Name:_____ Class:_____ Date:_____

Sample Problem Set I Solutions

Forces and the Laws of Motion

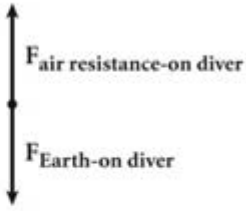
ADDITIONAL PRACTICE A

Givens *Solutions*

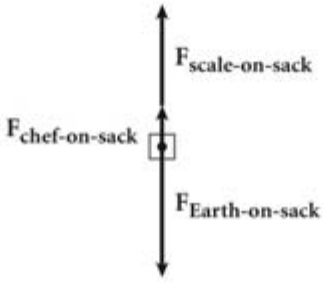
1.

a.

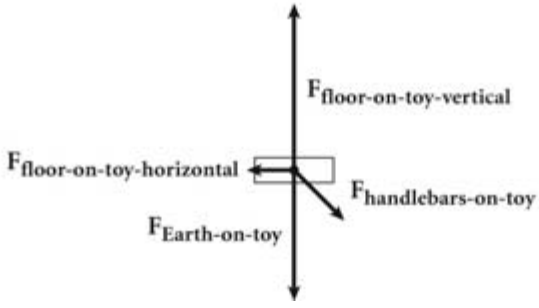
b.



2.



3.



Name:_____ Class:_____ Date:_____

Forces and the Laws of Motion

Problem A

DRAWING FREE-BODY DIAGRAMS

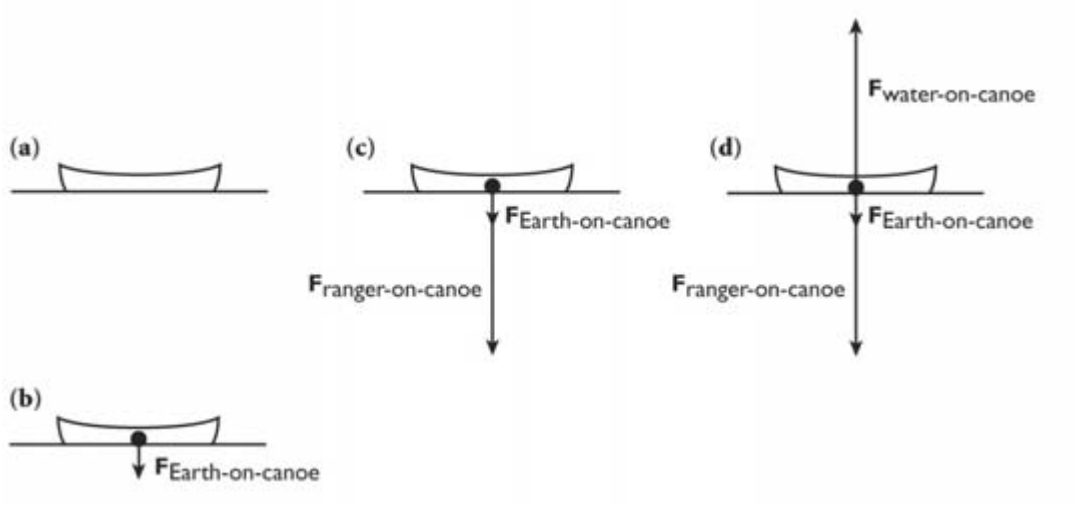
PROBLEM

In the early morning, a park ranger in a canoe is observing wildlife on the nearby shore. The Earth's gravitational force on the ranger is 760 N downward and its gravitational force on the boat is 190 N downward. The water keeps the canoe afloat by exerting a 950 N force upward on it. Draw a free-body diagram of the canoe.

SOLUTION

1. **Identify the forces acting on the object and the directions of the forces.**
   - The Earth exerts a force of 190 N downward on the canoe.
   - The park ranger exerts a force of 760 N downward on the canoe.
   - The water exerts an upward force of 950 N on the canoe.
2. **Draw a diagram to represent the isolated object.**
   The canoe can be represented by a simple outline, as shown in **(a)**.
3. **Draw and label vector arrows for all external forces acting on the object.**
   A free-body diagram of the canoe will show all the forces acting on the canoe as if the forces are acting on the center of the canoe. First, draw and label the gravitational force acting on the canoe, which is directed toward the center of Earth, as shown in (**b**). Be sure that the length of the arrow approximately represents the magnitude of the force.

   Next, draw and label the downward force that is exerted on the boat by the Earth's gravitational attraction on the ranger, as shown in **(c)**. Finally, draw and label the upward force exerted by the water on the canoe as shown in **(d)**. Diagram **(d)** is the completed free-body diagram of the floating canoe.



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ADDITIONAL PRACTICE

1. After a skydiver jumps from a plane, the only force initially acting on the diver is Earth's gravitational attraction. After about ten seconds of falling, air resistance on the diver will have increased so that its magnitude on the diver is now equal in magnitude to Earth's gravitational force on the diver. At this time, a diver in a belly-down position will be falling at a constant speed of about 190 km/h.
   a. Draw a free-body diagram of the skydiver when the diver initially leaves the plane.
   b. Draw a free-body diagram of the skydiver at the tenth second of the falling.
2. A chef places an open sack of flour on a kitchen scale. The scale reading of 40 N indicates that the scale is exerting an upward force of 40 N on the sack. The magnitude of this force equals the magnitude of the force of Earth's gravitational attraction on the sack. The chef then exerts an upward force of 10 N on the bag and the scale reading falls to 30 N. Draw a free-body diagram of the latter situation.
3. A music box within the toy shown below plays tunes when the toy is pushed along the floor. As a child pushes along the handlebars with a force of 5 N, the floor exerts a force of 13 N directly upward on the toy. The Earth's gravitational force on the toy is 10 N downward while interactions between the wheels and the floor produce a backward force of 2 N on the toy as it moves. Draw a free-body diagram of the toy as it is being pushed.