

Part A: Inertia, Systems, and Laws

Answer each question in one to three complete sentences.

1. A 0.060 kg tennis ball rolls across the gym at 5.0 m/s. A 4.0 kg medicine ball sits still on the floor. Which one has more inertia? Explain how you know.

The medicine ball has more inertia. Inertia depends only on mass, and 4.0 kg is much more than 0.060 kg (about 67 times more). The tennis ball's speed does not matter.

2. Tasha is standing in the aisle of a city bus. Use inertia to explain what happens to her in each case.
- The bus suddenly speeds up from a stop.
 - The bus makes a sharp turn to the left.

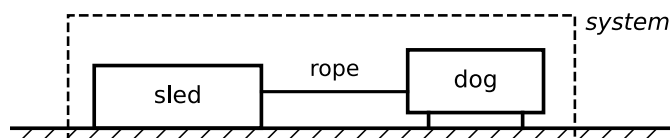
a. Tasha's body was at rest and tends to stay at rest. The bus floor moves forward under her, so she **lurches backward** (toward the back of the bus) until a force, like her grip on a pole, speeds her up.

b. Her body tends to keep moving in a straight line while the bus turns left, so she **slides toward the right side** of the bus (the outside of the turn).

3. Devin says, "Newton's first law is just a theory that has been tested so many times it became a law." Explain what is wrong with Devin's statement.

A theory never turns into a law. A **law describes what happens** (Newton's first law describes how objects move when forces are balanced), while a **theory explains why** it happens. Both are supported by lots of evidence. They are different kinds of ideas, not different levels of proof.

4. A dog pulls a sled across the snow with a rope. Marco chooses the dog and the sled together as his system, shown by the dashed box. For each force, say whether it is an inside or an outside force, and whether it can change the motion of the whole system.



- The rope pulling forward on the sled.
- The ground pushing forward on the dog's paws.
- Friction from the snow pushing backward on the sled.

a. Inside force. The rope connects two parts of the system, so it cannot change the motion of the whole system.

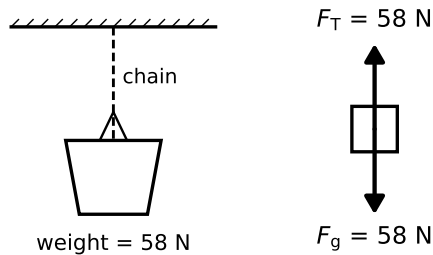
b. Outside force. The ground is not part of the system, so this force can change the system's motion (it is what moves the dog and sled forward).

c. Outside force. The snow is not part of the system, so this force can change the system's motion (it slows the system down).

Part B: Balanced Forces and Equilibrium

Show your work. Give each force a size and a direction.

5. A potted plant hangs at rest from a single chain, as shown. What force does the chain exert on the pot?



Knowns: $F_g = 58 \text{ N}$ down. The pot is at rest.

Equilibrium: at rest means the forces are balanced, so up equals down.

Equation: $F_T = F_g$

Answer: $F_T = 58 \text{ N}$ up

6. Priya pulls her rolling suitcase east through the airport with a steady horizontal pull of 42 N. The suitcase moves at a constant velocity. The suitcase weighs 180 N. Find the friction force and the normal force on the suitcase.

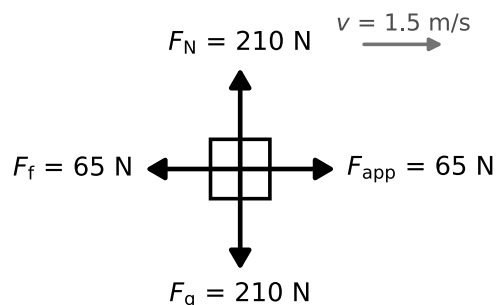
Knowns: $F_{\text{app}} = 42 \text{ N}$ east, $F_g = 180 \text{ N}$ down, constant velocity.

Equilibrium: constant velocity means the forces are balanced in both directions.

Equations: $F_f = F_{\text{app}}$ (opposite direction) and $F_N = F_g$ (opposite direction)

Answer: $F_f = 42 \text{ N}$ west and $F_N = 180 \text{ N}$ up

7. The diagram shows all of the forces on a crate that is sliding to the right across a floor at 1.5 m/s.



- Are the forces on the crate balanced? Is the crate in equilibrium?
- Describe the crate's motion 5 seconds later if the forces stay the same.
- Jaylen says the crate must be slowing down because the push is not bigger than friction. Explain why Jaylen is wrong.

a. Yes and yes. 65 N right balances 65 N left, and 210 N up balances 210 N down, so the crate is in equilibrium.

b. Balanced forces cannot change velocity, so the crate is **still moving 1.5 m/s to the right**.

c. An object does not need a force to keep moving, only to change how it moves. Equal forces mean no change, so the crate keeps a constant velocity. A push bigger than friction would make it speed up.