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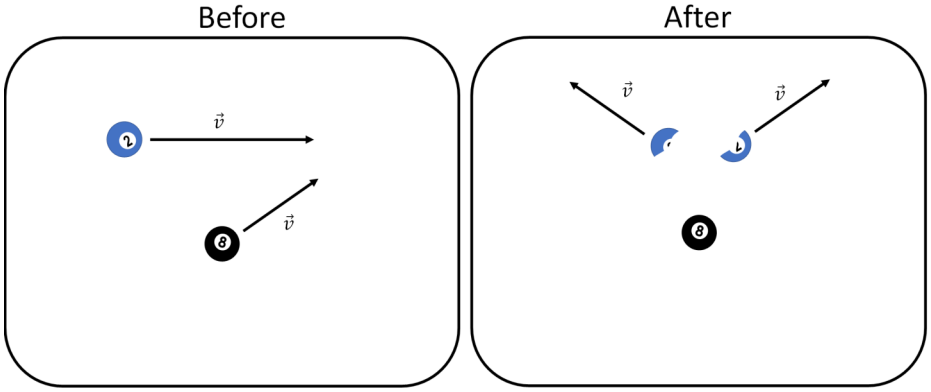
Physics 201

Final Exam | Part 1 (35 minutes) | Corvallis

12/09/2020

Collaboration is not allowed. You will have 35 minutes to download, solve, take pictures, AND upload this exam to Gradescope.

1. (8 points) Bill Yards, the astronaut, is playing a game of space billiards in outer space, far from any other objects. Two identical billiard balls collide. The blue ball breaks into two even pieces. The velocities of both balls before the collision, and the two pieces of the blue ball after the collision are given in the diagrams below. The velocities are drawn to scale. The velocity of the black ball (8 ball) after the collision is unknown. The velocity of one of the broken pieces after the collision is identical to the velocity of the black ball before the collision.



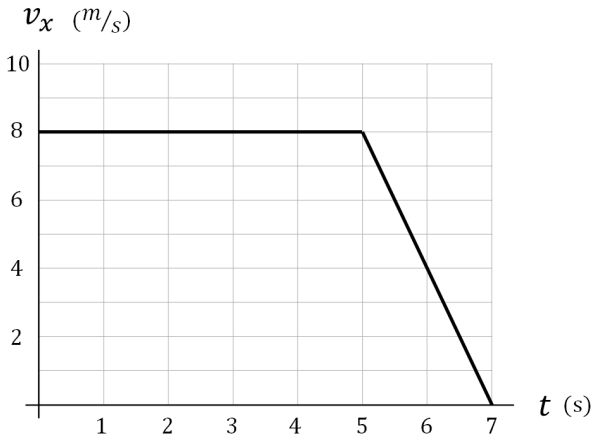
(a) Draw a properly scaled vector that represents the total **momentum** of the system (including both balls) **before** the collision. Show your work using words, diagrams, etc.

(b) Draw a properly scaled vector that represents the total **momentum** of the system (including the two blue pieces and the black ball) **after** the collision. Show your work using words, diagrams, etc.

(c) Draw a properly scaled vector that represents the **velocity** of the black ball **after** the collision. Show your work using words, diagrams, etc.

Question 2 on next page

2. (6 points) Bernice and Daisy are racing in the Annual Mascot Race, which is 100 m long. Benny is supposed to be recording the race, but makes a mistake and only records the last few seconds of Bernice winning the race. He manages to record Bernice crossing the finish line and the few moments of motion afterwards. A plot of Bernice's motion is made from the recording that Benny made, and is displayed on the right.



(a) Describe Bernice's recorded motion in words.

(b) At **t** = 0 seconds on the graph Bernice is 24 meters from the finish line. How many more seconds until she cross the finish line?

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Physics 201

Final Exam | Part 2 (35 minutes) | Corvallis

12/09/2020

Collaboration is not allowed. You will have 35 minutes to download, solve, take pictures, AND upload this exam to Gradescope.

