ABRHS PHYSICS

NAME: KEY

Gravity, Part 2

Some useful numbers for this sheet. $G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$

Mass of Earth: 6×10^{24} kg
Mass of Moon: 7.4×10^{22} kg
Radius of Earth: 6.4×10^{6} m
Radius of Moon: 1.74×10^{6} m

Distance Earth-Moon: 3.8×10^{8} m
Distance Earth-Sun: 1.5×10^{11} m

1. The earth exerts a gravitational force of 7000 N on a satellite. What force does the satellite exert on the earth?
   7000 N! (Newton's 3rd Law!)

2. The Law of Universal Gravitation states that the gravitational force increases as the mass increases and decreases as the distance increases.

3. Calculate the force of attraction between a 300 kg mass and a 550 kg mass that are 20 cm apart.
   20 cm = .2 m
   $F = \frac{(6.67 \times 10^{-11})(300)(500)}{(.2)^2} = 2.75 \times 10^{-4}\ N$ or .000275 N

4. If the earth shrank to half its current size, but kept the same mass, how much would a 45 kg child weigh on the surface of the earth?
   $\frac{1}{2}(6.4 \times 10^{6}) = 3.2 \times 10^{6}$
   $F = \frac{(6.67 \times 10^{-11})(6 \times 10^{24})(45)}{(3.2 \times 10^{6})^2} = 1760\ N$
   OR normally $w = mg = (45)(10) = 450\ N$
   If we $\frac{1}{2}$ radius, then we $\frac{1}{2}$ d $\therefore$ $F_g \to \frac{1}{(\frac{1}{2})^2} = \frac{1}{1/4} = 4x!$ $\therefore$ 1800N

5. Imagine you and a friend are on a planet with a mass of 3.67×10^{24} kg and a radius of 7×10^{6} m.
   a. How much would you weigh on that planet on this planet if your mass were 60 kg?
      $\frac{(6.67 \times 10^{-11})(3.67 \times 10^{24})(60)}{(7 \times 10^{6})^2} = 1300\ N$
   b. How much would your dog weigh on that planet if your dog's mass were 30 kg?
      $\frac{(6.67 \times 10^{-11})(3.67 \times 10^{24})(30)}{(7 \times 10^{6})^2} = 150\ N$
   c. How much would a big 120 kg rock weigh on that planet?
      $\frac{(6.67 \times 10^{-11})(3.67 \times 10^{24})(120)}{(7 \times 10^{6})^2} = 600\ N$
   d. Do you notice any pattern with your answers to parts a, b and c? (Hopefully you do.)
      They are all 5 times the mass of dog/rock!
      $\to \therefore \frac{(6.67 \times 10^{-11})(3.67 \times 10^{24})}{(7 \times 10^{6})^2} = 5!$
   e. What is the acceleration due to gravity on that planet?
      $5\ m/s^2$!

↑ from rounded off g_C 10 m/s²

Gravity, Part 2

6. Two masses are placed so that their centers are 0.26 m apart. The force between them is 2.75×10^{-12} N.

   a. If one mass is 0.025 kg, what is the other mass?

$$2.75 \times 10^{-12} = \frac{(6.67 \times 10^{-11})(.025)\, m}{(.26)^2}$$

$m = 0.11$ kg

   b. Calculate m_1 and m_2 if the masses are identical.

$$2.75 \times 10^{-12} = \frac{(6.67 \times 10^{-11})(m)(m)}{(.26)^2} = \frac{(6.67 \times 10^{-11})\, m^2}{(.26)^2}$$

$m^2 = 0.00279$

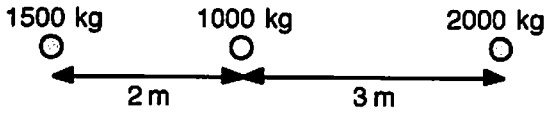
$m = .053$ kg

   c. Calculate m_1 and m_2 if $m_1 = 2m_2$. ← $= 2m_2^2$

$$2.75 \times 10^{-12} = \frac{(6.67 \times 10^{-11})(2m_2)(m_2)}{(.26)^2}$$

$m_2^2 = 0.00139$ $\quad m_2 = 0.037$ kg $\quad \& \quad m_1 = 2m_2 = 0.075$ kg

7. Calculate the net force on the 1000 kg mass in the diagram below.



$F_1 \leftarrow \circ \rightarrow F_2$

opposite directions, so subtract!

$$F_1 = G\frac{(1500)(1000)}{2^2}$$

$F_1 = 2.50 \times 10^{-5}$ N

$$F_2 = G\frac{(1000)(2000)}{3^2}$$

$F_2 = 1.48 \times 10^{-5}$ N

$F_1 - F_2 = 1.02 \times 10^{-5}$ N ← to left

8. Instead of 2000 kg, what should the third mass be so that the net force on the middle mass is zero?

So $F_1 = F_2$

$$G\frac{(1500)(1000)}{2^2} = G\frac{(1000)\, m}{3^2}$$

$$2.5 \times 10^{-5} = G\frac{(1000)\, m}{3^2}$$

$m = 3375$ kg

Answers: 1) 7000 N 2) increases; decreases 3) 0.000275 N 4) 1760 N
5. a) 300 N b) 150 N c) 600 N d) all 5x the mass; all proportional e) 5 m/s²
6. a) 0.11 kg b) 0.053 kg c) 0.0373 kg & 0.0747 kg
7) 1.02×10^{-5} N to the left 9) 3375 kg