PHYS141 OUTLINE QUESTIONS SOLUTIONS

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Exercise 5a

Chapter 4, Page 73

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Solution Verified Answered 1 year ago

Step 1

Given values:

$t_1 = 40.0\ \mathrm{min}$

$t_2 = 20.0\ \mathrm{min}$

$t_3 = 50.0\ \mathrm{min}$

In order to find the magnitude of the average velocity i.e $\vec{v}_{avg}$, we use the next relation:

$$\vec{v}_{avg} = \frac{\Delta\vec{r}}{\Delta t} \qquad \text{(Equation 1.)}$$

First step is to determine the total time of the entire trip (Δt).

$$\begin{aligned} \Delta t &= t_1 + t_2 + t_3 \\ \Delta t &= 40.0\ \mathrm{min} + 20.0\ \mathrm{min} + 50.0\ \mathrm{min} \\ \Delta t &= 110\ \mathrm{min} \qquad (1.83\ \mathrm{h.}) \end{aligned}$$

Next, we have to determine $\Delta\vec{r}$ by summing the three displacements of the trip.

$$\Delta\vec{r} = \Delta\vec{r_1} + \Delta\vec{r_2} + \Delta\vec{r_3} \qquad \text{(Equation 2.)}$$

$$\rightarrow \Delta\vec{r_1} = (60.0\ \mathrm{km/h}) \cdot \frac{40.0\ \mathrm{min}}{60.0\ \mathrm{km/h}}\hat{i} = (40.0\ \mathrm{km})\hat{i}$$

$$\rightarrow \Delta\vec{r_2} = (60.0\ \mathrm{km/h}) \cdot \frac{20.0\ \mathrm{min}}{60.0\ \mathrm{km/h}}\cos(40.0°)\hat{i} + (60.0\ \mathrm{km/h}) \cdot \frac{20.0\ \mathrm{min}}{60.0\ \mathrm{km/h}}\sin(40.0°)\hat{j}$$

$$\Delta\vec{r_2} = (15.3\ \mathrm{km})\hat{i} + (12.9\ \mathrm{km})\hat{j}$$

$$\rightarrow \Delta\vec{r_3} = -(60.0\ \mathrm{km/h}) \cdot \frac{50.0\ \mathrm{min}}{60.0\ \mathrm{km/h}}\hat{i} = (-50.0\ \mathrm{km})\hat{i}$$

Exercise 4 Show all steps Exercise 5b

Exercise 5b

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Step 1 1 of 2

b) We have to find corresponding angle:

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$$

$$\theta = \tan^{-1}\left(\frac{7.05\ \mathrm{km/h}}{2.90\ \mathrm{km/h}}\right)$$

$$\theta = \boxed{67.6^\circ}$$

Result 2 of 2

$$\mathbf{b)}\ \theta = 67.6^\circ$$

Exercise 5a
Rate this solution
Exercise 6

Exercise 7

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Step 1 1 of 2

To solve this problem we will have to use the fact that the average velocity is defined as

$$v_{avg} = \frac{\Delta\vec{r}}{\Delta t}$$

Where $\Delta\vec{r} = \vec{r_2} - \vec{r_1} = -3\vec{i} + 9\vec{j} - 3\vec{k} - 6\vec{i} + 7\vec{7} - 3\vec{k}$ $\Delta\vec{r} = -9\vec{i} + 16\vec{j} - 6\vec{k}$ Now, we can find the velocity as follows

$$\vec{v_{avg}} = \frac{-9\vec{i} + 16\vec{j} - 6\vec{k}}{\Delta t}$$

$$\vec{v_{avg}} = -0.9\vec{i} + 1.6\vec{j} - 0.6\vec{k}$$

Result 2 of 2

$$\vec{v_{avg}} = -0.9\vec{i} + 1.6\vec{j} - 0.6\vec{k}$$

Exercise 6
Rate this solution
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Exercise 11

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Step 1 1 of 3

In order to solve this problem we will have to use some calculus and find the first and the second time derivative of the radius-vector given in the problem

$$\vec{r} = (3t^3 - 6t)\hat{\imath} + (7 - 8t^4)\hat{\jmath}$$

The first time derivative gives us the vector of the velocity

$$\vec{v} = \frac{d\vec{r}}{dt} = (9t^2 - 6)\hat{\imath} - 32t^3\hat{\jmath}$$

And if we differentiate once more we obtain the vector of the acceleration

$$\vec{a} = \frac{d^2\vec{r}}{dt^2} = 18t\hat{\imath} - 96t^2\hat{\jmath}$$

Now, we can solve the first three tasks calculating the above values for $t = 3$s.

