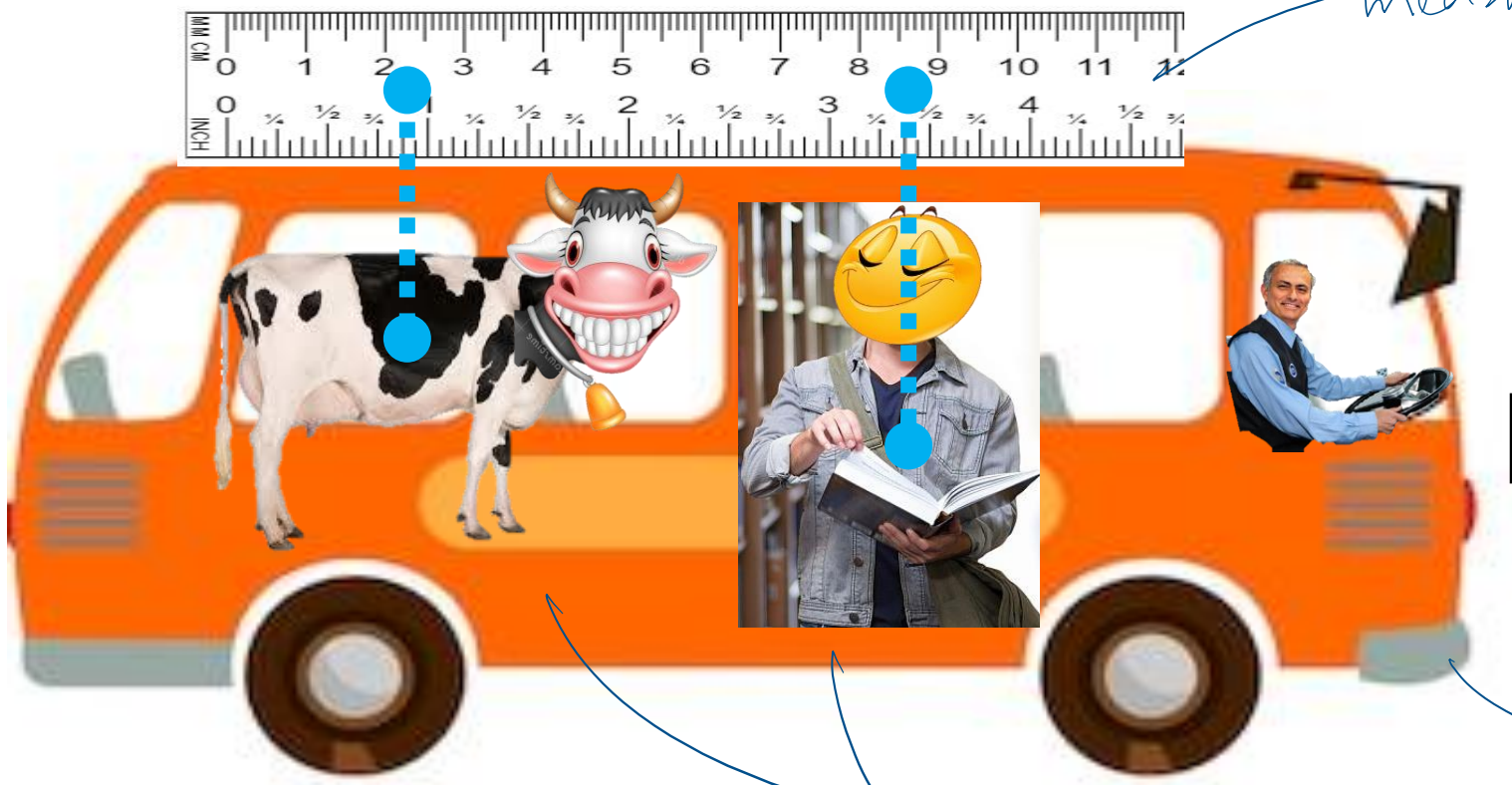
Newton's Laws of Motion

Newtonian Mechanics

NEWTON'S FIRST LAW OF MOTION: **A body acted on by no net force has a constant velocity (which may be zero) and zero acceleration.**



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sudden change in position

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one way to find out whats happened is by using external inertial frame

