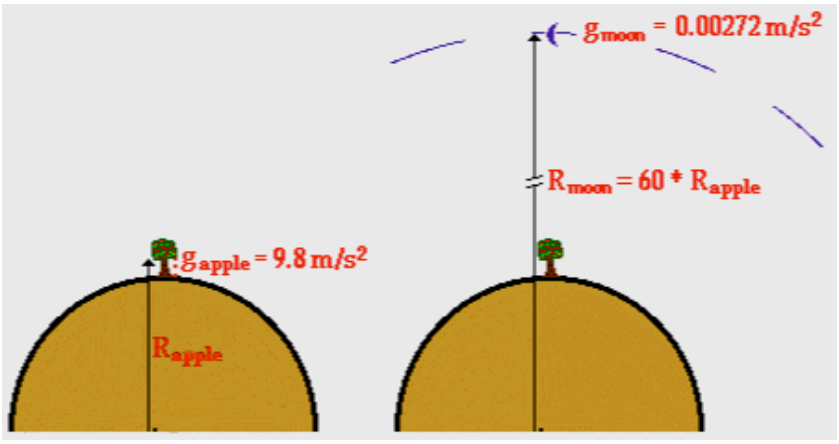
Gravity Practice Name:_____ Block:_____

1. Isaac Newton compared the acceleration of a falling apple to the acceleration of the *falling* moon. In his comparison, he proved that the moon accelerates at a rate that is 1/3600-th of the apple's rate; he also showed that the separation distance (center to center) between the moon and the Earth was 60 times the separation distance between the apple and the Earth.



This is evidence that the acceleration caused by gravity is _____ (directly, inversely)

dependent upon the _____ (square, square root, cube, cubed root, etc.) of the separation distance.

Use Newton's gravitational law and proportional reasoning in order to fill in the following blanks.

2. Two objects gravitationally attract with a force of 18 N. If the distance between the two objects' centers is doubled, then the new force of attraction is _____ N.

3. Two objects gravitationally attract with a force of 18 N. If the distance between the two objects' centers is tripled, then the new force of attraction is _____ N.

4. Two objects gravitationally attract with a force of 18 N. If the distance between the two objects' centers is halved, then the new force of attraction is _____ N.

5. Two objects gravitationally attract with a force of 18 N. If the distance between the two objects' centers is decreased by a factor of three, then the new force of attraction is _____ N.

6. Two objects gravitationally attract with a force of 18 N. If the distance between their centers is decreased by a factor of four, then the new force of attraction is ___ N.

7. Two objects gravitationally attract with a force of 18 N. If the **mass** of one of the objects is doubled and the **distance** between their centers is doubled, then the new force of attraction is _____ N.

8. Two objects gravitationally attract with a force of 18 N. If the **masses** of both of the objects are doubled and the **distance** between their centers is doubled, then the new force of attraction is _____ N.

9. Two objects gravitationally attract with a force of 18 N. If the **masses** of both of the objects are tripled and the **distance** between the two objects' centers is doubled, then the new force of attraction is _____ N.

10. The evidence that stimulated Newton to propose the law of gravitation emerged from a study of ____.
    a. the motion of the moon and other celestial or heavenly bodies
    b. the fall of an apple to the Earth
    c. the gravitational interaction of smaller objects upon the Earth
    d. ...nonsense! There was no evidence; it was just proposed as a theory.

11. The *universal* of Newton's law of universal gravitation is a common source of confusion. *Universal* means _.
    a. the amount of gravitational forces is the same for all objects.
    b. the acceleration caused by gravity is the same for all objects.
    c. the force of gravity acts between all objects - not just between the Earth and an object, but also between two people. All objects with mass attract.

12. According to Newton's gravitation law, the force of gravitational attraction between a planet and an object located upon the planet's surface depends upon _____. Choose all that apply.
    a. the radius of the planet
    b. the mass of the planet
    c. the mass of the object
    d. the volume of the object
    e. ... nonsense! None of these variables affect the force of gravity.

13. The more massive that an object is, the _____ (more, less) that the object will be attracted to Earth.

14. The more massive the Earth is, the _____ (more, less) that another object will be attracted to Earth.

15. The greater that Earth's radius is, the _____ (more, less) that another object will be attracted to Earth.

16. In the mathematical form of Newton's law of universal gravitation, the symbol **G** stands for _____.
    a. gravity
    b. the acceleration of gravity
    c. the gravitational constant

$$F_g = \frac{Gm_1m_2}{d^2}$$

17. **TRUE** or **FALSE**: The value of **G** (in the equation above) is an enormously large number; that explains why (at least in part) the force of gravitational attraction between the Sun and the very distant Earth is such a large number.

18. **TRUE** or **FALSE**: Two lab partners attract each other with a gravitational force. However, it is impossible to calculate such a force since it is only an unproven theory.

19. **TRUE** or **FALSE**: The notion that any two objects attract each other gravitationally is a theory. There is no empirical evidence for such a notion.

20. Orbiting astronauts on the space shuttle do not have weight in space because _____.
    a. there is no gravity in space
    b. there is no air resistance in space
    c. there are no scales in space
    d. the food is terrible and they work all the time
    e. ... nonsense! The astronauts do have weight in space.

21. Use the gravitational force equation to fill in the following table ($G = 6.67 \times 10^{-11}$ N•m^2/kg^2).

Mass of Object 1 (kg)	Mass of Object 2 (kg)	Distance of Separation* (m)	F_{grav} (N)	Significance of Numbers
60.0	60.0	1.0		Two typical students in physics class
60.0	5.98×10^{24}	6.37×10^{6}		A typical student on the surface of the Earth
60.0	11.96×10^{24}	6.37×10^{6}		A typical student on *an Earth* with twice the mass
60.0	5.98×10^{24}	3.18×10^{6}		A typical student on *an Earth* with half the radius
60.0	5.98×10^{24}	6.47×10^{6}		A *typical* student in orbit 60 miles above the Earth
60.0	1.2×10^{22}	1.15×10^{6}		A *typical* student on the surface of the Pluto
60.0	1.901×10^{27}	6.98×10^{7}		A *typical* student on the "surface" of the Jupiter

*The distance of separation means the distance between the centers of the two masses (NOT the distance between the two objects' edges.)

Mass of Earth	5.98×10^{24} kg	**Radius of Earth**	6,378,000 m
g (Earth)	9.8 m/s^2	**Radius of Mars**	3,398,000 m
g (Mars)	3.7m/s^2	**Mass of the Sun**	1.99×10^{30} kg

22. Using two different methods, calculate the weight of a 25 kg object on Earth. (Hint: $F_w = F_g$)

23. Using what you learned from 22 and the acceleration of gravity on Mars, calculate the mass of Mars.

24. Calculate the distance between Mars and the Sun (in both meters and kilometers) if the gravitational force between the two bodies is 1.68×10^{21} N. (You will need the mass of Mars you calculated in number 5.)