

EQUILIBRIUM

Objects that are either at rest or moving with constant velocity are said to be in **equilibrium**. Newton's first law describes objects in equilibrium, whether they are at rest or moving with a constant velocity. Newton's first law states one condition that must be true for equilibrium: the net force acting on a body in equilibrium must be equal to zero.

The net force on the fishing bob in **Figure 6(a)** is equal to zero because the bob is at rest. Imagine that a fish bites the bait, as shown in **Figure 6(b)**. Because a net force is acting on the line, the bob accelerates toward the hooked fish.

Now, consider a different scenario. Suppose that at the instant the fish begins pulling on the line, the person reacts by applying a force to the bob that is equal and opposite to the force exerted by the fish. In this case, the net force on the bob remains zero, as shown in **Figure 6(c)**, and the bob remains at rest. In this example, the bob is at rest while in equilibrium, but an object can also be in equilibrium while moving at a constant velocity.

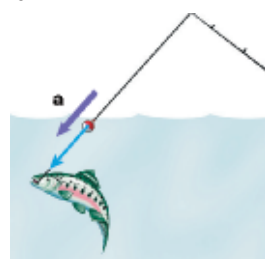
An object is in equilibrium when the vector sum of the forces acting on the object is equal to zero. To determine whether a body is in equilibrium, find the net force, as shown in Sample Problem B. If the net force is zero, the body is in equilibrium. If there is a net force, a second force equal and opposite to this net force will put the body in equilibrium.

equilibrium

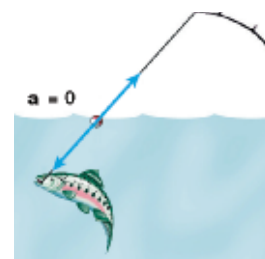
the state in which the net force on an object is zero



(a)



(b)



(c)

Figure 6

(a) The bob on this fishing line is at rest. (b) When the bob is acted on by a net force, it accelerates. (c) If an equal and opposite force is applied, the net force remains zero.

SECTION REVIEW

1. If a car is traveling westward with a constant velocity of 20 m/s, what is the net force acting on the car?
2. If a car is accelerating downhill under a net force of 3674 N, what additional force would cause the car to have a constant velocity?
3. The sensor in the torso of a crash-test dummy records the magnitude and direction of the net force acting on the dummy. If the dummy is thrown forward with a force of 130.0 N while simultaneously being hit from the side with a force of 4500.0 N, what force will the sensor report?
4. What force will the seat belt have to exert on the dummy in item 3 to hold the dummy in the seat?
5. **Critical Thinking** Can an object be in equilibrium if only one force acts on the object?