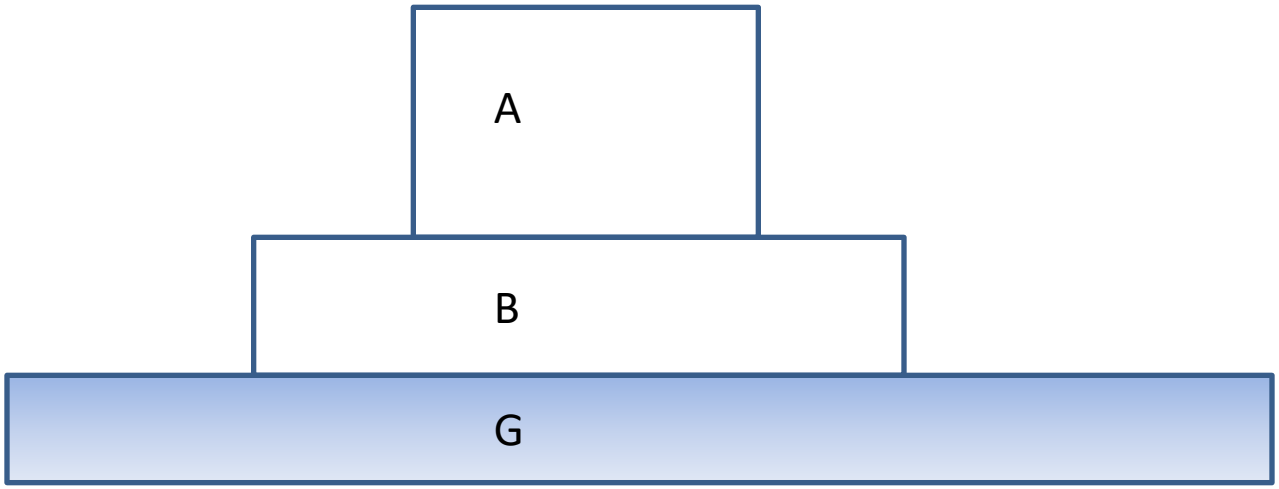
Newton's Third Laws

- Newton's 3rd Law: For every action there is an equal and opposite reaction – a pair of action and reaction forces
  - Involves two objects (pair).
  - Action-reaction forces: from one to the other (and vice versa) the two forces are always on two objects (never on the same object).
  - Equal in magnitude and opposite in direction.
  - Always the same type of forces.

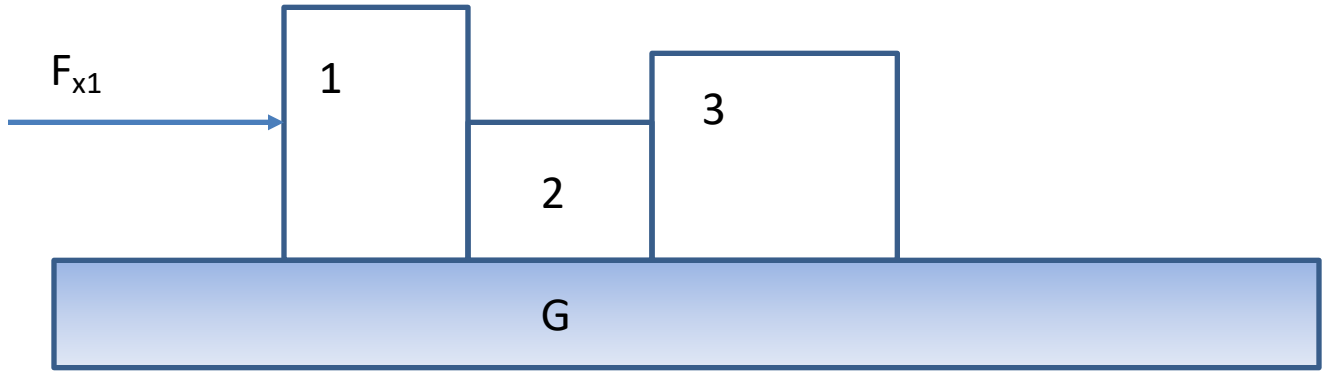
Free Body Diagram

All objects are stationary and all surfaces have no friction.