External fame

comes with their own scales

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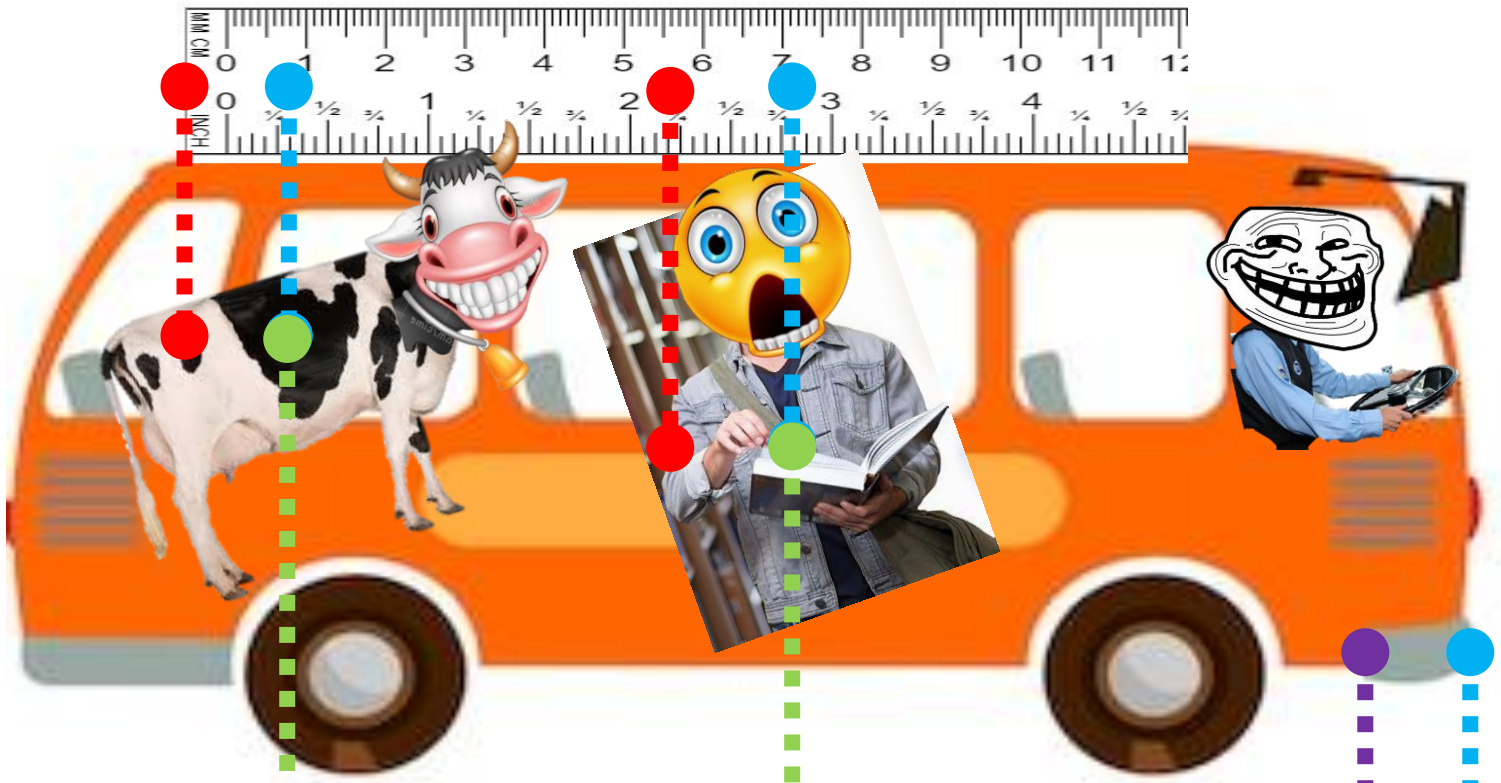

Accelerate

Inertial frame: A frame where Newton's laws are valid. No accelerations.

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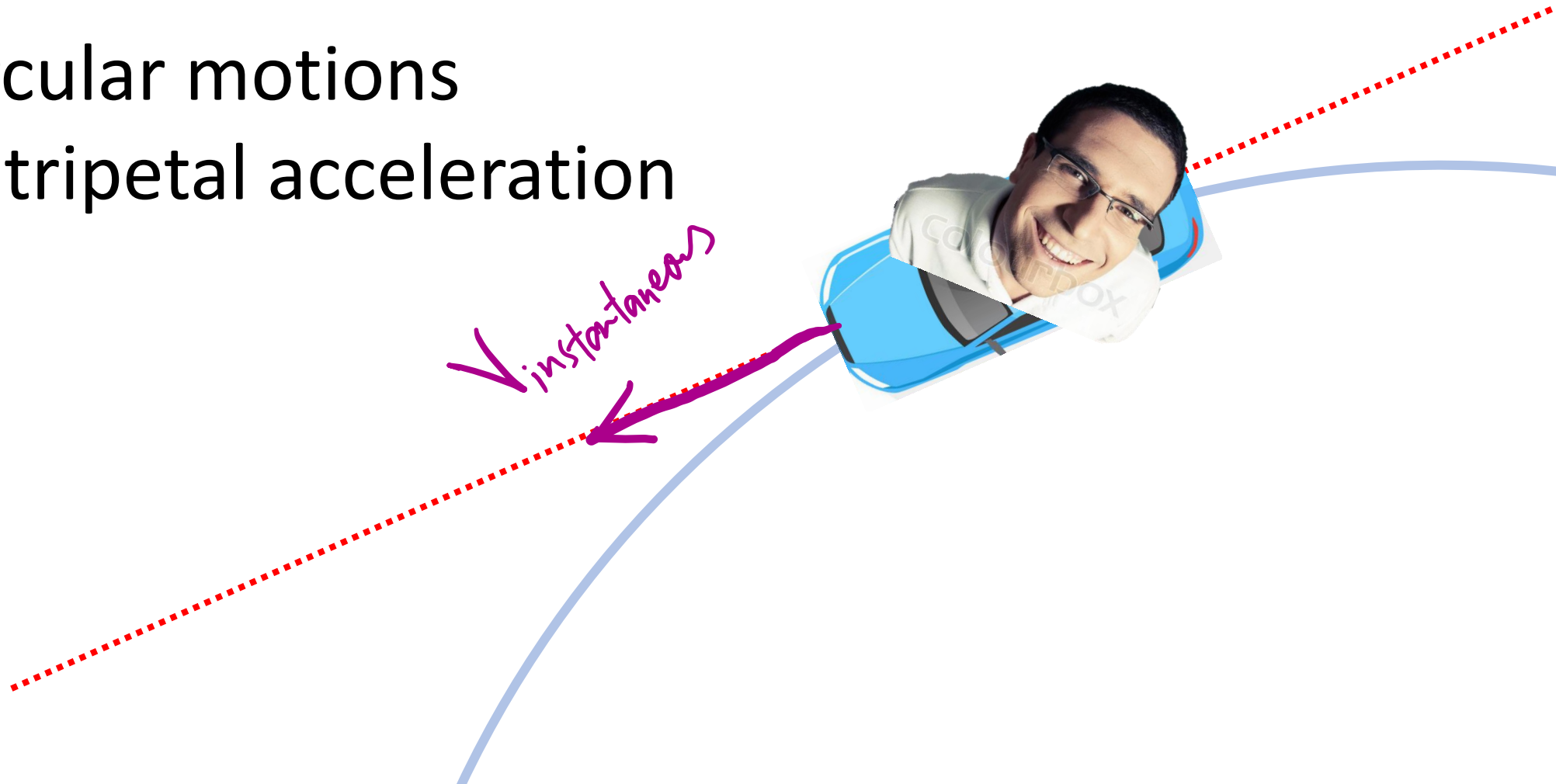
Uniform circular motions require centripetal acceleration **only**