$$\text{a) } \vec{r}(3) = 63\text{m}\,\hat{\imath} - 641\text{m}\,\hat{\jmath}$$
$$\text{b) } \vec{v}(3) = 75\text{m/s}\,\hat{\imath} - 864\text{m/s}\,\hat{\jmath}$$
$$\text{c) } \vec{a}(3) = 54\text{m/s}^2\,\hat{\imath} - 864\text{m/s}^2\,\hat{\jmath}$$

Step 2 2 of 3

d) To find the angle between the tangent of the path at $t = 3$s we have to understand that the tangent of the motion is it's velocity which is given as in part b

$$\vec{v}(3) = 75\text{m/s}\,\hat{\imath} - 864\text{m/s}\,\hat{\jmath}$$

Now, the angle between the vector of velocity and positive direction of x-axis is given as follows

$$\tan\theta = \frac{v_y}{v_x} = \frac{-864}{75}$$
$$\theta = \arctan\frac{-864}{75} = -85^\circ$$

Result 3 of 3

$$\text{a) } \vec{r}(3) = 63\text{m}\,\hat{\imath} - 641\text{m}\,\hat{\jmath}$$
$$\text{b) } \vec{v}(3) = 75\text{m/s}\,\hat{\imath} - 864\text{m/s}\,\hat{\jmath}$$
$$\text{c) } \vec{a}(3) = 54\text{m/s}^2\,\hat{\imath} - 864\text{m/s}^2\,\hat{\jmath}$$
$$\text{d) } \theta = -85^\circ$$

Exercise 10b

Rate this solution

Exercise 12

Exercise 14a

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Solutions Verified

Solution A Solution B

Answered 1 year ago

Step 1 1 of 4

Given Quantities

- $\vec{v}_0 = 4.0\hat{\text{i}} - 2.0\hat{\text{j}} + 3.0\hat{\text{k}}$: initial velocity of a proton
- $\vec{v}_1 = -2.0\hat{\text{i}} - 2.0\hat{\text{j}} + 5.0\hat{\text{k}}$: final velocity of the proton
- $\Delta t = 4.0$ s: the time interval in which the velocity changes

Required Quantities

- $\vec{a}_{\text{avg}}$: average acceleration of the proton

Step 2 2 of 4

The average acceleration of an object that changes velocity over a period of time is

$$\vec{a}_{\text{avg}} = \frac{\vec{v}_1 - \vec{v}_0}{\Delta t} \tag{1}$$

Step 3 3 of 4

Substituting the given quantities into Equation (1), we can calculate the average velocity in the unit-vector notation

$$\begin{aligned}\vec{a}_{\text{avg}} &= \frac{\vec{v}_1 - \vec{v}_0}{\Delta t} \\ &= \frac{\left(-2.0\hat{\text{i}} - 2.0\hat{\text{j}} + 5.0\hat{\text{k}}\right) - \left(4.0\hat{\text{i}} - 2.0\hat{\text{j}} + 3.0\hat{\text{k}}\right)}{(4.0)} \\ &= \boxed{(-1.5\ \text{m/s}^2)\hat{\text{i}} + (0.50\ \text{m/s}^2)\hat{\text{k}}}\end{aligned}$$

Result 4 of 4

$$\vec{a}_{\text{avg}} = (-1.5\ \text{m/s}^2)\hat{\text{i}} + (0.50\ \text{m/s}^2)\hat{\text{k}}$$

Exercise 13 Rate this solution Exercise 14b

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Exercise 14b

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Solution Verified Answered 1 year ago

Step 1 1 of 3

Given Quantities

- $\vec{v}_0 = 4.0\hat{\text{i}} - 2.0\hat{\text{j}} + 3.0\hat{\text{k}}$: initial velocity of a proton
- $\vec{v}_1 = -2.0\hat{\text{i}} - 2.0\hat{\text{j}} + 5.0\hat{\text{k}}$: final velocity of the proton
- $\Delta t = 4.0\ \text{s}$: the time interval in which the velocity changes

Required Quantities

- $|\vec{a}_{\text{ave}}|$: magnitude of the average acceleration

Step 2 2 of 3

From Part (a) we have : $\vec{a}_{\text{avg}} = (-1.5\ \text{m/s}^2)\hat{\text{i}} + (0.50\ \text{m/s}^2)\hat{\text{k}}$
The magnitude of the average vector can be calculated using the components

$$\begin{aligned}|\vec{a}_{\text{ave}}| &= \sqrt{a^2_{\text{avg},x} + a^2_{\text{avg},y} + a^2_{\text{avg},z}}\\ &= \sqrt{(-1.5)^2 + (0)^2 + (0.50)^2}\\ &= 1.581139\ \text{m/s}^2\\ &= \boxed{1.6\ \text{m/s}^2}\end{aligned}$$

