PHYS141 OUTLINE QUESTIONS SOLUTIONS

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Exercise 9a

Chapter 6, Page 121

Principles of Physics, International Edition
ISBN: 9781118230749
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Solutions Verified

Solution A Solution B

Answered 1 year ago

Step 1 1 of 4

Givens:
Mass of the block is: m = 3.5kg
Force with a magnitude 15N, at an angle$\theta = 40^o$ with the horizontal.
The coefficient of kinetic friction between the block and the floor is 0.25, $\mu_k = 0.25$

Step 2 2 of 4

Part a:

First, we must find the x, and the y components of the applied force.

Due to that the force making an angle$\theta = 40^o$ with the horizontal so,

The x-component of the force will equal:

$$F_x = F \ \cos(\theta)$$

$$= 15 \ \cos(40^o)$$

$$= 11.5 \text{ N}$$

While the y-component will equal:

$$-F_y = -F \ \sin(\theta)$$

$$= -15 \ \sin(40^o)$$

$$= -9.64 \text{ N}$$

Step 3 3 of 4

So, in this case, the normal force of the ground on the block will be:

$$F_N = F_y + m\,g$$

$$= 9.64 + (3.5 \ \times \ 9.8)$$

$$= 43.94 \text{ N}$$

In order to find the frictional force on the block from the floor we will use the following equation:

$$f_K = \mu_K \ F_N$$

$$= 0.25 \ \times \ 43.94$$

$$= 10.98 \text{ N}$$

Then,

$$\boxed{f_K = 10.98 \text{ N}}$$

Result 4 of 4

(a) $f_k = 10.98$

Exercise 8 Rate this solution Exercise 9b

Exercise 9b

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Step 1 1 of 2

Part b:

In order to calculate the acceleration of the crate, we will use the following equation:

$$\sum F_x = m\,a$$

$$F_x - f_K = m\,a$$

$$11.5 - 10.98 = 3.5\,a$$

Then,

$$a = \frac{0.52}{3.5}$$

$$\boxed{a = 0.148\ \mathrm{m/s^2}}$$

And it will be directed toward the positive x-axis due to its positive value

Result 2 of 2

(b) $a = 0.148\ \mathrm{m/s^2}$

Rate this solution

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Exercise 10

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Solution Verified Answered 2 years ago

Step 1 1 of 2

To solve this problem, we have to determine the normal force on the block. From the problem's diagram we see that

$$F_N = W + \frac{W}{2} - \frac{W}{2}\sin\theta = \frac{3}{2}W - \frac{1}{4}W$$

$$F_N = \frac{5}{4}W$$

Now, we can write the force equation for the the horizontal coordinate which is on the verge of the motion

$$\frac{W}{2}\cos\theta - \mu F_N = 0$$

Which we can solve for μ to get

$$\mu = \frac{\frac{W}{2}\cos\theta}{F_N} = \frac{\frac{\sqrt{3}}{4}W}{\frac{5}{4}W}$$

From where we see that

$$\mu = \frac{\sqrt{3}}{5}$$

$$\mu = 0.35$$

Result 2 of 2

$$\mu = 0.35$$

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Solution Verified Answered 1 year ago

Part a

In this situation, the normal force $\vec{F}_N$ is the applied force acting $\vec{F}$ on the block.
Therefore the maximum static friction force is $f_{s,max}$ is given by :

$$f_{s,max} = \mu_s F_N = \mu_s F = 0.6(12\ \mathrm{N}) = 7.2\ \mathrm{N}$$

which acts upward.
The force that acts downward is the weight of the block $F_g = 5\ \mathrm{N}$ Since the weight is less than the maximum static friction force, the block won't move.

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Step 1 1 of 2

Part b

There are two forces acting on the block by the wall, the static friction force acting upward and the normal force acting on the block.
We set our coordinates so that $\hat{i}$ points to the right and $\hat{j}$ points upward,so that the total force is given by :

$$\vec{F} = \vec{F}_N\hat{i} + \vec{f}\hat{j} = -\vec{F}\hat{i} + \vec{f}\hat{j} = -12\ \mathrm{N}\hat{i} + 5\ \mathrm{N}\hat{j}$$

Result 2 of 2

(b) $-12\ \mathrm{N}\hat{i} + 5\ \mathrm{N}\hat{j}$

Exercise 19a

Rate this solution

Exercise 20

Exercise 20

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Solution Verified Answered 2 years ago

