



Chapter Five: Force

- **5.1 Forces**
- **5.2 Friction**
- **5.3 Forces and Equilibrium**



Chapter 5.3 Learning Goals

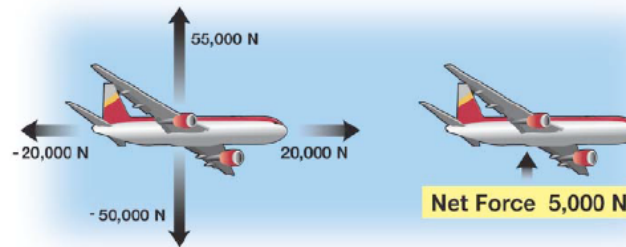
- Determine the net force acting on an object.
- Define equilibrium.
- Draw free-body diagrams to represent all forces acting on a body.



5.3 Forces and Equilibrium

- The sum of all the forces on an object is called the **net force**.
- The word **net** means total but also means the direction of the forces has been taken into account.

In what direction will this plane go?



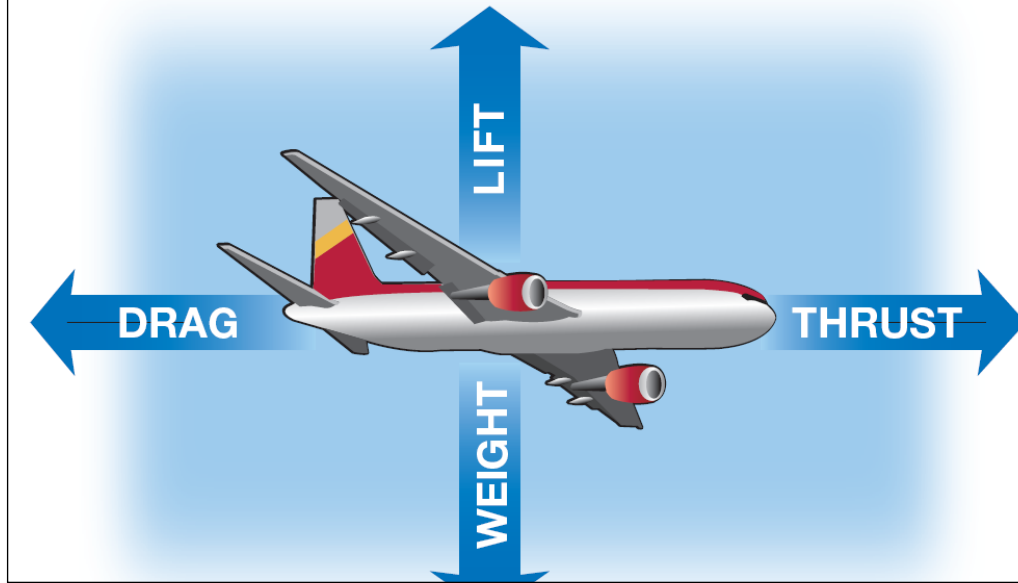


5.3 Adding forces

- To figure out if or how an object will move, we look at ALL of the forces acting on it.

- Four forces act on a plane:
 1. weight
 2. drag (air friction)
 3. the thrust of the engines, and
 4. the lift force caused by the flow of air over the wings.

Airplane Forces



Adding Forces

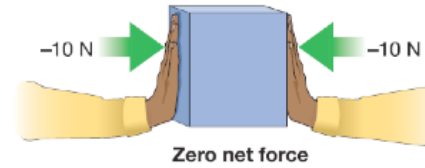




5.3 Equilibrium

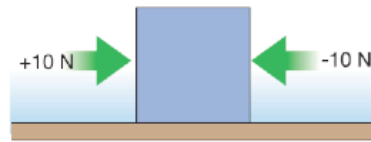
When several forces act on the same object:

1. The net force is zero, or
2. The net force is NOT zero.



Equilibrium

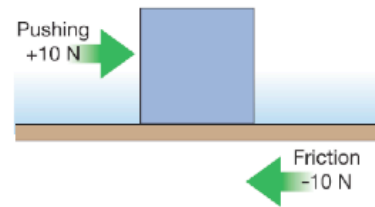
When the net force is zero . . .



