12 Chapter Assessment

Go Online PHSchool.com
For: Study and Review
Visit: PHSchool.com
Web Code: csd-1120

Ch. 12 Universal Gravitation

Concept Summary

The moon and other objects in orbit around Earth are actually falling toward Earth but have great enough tangential velocity to avoid hitting Earth.

According to Newton's law of universal gravitation, everything pulls on everything else with a force that depends upon the masses of the objects and the distances between their centers of mass.

- The greater the masses, the greater is the force.
- The greater the distance, the smaller is the force.

Gravitation decreases according to the inverse-square law. The force of gravity weakens as the distance squared.

Key Terms

inverse-square law (12.5)
law of universal gravitation (12.4)
perturbation (12.6)
universal gravitational constant, G (12.4)

Review Questions *Check Concepts*

1. Why did Newton think that a force must act on the moon? (12.1)
2. What did Newton conclude about the force that pulls apples to the ground and the force that holds the moon in orbit? (12.1)
3. If the moon falls, why doesn't it get closer to Earth? (12.2)
4. What is meant by tangential velocity? (12.2)
5. How did Newton check his hypothesis that there is an attractive force between Earth and the moon? (12.2)
6. What is required before a hypothesis (an educated guess) advances to the status of a scientific theory (organized knowledge)? (12.2)
7. Since the planets are pulled to the sun by gravitational attraction, why don't they simply crash into the sun? (12.3)
8. What did Newton discover about gravity? (12.
9. What does the very small value of the gravitational constant G (in standard units) tell us about the strength of gravitational forces? (12.
10. What are the two masses and the one distance that determine your weight? (12.4)
11. In what way is gravity reduced with distance from Earth? (12.5)
12. What would be the difference in your weight if you were five times farther from the center of Earth than you are now? Ten times? (12.5)
13. What makes Earth round? (12.6)
14. What causes planetary perturbations? (12.6)

Plug and Chug *Use Equations*

15. Calculate the force of gravity on a 1-kg mass at Earth's surface. The mass of Earth is 6×10^{24} kg, and its radius is 6.4×10^{6} m.
16. Calculate the force of gravity on the same 1-kg mass if it were 6.4×10^{6} m above Earth's surface (that is, if it were 2 Earth radii from Earth's center).
17. Calculate the force of gravity between Earth (mass = 6.0×10^{24} kg) and the moon (mass = 7.4×10^{22} kg). The average Earth–moon distance is 3.8×10^{8} m.
18. Calculate the force of gravity between Earth and the sun (sun's mass = 2.0×10^{30} kg; average Earth–sun distance = 1.5×10^{11} m).

19. Calculate the force of gravity between a newborn baby (mass = 4 kg) and the planet Mars (mass = 6.4×10^{23} kg), when Mars is at its closest to Earth (distance = 8×10^{10} m).

20. Calculate the force of gravity between a newborn baby of mass 4 kg and the obstetrician of mass 75 kg, who is 0.3 m from the baby. Which exerts more gravitational force on the baby, Mars or the obstetrician? By how much?

Think and Explain *Think Critically*

21. Comment on whether or not this label on a consumer product should be cause for concern. *CAUTION: The mass of this product affects every other mass in the universe, with an attracting force that is proportional to the product of the masses and inversely proportional to the square of the distance between them.*

22. Earth and the moon are gravitationally attracted to each other. Does the more massive Earth attract the moon with a greater force, the same force, or less force than the moon attracts Earth?

23. What is the magnitude and direction of the gravitational force that acts on a woman who weighs 500 N at the surface of Earth?

24. If the gravitational forces of the sun on the planets suddenly disappeared, in what kind of paths would the planets move?

25. The moon "falls" 1.4 mm each second. Does this mean that it gets 1.4 mm closer to Earth each second? Would it get closer if its tangential velocity were reduced? Explain.

26. If the moon were twice as massive, would the attractive force of Earth on the moon be twice as large? Of the moon on Earth?

27. Which requires more fuel—a rocket going from Earth to the moon, or a rocket coming from the moon to Earth? Why?

28. Evidence indicates that the present expansion of the universe is slowing down. Is this consistent with, or contrary to, the law of gravity? Explain.

29. The planet Jupiter is about 300 times as massive as Earth, but an object on its surface would weigh only 2.5 times as much as it would on Earth. Can you come up with an explanation? (*Hint:* Let the terms in the equation for gravitational force guide your thinking.)

30. Some people dismiss the validity of scientific theories by saying they are "only" theories. The law of universal gravitation is a theory. Does this mean that scientists still doubt its validity? Explain.

Think and Solve
Develop Problem-Solving Skills

31. If the moon orbited twice as far from Earth, how far would it "fall" each second?

32. By what factor would your weight change if Earth's diameter were doubled and its mass were also doubled?

33. If you stood atop a ladder that was so tall that you were twice as far from Earth's center, how would your weight compare with its present value?

34. Estimate the size of Jupiter's diameter (compared with Earth's diameter). See Think and Explain 29.

35. To better comprehend the magnitude of the gravitational force between Earth and the moon, pretend gravity is turned off and the pull replaced by the tension in a steel cable joining them. How thick would such a cable need to be? You can estimate the diameter by knowing that the tensile strength of steel cable is about 5.0×10^8 N/m^2 (each square-meter cross section can support a force of 5.0×10^8 newtons).

More Problem-Solving Practice
Appendix F