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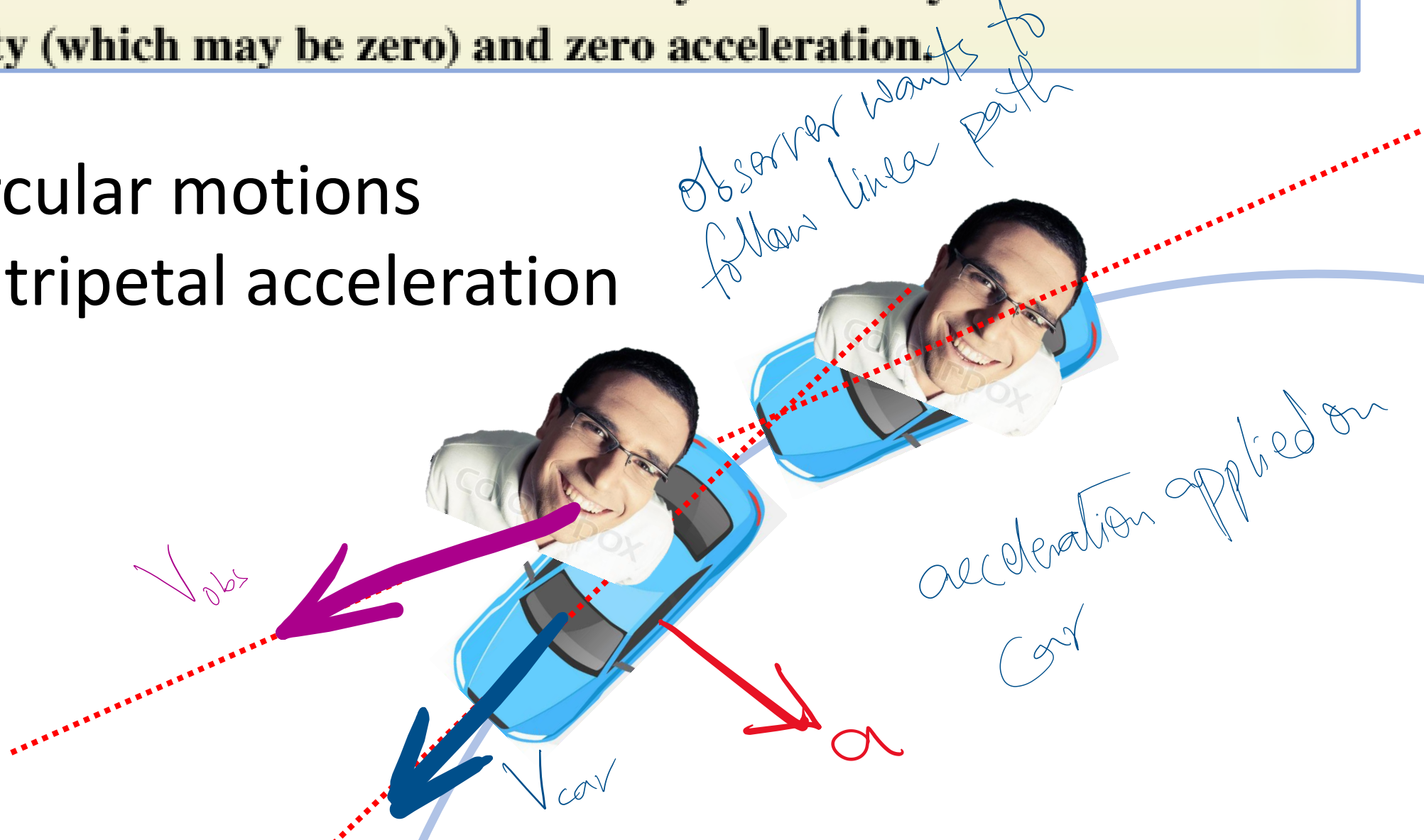
