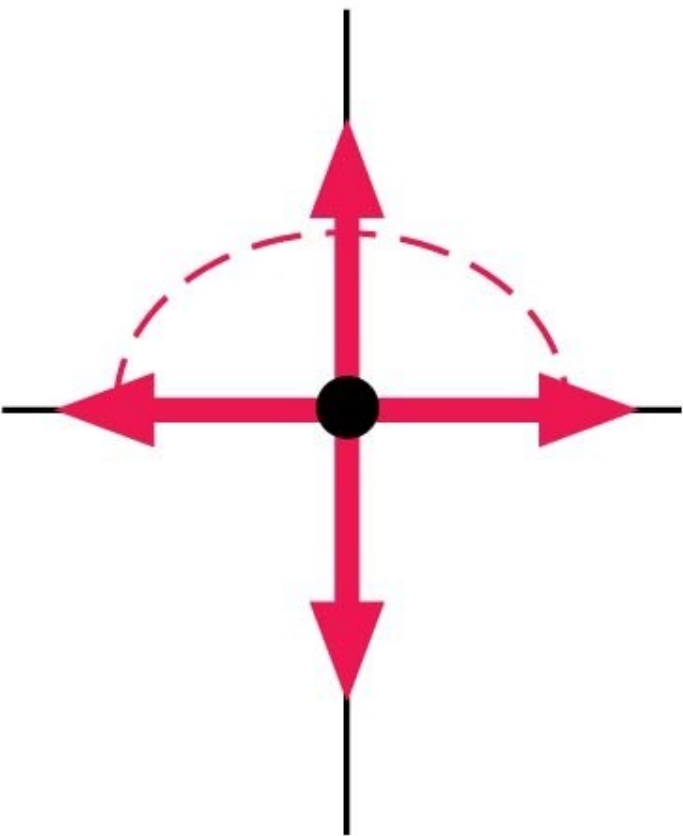
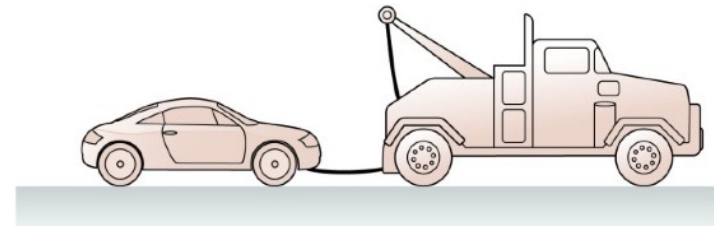
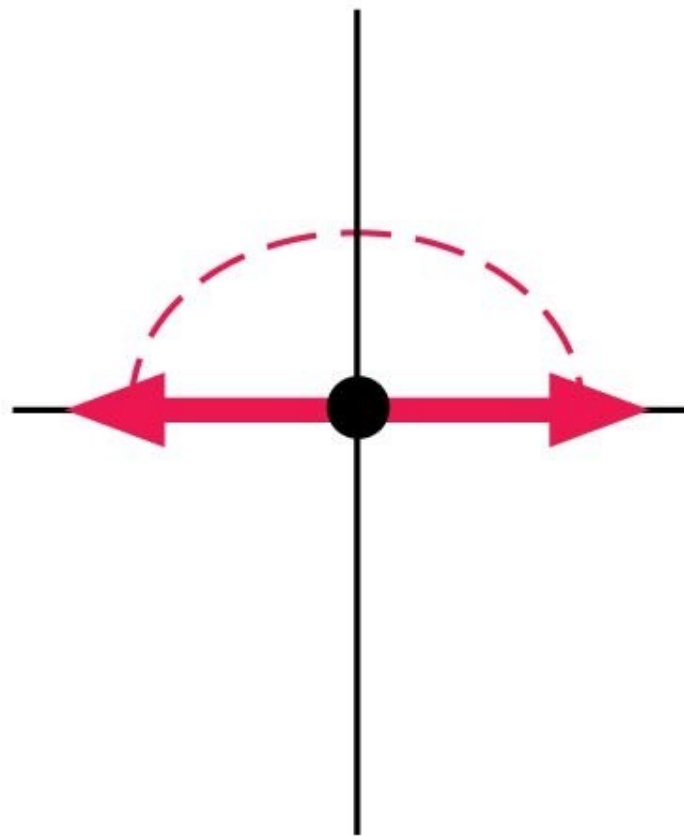


Question #17

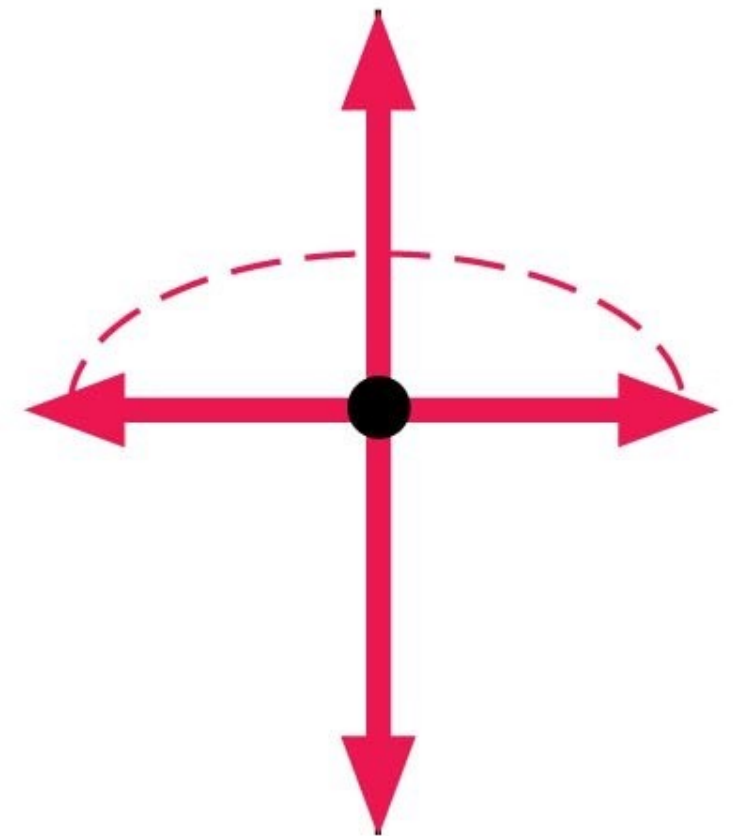
What, if anything, is wrong with these free-body diagrams for a truck towing a car at steady speed? The truck is heavier than the car and the rope is massless.



