All Assignments

Help

HW #5: Impulse and momentum

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Overview Diagnostics Print View with Answers

HW #5: Impulse and momentum

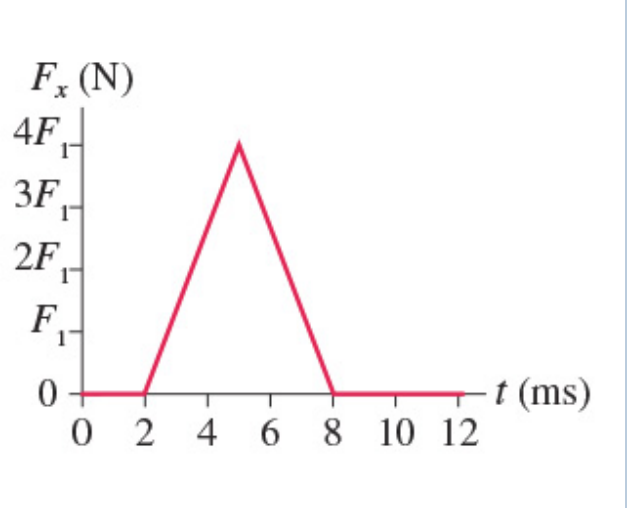
Due: 11:59pm on Wednesday, October 16, 2024

You will receive no credit for items you complete after the assignment is due. Grading Policy

Problem 11.4

Description: Suppose F_1 = ## N. (a) What is the impulse on a 3.0 kg particle that experiences the force shown in the figure?

Suppose $F_1 = 250$ N.



Part A

What is the impulse on a 3.0 kg particle that experiences the force shown in the figure?

Express your answer in newton-seconds.

ANSWER:

$J = \frac{12F_1}{1000} = 3.0$ N · s

Also accepted: $\frac{12F_1}{1000} = 3.00$, $\frac{12F_1}{1000} = 3.0$

Problem 11.12

Description: A ## g ball collides with a wall. The figures show the ball's velocity and the force exerted on the ball by the wall. , (a) What is v_((f)x), the ball's rebound velocity?

A 300 g ball collides with a wall. The figures show the ball's velocity and the force exerted on the ball by the wall.

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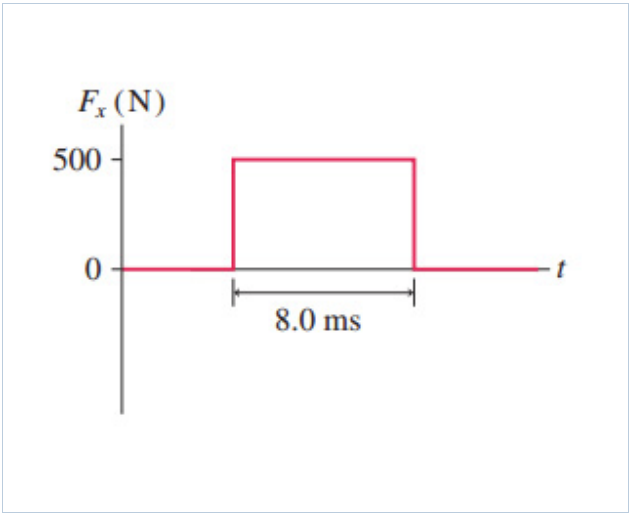
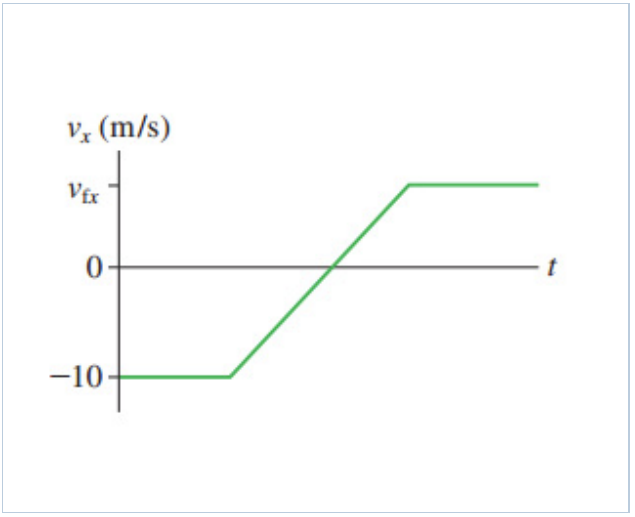




Part A

What is v_{fx}, the ball's rebound velocity?

Express your answer with the appropriate units.