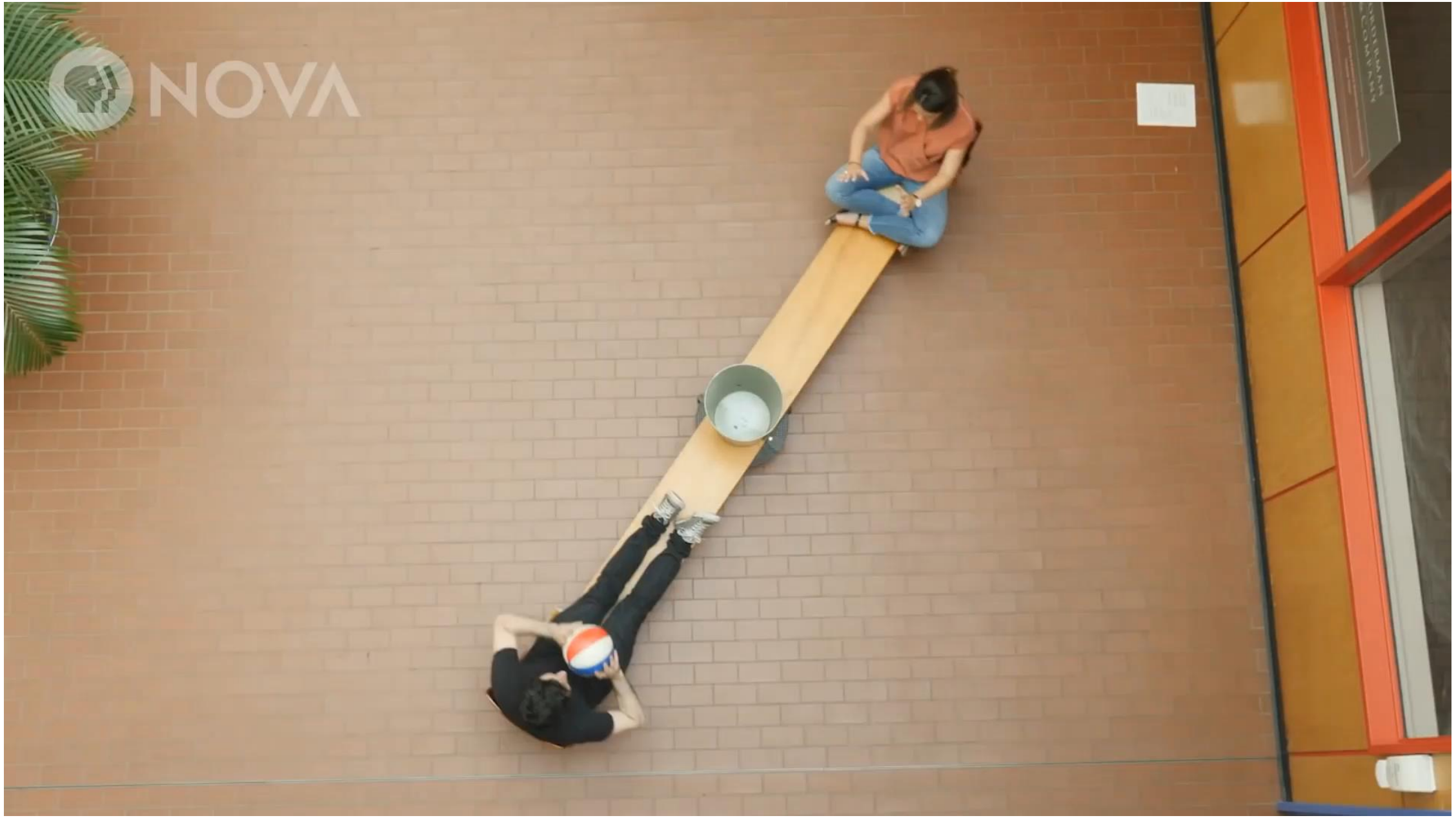
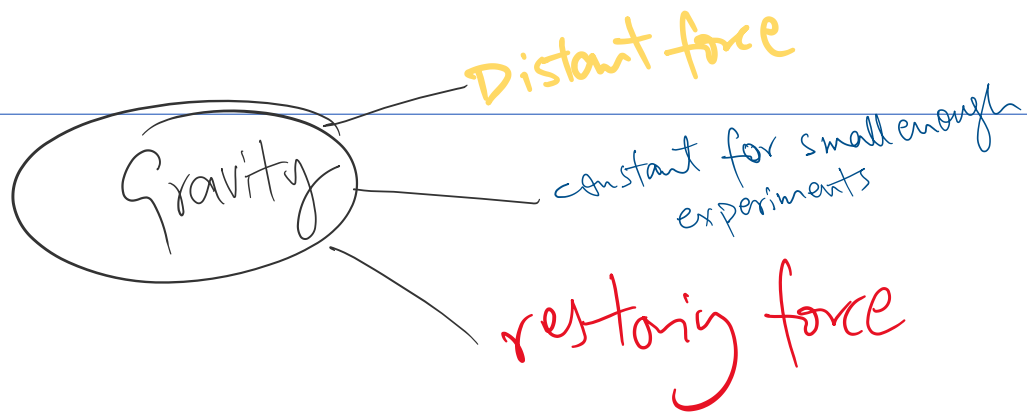




