s}$

Exercise 8.20

Description: You are standing on a sheet of ice that covers the football stadium parking lot in Buffalo; there is negligible friction between your feet and the ice. A friend throws you a m1-kg ball that is traveling horizontally at 10.0 m/s. Your mass is ...

You are standing on a sheet of ice that covers the football stadium parking lot in Buffalo; there is negligible friction between your feet and the ice. A friend throws you a 0.500-kg ball that is traveling horizontally at 10.0 $\mathrm{m/s}$. Your mass is 79.0 kg .

Part A

If you catch the ball, with what speed do you and the ball move afterward?

Express your answer with the appropriate units.

ANSWER:

$v =$ $\dfrac{m1 \cdot 10}{m1 + m2}$ = $6.29 \times 10^{-2}\,\dfrac{\mathrm{m}}{\mathrm{s}}$

Part B

If the ball hits you and bounces off your chest, so afterward it is moving horizontally at 8.0 $\mathrm{m/s}$ in the opposite direction, what is your speed after the collision?

Express your answer with the appropriate units.

ANSWER:

$v =$ $\dfrac{m1 \cdot 10 + m1 \cdot 8}{m2}$ = $0.114\,\dfrac{\mathrm{m}}{\mathrm{s}}$

Exercise 8.23

Description: Two identical m-kg masses are pressed against opposite ends of a light spring of force constant 1.75 N/cm, compressing the spring by l from its normal length. (a) Find the speed of each mass when it has moved free of the spring on a...

Two identical 0.300-kg masses are pressed against opposite ends of a light spring of force constant 1.75 $\mathrm{N/cm}$, compressing the spring by 13.0 cm from its normal length.

Part A

Find the speed of each mass when it has moved free of the spring on a frictionless, horizontal table.

Express your answer with the appropriate units.

ANSWER:

$v = l\sqrt{\frac{175}{2m}} = 2.22\frac{\mathrm{m}}{\mathrm{s}}$

Exercise 8.25

Description: A hunter on a frozen, essentially frictionless pond uses a rifle that shoots m1 bullets at v. The mass of the hunter (including his gun) is m2, and the hunter holds tight to the gun after firing it. (a) Find the recoil speed of the hunter if he fires ...

A hunter on a frozen, essentially frictionless pond uses a rifle that shoots 4.20 g bullets at 955 $\mathrm{m/s}$. The mass of the hunter (including his gun) is 72.5 kg , and the hunter holds tight to the gun after firing it.

Part A

Find the recoil speed of the hunter if he fires the rifle horizontally.

ANSWER:

$v =$ $= 5.53\times10^{-2}$ $\mathrm{m/s}$

Part B

Find the recoil speed of the hunter if he fires the rifle at 54.0 $^\circ$ above the horizontal.

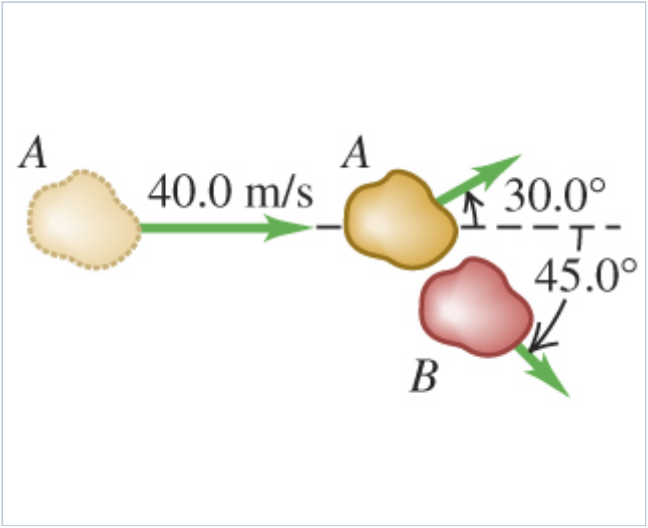
ANSWER:

$v = \frac{m1v}{m2}\cos(\theta) = 3.25\times10^{-2}$ $\mathrm{m/s}$

Exercise 8.31: Asteroid Collision

Description: Two asteroids of equal mass in the asteroid belt between Mars and Jupiter collide with a glancing blow. Asteroid A, which was initially traveling at v_A1 = 40.0 m/s with respect to an inertial frame in which asteroid B was at rest, is deflected 30.0 d...