Step 1

1 of 2

To solve this problem we will have to write down the force equations for both boxes and find their acceleration. Once we have it, we can use it to get the force acting on the Cheerios box from the Wheaties box.

$$m_C a = F - f_C - F_{WC}$$

$$m_W a = F_{CW} - f_W$$

But we know that $F_{WC} = F_{CW}$ so we can add up these two equations to have that

$$(m_C + m_W)a = F - f_W - f_C$$

Which can be solved for a to yield

$$a = \frac{F - f_W - f_C}{m_C + m_W} = \frac{12 - 2 - 3.5}{1 + 3}$$

$$a = 1.625 \mathrm{m/s^2}$$

Now, we can get back to the first equation and after we solve it for F_{CW} and insert the values we obtain

$$m_C a = F - f_C - F_{WC}$$

$$F_{WC} = F - f_C - m_C a = 12 - 2 - 1 \times 1.625$$

$$F_{WC} = 8.4 \mathrm{N}$$

Result

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$$F_{WC} = 8.4 \mathrm{N}$$

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Solution Verified Answered 2 years ago

Step 1 1 of 2

To solve this problem we will have to write down the force equations for both , sand box and the sled and find their acceleration. Once we have it, we can use it to get the tension.

$$m_{sand}a = m_{sand}g - T$$

$$m_{sled}a = T - \mu m_{sled}g$$

so we can add up these two equations to eliminate T and have that

$$(m_{sand} + m_{sled})a = m_{sand}g - \mu m_{sled}g$$

Which can be solved for a to yield

$$a = \frac{(m_{sand} - \mu m_{sled})}{(m_{sand} + m_{sled})} = \frac{2 - 0.04 \times 15}{2 + 15}g$$

$$\text{a) } a = 0.8 \text{m/s}^2$$

Now, we can get back to the first equation and after we solve it for T and insert the values we obtain

$$m_{sand}a = m_{sand}g - T$$

$$T = m_{sand}g - m_{sand}a = 2 \times (9.8 - 0.8)$$

$$\text{b) } T = 18\text{N}$$

Result 2 of 2

$$\text{a) } a = 0.8 \text{m/s}^2$$

$$\text{b) } T = 18\text{N}$$

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Solution Verified Answered 1 year ago