Car



Rope



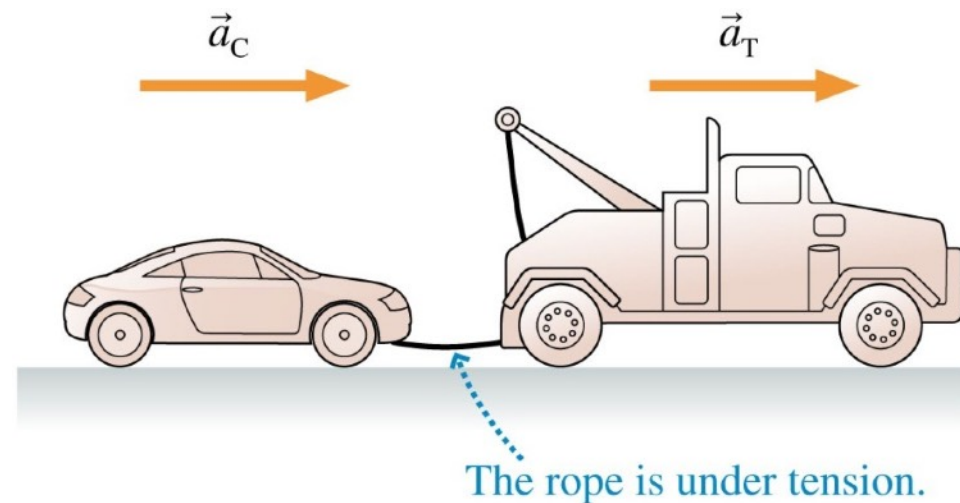
Truck

- a. Nothing is wrong.
- b. Both D and E.
- c. One of more forces have the wrong direction.
- d. One or more action/reaction pairs are wrong.
- e. One or more forces have the wrong length.