1. (6 points) Provide one example for each of Newton's 3 laws of motion that you have (or can) observe in your everyday life. Using words, phrases, diagrams, etc… briefly explain how each situation exemplifies each specific law.

   (a) Example of Newton's 1st Law

   (b) Example of Newton's 2nd Law

   (c) Example of Newton's 3rd Law

Question 2 on next page

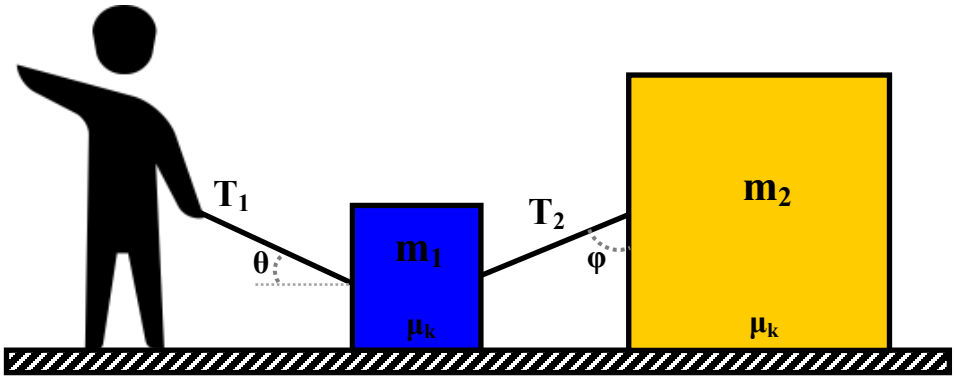
2. (14 point) A child ties a rope ($\mathbf{T_2}$) between two toy boxes. They then tie another rope ($\mathbf{T_1}$) to the other side of the first box ($\mathbf{m_1}$) and begin dragging both of them across the floor at a constant speed. They call it their toy train! The mass of both boxes are equivalent as is the coefficient of kinetic friction (μ_k) between them and the floor.

   (a) Draw two Free-body Diagrams, one for each toy box. Pay careful attention to scale of each vector, making sure they are all scaled relative to each other. Use what you know about the net force to aid in the scaling of the vectors.

   (b) Compare the velocity of the two boxes. Compare the acceleration of the two boxes.

   (c) Choose a coordinate system and write out Newton's 2nd Law in both the **x** and **y** directions for box 1 ($\mathbf{m_1}$) in terms of the variables: $\mathbf{T_1}$, $\mathbf{m_1}$, $\mathbf{g}$, $\mathbf{T_2}$, $\boldsymbol{\theta}$, $\boldsymbol{\varphi}$, $\mathbf{F^N}$, and $\boldsymbol{\mu_k}$. You do not have to solve for anything.

   (d) Is the friction force from the floor acting on $\mathbf{m_1}$ greater than, less than, or equal to $\mu_k(\mathbf{m_1 g})$? Explain your reasoning in words, phrases, diagrams, etc...