Two asteroids of equal mass in the asteroid belt between Mars and Jupiter collide with a glancing blow. Asteroid A, which was initially traveling at v_{A1} = 40.0 $\mathrm{m/s}$ with respect to an inertial frame in which asteroid B was at rest, is deflected 30.0 $^\circ$ from its original direction, while asteroid B travels at 45.0 $^\circ$ to the original direction of A, as shown in .



Part A

Find the speed of asteroid A after the collision.

ANSWER:

v_{A2} = 29.3 $\mathrm{m/s}$

Part B

Find the speed of asteroid B after the collision.

ANSWER:

v_{B2} = 20.7 $\mathrm{m/s}$

Part C

What fraction of the original kinetic energy of asteroid A dissipates during this collision?

ANSWER:

0.196

Exercise 8.37

Description: On a very muddy football field, a m1 linebacker tackles an m2 halfback. Immediately before the collision, the linebacker is slipping with a velocity of v1 north and the halfback is sliding with a velocity of v2 east. (a) What is the magnitude of the...

On a very muddy football field, a 120 kg linebacker tackles an 75 kg halfback. Immediately before the collision, the linebacker is slipping with a velocity of 8.5 $\mathrm{m/s}$ north and the halfback is sliding with a velocity of 7.2 $\mathrm{m/s}$ east.

Part A

What is the magnitude of the velocity at which the two players move together immediately after the collision?

ANSWER:

v = = 5.9 $\mathrm{m/s}$

Part B

What is the direction of this velocity ?

ANSWER:

θ = = 28 $^\circ$ east of north.

Exercise 8.44

Description: A ## kg block is attached to a very light horizontal spring of force constant ## N/m and is resting on a smooth horizontal table. (See the figure below .) Suddenly it is struck by a ## kg stone traveling horizontally at ## m/s to the right, whereupon...

A 15.0 kg block is attached to a very light horizontal spring of force constant 425 $\mathrm{N/m}$ and is resting on a smooth horizontal table. (See the figure below .) Suddenly it is struck by a 3.00 kg stone traveling horizontally at 8.00 $\mathrm{m/s}$ to the right, whereupon the stone rebounds at 2.00 $\mathrm{m/s}$ horizontally to the left.

Part A

Find the maximum distance that the block will compress the spring after the collision.(*Hint*: Break this problem into two parts - the collision and the behavior after the collision - and apply the appropriate conservation law to each part.)

Enter your answer using three significant figures.

ANSWER:

x = $\sqrt{\frac{m1}{k}\left(\frac{m2\,(v1+v2)}{m1}\right)^2}$ = 0.376 m

Problem 8.65

Description: Just before it is struck by a racket, a tennis ball weighing 0.560 N has a velocity of (20.0 m/s)i_unit - (4.0 m/s)j_unit. During the 3.00 ms that the racket and ball are in contact, the net force on the ball is constant and equal to -(380...

Just before it is struck by a racket, a tennis ball weighing 0.560 N has a velocity of $(20.0\ \mathrm{m/s})\hat{i} - (4.0\ \mathrm{m/s})\hat{j}$. During the 3.00 ms that the racket and ball are in contact, the net force on the ball is constant and equal to $-(380\ \mathrm{N})\hat{i} + (110\ \mathrm{N})\hat{j}$.

Part A

What is the x -component of the impulse of the net force applied to the ball?

ANSWER:

J_x = -1.14 $\mathrm{N \cdot s}$

Part B

What is the y-component of the impulse of the net force applied to the ball?

ANSWER:

J_y = 0.330 $\mathrm{N \cdot s}$

Part C

What is the x-component of the final velocity of the ball?

ANSWER:

v_x = 5.00×10^{-2} $\mathrm{m/s}$

Also accepted: 2.96×10^{-2}

Part D

What is the y-component of the final velocity of the ball?