Acceleration constraints

If two objects move together, their accelerations are constrained to be equal

$$\vec{a}_{cX} = \vec{a}_{tX} = \vec{a}_X$$

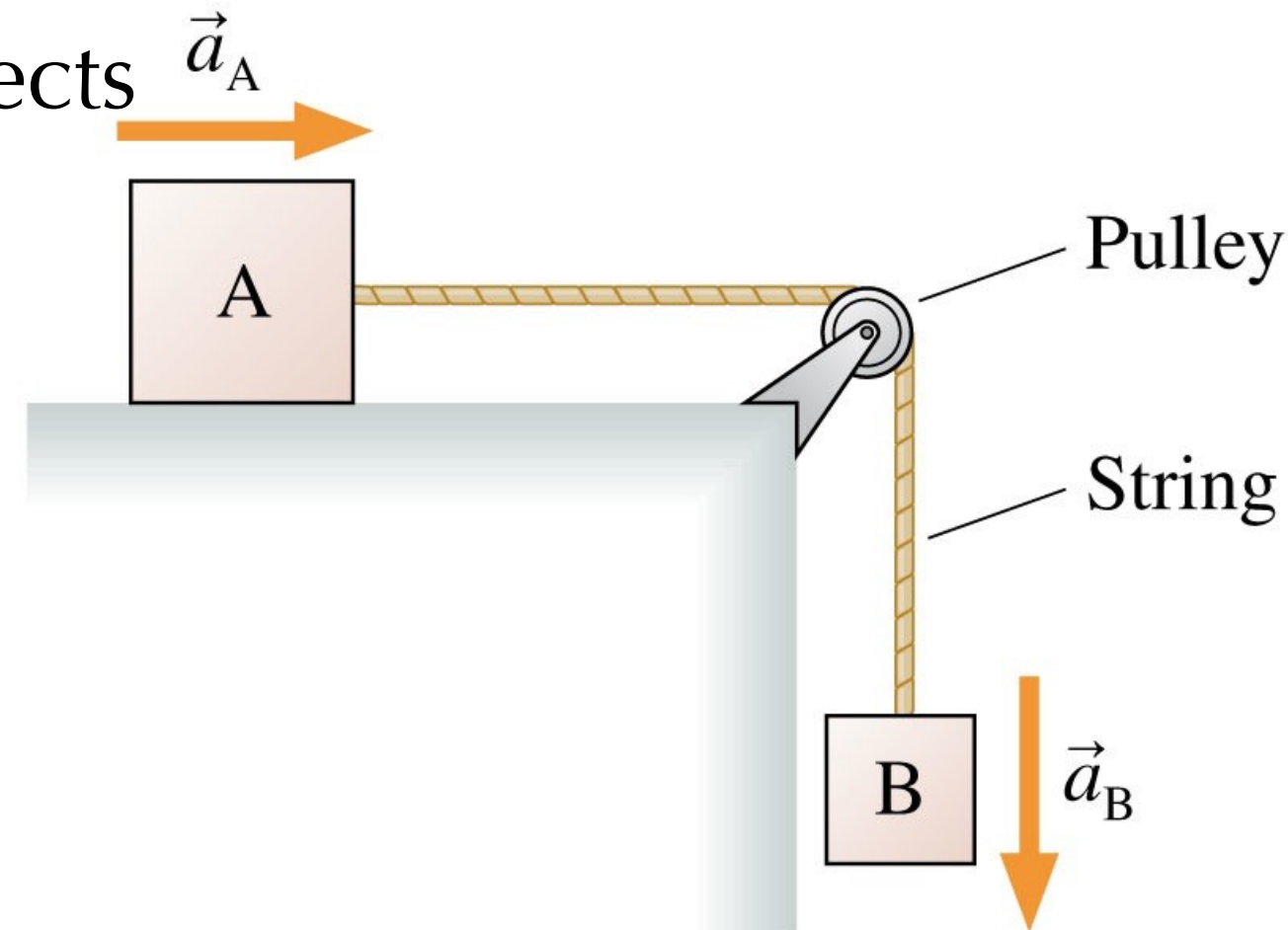


Acceleration constraints

Sometimes the accelerations of two objects may have different signs and they may travel in different directions

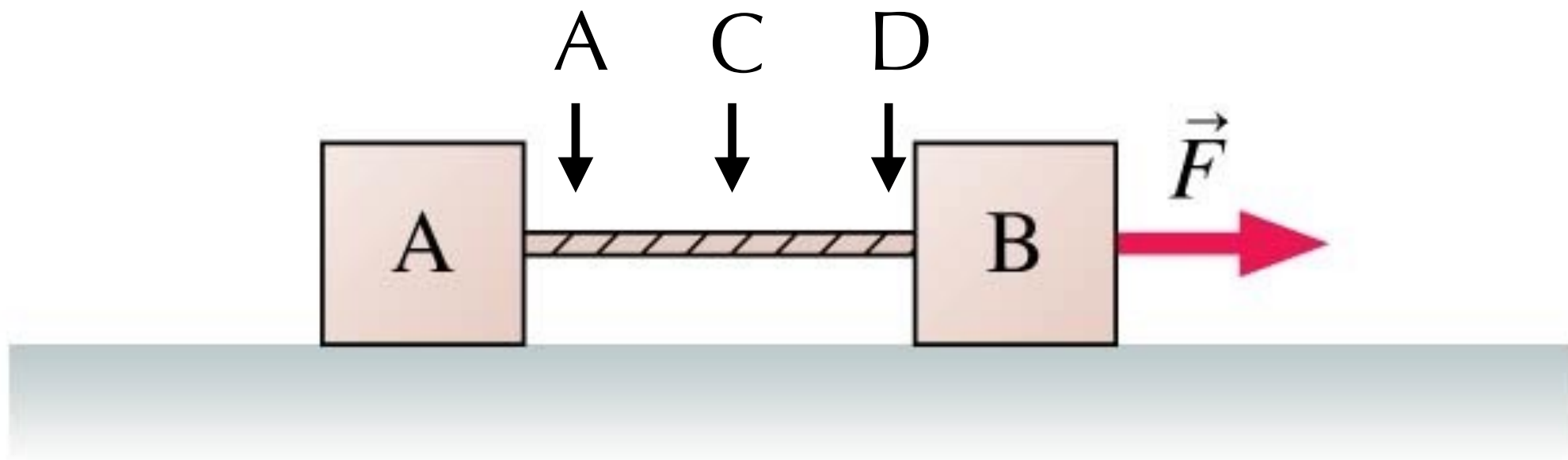
The string constrains the objects to accelerate together

$$\vec{a}_{Ax} = -\vec{a}_{By}$$



The massless string approximation

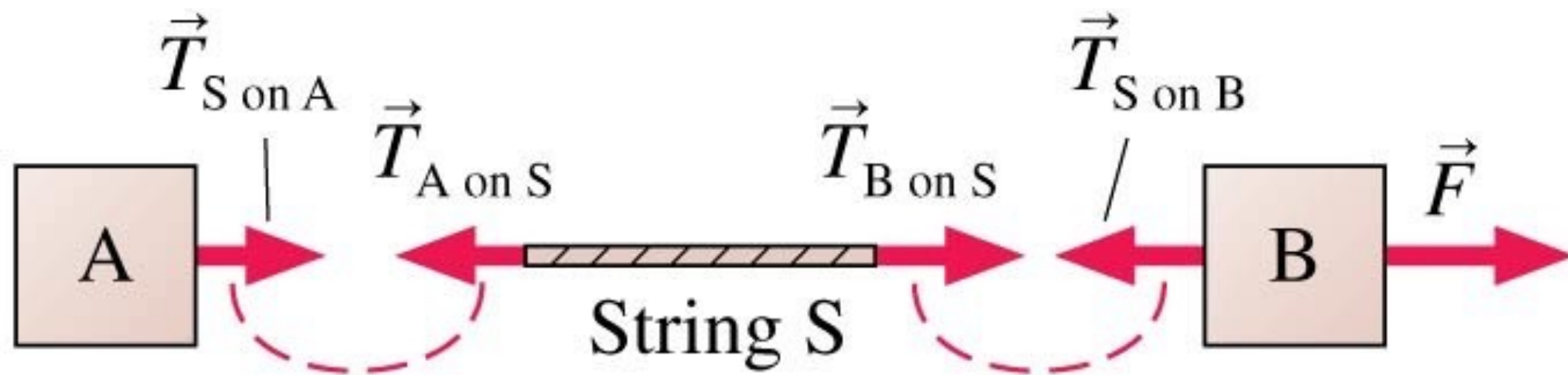
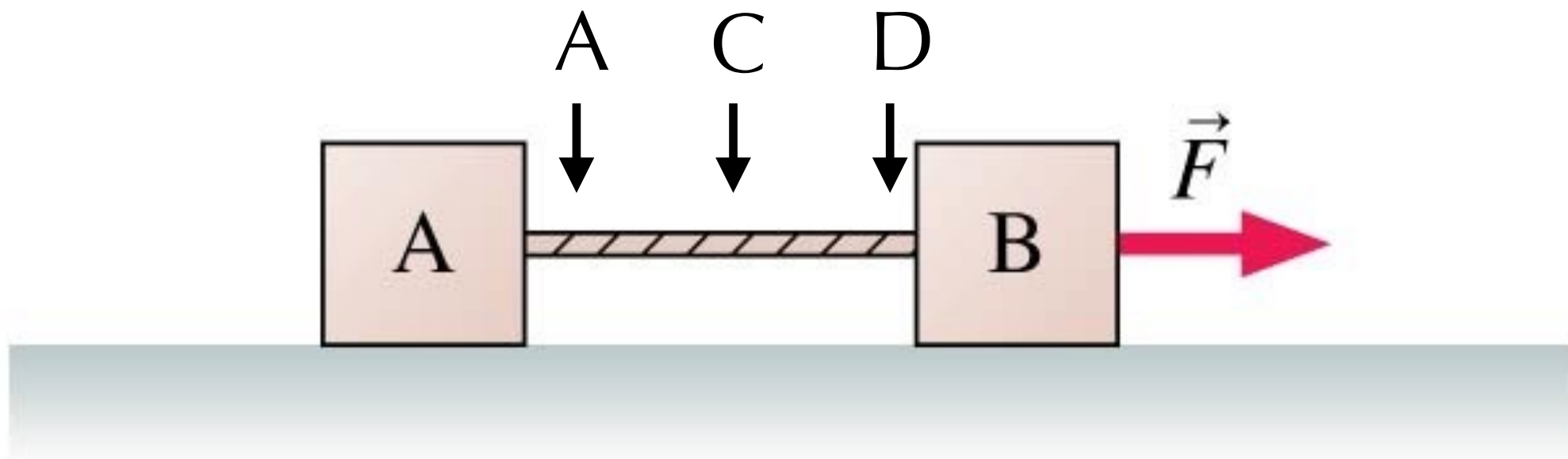
Question #18