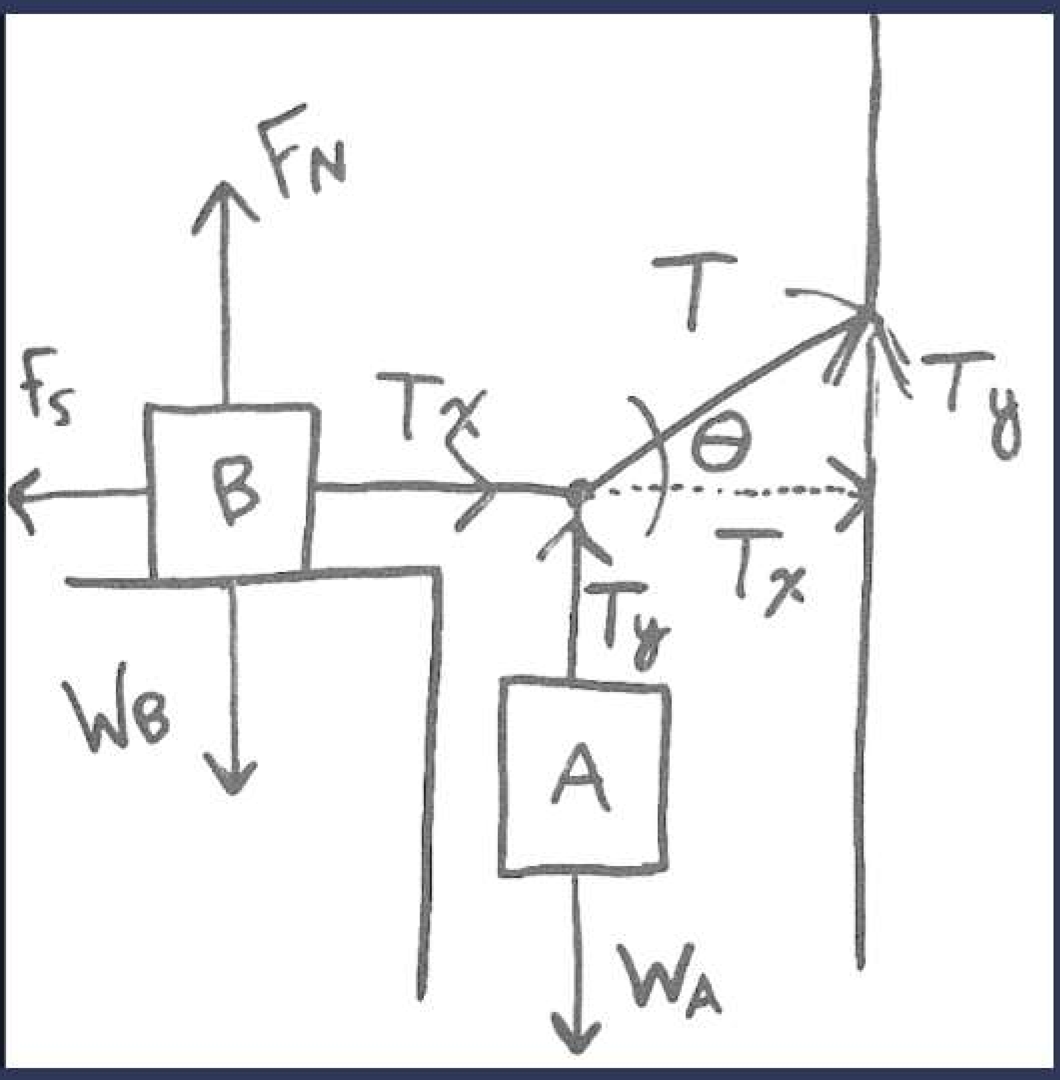
Step 1 1 of 5

If we observe the free body diagram, we will notice that in order for the system to remain stationary,

$T_y = W_A$, $T_x = f_s$ and $W_B = F_N$.

Based on these equations, we can solve for W_A

Figure 1:



Step 2 2 of 5

The max weight that can be held up is based on the max static frictional force, where $f_{s,max} = \mu_s F_N$.

$$f_{s,max} = T_x = \mu_s F_N$$

When we substitute values into above equation, we get:

$$f_{s,max} = (0.25)(711N) = 177.8N$$

Step 3 3 of 5

We can then determine a value for T

$T_x = 177.8N = T\cos\theta$

When we substitute values, we get.

$T = \dfrac{177.8N}{\cos(30^\circ)} = 205.3N$

Step 4 4 of 5

Now we can determine a value for the max weight W_A

$W_A = T_y$

After rearranging we have,

$W_A = T\sin\theta$

Finally, we get

$W_A = (205.3\ N)\sin(30^\circ)$

So, we get.

$W_A = 103\ N$ or

$W_A \approx 1.0 \times 10^2\ N$

Result 5 of 5

$$W_A = 1.0 \times 10^2\ N$$

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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 write down the force equations for both blocks having in mind that since they are moving with the constant speed, their acceleration is zero. Taking care that the block A is sliding down and the friction force is pointing to the right

$$m_A g \sin\theta - T - \mu m_A g \cos\theta = 0$$

$$T - m_B g = 0$$

Let's sum up the two equations to get rid of T

$$m_A g \sin\theta - \mu m_A g \cos\theta - m_B g = 0$$

which after we reduce the equation for g and solve it for m_B becomes

$$m_B = m_A \sin\theta - \mu m_A \cos\theta = (\sin\theta - \mu\cos\theta) m_A$$

And after we plug in the given values

$$m_B = (\sin 30^\circ - 0.2\cos 30^\circ) \times 15$$

Finally, we have that

$$m_B = 4.9\text{kg}$$

Result 2 of 2

$$m_B = 4.9\text{kg}$$

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Solution Verified Answered 2 years ago

Step 1 1 of 2

To solve this problem we will have take a look at Newton's second law for the boat and find the relationship between the friction force and the deceleration of the both. Let's do it

$$F = ma = -f$$

$$ma = -70v$$

but we know that $a = \frac{dv}{dt}$ so we have that

$$\frac{dv}{dt} = -\frac{70v}{m}$$

Now, we can group the velocity part on one side and integrate

$$\frac{dv}{v} = -\frac{70}{m}dt$$

$$\int_{v_0}^{v} \frac{dv}{v} = -\frac{70}{m}\int_0^t dt$$

We get that

$$\ln\frac{v}{v_0} = -\frac{70t}{m}$$

We can solve this expression for t to obtain that

$$t = \ln\frac{v_0}{v} \times \frac{m}{70} = \ln\frac{100}{47} \times \frac{1000}{70}$$