Result 3 of 3

$$|\vec{a}_{\text{ave}}| = 1.6\ \text{m/s}^2$$

Exercise 14a
Rate this solution
Exercise 14c

Exercise 14c

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Step 1

1 of 5

Given Quantities

- $\vec{v}_0 = 4.0\hat{\mathrm{i}} - 2.0\hat{\mathrm{j}} + 3.0\hat{\mathrm{k}}$: initial velocity of a proton
- $\vec{v}_1 = -2.0\hat{\mathrm{i}} - 2.0\hat{\mathrm{j}} + 5.0\hat{\mathrm{k}}$: final velocity of the proton
- $\Delta t = 4.0$ s: the time interval in which the velocity changes

Required Quantities

- $\angle\vec{a}_{\text{avg}}$: the angle of the average acceleration with $+x$ axis.

Step 2

2 of 5

From Part (a) we have : $\vec{a}_{\text{avg}} = (-1.5\ \mathrm{m/s^2})\hat{\mathrm{i}} + (0.50\ \mathrm{m/s^2})\hat{\mathrm{k}}$
The acceleration vector is within the xz-plane hence, we need to use the x and z coordinates of $\vec{a}_{\text{avg}}$, with the angle follows the equation

$$\tan\theta = \frac{a_{\text{avg},z}}{a_{\text{avg},x}}$$
$$\implies \theta = \tan^{-1}\left[\frac{a_{\text{avg},z}}{a_{\text{avg},x}}\right] \qquad (1)$$

Step 3

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Substituting values into Equation (1) we can calculate the angle θ

$$\begin{aligned}\theta &= \tan^{-1}\left[\frac{a_{\text{avg},z}}{a_{\text{avg},x}}\right]\\ &= \tan^{-1}\left[\frac{(0.50)}{(-1.50)}\right]\\ &= -18.434949^\circ\end{aligned}$$

Step 4

4 of 5

The acceleration has positive z component and negative x component, while the angle has a negative z component and positive x component. Hence, we must add 180° in order to calculate the angle of the acceleration vector with $+x$ axis.

$$\begin{aligned}\theta &= -18.434949^\circ + 180^\circ\\ \angle\vec{a}_{\text{avg}} &= 161.565051^\circ\\ &= \boxed{160^\circ}\end{aligned}$$

Result

5 of 5

$$\angle\vec{a}_{\text{avg}} = 160^\circ$$

Exercise 14b
Rate this solution
Exercise 15

Exercise 15

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Solution Verified Answered 2 years ago

Step 1

In order to solve this problem we will have to write down the radius vector of the particle as a function of time

$$\vec{r} = \vec{v}t + \frac{1}{2}\vec{a}t^2$$

If we now insert the given values of acceleration and the velocity we obtain that

$$\vec{r} = 7t\hat{+}\frac{1}{2}t^2(-9\hat{i} + 3\hat{j})$$

After we regroup the terms we obtain that

$$\vec{r} = (7t - \frac{9}{2}t^2)\hat{i} + \frac{3}{2}t^2\hat{j}$$

The maximum value of x coordinate we obtain after we use the mathematical definition of a maximum

$$\frac{dx}{dt} = 0 = \frac{d(7t - \frac{9}{2}t^2)}{dt}$$
$$0 = 7 - 9t$$

From which we get that the x-coordinate has it's maximum at

$$t = \frac{7}{9}s$$

a) Now we can find the velocity vector at the this exact time using

$$\vec{v} = \frac{d\vec{r}}{dt}$$
$$\vec{v} = (7 - 9t)\hat{i} + 3t\hat{j}$$

But we know that $v_x = 0$ at this moment so we have that

$$\vec{v}(7/9) = 3 \times \frac{7}{9}\hat{j} = \frac{7}{3}\hat{j} = 2.3\text{m/s}\,\hat{j}$$

b) The functional form of the radius vector we have obtained in the setup part

$$\vec{r} = (7t - \frac{9}{2}t^2)\hat{i} + \frac{3}{2}t^2\hat{j}$$

Now, at $t = 7/9$s we have that

$$\vec{r}(7/9) = (7 \times \frac{7}{9} - \frac{9}{2}\frac{7^2}{9^2})\hat{i} + \frac{3}{2}\frac{7^2}{9^2}\hat{j}$$
$$\vec{r}(7/9) = 2.7\hat{i} + 0.91\hat{j}$$

Result

$$\text{a) } \vec{v}(7/9) = 2.3\text{m/s}\,\hat{j}$$
$$\text{b) } \vec{r}(7/9) = 2.7\hat{i} + 0.91\hat{j}$$

Exercise 14c
Rate this solution
Exercise 16a

Exercise 20

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Solution Verified Answered 2 years ago