Watch the complete episode


experimentalist in rotating frame same as 1th camera (us/observer)
ground (inertial frame)
motion of platform
Path of object in rotating frame
Path of ball in ground inertial frame
motion of platform
path of experimentalist
Path of camera (observer)
in ground inertial frame

The Force



- Distant forces
- Contact forces
- Constant forces
- Varying forces
- Drag forces
- Frictional forces
- Restoring forces
- Tension ✗ Force due to tension ($\vec{T}$)

Nature of forces

with respect to the experiment

fluid related

surface dependent

related to potentials

The Force

- Distant forces
- Contact forces
- Constant forces
- Varying forces
- Drag forces
- Frictional forces
- Restoring forces
- Tension

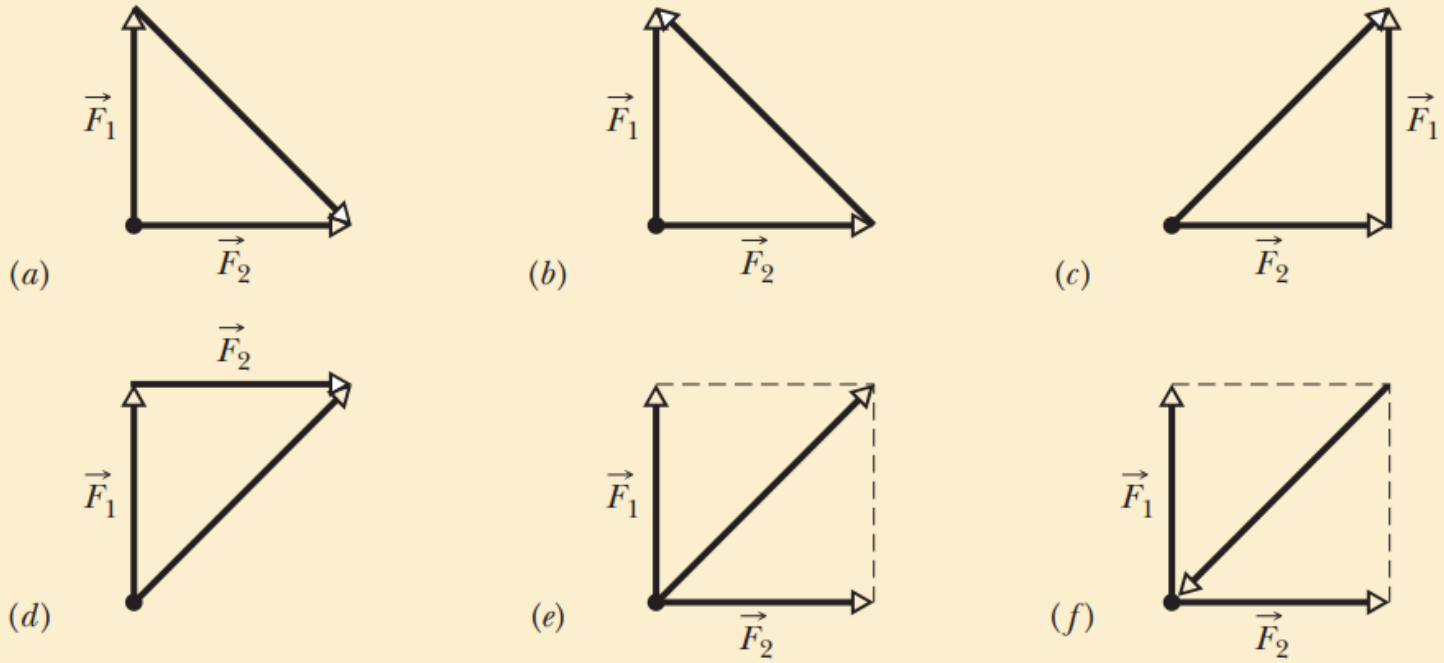
All forces can be represented by vector

All forces can be added vectorially

All components of forces remain independent

Checkpoint 1

Which of the figure's six arrangements correctly show the vector addition of forces $\vec{F}_1$ and $\vec{F}_2$ to yield the third vector, which is meant to represent their net force $\vec{F}_{net}$?



NEWTON'S SECOND LAW OF MOTION: If a net external force acts on a body, the body accelerates. The direction of acceleration is the same as the direction of the net force. The mass of the body times the acceleration vector of the body equals the net force vector.

resultant net force may not be of any type

This only represents the motion in object of mass 'm'

Newton's second law:
If there is a net force on a body ... $\sum \vec{F} = m\vec{a}$ ... the body accelerates in same direction as the net force.

