F: Forces Acting on You

In this quiz, you will answer questions in which you will need to relate your own motion and your own experiences to Newton's Laws of Motion.

Newton's Laws (applied to you)

Newton's First Law

If you are at rest and no force acts on you, you will stay at rest.
If you are moving at a constant speed, unless a force acts on you, you are going to keep moving at a constant speed.

Newton's Second Law

The net force on you = (your mass)*(your acceleration)

For you to accelerate, a force needs to act on you.
For you to slow down, a force needs to act on you.

Newton's Third Law

If you exert a force on something, that thing exerts a force on you of equal magnitude and opposite direction.

Newton's Laws Inside a Vehicle

If you are inside of a vehicle (such a car, and airplane, or an elevator), these laws still apply. That means, if the car accelerates and you are inside the car, then you are accelerating, too, and there needs to be a force acting on YOU. It isn't enough that the car is accelerating and you are inside of it, there needs to be a force on you equal to your mass times your acceleration. In this specific case, that force is provided by the back of your seat, which is why you can feel your seat press into you if you

This is why we make free-body diagrams. Your free-body diagram is an illustration of all of the forces acting on you. It doesn't matter where you are: resting on the couch, in a speeding car, in a rocket ship, or alone in outer space, your free-body diagram shows only the forces acting on you and explains your motion.

Problems:

1. You are in a plane at rest on the runway. For the plane to take off, it must accelerate to a very high speed. As the plane begins moving, you feel the back of your seat pressing into you. Explain why by drawing a *free-body diagram* of yourself and connecting it to Newton's Second Law.
(FYI: This is why you aren't allowed to recline during the takeoff. That might not be perfect.)

2. When walking, you do not actually "put one foot in front of the other." What you actually do is press off the ground with your back foot. Explain why your body accelerates when you do this by referring to at least two of Newton's Laws.

3. If you are in a car that stops very quickly, and you are not wearing a seat belt, then even though the car stops, you can continue moving forward. By referring to Newton's Laws, explain what happens when you are wearing a seatbelt and what happens when you are not.

4. Using Newton's Second and Third Laws, explain how swimmers move in the water and why swimming is so difficult

Answers:

1. According to Newton's Second Law, in order for you to accelerate a force must act on *you*. The plane accelerates because of air shooting fast out of the engine, but this is not a force on you.
The force on you is provided by the back of your seat.
The free body diagram would have three forces:
- gravity DOWN
- the normal force provided by the seat UP
- the force of your seat pressing you horizontally FORWARD

Because the seat is pressing you, you feel a sensation of begin pressed into your seat while the plane is taking off.

2. In order to properly walk, you need to press off the ground.
According to newton's Third Law, when you press back on the ground the ground presses your body forward.
Newton's Second Law (F = ma) means that a significant force is necessary to make a large mass accelerate. As an average human has a mass of about 80 kg, humans need a significant force in order to accelerate their body forward. This force is the reaction force of the ground pressing back on you.

3. If the car stops moving, this counts as an acceleration (a negative acceleration, or an acceleration opposite the direction of motion). However, an acceleration (even a negative one), requires a force. In the absence of a seat belt, no force will act on you. According to Newton's First Law, as the car slows down, you will continue moving forward at a constant velocity.

4. Third Law: A swimmer presses *backwards* against the water with his or her arms. The water then exerts a forward force on the swimmer.
Second Law: Because of the high mass of the swimmer, a very large force is necessary to move the body through the water. Also, according to Newton's Second Law, *net force* determines acceleration, which means the substantial fluid resistance of the water must be overcome to make your body accelerate.