# SPH3U UNIVERSITY PHYSICS

FORCES

- Forces in Nature (P.121)

## Forces in Nature

*Forces are all around us, acting on every object we see. Engineers must consider forces carefully when designing bridges and buildings. Forces are involved in every type of sport and activity. For example, when a pitcher throws a ball, she exerts a force on the ball that causes the ball to move forward. If the batter hits the ball, then the bat exerts a force on the ball to change its motion.*



## Forces in Nature

*In simple terms, a **force (F)** is a push or pull (and thus a vector). Forces can cause objects to change their motion – they speed things up, slow them down, push them around corners and up hills. Forces can also distort matter by compressing, stretching, or twisting them.*

## Forces in Nature

**FORCE (F)**

- a push or a pull
- causes objects to change their motion and/or shape
- is a vector quantity



## Forces in Nature

*Isaac Newton discovered many of the concepts in this unit. For this reason the unit of force, the newton, is named after him. The* ***newton (N)*** *is a derived SI unit equal to 1 kg·m/s $^2$. To measure force in the laboratory, you can use either a spring scale (mechanical) or a force sensor (electronic).*



## Forces in Nature

**FORCE (continued …)**

- is measured in newtons (N)
- 1 N = 1 kg·m/s$^2$

## The Four Fundamental Forces

*There may seem to be many different types of forces around us, but physicists have found that they are able to understand how objects interact with one another by classifying forces into only four categories:*

1. *gravitational force*
2. *electromagnetic force*
3. *strong nuclear force*
4. *weak nuclear force*



## Gravitational Force

***Gravitational force*** *is the force of attraction between all objects in the universe. It is important for large objects such as stars, planets, and moons because it holds them together and controls their motions in the same way that it controls the motion of falling objects here on Earth. However, it has an important role in the universe because it exerts attraction only.*



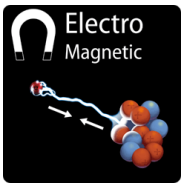

## Gravitational Force

**GRAVITATIONAL FORCE**

- known as "force of gravity" or "weight"
- attraction ONLY
- acts between all objects in the universe
- weak force but long range

## Electromagnetic Force

*The **electromagnetic force** can exert either an attraction or a repulsion, so on overage, the forces tend to cancel each other out. It is the electromagnetic force that holds atoms and molecules together, making diamonds hard and cotton weak. In fact, most of the forces that we experience daily are electromagnetic in origin.*

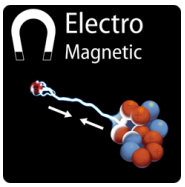





## Electromagnetic Force

**ELECTROMAGNETIC FORCE**

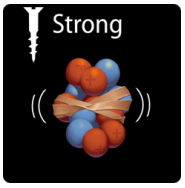
- caused by electric charges
- most common (i.e. light, electricity, magnetic attraction, ...)
- strong force and long range






## Strong Nuclear Force

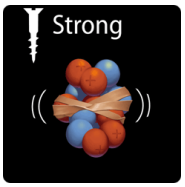
*There are strong and weak nuclear forces acting between the particles within the nucleus of an atom. The **strong nuclear force** holds the protons and neutrons together. This force is a short-range force but it is much stronger than the electromagnetic force.*



## Strong Nuclear Force

**STRONG NUCLEAR FORCE**

- holds protons and neutrons together in the nucleus of an atom
- strongest force but very short range






## Weak Nuclear Force

*Besides the proton and the neutron, there are many more "elementary" particles including the electron. Many of these particles, including the neutron, are unstable and break up. The* ***weak nuclear force*** *is responsible for these interactions.*




## Weak Nuclear Force

**WEAK NUCLEAR FORCE**

- responsible for radioactive decay
- strong force but very short range

## The Four Fundamental Forces

**PRACTICE**

1. In what way is gravitational force unique among the fundamental forces?

   exerts an attractive force only (others can exert both attractive and repulsive forces)



## The Four Fundamental Forces

**PRACTICE**

2. Which of the fundamental forces do you notice most often in your everyday activities?

   electromagnetic (i.e. light, electricity, magnetic attraction, …)



## The Four Fundamental Forces

**PRACTICE**

3. Name the fundamental force that is responsible for:
   (a) preventing protons from flying apart in the nucleus of an atom.
   (b) keeping stars in huge groups called galaxies.
   (c) the function of a magnetic compass.

   (a) strong nuclear force
   (b) gravitational force
   (c) electromagnetic force

## The Four Fundamental Forces

**PRACTICE**

4. List the four fundamental forces from weakest to strongest.

    1. gravitational
    2. weak nuclear
    3. electromagnetic
    4. strong nuclear



## ✔ Check Your Learning

**TEXTBOOK**

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