Step 1 1 of 4

Givens:

$y_A = 30 \text{ m}$

$v = 3 \text{ m/s}$

$$|a| = 0.4 \text{ m/s}^2$$

Step 2 2 of 4

For particle A motion is constrained to the x-direction and starts from $x_0 = 0$, therefore :

$$x_A = x_0 + vt = vt$$

For particle B,motion in the x-direction is given by :

$$x_B = \frac{1}{2} a_x t^2$$

While motion in the y-direction is given by :

$$y_B = \frac{1}{2} a_y t^2$$

Where $a_x = |a| \sin\theta$ and $a_y = |a| \cos\theta$ The two will collision if their x and y positions coincide,this means that $x_A = x_B$ and $y_A = y_B$, therefore :

$$x_A = x_B$$
$$vt = \frac{1}{2} |a| \sin\theta t^2$$
$$t = \frac{2v}{|a| \sin\theta}$$

Step 3 3 of 4

Also for the displacement in y-direction:

$$y_A = \frac{1}{2} a_y t^2$$
$$y_A = \frac{1}{2} |a| \cos\theta t^2$$

substituting by t we get:

$$y_A = \frac{1}{2} |a| \cos\theta \left(\frac{2v}{|a| \sin\theta}\right)^2$$

$$= \frac{1}{2} |a| \cos\theta \left(\frac{4v^2}{|a|^2 \sin^2\theta}\right)$$

$$= \frac{2v^2 \cos\theta}{|a| \sin^2\theta}$$

We know that $\sin^2\theta = 1 - \cos^2\theta$,therefore :

$$y_A = \frac{2v^2}{|a|} \frac{\cos\theta}{1 - \cos^2\theta}$$

Rearranging we get :

$$y_A \cos^2\theta - \frac{2v^2}{|a|} \cos\theta - y_A = 0$$

This is a quadratic equation in $\cos\theta$,therefore solving for $\cos\theta$ gives

$$\cos\theta = \frac{1}{2}$$

.

$$\therefore \theta = \cos^{-1}\frac{1}{2} = 60^0$$

Result 4 of 4

$$\theta = 60^0$$

Exercise 19b
Rate this solution
Exercise 21

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Solution Verified Answered 2 years ago

Step 1 1 of 2

In order to solve this problem we will need to find the time needed for the ball to reach the target which can be found by taking into account that the motion vertically is only due to the gravitational force and it is given as

$$\Delta h = \frac{1}{2}gt^2$$

Where $\Delta h = 1.5\text{m}$ as given in the problem. Solving this for t we get

$$t = \sqrt{2\Delta h g} = \sqrt{\frac{2\times 1.5}{9.81}}$$

$$\text{a) } t = 0.55\text{s}$$

Now, we can get the horizontal speed component from the equation

$$\Delta x = v_x t$$

Which after we solve it for v_x becomes

$$v_x = \frac{\Delta_x}{t} = \frac{1.52}{0.55}$$

and finally we have that

$$\text{b) } v_x = 2.8\text{m/s}$$

Result 2 of 2

$$\text{a) } t = 0.55\text{s}$$

$$\text{b) } v_x = 2.8\text{m/s}$$

Rate this solution

Exercise 21

Exercise 23

Exercise 27a

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Solution Verified Answered 1 year ago

Step 1 1 of 3

Givens:

$|v| = 290 \text{ km/h} = 80.5 \text{ m/s}$
$\theta = 30^0$
$d = 700 \text{ m}$

Step 2 2 of 3

The decoy moves under a constant velocity in the horizontal direction. To find the time it spends in the air we use the equation:

$$\Delta x = d = v_x t$$

We take $\theta_0 = -30^0$ because it is measured clockwise from horizontal and $v_x = |v| \cos\theta$,

Therefore:

$$t = \frac{d}{v_x} = \frac{d}{|v|\cos\theta_0} = \frac{(700 \text{ m})}{(80.5 \text{ m/s})\cos(-30)} = 10 \text{ s}$$

Result 3 of 3

$$t = 10 \text{ s}$$

Exercise 27b

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Solution

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Step 1

1 of 2

The decoy moves under gravitational acceleration in the y-direction. Its motion is given by:

$$y = y_0 + v_{0y}t - \frac{1}{2}gt^2$$

where we assume $y = 0$ and $v_{0y} = |v|\cos\theta$ so we want to know y_0.

$$\begin{aligned} y_0 &= \frac{1}{2}gt^2 - |v|\sin\theta_0 t \\ &= \frac{1}{2}(9.8\ \mathrm{m/s^2})(10\ \mathrm{s})^2 - (80.5\ \mathrm{m/s})(\sin(-30))(10\ \mathrm{s}) \\ &= 892.5\ \mathrm{m} \end{aligned}$$

