PHYS141 OUTLINE QUESTIONS SOLUTIONS

BY AHMAD HAMDAN

BZU-HUB.COM

Exercise 1

Chapter 9, Page 213

Principles of Physics, International Edition
ISBN: 9781118230749

Solution Verified Answered 2 years ago

Step 1 1 of 5

Givens:

Mass of particle A $m_A = 1$ kg

Mass of particle B $m_B = 2$ kg

Mass of particle C $m_C = 3$ kg

Edge length $L = 1$ m

Step 2 2 of 5

We have three particles form an equilateral triangle of edge length L and it is required to find the x and y coordinates of its center of mass.

Thus,

$$x_{com} = \frac{1}{M}\sum_{i=1}^{n} m_i x_i$$

and

$$y_{com} = \frac{1}{M}\sum_{i=1}^{n} m_i y_i$$

Where M is the total mass of the system.

Thus,

$$x_{com} = \frac{m_A x_A + m_B x_B + m_C x_C}{m_A + m_B + m_C}$$

and

$$y_{com} = \frac{m_A y_A + m_B y_B + m_C y_C}{m_A + m_B + m_C}$$

Step 3 3 of 5

The coordinates for the three particles:

For particle A:

$$x_A = 0$$

$$y_A = 0$$

For particle B:

$$x_B = L$$

$$y_B = 0$$

For particle C:

$$x_C = \frac{L}{2}$$

$$y_C = \sqrt{L^2 - (\frac{L}{2})^2}$$

Step 4 4 of 5

We can find,

$$\begin{aligned} x_{com} &= \frac{m_A x_A + m_B x_B + m_C x_C}{m_A + m_B + m_C} \\ &= \frac{(1 \times 0) + (2 \times 1) + (3 \times 0.5)}{1 + 2 + 3} \\ &= \frac{3.5}{6} \\ &= 0.58 \text{ m} \end{aligned}$$

and

$$\begin{aligned} y_{com} &= \frac{m_A y_A + m_B y_B + m_C y_C}{m_A + m_B + m_C} \\ &= \frac{(1 \times 0) + (2 \times 0) + (3 \times \sqrt{1^2 - 0.5^2})}{1 + 2 + 3} \\ &= \frac{2.6}{6} \\ &= 0.43 \text{ m} \end{aligned}$$

Result 5 of 5

$$\boxed{x_{com} = 0.58 \text{ m}}$$

$$\boxed{y_{com} = 0.43 \text{ m}}$$

Exercise 2

Chapter 9, Page 213

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution Verified Answered 2 years ago

Step 1 1 of 7

Givens:

$m_1 = 2$ kg

$m_2 = 4$ kg

$m_3 = 8$ kg

$x_s = 2$ m

$y_s = 2$ m

Step 2 2 of 7

We have three particles on the xy plane and it is required to find the x and y coordinates of its center of mass.

Thus,

$$x_{com} = \frac{1}{M}\sum_{i=1}^{n} m_i x_i$$

and

$$y_{com} = \frac{1}{M}\sum_{i=1}^{n} m_i y_i$$

Where M is the total mass of the system.

Thus,

$$x_{com} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{m_1 + m_2 + m_3}$$

and

$$y_{com} = \frac{m_1 y_1 + m_2 y_2 + m_2 y_2}{m_1 + m_2 + m_3}$$

Step 3 3 of 7

The coordinates for the three particles:

For particle 1:

$$x_1 = 0$$
$$y_1 = 0$$

For particle 2:

$$x_2 = x_s$$
$$y_2 = \frac{y_s}{2}$$

For particle 3:

$$x_3 = \frac{x_s}{2}$$
$$y_3 = y_s$$

Step 4 4 of 7

Part a:

From the previous figure We can find,

$$\begin{aligned} x_{com} &= \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{m_1 + m_2 + m_3} \\ &= \frac{(2 \times 0) + (4 \times 2) + (8 \times 1)}{2 + 4 + 8} \\ &= \frac{16}{14} \\ &= 1.14 \text{ m} \end{aligned}$$

$$\boxed{x_{com} = 1.14 \text{ m}}$$

Step 5 5 of 7

Part b:

$$\begin{aligned} y_{com} &= \frac{m_1 y_1 + m_2 y_2 + m_2 y_2}{m_1 + m_2 + m_3} \\ &= \frac{(2 \times 0) + (4 \times 1) + (8 \times 2)}{2 + 4 + 8} \\ &= \frac{20}{14} \\ &= 1.43 \text{ m} \end{aligned}$$

$$\boxed{y_{com} = 1.43 \text{ m}}$$

Step 6 6 of 7

Part c:

The COM is very close to m_3 and this is because it is the bigger mass in the system. Thus, if we increased m_3 the center of mass will shifted towards it.

Result 7 of 7

(a) $x_{com} = 1.14$ m

(b) $y_{com} = 1.43$ m

(c) The center of mass will shifted towards it

Exercise 4

Chapter 9, Page 213

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution Verified Answered 2 years ago

Step 1

1 of 4

In this problem the aim is to find the center of mass coordinates for a rigid body consists of three rods having the same length L but different in their masses.

We have three rods with length L, forming an inverted U shape. As shown in the figure in the problem.

Givens:

$L = 24$ cm,

$m_1 = 42$ g,

$m_2 = m_3 = 14$ g.