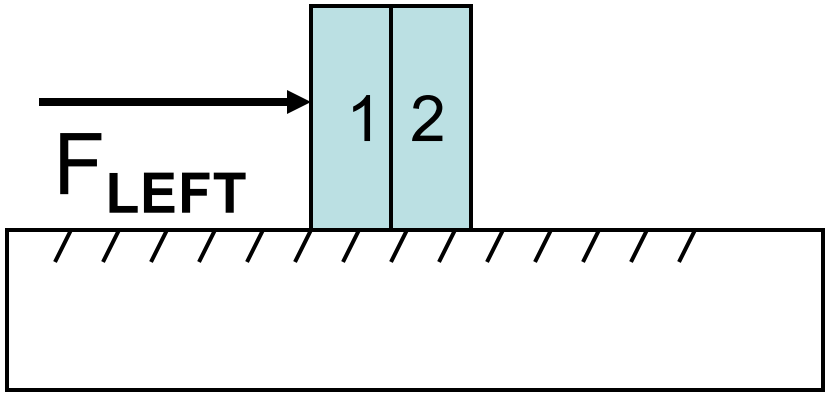


Free Body Diagram

No Friction

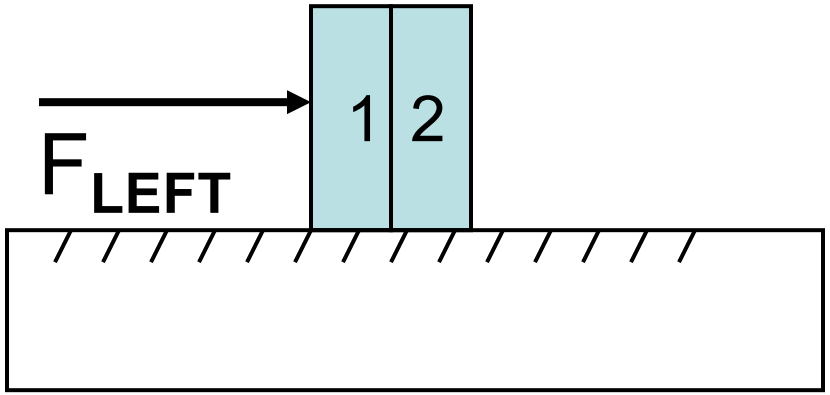


Tom pushes two identical blocks on a horizontal frictionless table ***from the left***. The force that block 1 exerts on block 2 is F_{12}. The force that block 2 exerts on block 1 is F_{21}. Compare ***the magnitude*** of F_{12} and F_{21}.

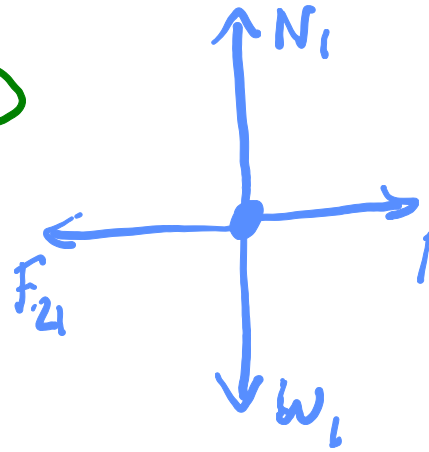


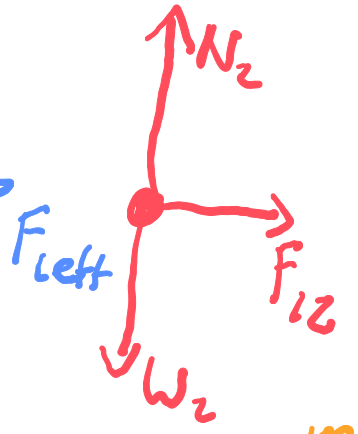
1. $F_{12} < F_{21}$
2. $F_{12} = F_{21}$
3. $F_{12} > F_{21}$
4. Cannot be determined

Tom pushes two identical blocks on a horizontal frictionless table ***from the left***. The force that block 1 exerts on block 2 is F_{12}. The force that block 2 exerts on block 1 is F_{21}. Compare ***the magnitude*** of F_{12} and F_{LEFT}.



