Name: _____

Class: _____

Due Date: _____

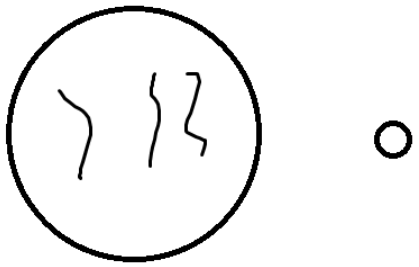
Physics Topic 19A - Newton's Law of Gravitation and Gravitational Field Strength

Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. C: State the names and describe the laws of Kepler's three laws of orbital motion.

2. C: Define *Newton's Law of Gravitation* $\vec{F}_{\mathrm{g}} = m_1\vec{g} = \frac{Gm_1m_2}{r^2}$. Units?

3. C: A satellite in space moves in a counterclockwise circle around the Earth with a constant speed at a radius *r* from the center of the Earth. Label the direction of the velocity, force, and acceleration of the satellite in the diagram below.



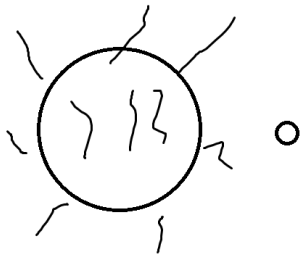
4. C: The force of gravity between a satellite circling the Earth at a distance *r* at a constant speed is F_g. What will happen to the magnitude of the force of gravity between the satellite and the Earth if the satellite moves a distance

a. 2*r*. b. 3*r*. c. 4*r*. d. *r*/2. e. *r*/3. f. *r*/4.

5. C: A satellite is moving in a circle with a constant speed around the sun.

   a. Use Newton's second law of motion to obtain an equation for the speed of the satellite in terms of the mass of the sun M_{sun}, the mass of the satellite $M_{\text{satellite}}$, the distance of the satellite to the sun r, and the gravitational constant G.

   b. Use your solution to obtain an equation for the period T of the satellite.



6. E: The mass of the Sun is approximately 1.99×10^{30} kg. The Earth is approximately 1.50×10^{11} m from the Sun. Use this information to determine

   a. the speed of the Earth in m/s and
   b. the period of the Earth in days.

7. E: A satellite, which has a mass of 550. kg and a radius of 2.20 meters, is orbiting the Earth at an altitude of 375 km.

   a. What will be the magnitude of the gravitational force between this satellite and the Earth?

   b. What must the velocity of this satellite be in order for the satellite to remain in a stable orbit?

   c. What will be the magnitude of the centripetal acceleration of this satellite?

d. How long, in seconds, will it take for this satellite to orbit the Earth once?

8. C: The following problem refers to *gravitational field strength*.

   a. Define g*ravitational field strength*. Is it a scalar or a vector?

   b. What is the equation and what are the units for *gravitational field strength*? Define and give the units of each variable.

   c. Between two objects where is the *gravitational field strength* zero? Between two objects where is the *gravitational field strength* maximum?

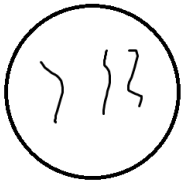
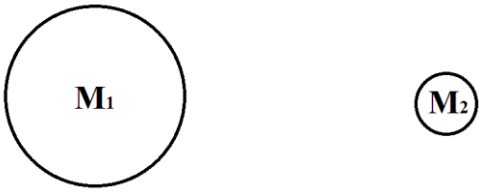
   d. What are the mathematical limits of *gravitational field strength*? Can *gravitational field strength* be positive? Negative? Zero?

9. E: The mass of the Earth is approximately 5.97×10^{24} kg and its radius is approximately 6.38×10^{6} m. Use the equation $g = \frac{GM}{r^2}$ to determine the acceleration of gravity near the Earth's surface.

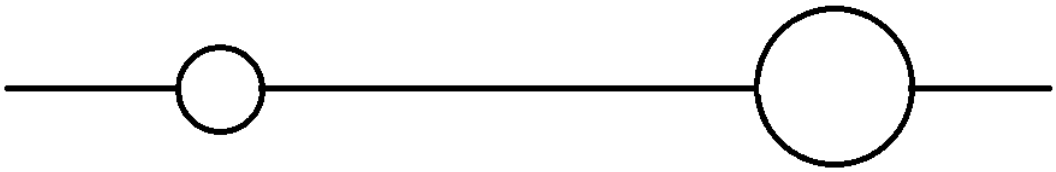
10. C: Draw a *gravitational field strength vs. distance* graph for a planet with a radius *r*.

11. C: List some rules in drawing gravitational field lines.

12.C: **Use a pencil and ruler!** Draw gravitational field lines for each figure.

A fixed uniform spherical mass	Two fixed uniform spherical masses with equal mass and equal radius
	
Two fixed uniform spherical masses with $M_1 \gg M_2$	
	

13.E: The center of a planet of mass of $m_1 = 4M$ is a distance of $5d$ to the left from the center of a larger planet of mass $m_2 = 9M$. Assume that the mass of the planets can be concentrated at their centers.



What will be the gravitational field strength (both magnitude and direction) at a point

a. $2d$ to the left of mass m_1?

b. $2d$ to the right of mass m_1?

c. $2d$ to the left of mass m_2?

d. $2d$ to the right of mass m_2?

14.E: Earth has a mass of approximately 5.97×10^{24} kg while Mars has a mass of approximately 6.42×10^{23} kg. Both planets are separated by approximately 2.28×10^{8} km and can be taken to be point particles. How many meters from Mars does a 3.00×10^{3} kg white rhino have to be placed to feel no force?

15.E: A rock in space, which is initially at rest, has a mass $m_1 = 400.\,\text{kg}$ and is 6.00×10^{3} km away from two fixed rocks, each with a mass of 1.00×10^{6} kg, as shown in the image below. What is the acceleration of m_1 at the moment when it is released from rest?