Mass of body

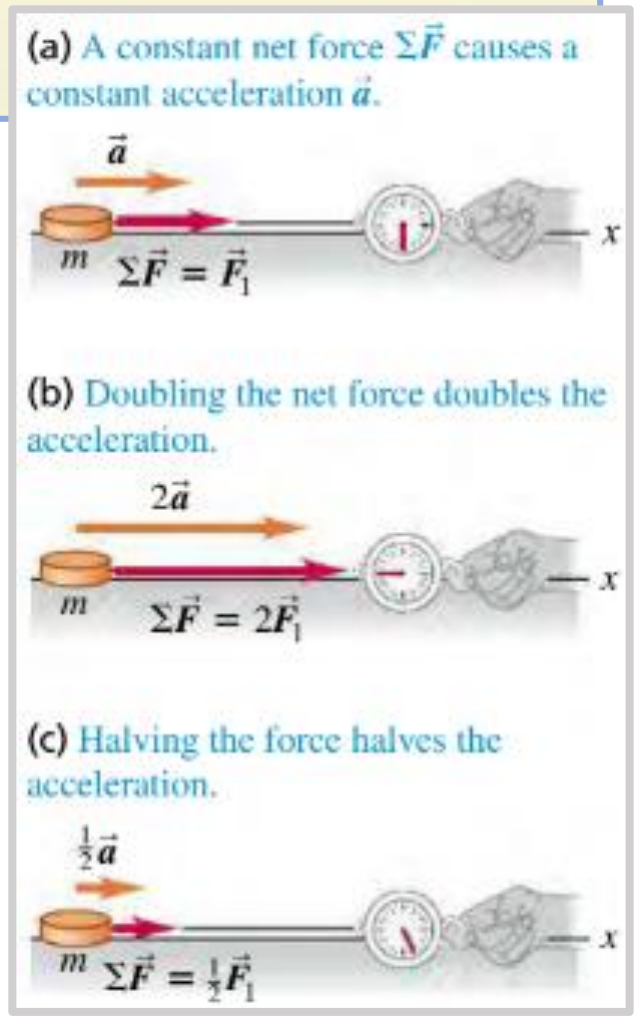
$m\vec{a}$ is not a force

The net force acting on a body ... $\vec{R} = \sum \vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \cdots$

These forces can be of different types.

... is the vector sum, or resultant, of all individual forces acting on that body.

$$Equilibrium,\ |\vec{R}| = \sum \vec{F} = 0$$



AXIOMS, OR LAWS OF MOTION.

LAW I.

Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon.

PROJECTILES persevere in their motions, so far as they are not retarded by the resistance of the air, or impelled downwards by the force of gravity A top, whose parts by their cohesion are perpetually drawn aside from rectilinear motions, does not cease its rotation, otherwise than as it is retarded by the air. The greater bodies of the planets and comets, meeting with less resistance in more free spaces, preserve their motions both progressive and circular for a much longer time.

LAW II.

The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.

If any force generates a motion, a double force will generate double the motion, a triple force triple the motion, whether that force be impressed altogether and at once, or gradually and successively. And this motion (being always directed the same way with the generating force), if the body moved before, is added to or subducted from the former motion, according as they directly conspire with or are directly contrary to each other; or obliquely joined, when they are oblique, so as to produce a new motion compounded from the determination of both.

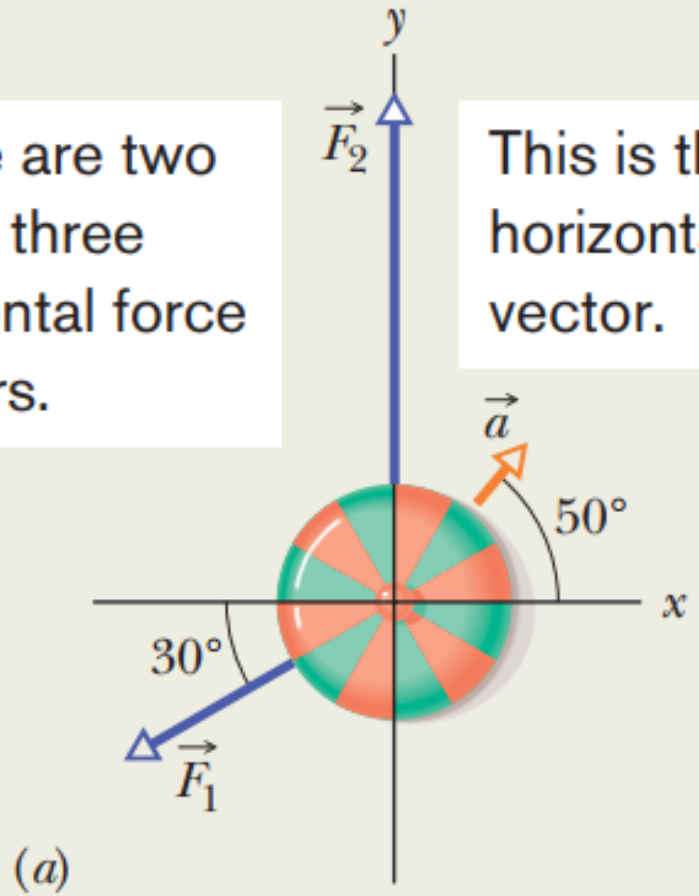
LAW III.

