

Answer to Essential Question 3.9: By Newton's second law, the net force acting on each box is equal to $m\vec{a}$ for each box. This gives 8.0 N to the right for the red box; 12 N to the right for the green box and 10 N to the right for the blue box. As they should, these net forces add together to 30 N to the right, matching the net force on the system (the 30 N force you apply, directed right).

Chapter Summary

Essential Idea: Forces and Newton's Laws

In this chapter, we covered one of the main methods of analyzing a physical situation, which is to think about all the forces being exerted on an object by external influences, and then apply Newton's second law to determine the acceleration.

Forces and Newton's Three Laws of Motion

A force, which is a push or a pull, acts on an object when there is an interaction between that object and another object. Newton's laws give us some guidelines to use when applying forces to solve problems. They are:

Newton's First Law: if no net force acts on an object, the object's velocity is unchanged: the object either remains at rest or it keeps moving with constant velocity. If there is a non-zero net force acting, then the object's velocity changes.

Newton's Second Law tells us that the connection between an object's net force and its acceleration is given by:

$$\vec{a} = \frac{\sum \vec{F}}{m}, \text{ which we can re-write as } \sum \vec{F} = m\vec{a}. \quad (\text{Equation 3.1})$$

Newton's Third Law: Whenever one object exerts a force on a second object, the second object exerts a force equal in magnitude, and opposite in direction, on the first object.

A General Method for Solving Problems Involving Newton's Laws, in One Dimension

The most important lesson to take away from this chapter is that most one-dimensional problems involving forces can be solved by applying the following method:

1. Draw a diagram of the situation.
2. Draw one or more free-body diagrams, with each free-body diagram showing all the forces acting on an object.
3. For each free-body diagram, choose an appropriate coordinate system. The coordinate systems for the different free-body diagrams should be consistent with one another. A good rule of thumb is to align each coordinate system with the direction of the acceleration.
4. Apply Newton's second law to each free-body diagram.
5. Put the resulting force equations together, and solve.