ANSWER:

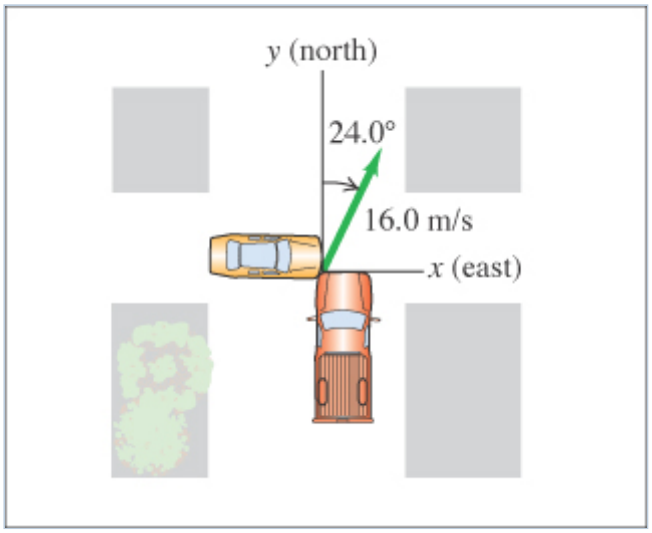
v_y = 1.78 $\mathrm{m/s}$

Also accepted: 1.78

Exercise 8.41

Description: At the intersection of Texas Avenue and University Drive, a yellow, subcompact car with mass m1 traveling east on University collides with a maroon pickup truck with mass m2 that is traveling north on Texas and ran a red light . The two vehicles ...

At the intersection of Texas Avenue and University Drive, a yellow, subcompact car with mass 900 kg traveling east on University collides with a maroon pickup truck with mass 1800 kg that is traveling north on Texas and ran a red light . The two vehicles stick together as a result of the collision and, after the collision, the wreckage is sliding at 16.0 $\mathrm{m/s}$ in the direction 24.0° east of north. The collision occurs during a heavy rainstorm; you can ignore friction forces between the vehicles and the wet road.



Part A

Calculate the speed of the car before the collision.

ANSWER:

$v =$ = 19.5 $\mathrm{m/s}$

Part B

Calculate the speed of the truck before the collision.

ANSWER:

$v =$ = 21.9 $\mathrm{m/s}$

Exercise 8.43

Description: A m_1 rifle bullet is fired with a speed of v into a ballistic pendulum with mass m_2, suspended from a cord 70.0 cm long. (a) Compute the initial kinetic energy of the bullet;... (b) Compute the kinetic energy of the bullet and pendulum ...

A 11.0 g rifle bullet is fired with a speed of 360 $\mathrm{m/s}$ into a ballistic pendulum with mass 10.0 kg , suspended from a cord 70.0 cm long.

Part A

Compute the initial kinetic energy of the bullet;

ANSWER:

$K =$ = 713 J

Part B

Compute the kinetic energy of the bullet and pendulum immediately after the bullet becomes embedded in the pendulum.

ANSWER:

K = = 0.783 J

Part C

Compute the vertical height through which the pendulum rises.

ANSWER:

h = = 0.798 cm

Exercise 8.53

Description: Pluto's diameter is approximately 2370 km, and the diameter of its satellite Charon is 1250 km. Although the distance varies, they are often about L apart, center-to-center. (a) Assuming that both Pluto and Charon have the same composition and hence...

Pluto's diameter is approximately 2370 km, and the diameter of its satellite Charon is 1250 km. Although the distance varies, they are often about 1.95×10^{4} km apart, center-to-center.

Part A

Assuming that both Pluto and Charon have the same composition and hence the same average density, find the location of the center of mass of this system relative to the center of Pluto.

ANSWER:

= 2490 km

Exercise 8.51

Description: Three odd-shaped blocks of chocolate have the following masses and center-of-mass coordinates: (1) m_1, (x_1, y_1); (2) m_2, (x_2, y_2); (3) m_3, (x_3, y_3). (a) Find the x-coordinate of the center of mass of the system of three...

Three odd-shaped blocks of chocolate have the following masses and center-of-mass coordinates:
(1) 0.300 kg , (0.200 m , 0.310 m); (2) 0.390 kg , (0.100 m , -0.380 m); (3) 0.210 kg , (-0.280 m , 0.610 m).

Part A

Find the *x*-coordinate of the center of mass of the system of three chocolate blocks.

ANSWER:

x_{cm} = = 4.47×10^{-2} m

Part B

Find the *y*-coordinate of the center of mass of the system of three chocolate blocks.

ANSWER:

y_{cm} = = 8.10×10^{-2} m