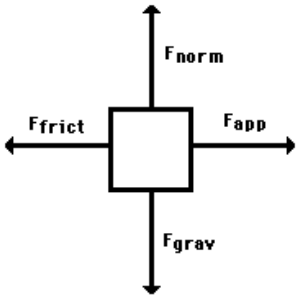
Force and Its Representation

Free-body diagrams are diagrams used to show the relative magnitude and direction of all forces acting upon an object in a given situation.

- The size of the arrow in a free-body diagram reflects the magnitude of the force.
- The direction of the arrow shows the direction that the force is acting.

Each force arrow in the diagram is labeled to indicate the exact type of force. It is generally customary in a free-body diagram to represent the object by a box and to draw the force arrow from the center of the box outward in the direction that the force is acting. An example of a free-body diagram is shown at the right.



The free-body diagram above depicts four forces acting upon the object. Objects do not necessarily always have four forces acting upon them. There will be cases in which the number of forces depicted by a free-body diagram will be one, two, or three. There is no hard and fast rule about the number of forces that must be drawn in a free-body diagram. The only *rule* for drawing free-body diagrams is to depict all the forces that exist for that object in the given situation.

If given a description of a physical situation, begin by using your understanding of the force types to identify which forces are present. Then determine the direction in which each force is acting. Finally, draw a box and add arrows for each existing force in the appropriate direction; label each force arrow according to its type.

Practice

Construct free-body diagrams for the various situations described below.

1. A book is at rest on a tabletop. Diagram the forces acting on the book.
2. A girl is suspended motionless from the ceiling by two ropes. Diagram the forces acting on the combination of girl and bar.
3. An egg is free-falling from a nest in a tree. Neglect air resistance. Diagram the forces acting on the egg as it is falling.
4. A rightward force is applied to a book in order to move it across a desk with a rightward acceleration. Consider frictional forces. Neglect air resistance. Diagram the forces acting on the book.
5. A rightward force is applied to a book in order to move it across a desk at constant velocity. Consider frictional forces. Neglect air resistance. Diagram the forces acting on the book.
6. A college student rests a backpack upon his shoulder. The pack is suspended motionless by one strap from one shoulder. Diagram the vertical forces acting on the backpack.
7. A skydiver is descending with a constant velocity. Consider air resistance. Diagram the forces acting upon the skydiver.
8. A force is applied to the right to drag a sled across loosely packed snow with a rightward acceleration. Diagram the forces acting upon the sled.
9. A football is moving upwards towards its peak after having been *booted* by the punter. Diagram the forces acting upon the football as it rises upward towards its peak.
10. A car is coasting to the right and slowing down. Diagram the forces acting upon the car.

Adapted from physicsclassroom.com