Concepts of Physics: Homework 4

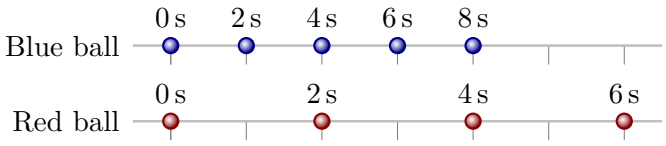
Due: 23 September 2024

1 Ball rolling in a circle

A circular groove is cut into a horizontal surface. A ball rolls along the circular groove at a constant speed. Is the net force on the ball zero or non-zero? Explain your answer.

2 Rolling balls

Two balls roll in straight lines along a surface. The locations of each ball are photographed at instants 2 s apart. Explain whether the net force on the red ball is smaller than, larger than or the same as the net force on the blue ball, during the period from 0 s to 6 s.



3 Walrus versus dog

A walrus, with mass 500 kg, and a dog, with mass 50 kg, both lie on a horizontal sheet of ice. One person pushes on the walrus, another on the dog. The walrus has acceleration 0.20 m/s^2 and the dog has acceleration 3.0 m/s^2. Is the net force on the walrus larger than, smaller than or the same as that on the dog? Explain your answer.

4 Forces and motion

Zane, with mass 70 kg, pushes on Yvonne who is on a skateboard. Yvonne and the skateboard are initially at rest and have a combined mass of 50 kg. Zane then pushes on Yvonne with a horizontal force that has size 150 N.

a) Determine the acceleration of Yvonne.

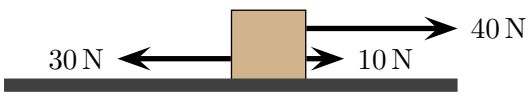
b) Determine the speed of Yvonne 1.0 s after Zane begins to push on her.

c) Determine the speed of Yvonne 3.0 s after Zane begins to push on her.

d) Suppose that Zane were able to push like this for 8.0 s. Determine Yvonne's speed. Does this seem possible? Recall that a world class sprinter runs 100 m in 10 s.

5 Multiple forces and motion

A 5.0 kg box can slide along a frictionless horizontal surface. Three people pull horizontally on the box with the indicated forces.



a) Determine the net force on the box.

b) Determine the acceleration of the box.

6 Ping-pong ball terminal velocity

Objects that fall in the presence of air resistance accelerate until they reach *terminal velocity*. This is a state where they fall with constant speed. A ping-pong ball with mass 0.0027 kg has terminal velocity of about 9.5 m/s.

a) Consider the period between the moment that the ball is released and when it reaches terminal velocity. Do you expect that, as the ball speeds up, the size of the air resistance force increases, decreases or stays constant?

b) Initially the ball falls with acceleration $9.80\,\mathrm{m/s^2}$. Determine the size of the air resistance force at this moment.

c) Determine the size of the air resistance force when the ball falls with terminal velocity.

d) Does the air resistance force increase or decrease after the ball reaches terminal velocity? Explain your answer.

7 Raising a cube of titanium

A heavy cube of titanium lies on an open hand that is held horizontal.

a) The hand holds the cube at rest. Is the net force on the cube zero or not? Explain if the force exerted by the hand is larger than, smaller than or the same as the gravitational force exerted by Earth.

b) The hand raises the cube and it moves upward at a constant rate. Is the net force on the cube zero or not? Explain if the force exerted by the hand is larger than, smaller than or the same as the gravitational force exerted by Earth.

8 Pushing sleds

Two people, Angela and Bryce, push heavily laden sleds across frozen ponds. The sleds are identical and have identical masses. There is no friction between the ice and the sleds. Air resistance can be ignored. During a particular period lasting for 30 s, Angela pushes her sled from rest to a speed of 5 m/s while Bryce pushes his sled at a constant speed of 10 m/s. How does the force which Angela exerts on her sled compare to that which Bryce exerts on his sled (same, larger, smaller)? Explain your answer.

9 Forces in one dimension activity

Go to the moving man animation at:

https://phet.colorado.edu/en/simulations/forces-1d

Run the moving man animation (this will require you to select the Run Cheerpj Browser-Compatible option).

Select the file cabinet; this has mass 200 kg. Turn the friction off (button on the right side).

a) Do you think that you will be able to move the cabinet with a force less than 200 N if there is **no friction**? Explain your answer.

b) Do you think that you will be able to move the cabinet with a force as low as 1 N if there is **no friction**? Explain your answer.

c) Enter 1 in the Applied Force box (left side below the image). The **friction must be turned off.** Does the cabinet eventually move (you may have to wait a while to see)? Does this require you to change your earlier answer?

d) If there is no friction does it seem that there is a minimum force needed to move the cabinet if it is initially at rest? Explain your answer.

e) Now suppose that the net force on the cabinet is 50 N. If the cabinet is initially at rest, *predict* its speed after 10s. Show your calculation.

f) Enter 50 in the Applied Force box, select the velocity graph, hit Go, pause it after about 15 s and use the velocity graph to check your prediction. The Playback option produces a slider that can check the velocity. Did you predict correctly?

g) Reset the animation and turn the friction on. Use the animation to find the minimum applied force that will start to move the cabinet. If there is friction present, explain why there is a minimum force needed to move the object if it initially at rest.

10 Freely falling objects

A light ball has has mass 0.10 kg and a large jug of water has mass 4.0 kg. Assume that the only force on each is Earth's gravitational force (this is free-fall).

a) Determine the gravitational force exerted by Earth on the ball.

b) Determine the gravitational force exerted by Earth on the jug of water.

c) Determine the acceleration of the ball.

d) Determine the acceleration of the jug of water. Is it the same (within rounding) as the acceleration of the feather?

11 Physics videos

Find a physics video from one of the following YouTube channels:

MinutePhysics

Physics Girl

Steve Mould

MinutePhysics

You can choose any video provided that it: a) is about physics or related to physics, b) you find it interesting and c) you have **not used this video in previous Phys 100 assignments.**

a) Provide the video location and title.

b) Briefly describe as best as you can what physics the video tried to describe and what it said about this. *Note that some of these videos can go into some depth. You don't need to understand or describe anything that the video covered. Just provide a rough idea of the video content and why you found it interesting.*

c) Go to D2L. In the Physics Videos discussion forum, find the Physics Videos: Homework 4 topic. Provide a link to your video there and a one sentence description of the video content (everyone in the class will eventually see this).