To every action there is always opposed an equal reaction: or the mu-

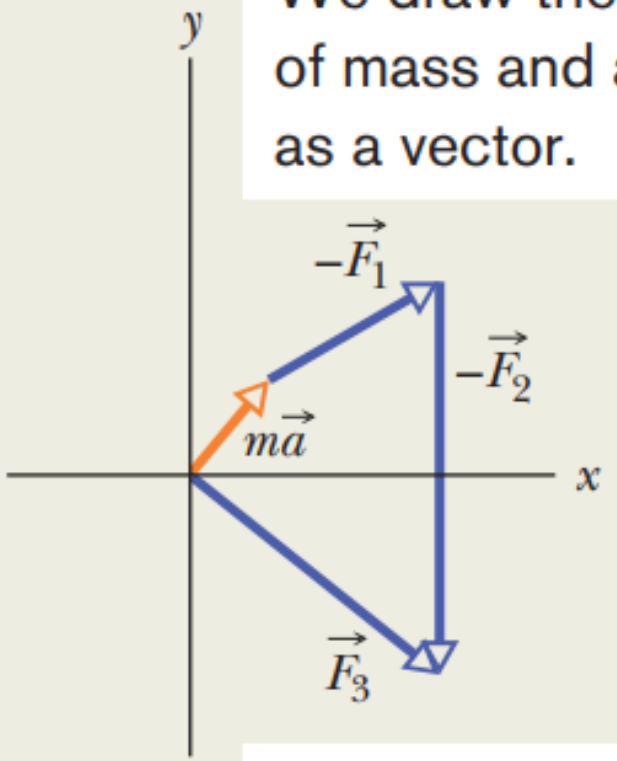
from
Principia Mathematica

These are two of the three horizontal force vectors.

This is the resulting horizontal acceleration vector.



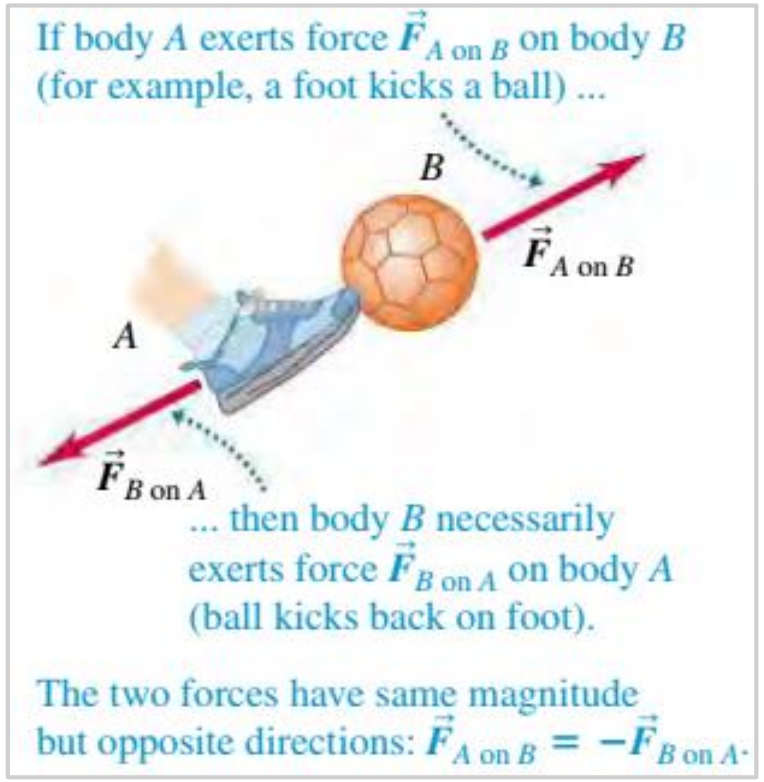
We draw the product of mass and acceleration as a vector.