Step 2

2 of 4

Part a:

The aim in this part is to find the x-coordinate of the center of mass. Which is given by:

$$x_{com} = \frac{1}{M}\sum_{i=1}^{n} m_i x_i$$

This formula is for discrete system. Therefore, we need to treat our system as discrete one. Since the rods are uniform, this means that its center of mass is in the middle. Thus,

The center of mass coordinates of the rods given by:

$$x_1 = \frac{L}{2} = 12 \text{ cm}, \quad y_1 = 0,$$

$$x_2 = 0, \quad y_2 = -12 \text{ cm},$$

and

$$x_3 = 24 \text{ cm}, \quad y_3 = -12 \text{ cm}$$

Therefore,

$$\begin{aligned} x_{com} &= \frac{1}{M}\sum_{i=1}^{n} m_i x_i \\ &= \frac{x_1 m_1 + x_2 m_2 + x_3 m_3}{m_1 + m_2 + m_3} \\ &= \frac{12 \times 42 + 0 \times 14 + 24 \times 14}{42 + 14 + 14} \\ &= 12 \text{ cm} \end{aligned}$$

Therefore,

$$\boxed{x_{com} = 12 \text{ cm}}$$

Step 3

3 of 4

Part b:

The aim in this part is to find the y-coordinate of the center of mass. Which is given by:

$$y_{com} = \frac{1}{M}\sum_{i=1}^{n} m_i y_i$$

As we mentioned in part a this formula is only used for discrete system. Since we have already found the y-coordinates for rod's center of mass.

Therefore,

$$\begin{aligned} y_{com} &= \frac{1}{M}\sum_{i=1}^{n} m_i y_i \\ &= \frac{y_1 m_1 + y_2 m_2 + y_3 m_3}{m_1 + m_2 + m_3} \\ &= \frac{0 \times 42 + (-12) \times 14 + (-12) \times 14}{42 + 14 + 14} \\ &= -4.8 \text{ cm} \end{aligned}$$

Therefore,

$$\boxed{y_{com} = -4.8 \text{ cm}}$$

Result

4 of 4

(a) $x_{com} = 12$ cm

(b) $y_{com} = -4.8$ cm

Exercise 3c
Rate this solution
Exercise 5a

Exercise 5a

Chapter 9, Page 213

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution Verified Answered 1 year ago

Step 1 1 of 5

Givens:

- $L = 5.0$ cm.

Required:

x coordinate of the plate's center of mass.

Step 2 2 of 5

Since the plate is uniform, we can assume that a piece of the plate with an area L^2 has a mass m. We calculate the mass of the whole plate by considering the mass of each rectangular piece shown in the Figure 9-38. We consider three rectangular pieces separately.

The first piece is the leftmost piece in the figure with sides $2L$ and $7L$. It has an area of $2L * 7L = 14L^2$ which makes it has a mass of $14m$. And, the center of mass of this piece is located at its midpoint since it is uniform. The coordinates of the center of mass of this piece are deduced from the figure as follows: $(-L, -0.5L)$.

The second piece is the upper piece on the right in the figure with sides $4L$ and L. It has an area of $4L * L = 4L^2$ which makes it has a mass of $4m$. And, the center of mass of this piece is located at its midpoint with coordinates deduced from the figure as follows: $(2L, 2.5L)$.

Step 3 3 of 5

The third piece is the bottom piece on the right in the figure with sides $2L$ and $2L$. It has an area of $2L * 2L = 4L^2$ which makes it has a mass of $4m$. And, the center of mass of this piece is located at its midpoint with coordinates deduced from the figure as follows: $(L, -3L)$.

Before calculating the coordinates of the center of mass of the plate, we need first to calculate the total mass of the plate by adding up the masses of the three rectangular pieces:

$$M = m_1 + m_2 + m_3 = 14m + 4m + 4m = 22m$$

The coordinates of the system's center of mass are given by the following equation:

$$\vec{r}_{\text{com}} = \frac{1}{M}\sum_{i=1}^{3} m_i \vec{r}_i = \frac{1}{M}\left[m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3\right]$$

Then,

Step 4 4 of 5

The x coordinate of the plate's center of mass:

$$\begin{aligned} x_{\text{com}} &= \frac{1}{M}\left[m_1x_1 + m_2x_2 + m_3x_3\right] \\ &= \frac{1}{22m}\left[14m\,(-L) + 4m\,(2L) + 4m\,(L)\right] \\ &= -\frac{2mL}{22m} = -\frac{1}{11}L \end{aligned}$$

Substituting with $L = 5.0$ cm,

$$= -\frac{5.0}{11} = -0.45 \text{ cm}$$

Then,

$$\boxed{x_{\text{com}} = -0.45 \text{ cm}}$$

Result 5 of 5

$$x_{\text{com}} = -0.45 \text{ cm.}$$

Exercise 5b

Chapter 9, Page 213

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution Verified Answered 1 year ago

Step 1 1 of 5

Givens:

- $L = 5.0$ cm.

Required:

y coordinate of the plate's center of mass.

Step 2 2 of 5

Since the plate is uniform, we can assume that a piece of the plate with an area L^2 has a mass m. We calculate the mass of the whole plate by considering the mass of each rectangular piece shown in the Figure 9-38. We consider three rectangular pieces separately.

The first piece is the leftmost piece in the figure with sides $2L$ and $7L$. It has an area of $2L * 7L = 14L^2$ which makes it has a mass of $14m$. And, the center of mass of this piece is located at its midpoint since it is uniform. The coordinates of the center of mass of this piece are deduced from the figure as follows: $(-L, -0.5L)$.

The second piece is the upper piece on the right in the figure with sides $4L$ and L. It has an area of $4L * L = 4L^2$ which makes it has a mass of $4m$. And, the center of mass of this piece is located at its midpoint with coordinates deduced from the figure as follows: $(2L, 2.5L)$.