An object at rest will stay at rest.



Zero net force



An object in motion will stay in motion.

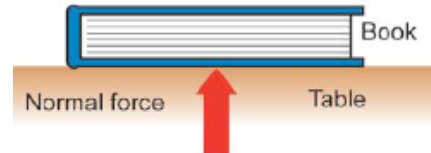


Non-zero net force



5.3 Normal forces

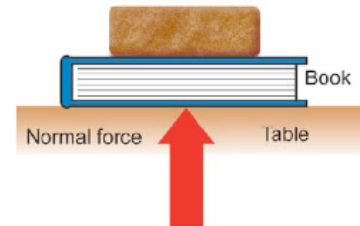
- When the forces are **balanced**, the net force is zero.
- When the net force on an object is zero, we say the object is in **equilibrium**.





5.3 Equilibrium and normal forces

- A normal force is created whenever an object is in contact with a surface.
- The normal force has equal strength to the force pressing the object into the surface, which is often the object's weight.

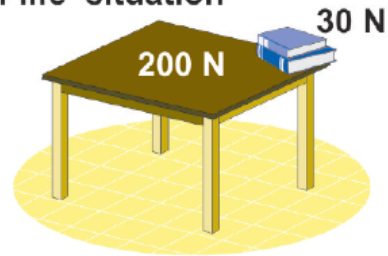


The normal force is sometimes called the *support force*.



5.3 The free body diagram

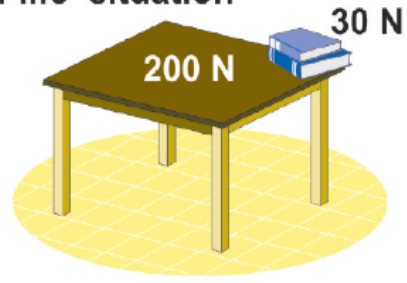
Real-life situation



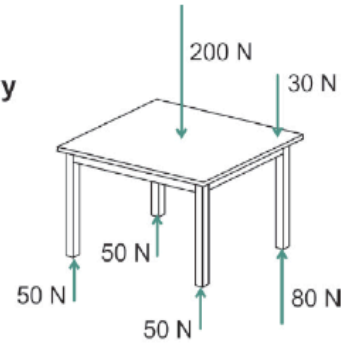
- How do you keep track of many forces with different directions?
- Draw a free-body diagram that contains the objects, like a book on a table.

Free-body diagram

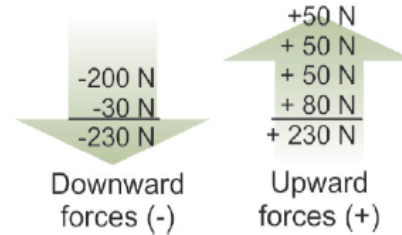
Real-life situation



Free-body diagram



Equilibrium (net force = 0)

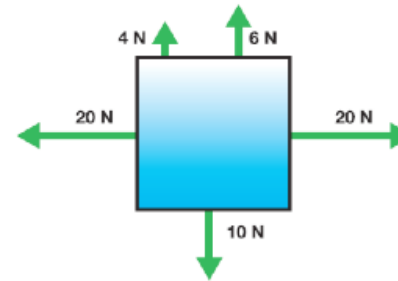




5.3 Solving equilibrium problems

- For an object to be in equilibrium, all the forces acting on the object must add up to zero.

Is this object in equilibrium?





Parabolic Flights

- **NASA has been conducting parabolic flights since the 1950s to train astronauts. Scientists and college students have also gone on parabolic flights to perform a wide variety of chemistry, biology, and physics experiments.**