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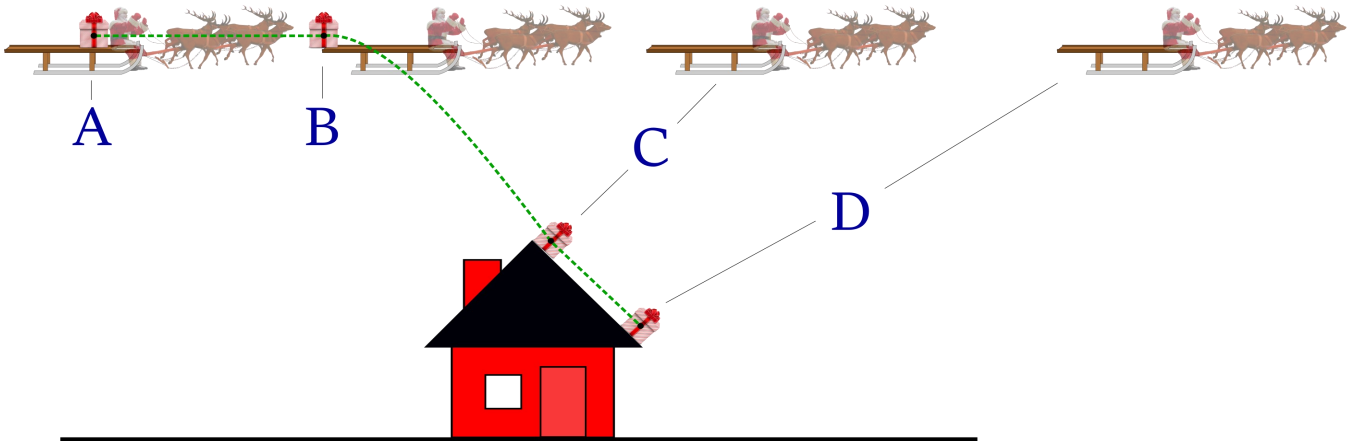
Physics 201

Final Exam | Part 3 (30 minutes) | Corvallis

12/09/2020

Collaboration is not allowed. You will have 30 minutes to download, solve, take pictures, AND upload this exam to Gradescope.

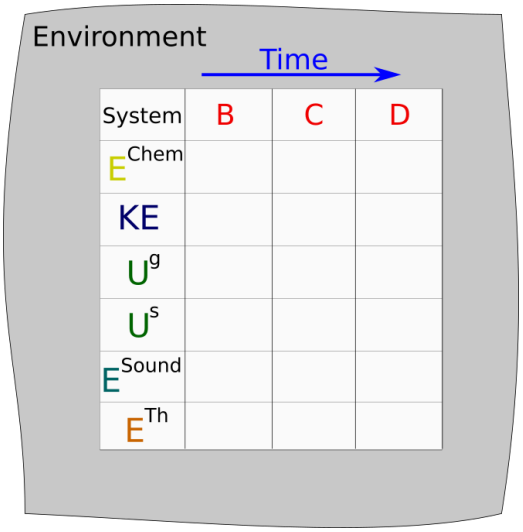
1. (6 points) Santa is using a new sled this year. Santa is flying horizontally to the right and accelerating to the right when a gift box slides off the back of the sled and then proceeds to land on a roof as seen in the image below. Snapshots in time were taken (**A** through **D**). Between snapshot **A** and **B**, the gift box slides off the horizontal sled. Between **B** and **C** the gift box is a projectile falling towards a house. Between **C** and **D**, the gift box slides down the inclined roof and comes to a rest at the bottom of the roof. The dashed green line represents the trajectory of the gift box.



(a) Draw a vector to represent the direction of the kinetic friction force on the gift box from the sled between **A** and **B**?

(b) Draw a vector to represent the direction of the kinetic friction force on the gift box from the inclined roof between **C** and **D**?

(c) Consider the motion from snapshot **B** through **D** only. Complete the Energy Flow Diagram for this scenario when the following objects are included in the system: Gift box, sled, roof, Earth.



Question 2 on next page

2. (10 points) The evil Headless Businessman is a really bad guy and has stolen Benny's spring loaded weather probe launcher. Benny recently unveiled his invention, providing a plot of the spring's force as a function of distance. While Headless threatens a crowd of people, Superman comes to the rescue. During the scuffle Headless compresses the spring all the way to its maximum value of 0.60 m and then fires a mysterious dark sphere directly horizontal towards the crowd. The dark sphere is unaffected by gravity. Assume all of the work from the spring goes into the sphere's kinetic energy. Superman, flying in mid-air, immediately applies a constant 250 N force for 3.00 seconds stopping the mysterious sphere. What is the mass of the mysterious dark sphere?