**What is a Force?**

A force is a push or pull on an object from another object resulting from an interaction. When the interaction stops, the two objects no longer experience the force. For the sake of simplicity, forces can be placed into two categories: contact forces and action-at-a-distance forces.

**Contact forces** are the types of forces that result when two interacting objects are physically contacting each other. Some examples of contact forces are frictional forces, tension forces, normal forces, and applied forces.

**At-a-distance** forces are the types of forces that result when to objects are interacting but are not in physical contact with each other. A great example of an at-a-distance force is gravitational force. The planets are not in contact with the sun, however they are attracted by the force of gravity and so they orbit the sun. Other examples of at-a-distance forces are electric forces and magnetic forces.

Before moving onto forces and their calculations, frames of reference need to be discussed. The use of frames of reference will be important in calculating force.

Frames of Reference

*Imagine you’re in a car moving at 100km/h along the highway. The other cars around you are also moving at 100km/h, but as you sit in the car and look around, the other cars may look as if they’re standing still. Meanwhile, if someone was standing on the side of the highway and looking at the cars, they would see cars zooming by them at 100km/h.*

The example above demonstrates frame of reference. A frame of reference can be thought as any spot where you are doing your measurement, as long as you are not accelerating. This can also be called an inertial frame of reference. Frames of reference are used to determine velocities relative to the observer.

Example:

In the following set of examples we will have two observers, person A and person B. Person A is standing on a moving track while person B is observing them. If the track and person A don’t move, both person A and person B can say that the velocity of person A is 0m/s.

Now imagine that the track doesn’t move, but person A decides to run forward at a speed of 10m/s. Person A observes that they’re moving at 10m/s and person B also observes that they’re moving at 10m/s. What would happen if the track started moving?

This time, the track moves forward at a speed of 5m/s as person A runs at a speed of 10m/s in the same direction. Person A will still observe that they are moving at 10m/s. However, person B will observe that person A Is moving at a faster speed. This new observed speed is the addition of the speed at which the track is moving and the speed of person A. Therefore, person B observes that person A is running at 15m/s.

What if the reverse happens? The track moves backwards at a speed of 5m/s as person A runs forward at 10m/s. Once again, person A observes that they are moving forward at a speed of 10m/s, however person B will observe that person A is running slower. The new observed speed is the difference between the speed of the track and the speed of person A. Thus, person B observes that person A is running at a speed of 5m/s forward.

These are examples of relative motion, or the velocity that is measured given a certain frame of reference.

Summary Table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Person B** | **Person A** | **Track** | **Observed Speed by Person A** | **Observed Speed by Person B** |
| Not Moving | Not Moving | Not Moving | 0m/s | 0m/s |
| Not Moving | Forwards at 10m/s | Not Moving | 10m/s | 10m/s |
| Not Moving | Forwards at 10m/s | Forwards at 5m/s | 10m/s | 15m/s |
| Not Moving | Forwards at 10m/s | Backwards at 5m/s | 10m/s | 5m/s |

Something of interest:

Frames of reference and relative velocities are actually the reason why people get car sick. The brain receives two sets of information about the body’s motion. This information comes from the eyes and the inner ear. When in a car, the brain receives two different sets of information as the eyes watch cars drive by. People who are sensitive to these changes, become car sick. For those prone to getting car sick, a quick relief is to look forward at a point far in the distance, and to stay focused on that point.

Practice problems

1. Fill in the charts below

|  |  |  |
| --- | --- | --- |
| **Interaction** | **Is it a Force?** | **Type of Force (Contact or At-a-distance)?**  |
| The force that pushes two magnets away | Yes | At-a-distance |
| Pushing a box up a hill | Yes | Contact |
| An apple falling from a tree | Yes | At-a-distance |
| A tug of war match | Yes | Contact |
| A X-ray | Yes | At-a-distance |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Person A** | **Person B** | **Track** | **Observed Speed of Person A by Person A** | **Observed Speed of Person A by Person B** |
| Not moving | Not moving | Forwards at 10m/s | No movement | Forwards 10m/s |
| Not moving | Forwards at 25m/s | Backwards at 5m/s | Forwards 25m/s | Forwards 20m/s |
| Not moving | Backwards at 15m/s | Forwards at 20m/s | Backwards 15m/s | Forwards 20m/s |
| Forwards at 5m/s | Forwards at 10m/s | Not moving | Forwards 10m/s | Forwards 5m/s |
| Forwards at 20m/s | Backwards at 5m/s | Forwards at 25m/s | Backwards 5m/s | Forwards 20m/s |