

Part A: What Is a Force?

Answer each question. Use the force names and symbols from the lesson.

- 1.** Force is a vector. What two things do you need to describe a force completely? What unit is force measured in?

You need a **size (magnitude)** and a **direction**. Force is measured in **newtons (N)**.

- 2.** Sort each force below into **contact** or **long-range**. Write the letter of each one under the correct heading in the space below.

- a. the pull of Earth on a falling apple
- b. a rope pulling a bucket up a well
- c. a magnet pulling a paperclip across a gap
- d. a table holding up a laptop
- e. air pushing back on a cyclist
- f. static electricity making your hair rise toward a balloon

Contact: b (tension), d (normal force), e (air resistance)

Long-range: a (gravity), c (magnetic force), f (electric force)

Long-range forces act across a gap without touching.

- 3.** Name the main force described in each case. Give its symbol if it has one.

- a. A leash keeps a dog from running into the street.
- b. A helium balloon rises when you let it go.
- c. A soccer player's foot kicks the ball.
- d. A car's tires skid on the road while it stops.
- e. A trampoline pushes up on a gymnast standing on it.

a. Tension, F_T

b. Buoyant force, F_B (the air pushes up on the balloon)

c. Applied force, F_{app}

d. Friction, F_f

e. Normal force, F_N

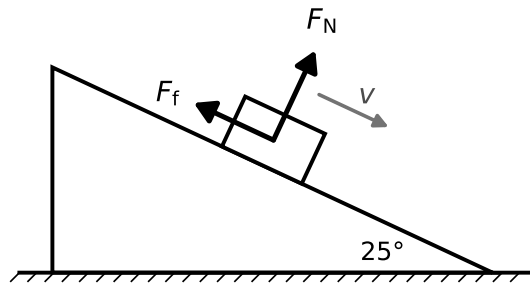
- 4.** Kai says, "A rope can push a box as well as pull it, so tension can point in any direction." Is Kai right? Explain.

No. Tension always **pulls** along the rope, away from the object. A rope goes slack if you try to push with it, so it can never push.

Part B: Directions of Forces

Draw arrows starting at the center of the object. Label each arrow with its symbol.

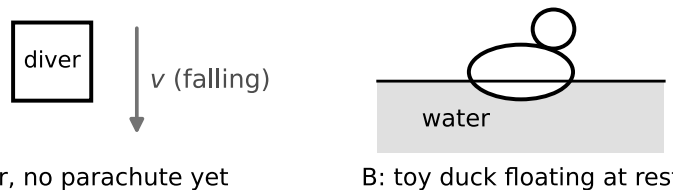
5. A block slides **down** a ramp, as shown. Draw and label an arrow for the **normal force** and an arrow for the **friction force** on the block. Then explain how you chose each direction.



Normal force: perpendicular to the ramp's surface, pointing out of the ramp (up and to the right). "Normal" means perpendicular, so it is **not** straight up.

Friction: parallel to the ramp, pointing **up the slope**, opposite the sliding.

6. Look at the two situations below.



A: skydiver, no parachute yet

B: toy duck floating at rest

- a. A skydiver falls before opening her parachute. Name each force on her, what exerts it, and its direction.
- b. A toy duck floats at rest in a bathtub. Name each force on the duck, what exerts it, and its direction.
- a. Gravity** (F_g), exerted by Earth, pointing **down**. **Air resistance** (F_{air}), exerted by the air, pointing **up** (opposite her motion).
- b. Gravity** (F_g), exerted by Earth, pointing **down**. **Buoyant force** (F_B), exerted by the water, pointing **up**.
7. Rosa pulls her little brother across a flat, snowy yard on a sled using a horizontal rope. The sled slides east.
- a. List all four forces on the sled. For each one, name what exerts it and give its direction.
- b. Which of the four forces are contact forces? Which are long-range?
- a. Gravity** (F_g): Earth, down. **Normal force** (F_N): the snow, up. **Tension** (F_T): the rope, east (toward Rosa). **Friction** (F_f): the snow, west (opposite the sliding).
- b. Contact:** normal force, tension, and friction. **Long-range:** gravity only.