Step 3 3 of 5

The third piece is the bottom piece on the right in the figure with sides $2L$ and $2L$. It has an area of $2L * 2L = 4L^2$ which makes it has a mass of $4m$. And, the center of mass of this piece is located at its midpoint with coordinates deduced from the figure as follows: $(L, -3L)$.

Before calculating the coordinates of the center of mass of the plate, we need first to calculate the total mass of the plate by adding up the masses of the three rectangular pieces:

$$M = m_1 + m_2 + m_3 = 14m + 4m + 4m = 22m$$

The coordinates of the system's center of mass are given by the following equation:

$$\vec{r}_{\text{com}} = \frac{1}{M}\sum_{i=1}^{3} m_i \vec{r}_i = \frac{1}{M}\left[m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3\right]$$

Then,

Step 4 4 of 5

The y coordinate of the plate's center of mass is:

$$\begin{aligned} y_{\text{com}} &= \frac{1}{M}\left[m_1 y_1 + m_2 y_2 + m_3 y_3\right] \\ &= \frac{1}{22m}\left[14m\,(-0.5L) + 4m\,(2.5L) + 4m\,(-3L)\right] \\ &= -\frac{9mL}{22m} = -\frac{9}{22}L \end{aligned}$$

Substituting with $L = 5.0$ cm,

$$= -\frac{9 * 5.0}{22} = -\frac{45}{22} = -2.0 \text{ cm}$$

Then,

$$\boxed{y_{\text{com}} = -2.0 \text{ cm}}$$

Result 5 of 5

$$y_{\text{com}} = -2.0 \text{ cm.}$$

Exercise 5a Rate this solution Exercise 6

Exercise 12

Chapter 9, Page 214

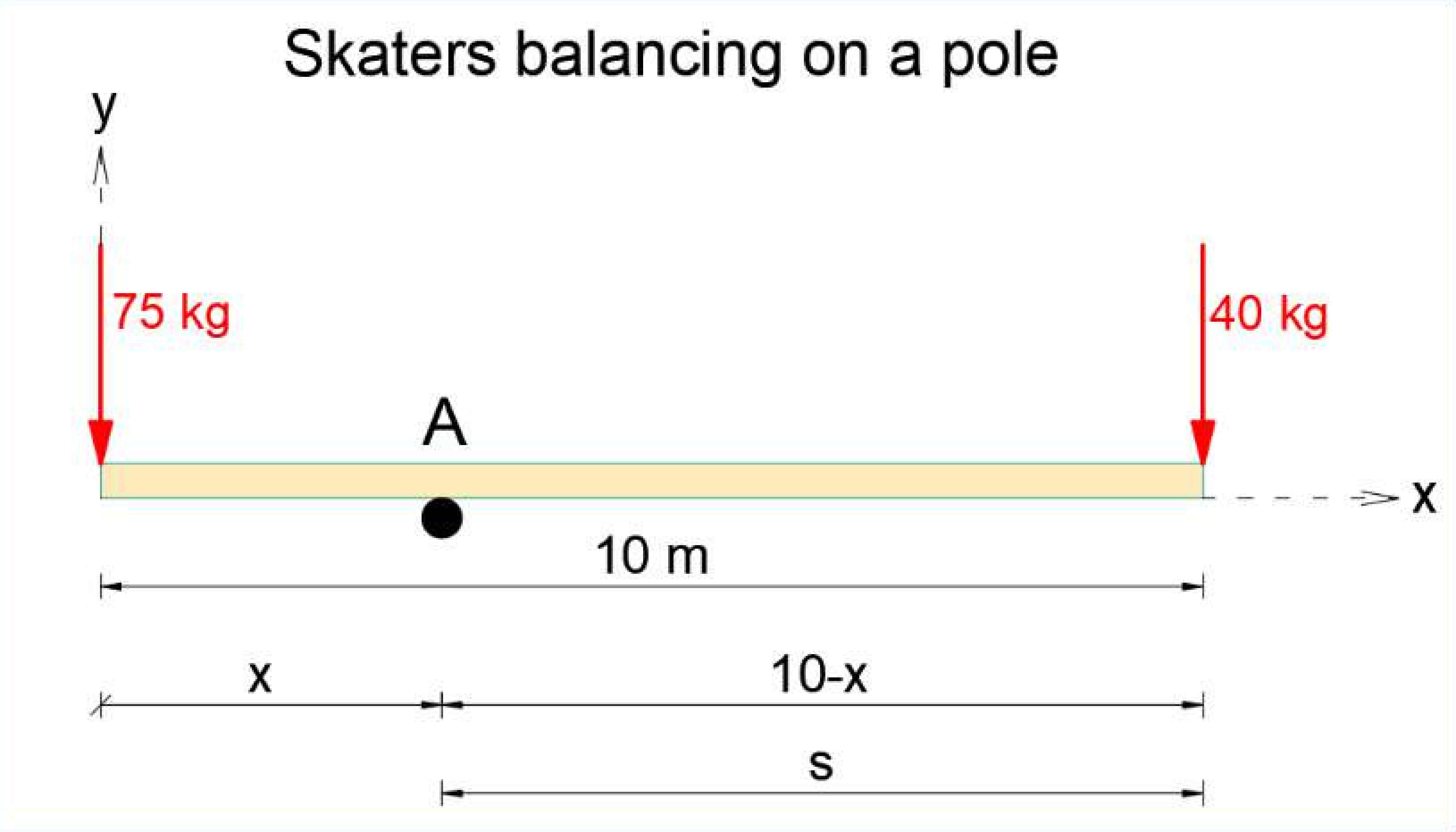
Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution Verified Answered 2 years ago

Step 1 1 of 5

Given values are: $m_1 = 75 \text{ kg}$ $m_2 = 40 \text{ kg}$

We are required to obtain the distance of the skater with a mass of 40 kg. First, we will draw a sketch with distances for a better understanding of the problem.



