

In the movie *Empire Strikes Back*, Yoda lifts an X-wing out of a swamp. If the X-wing is at rest at the surface of the swamp, how much Force must Yoda use to accelerate the 5,600 kg X-wing at 0.28 m/s^2 ?

Acceleration due to gravity on Dagobah is 0.9 times the Earth's gravity.

- $\Sigma F = F_{Yoda} - F_G$

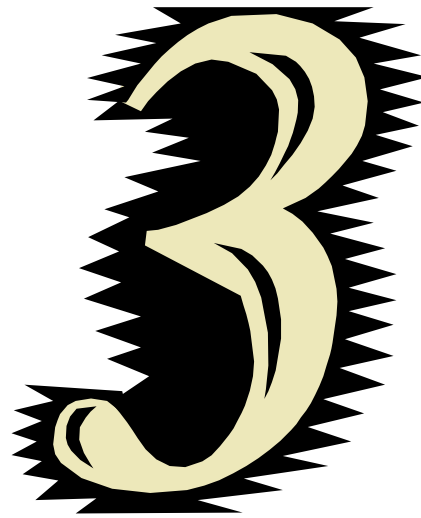
- $(5600\text{kg} \times 0.28 \text{ m/s}^2) = F_{Yoda} - (5600\text{kg} \times 0.9 \times 9.81 \text{ m/s}^2)$

- $F_{Yoda} = 51,000 \text{ N}$



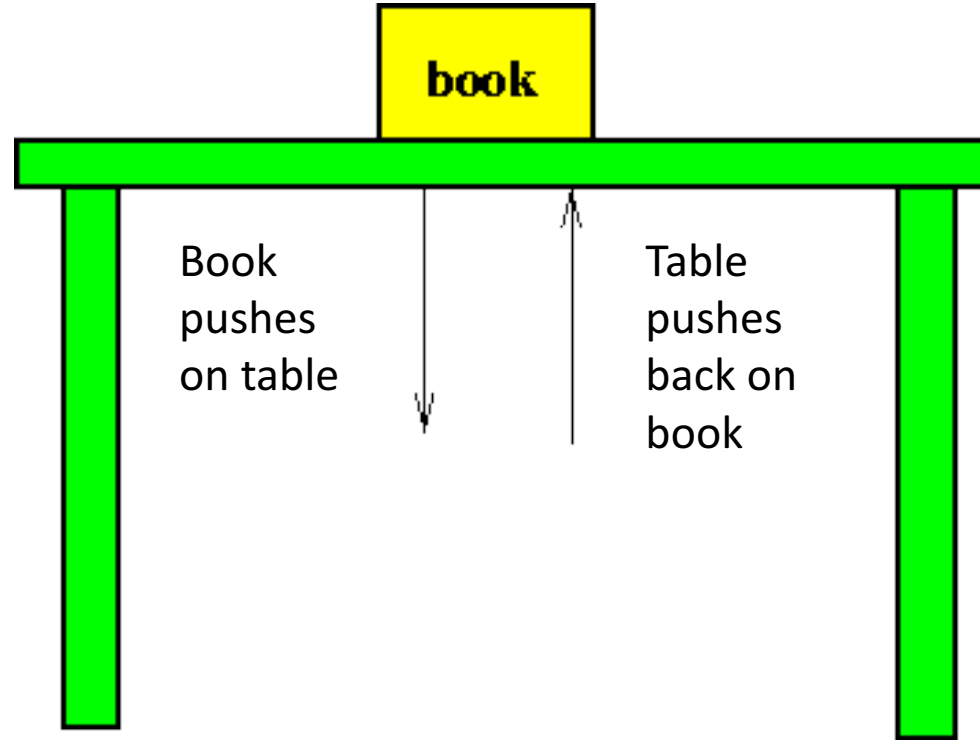
Newton's Third Law

“To every action there is always opposed an equal reaction: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.” --Newton

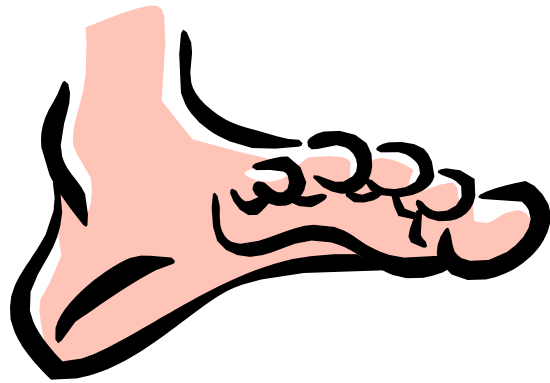


Newton's 3rd Law

For every action there is an equal and opposite reaction.



What happens if you are standing on a skateboard or a slippery floor and push against a wall? You slide in the opposite direction (away from the wall), because you pushed on the wall but the wall pushed back on you with equal and opposite force.