Result

2 of 2

$$y_0 = 892.5\ \mathrm{m}$$

Exercise 32a

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Solution Verified Answered 1 year ago

Step 1 1 of 5

Given Quantities

- $v_0 = 25.0\ \mathrm{m/s}$: initial speed of a ball thrown at an angle
- $\theta = 40.0^\circ$: angle with the horizontal in which the ball was thrown
- $d = 22.0\ \mathrm{m}$: distance of the wall from the release point

Useful Quantity

- $g = 9.80\ \mathrm{m/s^2}$: acceleration due to gravity

Required Quantities

- y the height of the ball as it hits the wall

Step 2 2 of 5

For an object in projectile motion, the x-component of the velocity is constant while the y-component of the velocity changes, since the acceleration on the y-direction is the acceleration due to gravity. The velocity components are

$$v_x = v_0 \cos\theta$$
$$v_y = v_0 \sin\theta - gt$$

Step 3 3 of 5

For a time t_1, the ball has hit the wall. Hence, it would have travelled a horizontal distance of d. Using kinematic equation along the x-direction, we have

$$d = v_x t_1$$
$$d = v_0 \cos\theta t_1$$
$$\implies t_1 = \frac{d}{v_0\cos\theta}$$

Step 4 4 of 5

Substituting values into Equation (1), the height of the ball as it hits the wall is

$$\begin{aligned} y &= d\tan\theta - \frac{gd^2}{2v_0^2\cos^2\theta} \\ &= (22.0)\tan(40.0^\circ) - \frac{(9.80)(22.0)^2}{2(25.0)^2\cos^2(40.0^\circ)} \\ &= +11.993927\ \mathrm{m} \\ &= \boxed{+12.0\ \mathrm{m}} \end{aligned}$$

Step 5 5 of 5

Substituting this expression into the equation of motion along the y-direction, we have

$$\begin{aligned} y &= y_0 + v_{y,0}t_1 + \frac{1}{2}at_1^2 \\ &= 0 + (v_0\sin\theta)\cdot\left(\frac{d}{v_0\cos\theta}\right) + \frac{1}{2}(-g)\cdot\left(\frac{d}{v_0\cos\theta}\right)^2 \\ \implies y &= d\tan\theta - \frac{gd^2}{2v_0^2\cos^2\theta} \end{aligned} \tag{1}$$

Exercise 31
Rate this solution
Exercise 32b

Exercise 32b

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Solution Verified Answered 1 year ago

Step 1

1 of 2

Given Quantities

- $v_0 = 25.0\ \mathrm{m/s}$: initial speed of a ball thrown at an angle
- $\theta = 40.0^\circ$: angle with the horizontal in which the ball was thrown
- $d = 22.0\ \mathrm{m}$: distance of the wall from the release point

Useful Quantity

- $g = 9.80\ \mathrm{m/s^2}$: acceleration due to gravity

Required Quantities

- v_x the horizontal velocity of the ball as it hits the wall

Step 2

2 of 2

The horizontal velocity of the ball is constant in projectile motion, which is given by the following equation

$$\begin{aligned} v_x &= v_0 \cos\theta \\ &= (25.0)\cos(40.0^\circ) \\ &= +19.151111\ \mathrm{m/s} \\ &= \boxed{+19.2\ \mathrm{m/s}} \end{aligned}$$

Exercise 32a
Rate this solution
Exercise 32c

Exercise 32c

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Solution Verified Answered 1 year ago

Step 1

1 of 2

Given Quantities

- $v_0 = 25.0\ \mathrm{m/s}$: initial speed of a ball thrown at an angle
- $\theta = 40.0^\circ$: angle with the horizontal in which the ball was thrown
- $d = 22.0\ \mathrm{m}$: distance of the wall from the release point

Useful Quantity

- $g = 9.80\ \mathrm{m/s^2}$: acceleration due to gravity

Required Quantities

- v_y the vertital velocity of the ball as it hits the wall

Step 2

2 of 2

The vertical velocity undergoes a constant acceleration in projectile motion, following the equation

$$\begin{aligned} v_y &= v_0 \sin\theta - g t_1 \\ &= v_0 \sin\theta - g \frac{d}{v_0 \cos\theta} \\ &= (25.0)\sin(40.0^\circ) - (9.80)\frac{(22.0)}{(25.0)\cos(40.0^\circ)} \\ &= +4.811858\ \mathrm{m/s} \\ &= \boxed{+4.81\ \mathrm{m/s}} \end{aligned}$$

As the ball hits the wall, it is moving upwards.