Step 2 2 of 5

We can obtain the distance for a 40 kg skater in two ways.

1. We can use the center of mass formula.

$$x_{CM} = \frac{\sum x_i \cdot m_i}{\sum m_i}$$

2. To balance a pole, we can make a moment about point A to be equal to zero. (Moment is a product of force acting on a distance for that point)

$$\sum M_A = 0$$

Step 3 3 of 5

We will start with the center of the mass formula:

$$x_{CM} = \frac{\sum x_i \cdot m_i}{\sum m_i}$$

$$0 = \frac{(10 - x) \cdot 40 - 75x}{40 + 75}$$

$$= \frac{400 - 40x - 75x}{115}$$

$$= \frac{400 - 40x - 75x}{115}$$

$$x = \frac{400}{115} = \boxed{3.478 \text{ m}}$$

$$s = 10 - x = \boxed{6.522 \text{ m}}$$

Step 4 4 of 5

To make sure the result is good we can confirm it with a second method:

$$+\circlearrowleft \sum M_A = 0$$

$$75 \cdot x - 40 \cdot (10 - x) = 0$$
$$75x - 400 + 40x = 0$$

$$x = \frac{400}{115} = \boxed{3.478 \text{ m}}$$

$$s = 10 - x = \boxed{6.522 \text{ m}}$$

Result 5 of 5

$$s = 6.522 \text{ m}$$

Exercise 13

Chapter 9, Page 214

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solutions

Verified

Solution A   Solution B

Answered 2 years ago

Step 1

1 of 5

Givens:

Initial angle $\theta = 60^\circ$

Initial velocity $v_i = 20$ m/s

Step 2

2 of 5

This is a projectile problem, so we need to know the projectile equations (it is simply derived form Newton's law):

The position of the projectile at any time t:

$$x = v_{ix}t \quad \& \quad y = v_{iy}t - \frac{1}{2}gt^2$$

Where v_{ix} is the initial x-component velocity and it is given by:

$$v_{ix} = v_i \cos\theta_0$$

Where θ_0 is the initial angle with the x-axis.

and v_{iy} is the y-component velocity and it is given by:

$$v_{iy} = v_i \sin\theta_0$$

The y-component of the velocity:

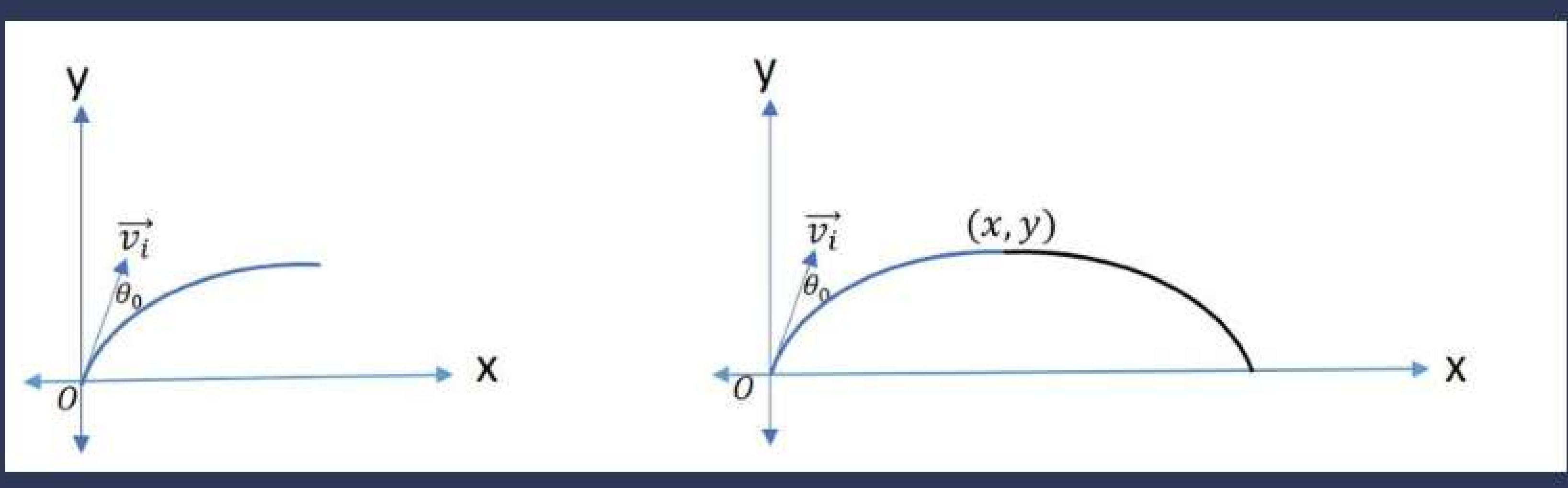
$$v_y = v_{iy} - gt$$

Step 3

3 of 5

To solve it we will consider it as two problems; first when the projectile fired till the moment before it explodes, secondly form the explosion to the fragmented land.