1. $F_{12} < F_{LEFT}$
2. $F_{12} = F_{LEFT}$
3. $F_{12} > F_{LEFT}$
4. Cannot be determined





$F_{left} - F_{21} = m_1 a$

$F_{21} = m_2 a$

$F_{left} = (m_1 + m_2) a$

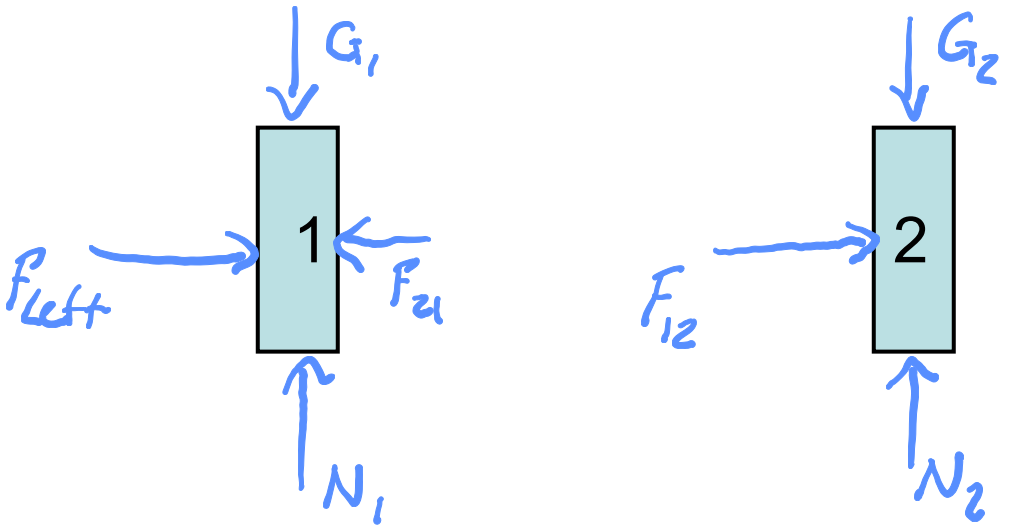
$a = \frac{F_{left}}{m_1 + m_2}$

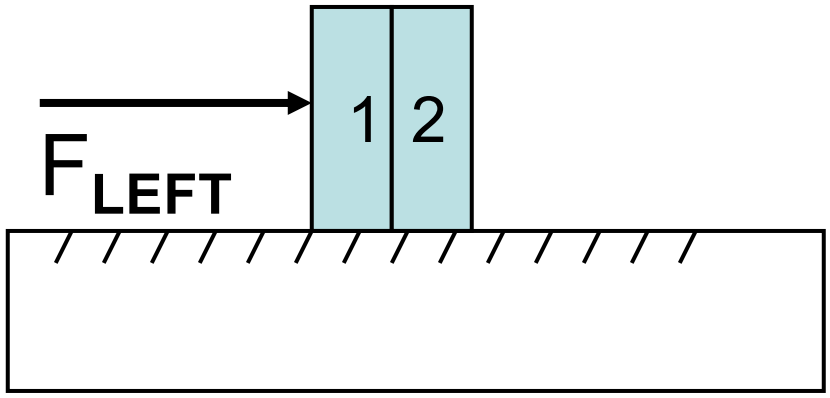
$F_{12} = m_2 a$

$= m_2 \frac{F_{left}}{m_1 + m_2}$

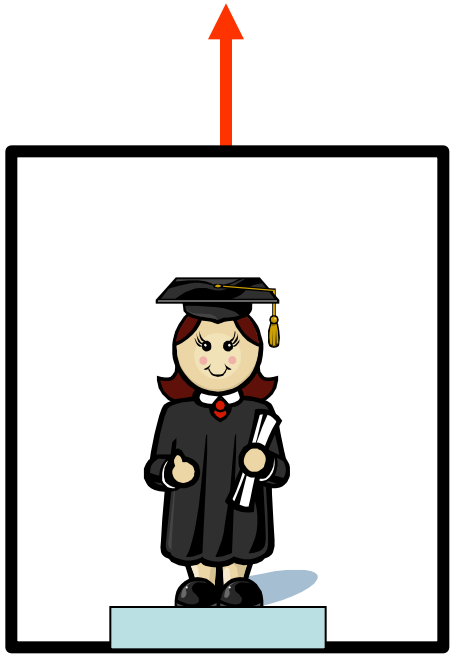
$F_{12} = \frac{m_2}{m_1 + m_2} F_{left}$