ANSWER:

$v_{fx} = -10 + \frac{4}{m} = 3.3 \frac{\text{m}}{\text{s}}$

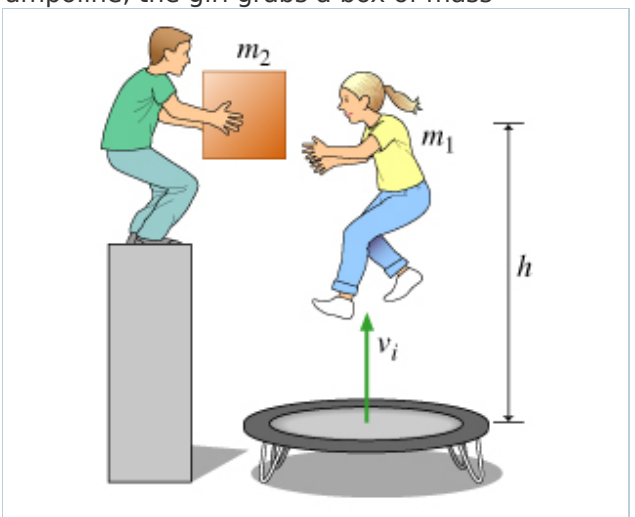
Also accepted: $-10 + \frac{4}{m} = 3.33 \frac{\text{m}}{\text{s}}$, $-10 + \frac{4}{m} = 3.3 \frac{\text{m}}{\text{s}}$

A Girl on a Trampoline

Description: A girl bouncing on a trampoline is handed a box while she is in midair. Determine her velocity at the moment before she grabs the box and the moment after she grabs the box, and then the maximum height reached by the girl/box system. Numerical.

A girl of mass $m_1 = 60.0$ kilograms springs from a trampoline with an initial upward velocity of $v_i = 8.00$ meters per second. At height $h = 2.00$ meters above the trampoline, the girl grabs a box of mass $m_2 = 15.0$ kilograms.

For this problem, use $g = 9.80$ meters per second per second for the magnitude of the acceleration due to gravity.



Part A

What is the speed v_{before} of the girl immediately before she grabs the box?

Express your answer numerically in meters per second.

Hint 1. How to approach the problem

Use conservation of energy. Find the initial kinetic energy K_{i} of the girl as she leaves the trampoline. Then find her gravitational potential energy U_{before} just before she grabs the box (define her initial potential energy to be zero). According to the principle of conservation of energy, $K_i = U_{\text{before}} + K_{\text{before}}$. Once you have K_{before}, use the definition of translational kinetic energy to find the girl's speed v_{before}.

Hint 2. Initial kinetic energy

What is the girl's initial kinetic energy K_{i} as she leaves the trampoline?

Express your answer numerically in joules.

ANSWER:

$K_{\text{i}} = 1920 \text{ J}$

Hint 3. Potential energy at height h

What is the girl's gravitational potential energy U_{before} immediately before she grabs the box?

Express your answer numerically in joules.

ANSWER:

$U_{\text{before}} = 1180 \text{ J}$

ANSWER:

$v_{\text{before}} = 4.98 \text{ m/s}$

Part B

What is the speed v_{after} of the girl immediately after she grabs the box?

Express your answer numerically in meters per second.

Hint 1. How to approach the problem

Think of the process of grabbing the box as a collision. Though the girl and the box don't collide as such, any interaction between two objects that takes place extremely fast can be thought of as a collision. To find the velocity at a later time, which of the following principles could you use?

ANSWER:

- (●) conservation of momentum alone
- ( ) conservation of energy alone
- ( ) both conservation of momentum and conservation of energy
- ( ) Newton's second law

If the girl merely "grabs" the box, there are no external forces other than gravity, and in the limit that the "collision" takes place instantaneously, gravity does not change the momentum of the girl/box system.

Hint 2. Total initial momentum

What is the total momentum before the collision?

Answer in kilogram meters per second.

ANSWER:

$p_{\text{before}} = 299 \ \text{kg m/s}$

The girl and the box travel with the same speed after she grabs it.

ANSWER:

$v_{\text{after}} = 3.98 \ \text{m/s}$

Part C

Is this "collision" elastic or inelastic?

Hint 1. Definition of an inelastic collision

If two objects move together with the same velocity after a collision, the collision is said to be inelastic.

ANSWER:

- ( ) elastic
- (●) inelastic

In inelastic collisions, some of the system's kinetic energy is lost. In this case the kinetic energy lost is converted to heat energy in the girl's muscles as she grabs the box, and sound energy.