This is shown in the following figure:



Step 4

4 of 5

First:

At the highest point on the trajectory of the projectile the y-component velocity is equal to zero. So, we can find out the time when the projectile reach this point and form it we find its coordinate and then we start with the second problem.

$$\begin{aligned} v_y &= v_{iy} - gt \\ 0 &= v_i \sin\theta_0 - gt \\ t &= \frac{v_i \sin\theta_0}{g} \end{aligned}$$

Therefore, the coordinates

$$\begin{aligned} x &= v_{ix}t \\ &= v_i \cos\theta \times \frac{v_i \sin\theta_0}{g} \\ &= \frac{v_i^2 \cos\theta_0 \sin\theta_0}{g} \\ &= \frac{20^2 \cos 60^\circ \sin 60^\circ}{9.8} \\ &= 17.67\ \text{m} \end{aligned}$$

and

$$\begin{aligned} y &= v_{iy}t - \frac{1}{2}gt^2 \\ &= v_i \sin\theta_0 \frac{v_i \sin\theta_0}{g} - \frac{1}{2}g\left(\frac{v_i \sin\theta_0}{g}\right)^2 \\ &= \frac{v_i^2 \sin^2\theta_0}{2g} \\ &= \frac{20^2 \sin^2 60^\circ}{2 \times 9.8} \\ &= 15.31\ \text{m} \end{aligned}$$

At this point $(17.67, 15.31)$ the explosion happens, So, we can consider it from here as another problem with this initial point rather than the origin in the first case.

Before the explosion, the projectile had only x-component velocity and it is equal to:

$$v_i \cos\theta_0$$

Since the momentum has to be conserved. Therefore the momentum of the two fragments has to equal the initial momentum of the projectile and since one fragment after the explosion had zero horizontal velocity. Thus:

$$\begin{aligned} P_i &= P_f \\ mv_i \cos\theta_0 &= \frac{m}{2}V_f \\ V_f &= 2v_i \cos\theta_0 \end{aligned}$$

Where, m is the projectile mass and V_f is the fragment velocity.

$$\begin{aligned} V_f &= 2 \times 20 \times \cos 60^\circ \\ &= 20\ \text{m/s} \end{aligned}$$

The y-component when it land will be zero. So, the time of landing is:

$$\begin{aligned} y &= y_0 - \frac{1}{2}gt^2 \\ 0 &= y_0 - \frac{1}{2}g \times t^2 \\ t &= \sqrt{\frac{2y_0}{g}} \\ &= \sqrt{2 \times \frac{15.31}{9.8}} \\ &= 1.77\ \text{s} \end{aligned}$$

The x-component:

$$\begin{aligned} x &= x_0 + V_f t \\ &= 17.67 + 20 \times 1.77 \\ &= 53.07\ \text{m} \end{aligned}$$

$$\boxed{\text{The fragment will land after } 53.07\ \text{m}}$$

Result

5 of 5

The fragment will land after 53.07 m

Rate this solution

Exercise 17

Chapter 9, Page 214

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution

Verified Answered 2 years ago

Step 1

1 of 4

Givens:

Dog's mass $m_d = 4.5$ kg

Boat's mass $m_b = 18$ kg

The distance between the dog and the shore $D = 6.1$ m

Step 2

2 of 4

The net horizontal force on the boat is zero which means that the dog displacement in its mass equals to the boat displacement in its mass:

$$m_d x_d = m_b x_b$$

This implies that the dog moves toward the shore but the boat otherwise goes in the other side. The dog moves a distance d and this distance equals to the sum of the two displacements.

$$d = x_b + x_d$$

Step 3

3 of 4

Form the first equation we have:

$$\begin{aligned} x_d + x_b &= d \\ x_d + \frac{m_d}{m_b} x_d &= d \\ x_d &= \frac{d}{1 + \frac{m_d}{m_b}} \\ &= \frac{2.4}{1 + \frac{4.5}{18}} \\ &= 1.92 \text{ m} \end{aligned}$$

After, we get the actual displacement the dog did. We simply subtract it from the total distance.

$$\begin{aligned} d &= D - x_d \\ &= 6.1 - 1.92 \\ &= 4.18 \text{ m} \end{aligned}$$

$$\boxed{\text{d=4.18 m}}$$

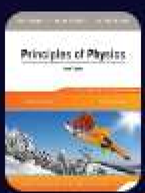
Result

4 of 4

$$d = 4.18 \text{ m}$$

Exercise 22

Chapter 9, Page 215



Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution

Verified Answered 2 years ago

Step 1

If there is no spin and flat edge of coincidence, then:

$$\theta_1 = \theta_2 = \boxed{30^\circ}$$

From the sketch we see that:

$$\triangle \vec{p}_x = \boxed{\vec{0}}$$

For y component that is not the case, because we have change of direction:

$$\begin{aligned}\triangle \vec{p}_y &= m(\vec{v}_2 - \vec{v}_1)\\ &= 0,15 \cdot \cos 30 \cdot (-2 - 2)\\ &= \boxed{-0,52 \text{ kg m }/\text{s}}\end{aligned}$$

Result

$$\begin{aligned}\theta_1 &= \theta_2 = 30^\circ\\ \triangle \vec{p}_x &= \vec{0}\\ \triangle \vec{p}_y &= -0,52 \text{ kg m }/\text{s}\end{aligned}$$