Exercise 32b
Rate this solution
Exercise 32d

Exercise 32d

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Solution Verified Answered 1 year ago

Step 1 1 of 2

Given Quantities

- $v_0 = 25.0\ \mathrm{m/s}$: initial speed of a ball thrown at an angle
- $\theta = 40.0^\circ$: angle with the horizontal in which the ball was thrown
- $d = 22.0\ \mathrm{m}$: distance of the wall from the release point

Useful Quantity

- $g = 9.80\ \mathrm{m/s^2}$: acceleration due to gravity

Required Quantities

- determine if the ball has passed its maximum height y_{max} as it hits the wall

Step 2 2 of 2

For an object moving in projectile motion, it has a positive y-velocity as it moves towards the peak. At the peak, it would have 0 vertical velocity, then as it falls down, the velocity is negative. It was calculated in Part (c) that the velocity of the ball as it hits the wall is positive, hence **it has not yet reached the highest point on its trajectory**.

Exercise 32c
Rate this solution
Exercise 33

Exercise 56

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Solution Verified Answered 2 years ago

Step 1 1 of 2

In order to solve this problem, we will have to find the exact radius of the satellite's orbit which is given as

$$r = R_E + h = 6.37 \times 10^6 + 0.75 \times 10^6$$

$$r = 7.12 \times 10^6 \mathrm{m}$$

a) Now, we can calculate the speed of the satellite by dividing the circumference of its orbit by orbiting period

$$s = \frac{2\pi r}{T} = \frac{6.28 \times 7.12 \times 10^6}{98 \times 60}$$

Which gives that

$$s = 7.6 \times 10^3 \mathrm{m/s}$$

b) The magnitude of the centripetal acceleration is to be found via formula

$$a_c = \frac{v^2}{r} = \frac{7.6^2 \times 10^6}{7.12 \times 10^6}$$

Finally, we obtain that

$$a_c = 8.12 \mathrm{m/s^2}$$

Result 2 of 2

$$\text{a) } s = 7.6 \times 10^3 \mathrm{m/s}$$

$$\text{b) } a_c = 8.12 \mathrm{m/s^2}$$

Exercise 55
Rate this solution
Exercise 57a

Exercise 58

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Solution Verified Answered 2 years ago

Step 1

To solve this problem we will have to calculate the period the distance covered during one revolution and its period.

a) The distance the tip covers in one period is the circumference of the fan

$$L = 2\pi r = 2 \times 3.14 \times 0.15$$

$$L = 0.94\text{m}$$

Now, we should immediately calculate the period of a single revolution

$$T = \frac{1\text{min}}{N} = \frac{60}{1100}$$

$$T = 0.055\text{s}$$

b) Let's find the speed of the tip. We can do so by dividing the distance covered in a single revolution by its period

$$v = \frac{L}{T} = \frac{0.94}{0.055}$$

Finally, we have that

$$v = 17.1\text{m/s}$$

c) The magnitude of the centripetal acceleration is to be found from a well-known relation

$$a_c = \frac{v^2}{r} = \frac{17.1^2}{0.15}$$

$$a_c = 1.95 \times 10^3 \text{m/s}^2$$

d) Now, we can state explicitly the period of a single revolution found in the setup of this problem

$$T = 0.055\text{s}$$

Result

$$\text{a) } L = 0.94\text{m}$$

$$\text{b) } v = 17.1\text{m/s}$$

$$\text{c) } a_c = 1.95 \times 10^3 \text{m/s}^2$$

$$\text{d) } T = 0.055\text{s}$$

Exercise 60a

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Solution Verified Answered 1 year ago

Step 1 1 of 3

Givens:

Radius of the circular motion, $r = 3$ m.
Acceleration vector of motion, $\vec{a} = 6\hat{i} - 4\hat{j}$ m/s^2.

Step 2 2 of 3

In all instances, the rider is moving tangent to the circular path.

Since the direction of the velocity vector is the same as the direction of the rider's motion, the velocity vector is directed tangent to the circle as well.

While the acceleration is directed toward the center of the circular path, i.e. perpendicular to the velocity vector.

Then,

$$\vec{v} \cdot \vec{a} = |\vec{v}||\vec{a}| \cos 90^\circ = 0$$

where $\vec{v}$ is the velocity vector of motion, and $\vec{a}$ is the acceleration vector of motion.

$$\boxed{\vec{v} \cdot \vec{a} = 0}$$

Result 3 of 3

$$\vec{v} \cdot \vec{a} = 0$$

Exercise 59
Rate this solution
Exercise 60b

Exercise 60b

Chapter 4, Page 77

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Solution Verified Answered 1 year ago