Why does your toe hurt so much when you stub your toe? When your toe exerts a force on a rock, the rock exerts an equal force back on your toe. The harder you hit your toe against it, the more force the rock exerts back on your toe (and the more your toe hurts).

Newton's Third Law



A bug with a mass of 5 grams flies into the windshield of a moving 1000kg bus.

Which force is greater?

- The bug on the bus**
- The bus on the bug**

Newton's Third Law

The force would be the same.

$$\text{Force (bug on bus)} = m \times A$$

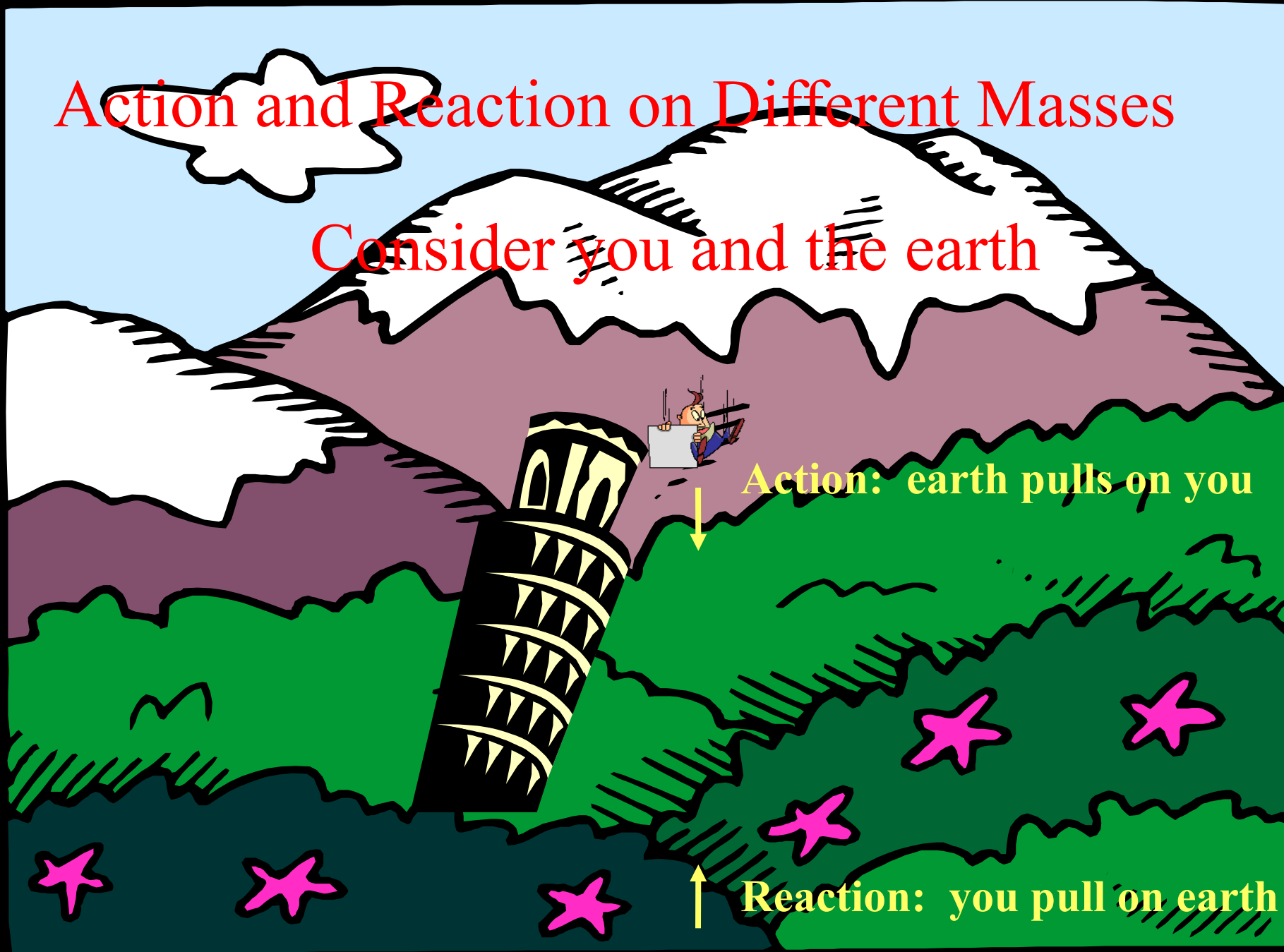
$$\text{Force (bus on bug)} = M \times a$$



Think I look bad?
You should see
the other guy!

Action and Reaction on Different Masses

Consider you and the earth



Action: earth pulls on you

Reaction: you pull on earth



Reaction: road pushes on tire

Action: tire pushes on road

Veritasium Incorrect 3 Laws

What could you change in his statements about the law/the examples to make them correct?

Veritasium Falling Objects

Even though a heavier ball has a higher force of gravity compared to a lighter ball, what makes them fall at the same rate?

- The inertia of the heavy ball is greater, so it takes more force for it to accelerate at the same rate as the lighter ball.