Exercise 21

Rate this solution

Exercise 23

Exercise 35

Chapter 9, Page 216

Principles of Physics, International Edition

ISBN: 9781118230749

Table of contents

Solutions Verified

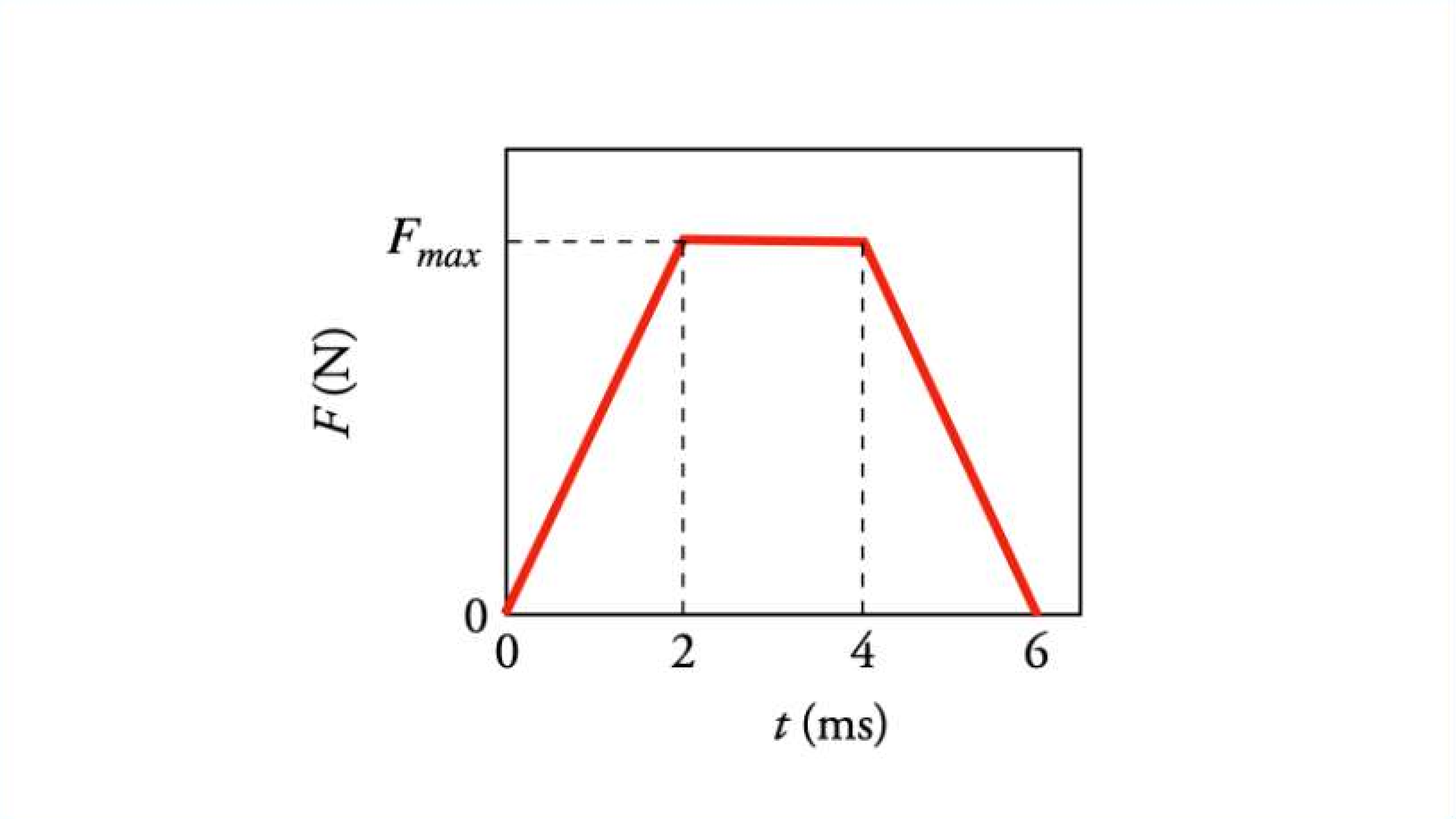
Solution A Solution B

Answered 2 years ago

Step 1

1 of 4

In this problem, we will solve for the maximum magnitude of the force experience by a ball when it collides with the wall. The 58-g ball has a speed of 34 m/s before collision and has the same speed but opposite direction after the collision. The force versus time plot during the collision is shown in the figure below.



Step 2

2 of 4

We will apply the law of conservation of linear momentum in order to solve this problem. This is given in Equation (1).

$$mv_1 + \sum F\Delta t = mv_2 \qquad \ldots(1)$$

Step 3

3 of 4

Let's now apply Equation (1) to solve the problem. Take note of the given units in the problem. The mass is in g and the time in ms. The sign of the velocity after collision is negative, as well as the force applied to the ball. The second term in the equation is simply the area under the curve of the F-t graph.

$$mv_1 + \sum F\Delta t = mv_2$$

$$0.058 \cdot 34 + 2 \cdot \frac{1}{2} \cdot -F_{max} \cdot 2 \times 10^{-3} + -F_{max} \cdot 2 \times 10^{-3} = 0.058 \cdot (-34)$$

$$F_{max} = \boxed{986 \text{ N}}$$

Step 4

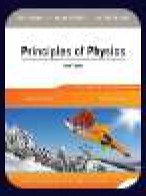
4 of 4

$$F_{max} = 986 \text{ N}$$

Science / Physics / Principles of Physics, International Edition (10th Edition)

Exercise 37

Chapter 9, Page 216



Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution

Verified Answered 2 years ago

Step 1

1 of 2

a)

The impulse in that interval is:

$$\begin{aligned}\vec{J} &= \int_{t_1}^{t_2} \vec{F}dt\\ &= \int_{2}^{2\,\mathrm{s}} (100e^{-2t})dt\,\mathrm{N}\hat{i}\\ &= -50e^{-2t}\Big|_0^{2\,\mathrm{s}}\,\mathrm{Ns}\hat{i}\\ &= -50e^{-2(2)} - (-50e^{-2(0)})\,\mathrm{Ns}\hat{i}\\ &= \boxed{49.1\,\mathrm{Ns}\hat{i}}\end{aligned}$$

b)

