

## Chapter 12 Forces and Motion

**Section 12.4 Universal Forces****(pages 378–382)**

*This section defines four forces that exist throughout the universe. It describes each force and discusses its significance.*

**Reading Strategy (page 378)**

**Comparing and Contrasting** As you read this section, compare two universal forces by completing the table. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.

Universal Nuclear Forces			
Force	Acts on Which Particles?	Acts Over What Distance?	Relative Strength
Strong nuclear		Very short	
Weak nuclear			Weaker than the strong force

**Electromagnetic Forces (pages 378–379)**

- Is the following sentence true or false? Electromagnetic force is associated with charged particles. \_\_\_\_\_
- Circle the two forces that can both attract and repel.  
electric force      gravitational force      magnetic force
- Complete the sentence using the words *attract* and *repel*. Objects with like charges \_\_\_\_\_ one another, and objects with opposite charges \_\_\_\_\_ one another.
- Circle the letters of the sentences that correctly describe magnets or magnetic forces.
  - Magnetic forces act on certain metals.
  - Magnets have two poles, north and south.
  - Two poles that are alike attract each other.

**Nuclear Forces (pages 379–380)**

- The force that holds particles in the nucleus together is the \_\_\_\_\_.

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6. Nuclear forces are strong enough to overcome the electric force of repulsion that acts among the positively charged \_\_\_\_\_ in the nucleus. Circle the correct answer.

neutrons          particles          protons

7. Circle the letter of the best answer. Over extremely short distances, approximately how many times stronger is the strong nuclear force than the electric force of repulsion?

- a. 10
- b. 100
- c. 1000

**Gravitational Force (pages 380–382)**

8. Newton’s law of universal gravitation states that every object in the universe \_\_\_\_\_ every other object.

9. Circle the letter of each sentence that is true about gravitational force.

- a. The farther apart two objects are, the weaker the gravitational force.
- b. The greater the mass of an object, the stronger its gravitational force.
- c. Earth’s gravitational force is stronger than the gravitational force of the sun.

10. The gravitational force of attraction between two objects depends on \_\_\_\_\_ and \_\_\_\_\_. Circle the best answers.

mass          velocity          distance

11. Is the following sentence true or false? Gravity is the weakest universal force, but it is the most effective force over long distances.

\_\_\_\_\_

12. The sun’s mass is much greater than the mass of Earth, so the sun’s gravitational force is much \_\_\_\_\_ than that of Earth.

13. Is the following sentence true or false? The gravitational pull of the moon is the primary cause of Earth’s ocean tides. \_\_\_\_\_

14. Is the following sentence true or false? An artificial satellite in a high orbit will slow down and lose altitude due to the pull of Earth’s gravity. \_\_\_\_\_