Where is the tension in the rope the greatest?

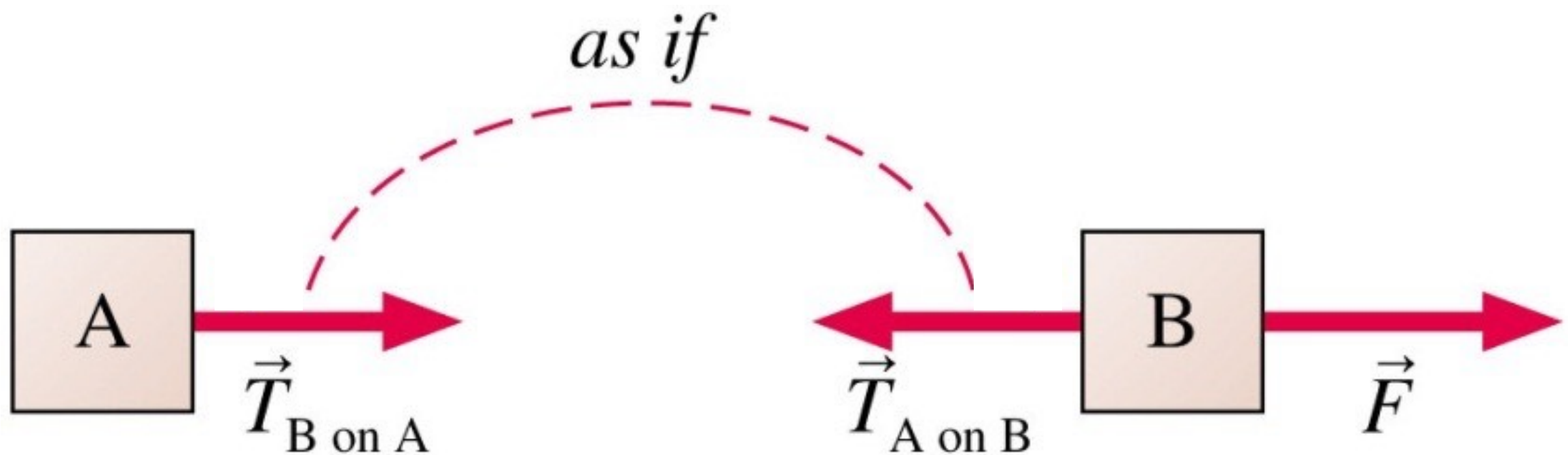
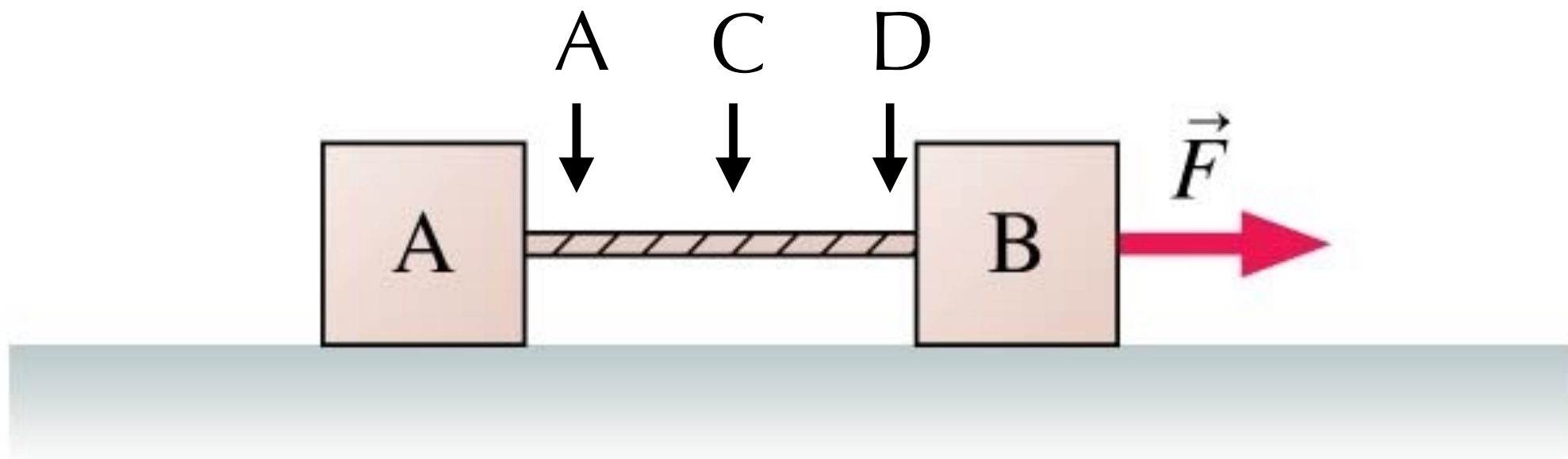
The massless string approximation