Part D

What is the maximum height h_{max} that the girl (with box) reaches? Measure h_{max} with respect to the top of the trampoline.

Express your answer numerically in meters.

Hint 1. How to approach the problem

Use conservation of energy. From Part B you know the velocity of the girl/box system just after the girl grabs the box. Therefore, you can compute the kinetic energy K_{after} of the girl/box system just after the collision. You can also compute the gravitational potential energy U_{after} of the girl/box system at this point. The sum of these two quantities must equal the gravitational potential energy of the girl/box system at the height h_{max} (where their velocity, and therefore kinetic energy, will be zero).

Hint 2. Finding U_{after}

What is the girl/box system's gravitational potential energy U_{after} immediately after she grabs the box?

Express your answer numerically in joules.

ANSWER:

$U_{\text{after}} = 1470 \text{ J}$

Hint 3. Finding K_{after}

What is the girl/box system's kinetic energy K_{after} immediately after she grabs the box?

Express your answer numerically in joules.

ANSWER:

$K_{\text{after}} = 594 \text{ J}$

ANSWER:

$h_{\text{max}} = 2.81 \text{ m}$

Problem 11.19

Description: A ## kg car is rolling at ## m/s. You would like to stop the car by firing a ## kg blob of sticky clay at it. (a) How fast should you fire the clay?

A 1400 kg car is rolling at 1.5 m/s . You would like to stop the car by firing a 7.0 kg blob of sticky clay at it.

Part A

How fast should you fire the clay?

Express your answer with the appropriate units.

ANSWER:

$v = \frac{m_1 v_1}{m_2} = 300 \frac{\text{m}}{\text{s}}$

Problem 11.28 - Enhanced - with Video Solution

Description: Dan is gliding on his skateboard at ## m/s. He suddenly jumps backward off the skateboard, kicking the skateboard forward at ## m/s. Dan's mass is ## kg and the skateboard's mass is ## kg. For general problem-solving tips and strategies for this...

Dan is gliding on his skateboard at 4.00 $\mathrm{m/s}$. He suddenly jumps backward off the skateboard, kicking the skateboard forward at 8.00 $\mathrm{m/s}$. Dan's mass is 70.0 kg and the skateboard's mass is 7.00 kg .

For general problem-solving tips and strategies for this topic, you may want to view a Video Tutor Solution of Softball toss.

Part A

How fast is Dan going as his feet hit the ground?

Express your answer with the appropriate units.

ANSWER:

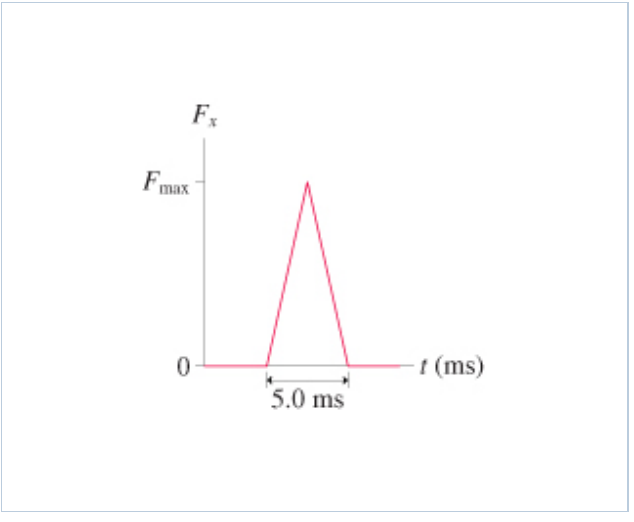
$$\frac{(m_1+m_2)v_1-m_2v_2}{m_1} = 3.60\,\frac{\mathrm{m}}{\mathrm{s}}$$

Here we learn how to calculate the speed of a system after some of its mass is ejected, using momentum conservation.

Problem 11.41

Description: A ## g ball is dropped from a height of ## m, bounces on a hard floor, and rebounds to a height of ## m. The figure shows the impulse received from the floor. (a) What maximum force does the floor exert on the ball?

A 150 g ball is dropped from a height of 1.7 m , bounces on a hard floor, and rebounds to a height of 1.0 m . The figure shows the impulse received from the floor.



Part A

What maximum force does the floor exert on the ball?

Express your answer with the appropriate units.

ANSWER:

$$F_{\max} = \frac{m\left(\sqrt{2 \cdot 9.8 h 0} + \sqrt{2 \cdot 9.8 h 1}\right) \cdot 2}{0.005} = 610 \text{N}$$

All Assignments

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Ends: 12/21/24