Step 1

1 of 2

At all instances, the direction of the centripetal acceleration is always directed toward the center of the path, inwards along the radius vector of the circular motion. Then, the centripetal acceleration and the radius vector are in opposite directions, i.e. the angle between them is 180°. Then,

$$\vec{r} \times \vec{a} = |\vec{r}||\vec{a}| \sin 180^\circ = 0$$

where $\vec{r}$ is the radius vector of motion, and $\vec{a}$ is the acceleration vector of motion.

$$\boxed{\vec{r} \times \vec{a} = 0}$$

Result

2 of 2

$$\vec{r} \times \vec{a} = 0$$

Exercise 60a
Rate this solution
Exercise 61a

Exercise 67

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Solutions Verified

Solution A Solution B

Step 1 1 of 4

Solution

Step 2 2 of 4

The centripetal force is given by the following equation

$$F = ma = \frac{mv^2}{r}$$

Or, we have

$$a = \frac{v^2}{r} \qquad (1)$$

Where, r is the radius of the circle at which the ball's orbiting, and v is the magnitude of the radial velocity of the ball.

Now, given that the boy whirls the ball horizontally, this means that the velocity of the ball does only have a horizontal component, hence the magnitude of the velocity of the ball at the moment the string breaks, is thus

$$v^2 = v_x^2$$

And, thus if we found the horizontal velocity of the ball when it has been released, then we can substitute in equation (1) to find the acceleration of the centripetal force.

Now the moment the ball breaks, it is a projectile which is at a height of 2.0 meters and will move a horizontal distance of 10.0 meters, and we also now that since the ball was moving in a horizontal plane, then it does not have a vertical component of velocity, i.e

$$v_y = 0$$

And we know that the ball would traverse the horizontal distance of 10.0 meter in a given time duration, and also the ball would traverse the vertical distance of 2.0 meter at the same time duration, hence if we find the time it took the ball to traverse the vertical distance of 2.0 meters, we can find the time which the ball would traverse the vertical distance.

Step 3 3 of 4

And knowing that the vertical component of acceleration acting on the ball is the acceleration of gravity, then using equation of motion, we can find the time which it took the ball to traverse the stated vertical distance, hence we use the following equation

$$S_y = u_y t - \frac{1}{2} g t^2$$

And, since the initial vertical velocity is zero, hence we have

$$S_y = -\frac{1}{2} g t^2$$

And taking our reference point at the height level of 2.0 meter, then the distance traveled by the ball is thus negatively signed, hence substituting the required values, we get

$$-2.0 = -\frac{9.81}{2} t^2$$

Or,

$$t = \sqrt{\frac{-4.0}{-9.81}} = 0.638551 \text{ s}$$

This is the time that it also took the ball to traverse the 10 meters horizontal distance, and since there is no horizontal component of acceleration acting on the ball, then we have

$$S_x = u_x t$$

Or,

$$u_x = \frac{S_x}{t}$$

Hence plugging in the known values,

$$u_x = \frac{10}{0.638551} = 15.6605 \text{ m/s}$$

Knowing the value of the horizontal component of the velocity, which is also equal to the magnitude of the velocity by which the ball was whirling, hence substituting in equation (1) to find the centripetal acceleration, we get

$$a = \frac{15.6605^2}{1.5} = \boxed{163.5 \text{ m/s}^2}$$

note: since the givens are given in two significant figures, then the final answers should have only two significant figures following the significant figures rules, and hence the final answer should be 160 m/s^2.

Result 4 of 4

$$a = 160 \text{ m/s}^2$$

Exercise 66
Rate this solution
Exercise 68a

Exercise 80

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Solution Verified Answered 1 year ago

Step 1 1 of 5

To solve this problem we have to write down the velocity components of the boat relative to the ground:

$$v_{BGx} = v_{BW} \sin\theta + v_{WG} = 8\sin(-30^\circ) + 2.5 = -1.5 \text{ m/s}$$

$$v_{BGy} = v_{BW} \cos\theta = 8\cos 30^\circ = 6.9 \text{ m/s}$$

Step 2 2 of 5

a) Now, we can determine the magnitude in a well-known manner:

$$v_{BG} = \sqrt{v_{BGx}^2 + v_{BGy}^2} = \sqrt{(-1.5)^2 + 6.9^2}$$

Which gives that

$$v_{BG} = 7.06 \text{ m/s}$$

Step 3 3 of 5

b) The direction relative to the ground, i.e. x-axis can be found from the relation:

$$\tan\theta_g = \frac{v_{BGy}}{v_{BGx}} = \frac{6.9}{-1.5}$$

After we perform the inverse tangent function

$$\theta_g = 102^\circ \text{ CCW from x axis}$$

Step 4 4 of 5

c) The time needed for the boat to cross the river is to be found using the y-component of the velocity

$$t = \frac{d}{v_{BGy}} = \frac{200}{6.9} = 29\text{s}$$

Result 5 of 5

$$\text{a) } v_{BG} = 7.06 \text{ m/s}$$

$$\text{b) } \theta_g = 102^\circ$$

$$\text{c) } t = 29 \text{ s}$$

Exercise 79d
Rate this solution
Exercise 81a

Exercise 77

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Solution

Verified

Step 1

1 of 5

Givens:

Snow speed $v_s = 8$ m/s

Traveller speed $v_t = 50$ km/h

Step 2

2 of 5

This problem is about relative motion between two objects each move.

