Chapter 4 of Tipler & Mosca, sections 1-3, 7
Newton's Laws of Motion

1. First Law ("law of inertia"):

a.) "An object at rest stays at rest unless acted on by an external force. An object in motion continues to travel with constant speed in a straight line unless acted on by an external force."

b.) Short form: No external force, no velocity change.

c.) Inertial reference frame – one where, if no external forces are acting on an object, it has 0 acceleration. First Law is only true in inertial frames.

i) Examples – demo

ii) Two frames moving with constant relative velocity
– If one is an inertial frame
– so is the other.

2. Force and Mass.

a.) Force is a vector, an external action that causes acceleration.

b.) Often several forces sum to give net force. Example: sitting person. In a room, in an airplane.

c.) Mass is measure of an object's resistance to being accelerated by a force.

d.) Weight: is the force of gravity, and we will get to it.

e.) What is this External business ?

3. Second Law

a.) "The acceleration of an object is directly proportional to the net force acting on it, and the reciprocal of the mass of the object is the constant of proportionality"

b.) Short form: $\vec{a} = \vec{F}_{\text{net}} / m$ **or**

$\vec{F}_{\text{net}} = m\vec{a}$

c.) Units: F has units ML/T^2
which is kg m/s^2 in S.I. units
Special name, Newton (N)

d.) "English" units: F is pound (lb), m is slug.
Pound is slug ft/s^2
and 1 lb = 4.44 N (approx).

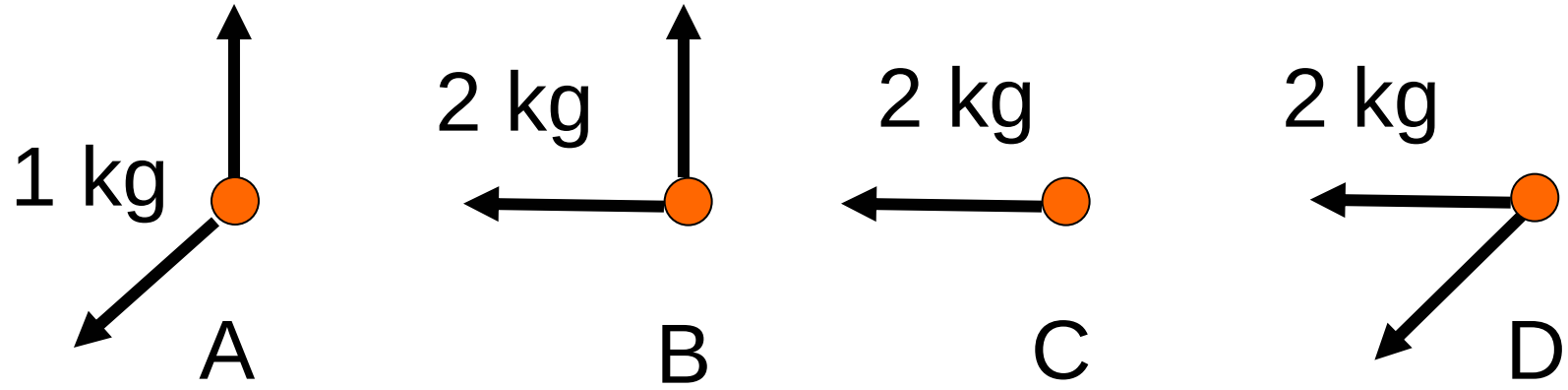
e.) Note, if $F_{\text{net}} = 0$, we get the first law from the second.
But we keep the first law to remind us of inertial reference frames.

f.) Demo

g.) Clicker question

Each force vector has magnitude 2 N.

Which object accelerates the most to the left?



7. Third Law

a.) "When two bodies interact, the force $\vec{F}_{BA}$ exerted by object B on object A is equal in magnitude and opposite in direction to the force $\vec{F}_{AB}$ exerted by object A on object B. Thus $\vec{F}_{AB} = -\vec{F}_{BA}$"

b.) Forces always occur in pairs.
One member of the pair acts on one body and contributes to the net force on that body.
The other member acts on the other body.
Have to keep which forces on which bodies straight.

c.) Examples:

d.) Demo