Finally, the time needed to reach the desired speed is

$$t = 11\text{s}$$

Result 2 of 2

$$t = 11\text{s}$$

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Solution Verified Answered 2 years ago

Step 1 1 of 2

To solve this problem we will have to write down the ratio of drag forces on the two planes. Before to do that, let's write down all the variables since there is plenty of them in this problem. We will use indexes H and L for the planes at higher and lower altitude respectively.

$$A_H = A,\, v_H = 1200\mathrm{km/h},\, \rho_H = 0.38\mathrm{kg/m^3}$$

$$A_L = A,\, v_L = 600\mathrm{km/h},\, \rho_L = 0.67\mathrm{kg/m^3}$$

If we know that the drag force is given by the formula

$$D = \frac{1}{2}C\rho A v^2$$

the requested ratio becomes

$$\frac{D_H}{D_L} = \frac{\frac{1}{2}C\rho_H A v_H^2}{\frac{1}{2}C\rho_L A v_L^2}$$

Now we can use the fact that $v_H = 2v_L$ so we can write that

$$\frac{D_H}{D_L} = \frac{\rho_H \cdot 2^2 \cdot v_L^2}{\rho_L \cdot v_L^2}$$

$$\frac{D_H}{D_L} = \frac{4\rho_H}{\rho_L} = \frac{4 \times 0.38}{0.67}$$

We finally have that

$$\frac{D_H}{D_L} = 2.3$$

Result 2 of 2

$$\frac{D_H}{D_L} = 2.3$$

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Solution Verified Answered 2 years ago

Step 1

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To be on the verge of sliding, the centripetal force on the car has to exceed the static friction force on the tires, i.e. it has to hold that

$$\frac{mv^2}{R} = \mu mg$$

We can solve this for the velocity to obtain that

$$v^2 = \mu Rg$$

which becomes

$$v = \sqrt{\mu Rg} = \sqrt{0.6 \times 32 \times 9.8}$$

We finally have that the velocity that puts the car at the verge of sliding is

$$v = 13.7\mathrm{m/s}$$

Result

2 of 2

$$v = 13.7\mathrm{m/s}$$

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Solution Verified Answered 2 years ago

Step 1

1 of 2

The condition for which we will have the minimal radius will suggest that the cyclist is on a verge of sliding. To be on the verge of sliding, the centripetal force on the cyclist has to start exceeding the static friction force on the tires, i.e. it has to hold that at least

$$\frac{mv^2}{R} = \mu mg$$

We can solve this for the radius to obtain that

$$R = \frac{v^2}{\mu g}$$

Now, let's transform the speed from km/h to m/s

$$v = 35\text{km/h} \times \frac{1000}{3600}$$

$$v = 9.7\text{m/s}$$

Now, we can get back to the expression obtained for the radius which becomes

$$R = \frac{v^2}{\mu g} = \frac{9.7^2}{0.4 \times 9.8}$$

We finally have that the minimal radius at which cyclist can cycle and not to slide is

$$R = 24\text{m}$$

Result

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$$R = 24\text{m}$$

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Solution Verified Answered 2 years ago

Step 1 1 of 2

In order to solve this problem we have to understand that when the streetcar starts turning the force of the inertia will start acting on the hand strap. This force is equal to the centripetal force but it has the opposite direction in the horizontal plane. The force that is acting on the hand strap all the time is the gravitational force and it is pointing vertically down. The total force than has two components

$$\vec{F} = F_c\hat{r} + F_g\hat{z}$$

in the cylindrical coordinates and if we take direction down as the positive. This force projection on the vertical axis is equal to $F_g = mg$ so we can us a well known relation to determine the angle between the force F and z-axis $\tan\theta = \frac{F_r}{F_z} = \frac{\frac{mv^2}{R}}{mg}$

$$\tan\theta = \frac{v^2}{Rg}$$

Let's transfer the velocity value to m/s

$$v = 16\text{km/h} \times \frac{1000}{3600}$$

$$v = 4.44\text{m/s}$$

Now, we have that the angle is given as

$$\theta = \arctan\frac{v^2}{Rg} = \arctan\frac{4.44^2}{10.5 \times 9.8}$$

$$\theta = 11^\circ$$

Result 2 of 2

$$\theta = 11^\circ$$