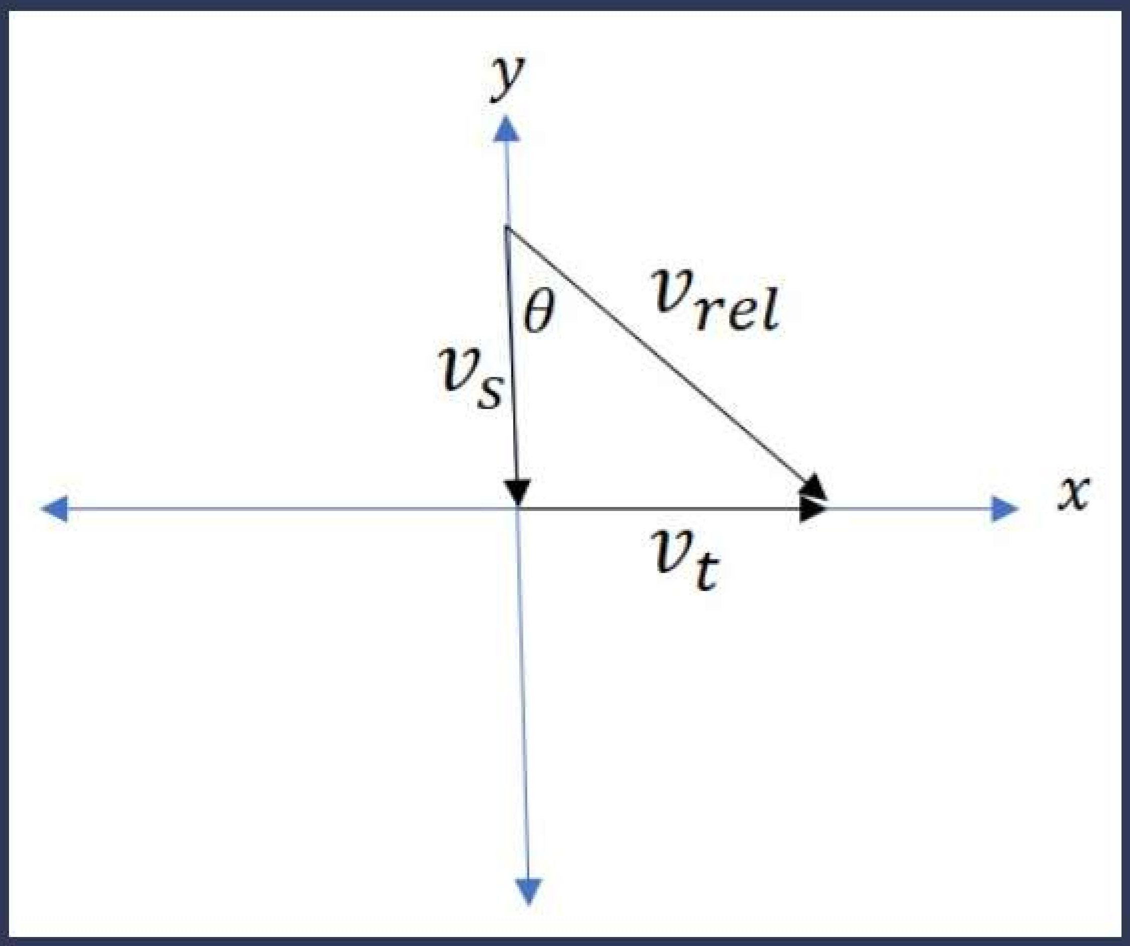
In this kind of problems we can imagine that one of the two objects are stable and the other object moves but with its velocity plus the first object velocity.

Like here we can simply imagine that the traveler not moving and the snow has vertical speed downward and horizontal speed.

Step 3

3 of 5

We can draw it as follow:



Step 4

4 of 5

So, the angle in this case will given by:

$$\tan\theta = \frac{v_t}{v_s}$$

$$\theta = \tan^{-1}\left(\frac{50 \times \frac{1000}{60\times 60}}{8}\right)$$

$$= 60^\circ$$

$$\boxed{\theta = 60^\circ}$$

Result

5 of 5

$$\theta = 60^\circ$$

Exercise 76
Rate this solution
Exercise 78