

SOLUTIONS TO THE MODULE #11 STUDY GUIDE

1. The four fundamental forces are the gravitational force, the weak force, the strong force, and the electromagnetic force. The electromagnetic force and the weak force are really different facets of the same force. Thus, some say there are only 3 fundamental forces in creation.
2. The weakest force is the gravitational force. The strongest one is the strong force.
3. The three principles are:
 1. All objects with mass are attracted to one another by the gravitational force.
 2. The gravitational force between two masses is directly proportional to the mass of each object.
 3. The gravitational force between two masses is inversely proportional to the square of the distance between those two objects.
4. When the 10 kg mass is replaced by a 20 kg mass, the mass doubled. This doubles the gravitational force. The 6 kg mass is also doubled to 12 kg. This once again doubles the gravitational force. Thus, the total change is $2 \times 2 = 4$. The new gravitational force, then, is 4 times larger than the old one.
5. The only difference between the first and second situation is the distance between the objects was *multiplied by 4*. The gravitational force decreases when the distance between the objects increases, and it decreases according to the square of that increase. Thus, the force is *divided by 4^2* , which is 16. The new gravitational force, then, is 16 times smaller than the old one.
6. When the 1 kg mass is replaced by a 5 kg mass, the mass was multiplied by 5. This multiplies the gravitational force by 5. The 2 kg mass is doubled to 4 kg. This doubles the gravitational force. The distance between the objects was *divided by 3*. The gravitational force increases with decreasing distance between the objects. The increase goes as the square of the change in the distance. Thus, the force is *multiplied by 3^2* , which is 9. Therefore, the total change is $5 \times 2 \times 9 = 90$. The new gravitational force, then, is 90 times larger than the old one.
7. The equal and opposite force is the gravitational force that Venus exerts on the sun.
8. Centripetal force is required for circular motion.

Centripetal force – The force necessary to make an object move in a circle. It is directed perpendicular to the velocity of the object, which means it points toward the center of the circle.

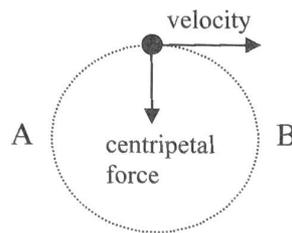
9. The three principles are:
 1. Circular motion requires centripetal force.
 2. The larger the centripetal force, the faster an object travels in a circle of a given size.
 3. At a given speed, the larger the centripetal force, the smaller the circle.

10. The wire is exerting the centripetal force. Thus, the force it exerts will change as needed by the principles listed in question #9.

- a. The wire will need to exert more force because objects that travel fast need large centripetal force.
- b. The wire will exert less force, because the larger the centripetal force, the smaller the circle. Thus, a larger circle needs less centripetal force (for the same speed).

11. It is a myth. There is no such force. The supposed effect of centrifugal force is just Newton’s First Law.

12. Traveling from “A” to “B” tells us that it is traveling clockwise. Its velocity is straight, however. Since it is traveling at a constant speed, the only force is centripetal, which always points to the center of the circle.



13. Inner Planets – Mercury, Venus, earth, and Mars

Outer Planets – Jupiter, Saturn, Uranus, Neptune

14. Mercury, Venus, earth, Mars, Jupiter, Saturn, Uranus, Neptune

15. Saturn, Uranus, Jupiter, and Neptune

16. Most of the asteroids are between the orbits of Mars and Jupiter. The student could also say that they are in the asteroid belt.

17. Perturbations in its orbit cause an asteroid to become a meteor.

18. A comet is made of a nucleus, a coma, and a tail. The nucleus is always present.

19. All three parts of a comet are present when the comet is close to the sun.

20. Comet orbits are elliptical.

21. Physicists think that short-period comets come from a mass of objects called the Kuiper belt.

22. According to General Relativity, gravity is caused by the fact that objects with mass bend space and time.

23. According to the graviton theory, gravity is caused by the exchange of particles called “gravitons.”