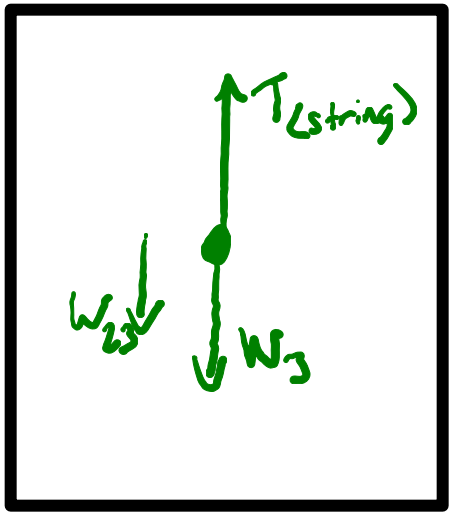
Free Body Diagrams for 1 and 2

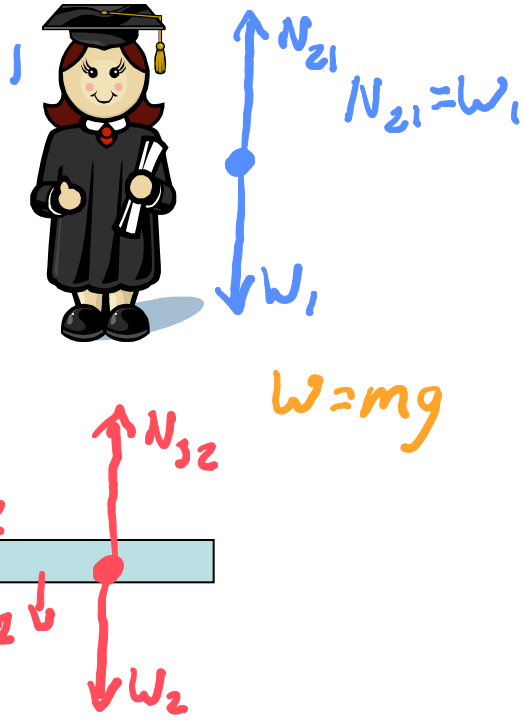




Set up the problem

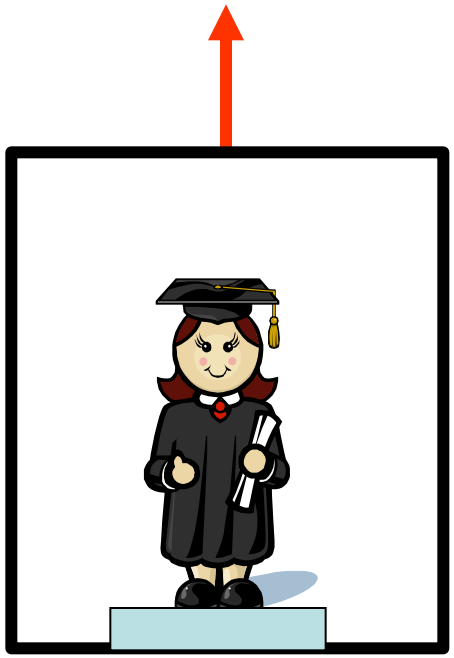


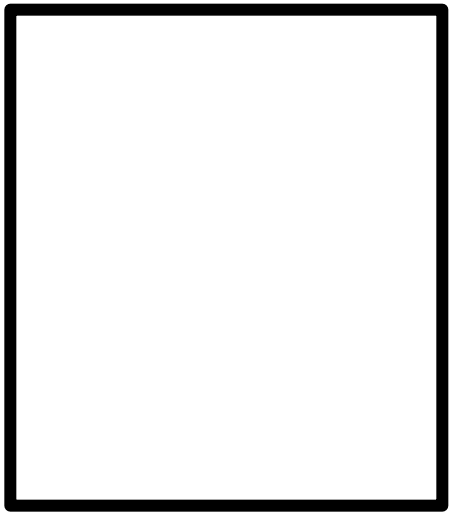




Free Body Diagrams

How do W_1 and N_{21} compare?



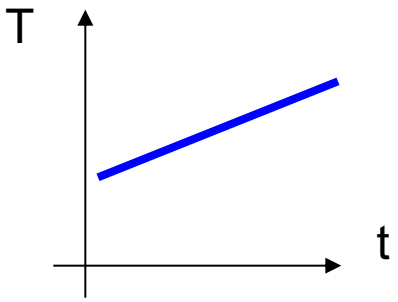


3

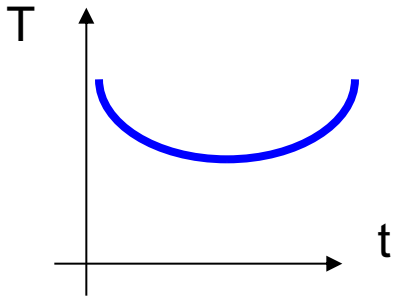
1

A student is riding an elevator in the Acme Building, and the elevator is moving a constant upward speed. Which plot shows the ***tension T in the elevator cable*** as a function of time?

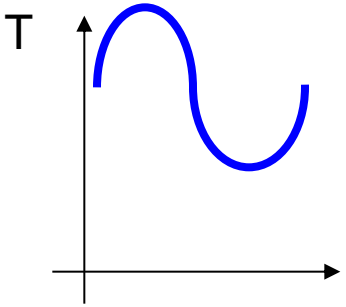