Question #18



The massless string approximation

Question #18

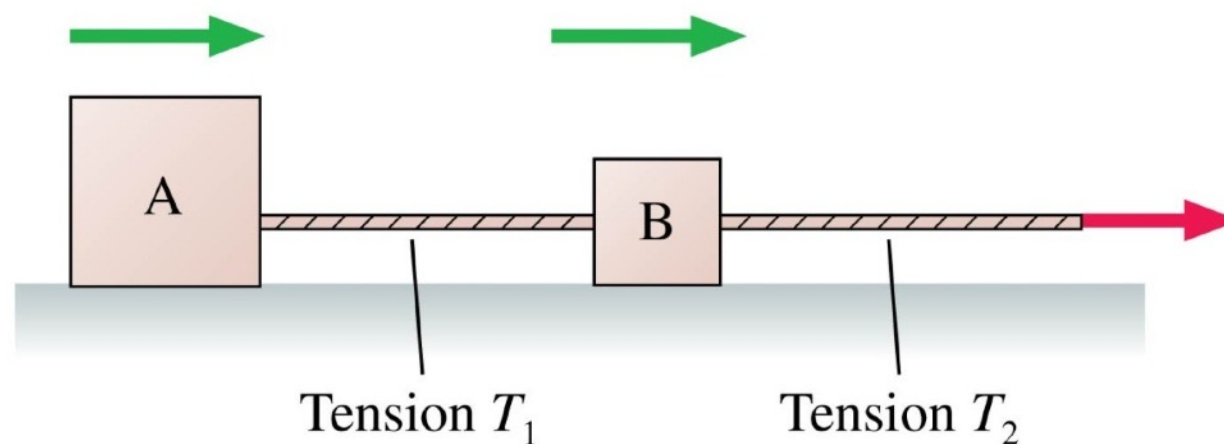


Question #19

Boxes A and B are being pulled to the right on a frictionless surface. Box A has a larger mass than B.

How do the two tension forces compare?

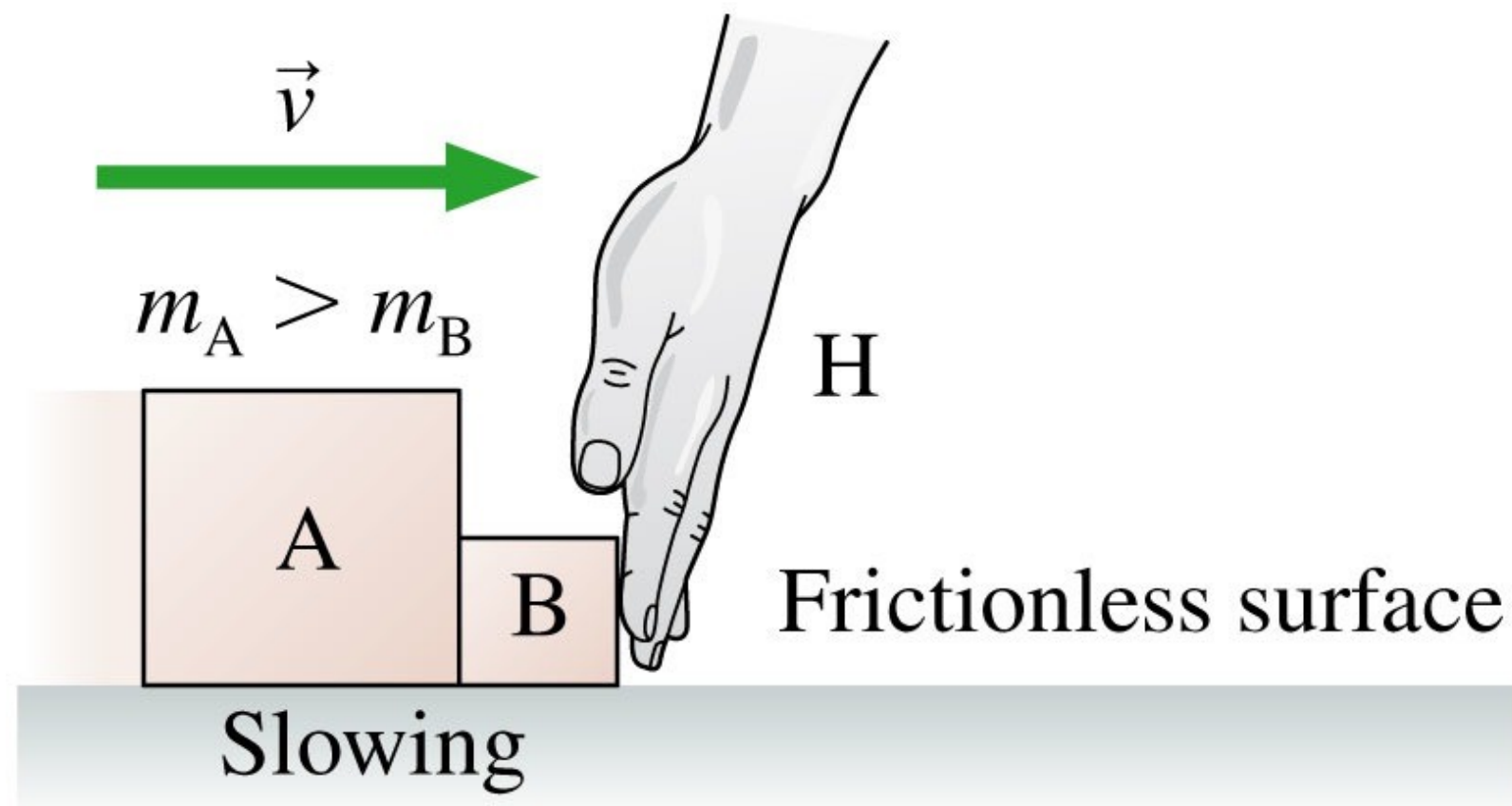
- a. $T_1 > T_2$
- b. $T_1 = T_2$
- c. .
- d. Not enough information to tell.
- e. $T_1 < T_2$