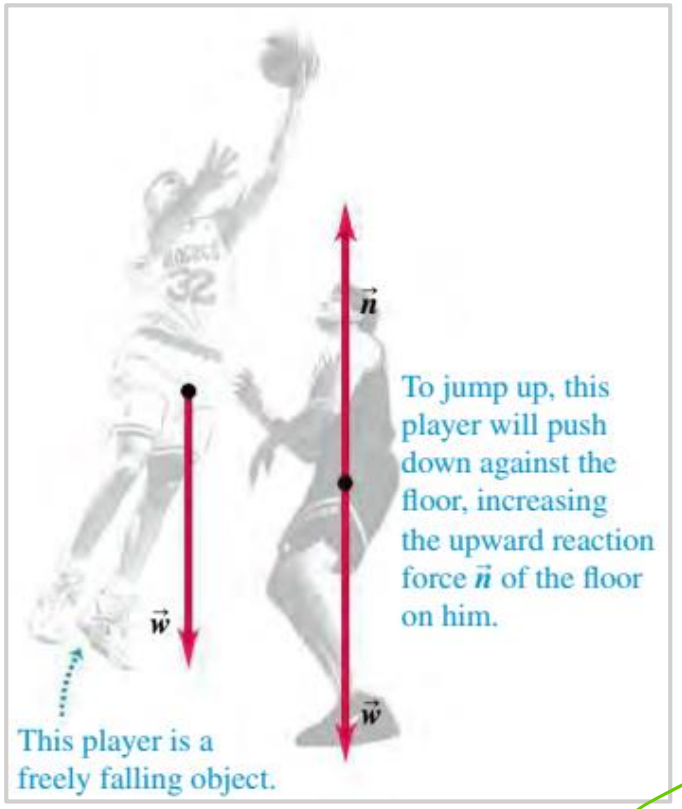


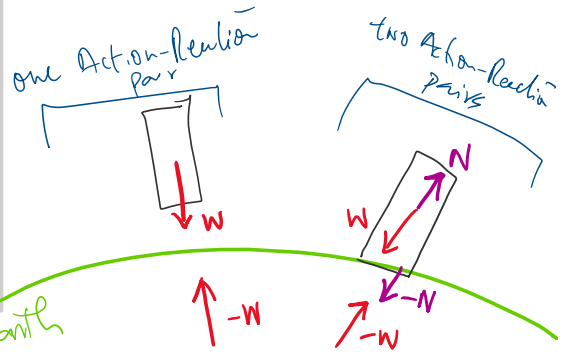
Then we can add the three vectors to find the missing third force vector.

read: Sample Problem 5.02

NEWTON'S THIRD LAW OF MOTION: **If body *A* exerts a force on body *B* (an "action"), then body *B* exerts a force on body *A* (a "reaction"). These two forces have the same magnitude but are opposite in direction. These two forces act on *different* bodies.**







$$a_{player} = \frac{F}{m_{player}}$$

$$a_{earth} = \frac{F}{m_{earth}}$$

earth pushes player with $F_{\text{on player by earth}}$

$a_{earth} \ll a_{player}$

player accelerates more than the earth.
This difference is due to the difference of masses.

player pushes earth with $-F_{\text{on earth by player}}$

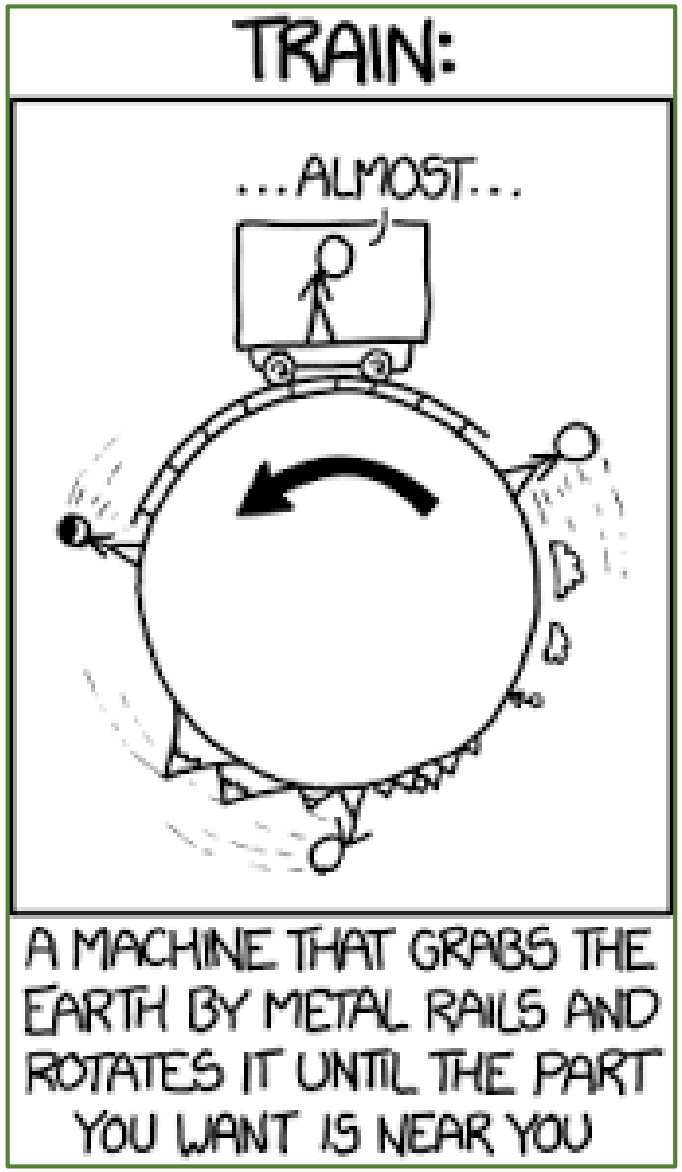
$F_{by\,B\,on\,A}$

$a_A \sim a_B$

both objects accelerate significantly

$F_{by\,A\,on\,B}$

Learning the Newton's three Laws should enable you to decide ...



if this statement is correct or not ???

Answer is all up to you.
The confidence in your answer will be a measure of how good you have learnt the three laws