The average force is:

$$\begin{aligned}\vec{F}_a &= \frac{\vec{J}}{\Delta t}\\ &= \frac{49.1\,\mathrm{Ns}\hat{i}}{2\,\mathrm{s}}\\ &= 24.5\,\mathrm{N}\hat{i}\end{aligned}$$

Result

2 of 2

$$\begin{aligned}&a)\\ &\quad \vec{J} = 49.1\,\mathrm{Ns}\hat{i}\\ &b)\\ &\quad \vec{F}_a = 24.5\,\mathrm{N}\hat{i}\end{aligned}$$

Exercise 46

Chapter 9, Page 217

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution

Verified Answered 2 years ago

Step 1

1 of 2

If we define the north as the y axis and east as x axis we can simply use the law of conservation of the momentum to get the speed of the kit.

$$\begin{aligned}
\vec{p}_i &= \vec{p}_f \\
m_{mk}\vec{v}_{mk} &= m_1\vec{v}_1 + m_2\vec{v}_2 \\
(4\,\mathrm{kg})\vec{v}_{mk} &= (2\,\mathrm{kg})(3\frac{\mathrm{m}}{\mathrm{s}}\hat{j}) + (2\,\mathrm{kg})(6\frac{\mathrm{m}}{\mathrm{s}}(\cos 30^\circ\hat{i} + \sin 30^\circ\hat{j})) \\
4\vec{v}_{mk} &= 6\sqrt{3}\frac{\mathrm{m}}{\mathrm{s}}\hat{i} + 12\frac{\mathrm{m}}{\mathrm{s}}\hat{i} \\
\vec{v}_{mk} &= 1.5\sqrt{3}\frac{\mathrm{m}}{\mathrm{s}}\hat{i} + 3\frac{\mathrm{m}}{\mathrm{s}}\hat{i}
\end{aligned}$$

The magnitude of this vector is:

$$\begin{aligned}
v_{mk} &= \sqrt{(1.5\sqrt{3}\frac{\mathrm{m}}{\mathrm{s}})^2 + (3\frac{\mathrm{m}}{\mathrm{s}})^2} \\
&= \boxed{3.97\frac{\mathrm{m}}{\mathrm{s}}}
\end{aligned}$$

Result

2 of 2

$$v_{mk} = 3.97\frac{\mathrm{m}}{\mathrm{s}}$$

Exercise 59

Chapter 9, Page 218

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution Verified

Step 1

Givens:

Block 1 with mass 2 kg and initial speed 10 m/s.

Block 2 with mass 5 kg and initial speed 3 m/s.

The spring with spring constant K = 1120 N/m.

The distance compressed is given by

$$U = \frac{1}{2}Kx^2$$

Where k is the spring constant and U is the energy sorted which is equal to the word done to compress the spring because the collision is elastic collision.

And so

$$\begin{aligned} x &= \sqrt{\frac{2U}{K}} \\ &= \sqrt{\frac{2(K.E_f - K.E_i)}{K}} \\ &= \sqrt{\left|\frac{(m_1+m_2)v_f - (m_2v_2 - m_1v_1)_i}{K}\right|} \end{aligned}$$

since the two blocks stick together just after collision they must have the same initial speed.

We need to find the final velocities of block 1 and 2.

From conversation of linear momentum

$$\vec{p_i} = \vec{p_f}$$
$$m_1v_1 + m_2v_2 = (m_1+m_2)v_f$$

Substitute the givens

$$\begin{aligned} v_f &= \frac{2\text{ (kg) } \times 10\text{ (m/s) } + 5\text{ (kg) } \times 3\text{ (m/s)}}{2\text{ (kg) } + 5\text{ (kg)}} \\ &= 5\text{ m/s} \end{aligned}$$

Substitute the givens and v_f in x

$$\begin{aligned} x &= \sqrt{\left|\frac{(2\text{ (kg) } + 5\text{ (kg) }) \times (5\text{ m/s })^2 - 5\text{ (kg) } \times (3\text{ m/s })^2 - 2\text{ (kg) } \times (10\text{ m/s })^2}{1120\text{ (N/m)}}\right.} \\ &= 0.25\text{ m} \end{aligned}$$

Result

$$x = 25\text{ cm}$$

Exercise 62

Chapter 9, Page 218

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution Verified Answered 2 years ago

Step 1 1 of 3

a)

From the law of conservation of momentum we get:

$$p_b = p_a$$
$$mv - 0.25\,\mathrm{kg}v = mv'$$
$$v = \frac{m}{m - 0.25\,\mathrm{kg}}v'$$

From the law of conservation of kinetic energy we get:

$$K_b = K_a$$
$$\frac{mv^2}{2} + \frac{0.25\,\mathrm{kg}v^2}{2} = \frac{mv'^2}{2}$$
$$v^2(m + 0.25\,\mathrm{kg}) = mv'^2$$
$$v = \sqrt{\frac{m}{m + 0.25\,\mathrm{kg}}}v'$$

Comparing these two expressions we get:

$$\frac{m}{m - 0.25\,\mathrm{kg}} = \sqrt{\frac{m}{m + 0.25\,\mathrm{kg}}}$$
$$\frac{m^2}{(m - 0.25\,\mathrm{kg})^2} = \frac{m}{m + 0.25\,\mathrm{kg}}$$
$$m^2(m + 0.25\,\mathrm{kg}) = m(m^2 - 0.5\,\mathrm{kg}m + 0.0625\,\mathrm{kg}^2)$$
$$0.25\,\mathrm{kg}m = -0.5\,\mathrm{kg}m + 0.0625\,\mathrm{kg}^2$$
$$\downarrow$$
$$m = \boxed{0.083\,\mathrm{kg}}$$

