Physics 2A

Forces and Newton's Laws of Motion

Forces

What is a force?

force ⇒ a push or pull exerted by one object on another object (contact is not necessary)

⇒ The vector sum ($\sum F$) of all forces on an object is called the net force.

net force = 50 N to the right

Newton's Laws

Newton's First Law ⇒ An object at rest will remain at rest, an object in motion will remain in motion in a straight line at a constant speed, unless acted upon by a (nonzero) net force.

Newton's Laws

Newton's First Law ⇒ If the net force on an object is zero ($\sum F=0$), then the acceleration of the object is zero.

Why??????

⇒ The answer is that we (physicists) don't know why. What we do know is that any object with mass will resist changing its state of motion (it will resist accelerating).

Newton's Laws

inertia ⇒ the natural tendency of an object to remain at rest or in motion at a constant speed along a straight line

the resistance of an object to change its state of motion

⇒ an object's inertia depends upon its mass

more mass → more inertia → more resistance to acceleration

Newton's Laws

Question: In terms of Newton's first law, how does a car headrest help guard against whiplash in a rear-end collision?

⇒ In a car at rest, your head tends to stay at rest. When the car is rear ended, the car lurches forward and if the headrest isn't there, tends to leave your head behind. Hence a neck injury.

Newton's Laws

Newton's Second Law ⇒ $\Sigma\vec{F} = m\vec{a}$

Newton's Third Law ⇒ Whenever one object exerts a force on a second object, the second object exerts an equal but opposite force on the first object.

in strength in direction

Newton's Laws

Newton's Third Law ⇒ For every action there is an equal but opposite reaction.

⇒ Most of our everyday motions takes place because of Newton's third law.

⇒ For example, to walk you push backwards on the floor. By Newton's third law, the floor pushed forwards on you. It is the floor pushing forward on you that allows you to walk.

Newton's Laws

Question: You push a heavy car by hand. The car, in turn, pushes back with an opposite but equal force on you. Doesn't this mean the forces cancel one another, making acceleration impossible? Why or why not?

⇒ No. You can't cancel a force exerted on the car with a force exerted on you. In order for forces to cancel, the forces have to be equal and opposite **and act on the same object**.

Types of Forces

Question: How many different types of forces exist in the universe?

⇒ There are only 3 fundamental forces in nature:

1) gravitational
2) strong nuclear
3) electroweak force (electromagnetic & weak nuclear)

⇒ All other forces arise from one of these three (most are related to the electromagnetic force).