Question #20

Boxes A and B are sliding to the right on a frictionless surface. Hand H is slowing them. Box A has a larger mass than B. Considering only the *horizontal* forces:

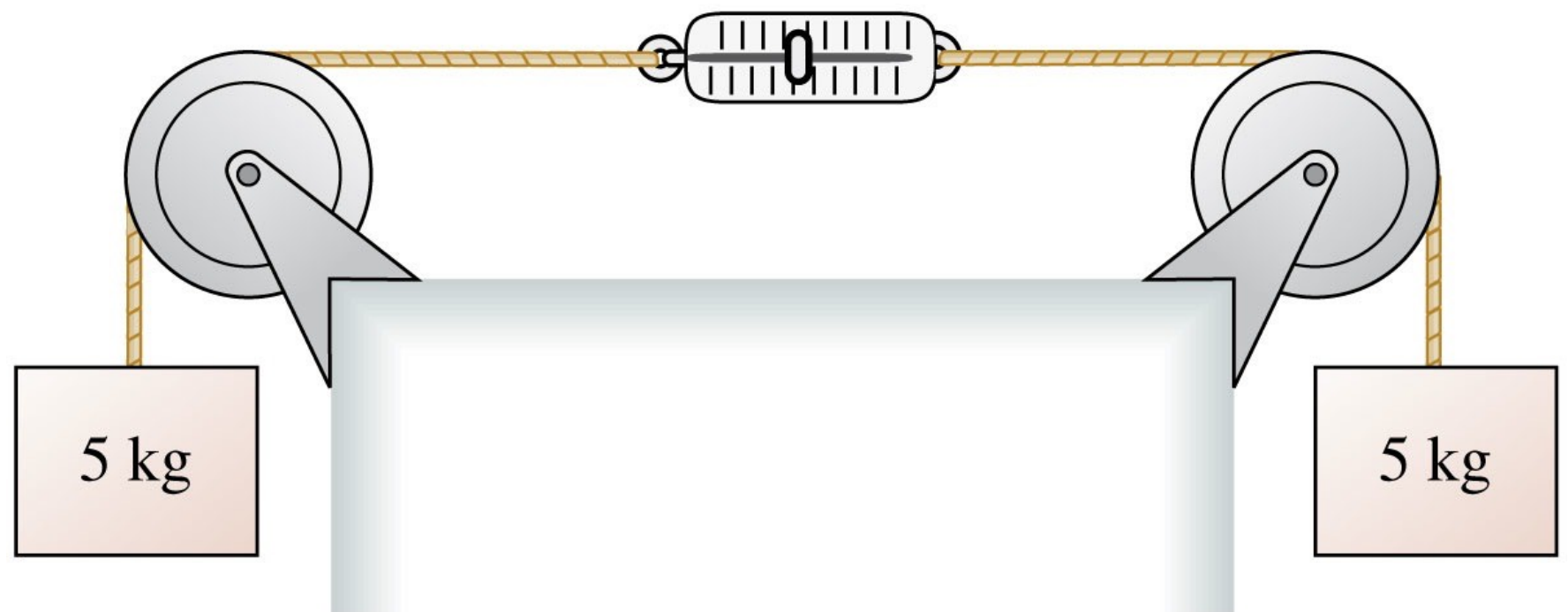
- a. $F_{B \text{ on } H} = F_{H \text{ on } B} = F_{A \text{ on } B} = F_{B \text{ on } A}$
- b. $F_{B \text{ on } H} = F_{H \text{ on } B} < F_{A \text{ on } B} = F_{B \text{ on } A}$
- c. $F_{B \text{ on } H} = F_{H \text{ on } B} > F_{A \text{ on } B} = F_{B \text{ on } A}$
- d. $F_{H \text{ on } B} = F_{H \text{ on } A} > F_{A \text{ on } B}$



Question #21

The two masses are at rest. The pulleys are frictionless. The scale is in kg. The scale reads