Step 2 2 of 3

b)

The total momentum of the system is:

$$p = 0.250\,\mathrm{kg}(2\frac{\mathrm{m}}{\mathrm{s}}) - 0.083\,\mathrm{kg}(2\frac{\mathrm{m}}{\mathrm{s}})$$
$$= 0.334\,\mathrm{Ns}$$

The speed of the center of mass is:

$$v_{cm} = \frac{p}{M}$$
$$= \frac{0.334\,\mathrm{Ns}}{0.25\,\mathrm{kg} + 0.083\,\mathrm{kg}}$$
$$= \boxed{1\frac{\mathrm{m}}{\mathrm{s}}}$$

Result 3 of 3

a)

$$m = 0.083\,\mathrm{kg}$$

b)

$$v_{cm} = 1\frac{\mathrm{m}}{\mathrm{s}}$$

< Exercise 61
Rate this solution
Exercise 63a >

Exercise 64

Chapter 9, Page 218

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution Verified Answered 2 years ago

Step 1 1 of 2

a)

Using the law of conservation of energy we can get the speed of the ball just before the collision:

$$\frac{mv^2}{2} = mgh$$
$$\downarrow$$
$$v = \sqrt{2gh}$$
$$= \sqrt{2(9.81\,\frac{\mathrm{m}}{\mathrm{s}^2})(0.7\,\mathrm{m})}$$
$$= 3.71\,\frac{\mathrm{m}}{\mathrm{s}}$$

Using the equation for the final speed of the projectile we get:

$$v_f = \frac{m_1 - m_2}{m_1 + m_2}v$$
$$= \frac{0.6\,\mathrm{kg} - 2.8\,\mathrm{kg}}{0.6\,\mathrm{kg} + 2.8\,\mathrm{kg}}(3.71\,\frac{\mathrm{m}}{\mathrm{s}})$$
$$= \boxed{-2.4\,\frac{\mathrm{m}}{\mathrm{s}}}$$

b)

Using the equation for the final speed of the target we get:

$$v_f = \frac{2m_1}{m_1 + m_2}v$$
$$= \frac{2(0.6\,\mathrm{kg})}{0.6\,\mathrm{kg} + 2.8\,\mathrm{kg}}(3.71\,\frac{\mathrm{m}}{\mathrm{s}})$$
$$= \boxed{1.31\,\frac{\mathrm{m}}{\mathrm{s}}}$$

Result 2 of 2

a)

$$v_f = -2.4\,\frac{\mathrm{m}}{\mathrm{s}}$$

b)

$$v_f = 1.31\,\frac{\mathrm{m}}{\mathrm{s}}$$

Exercise 68

Chapter 9, Page 219

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution Verified Answered 2 years ago

Step 1 1 of 3

The speed of the first block just before the collision is:

$$\begin{aligned}\frac{mv_1^2}{2} &= mgh\\ &\downarrow\\ v_1 &= \sqrt{2gh}\\ &= \sqrt{2(9.81\,\frac{\mathrm{m}}{\mathrm{s}^2})(3\,\mathrm{m})}\\ &= 7.67\,\frac{\mathrm{m}}{\mathrm{s}}\end{aligned}$$

a)

The speed of the second block after the collision is:

$$\begin{aligned}v_{f,2} &= \frac{2m_1}{m_1+m_2}v_1\\ &= \frac{2m_1}{m_1+2m_1}7.67\,\frac{\mathrm{m}}{\mathrm{s}}\\ &= 5.11\,\frac{\mathrm{m}}{\mathrm{s}}\end{aligned}$$

After the collision this block enters the region where it looses energy do to friction and it stops. This means that all of its kinetic energy is used for work, so:

$$\begin{aligned}K &= W\\ \frac{m_2v_{f,2}^2}{2} &= (m_2g\eta)s\\ &\downarrow\\ s &= \frac{v_{f,2}^2}{2g\eta}\\ &= \frac{(1.29\,\frac{\mathrm{m}}{\mathrm{s}})^2}{2(9.81\,\frac{\mathrm{m}}{\mathrm{s}^2})(0.5)}\\ &= \boxed{2.96\,\mathrm{m}}\end{aligned}$$

Step 2 2 of 3

b)

Using the law of conservation of momentum we get:

$$\begin{aligned}p_b &= p_a\\ m_1v_1 &= (m_1+m_2)v'\\ &\downarrow\\ v' &= \frac{m_1}{m_1+m_2}v_1\\ &= \frac{m_1}{m_1+2m_1}7.67\,\frac{\mathrm{m}}{\mathrm{s}}\\ &= 2.56\,\frac{\mathrm{m}}{\mathrm{s}}\end{aligned}$$

After the collision this block enters the region where it looses energy do to friction and it stops. This means that all of its kinetic energy is used for work, so:

$$\begin{aligned}K &= W\\ \frac{m_2v_{f,2}^2}{2} &= (m_2g\eta)s\\ &\downarrow\\ s &= \frac{v_{f,2}^2}{2g\eta}\\ &= \frac{(1.29\,\frac{\mathrm{m}}{\mathrm{s}})^2}{2(9.81\,\frac{\mathrm{m}}{\mathrm{s}^2})(0.5)}\\ &= \boxed{0.74\,\mathrm{m}}\end{aligned}$$

Result 3 of 3

a)

$$s = 2.96\,\mathrm{m}$$

b)

$$s = 0.74\,\mathrm{m}$$