$T = W_{23} + W_3$



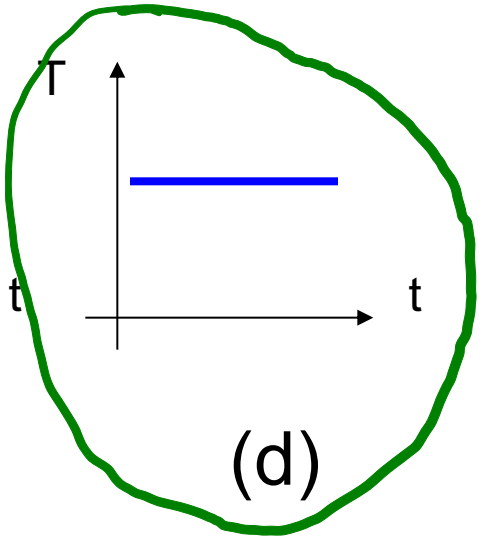
(a)



(b)



(c)



(d)

A student steps onto a bathroom scale in a stationary elevator on the first floor of the Acme Building. The elevator uniformly accelerates until it reaches the second floor and then continues at constant speed until the 5th floor, where it uniformly slows and stops on the 6th floor. Which sketch of ***weight shown on the scale vs. time during the entire process*** is most likely to be correct?

$N_{21} - W_1 = m_1 a \quad (a > 1)$

$N_{21} = W_1 + m_1 a \rightarrow = m_1 (g + a)$