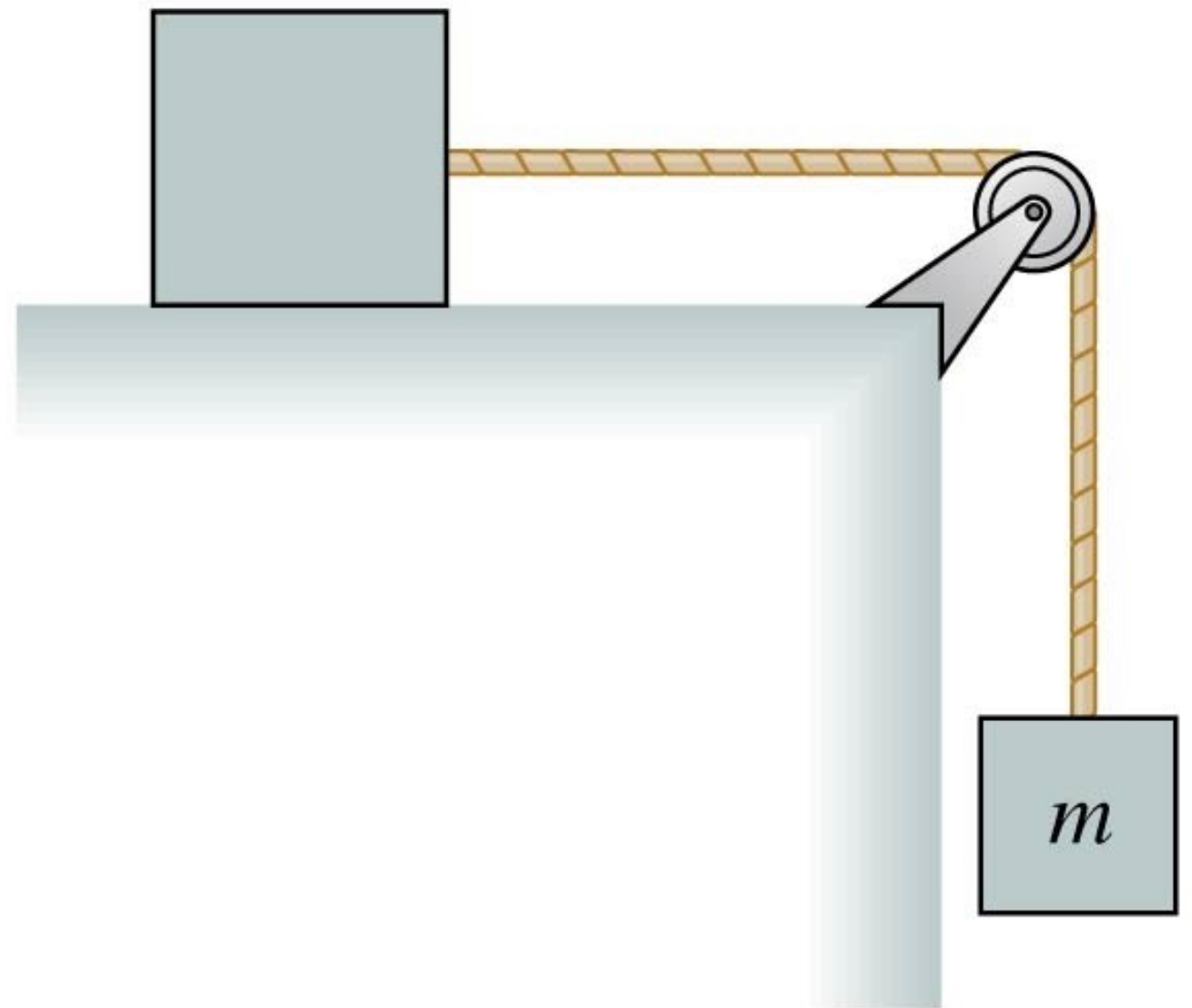
- A. 0 kg.
- B. 5 kg.
- C. 10 kg.



Question #22

The top block is accelerated across a frictionless table by the falling mass m . The string is massless, and the pulley is both massless and frictionless. The tension in the string is

- a..
- b. $T = mg$.
- c. $T > mg$.
- d. $T < mg$.



Question #23

Block A is accelerated across a frictionless table. The string is massless, and the pulley is both massless and frictionless.

Which is true?

A..

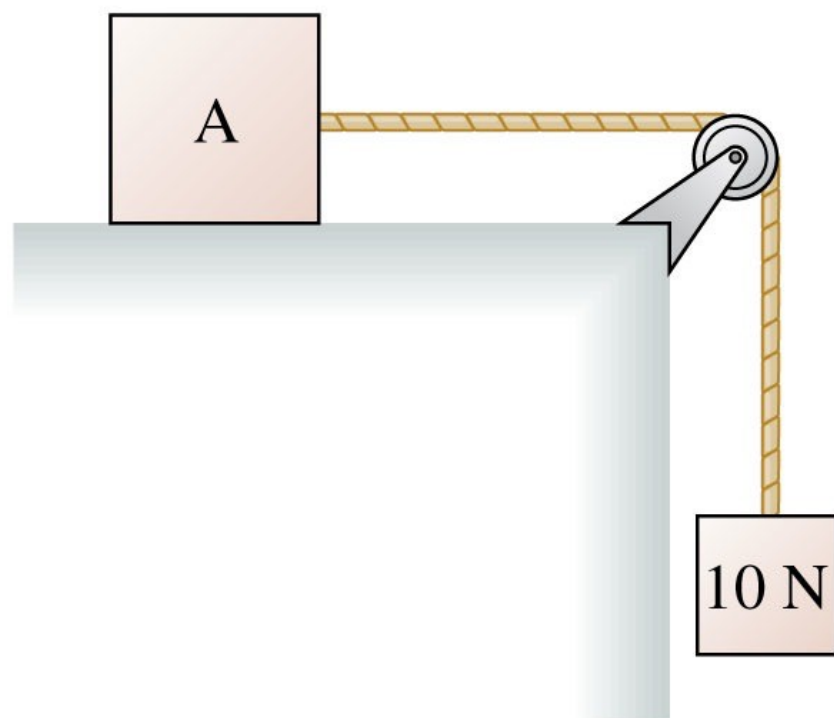
B..

C. Block A has the same acceleration in case a and case b.

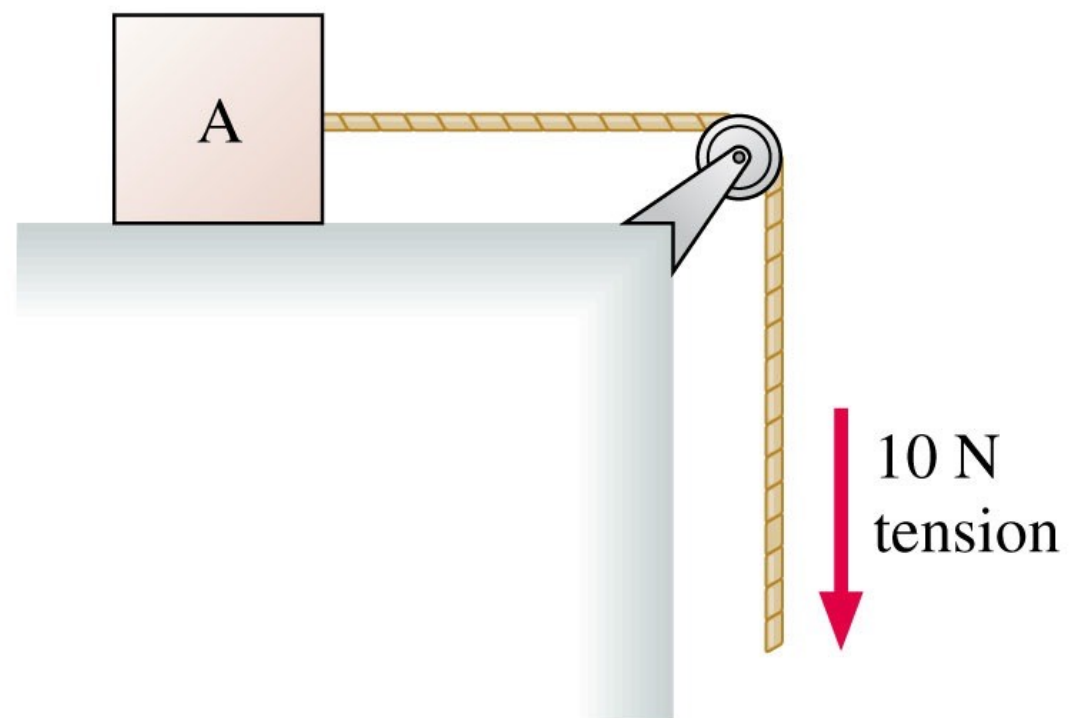
D. Block A accelerates faster in case a than in case b.

E. Block A accelerates slower in case a than in case b.

Case a



Case b

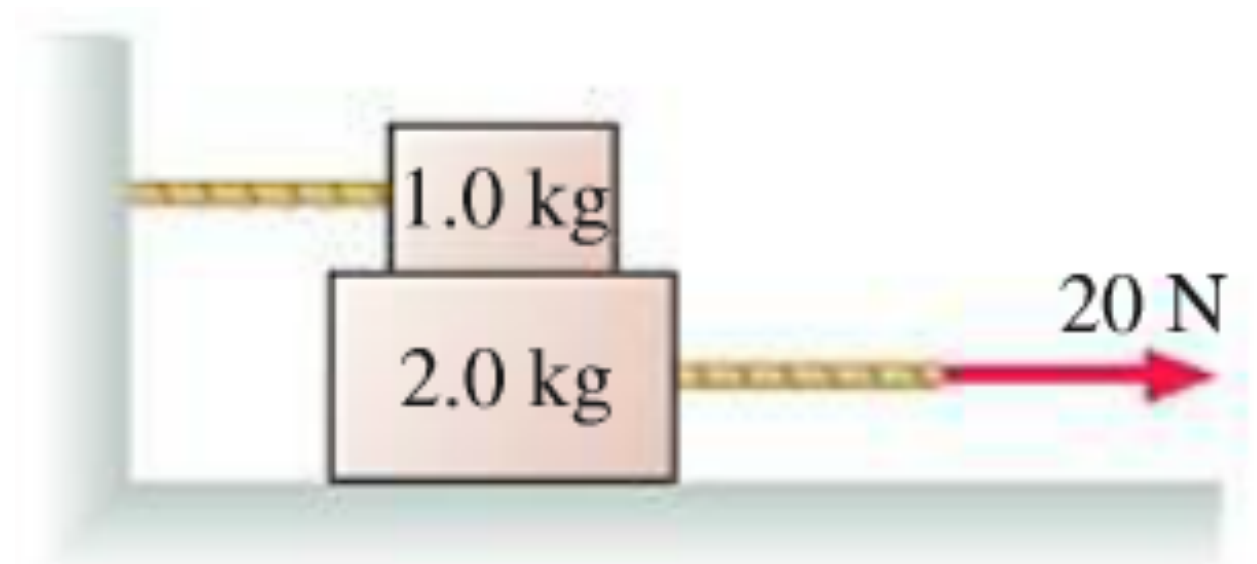


Harder Problem

The 1.0 kg block in the figure is tied to the wall with a rope. It sits on top of a 2.0 kg block. The lower block is pulled to the right with a 20 N tension force. The coefficient of kinetic friction between all surfaces is 0.40.

- a) What is the tension in the rope holding the 1.0 kg block?
- b) What is the acceleration of the 2.0 kg block?

- a) Draw the free body diagrams for both blocks (6 forces for bottom block and 4 forces on the top)
- b) Identify the action/reaction pairs
- c) Write down Newton's second law in the x and y directions for both blocks (4 equations)
- d) Work on the math to solve the system of equations.



Example Problem with Pulleys

The 10.2 kg block is held in place by a force applied to the rope. Find the tensions T_1 to T_5 and the magnitude of F .

