 NAME: KEY

Gravity, Part 1

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

Conceptual Questions

1. What is Newton's Theory of Universal Gravitation? (Words and equation.)
   Every particle is attracted to every other particle in the universe. $F_g = G\frac{m_1 m_2}{d^2}$
2. Why does he call it universal?
   Because it applies universely to all matter.
3. What does the "d" represent in the equation?
   the distance between m_1 & m_2 (from center to center)
4. What is "G?" (Words and number.)
   Just a constant in nature. $G = 6.67 \times 10^{-11}\ N{\cdot}m^2/kg^2$
5. If you get farther away from the earth, what happens to:
   a. the force of gravity acting on you? smaller!
   b. the acceleration due to gravity acting on you? smaller!
   c. your weight? smaller!
5. Why do we only notice the gravitational attraction to the earth, and not to the people and objects around us?
   Gravity is actually a pretty weak force – except for the earth, the forces are way too small feel or notice.
6. If you are standing on the earth, what is the distance between you and the earth, at least as far as universal gravitation is concerned?
   the radius of the earth – 6.4×10^{6} m

Calculations

1. a. Calculate the gravitational force between the earth and the moon.
   $$F_g = G\frac{(6\times10^{24})(7.4\times10^{22})}{(3.8\times10^{8})^2} = \boxed{2.05 \times 10^{20}\ N}$$
   b. Which experiences the greater force – the earth or the moon?
   The same! (Newton's 3rd Law)
   c. Which experiences the greater acceleration – the earth or the moon?
   the moon! ($F=ma$ → same force, but mass of moon is less)
   d. Why doesn't the moon crash into the earth?
   b/c it is moving! The force of gravity on the moon is the centripetal force that lets the moon go in (basically) a circle around the earth.

Gravity, Part 1

2. a. What is gravitational force between two people (60 kg and 75 kg) who are 1 meter apart.

$$F_g = (6.67 \times 10^{-11})\frac{(60)(75)}{1^2} = 3 \times 10^{-7}\ N$$

b. Compared to other every day forces, how large is this attraction?

Stupidly small.

c. Is it even noticable?

Nope.

3. Calculate the gravitational force between you (m = 65 kg) and the earth.

Old way: $w = mg$

$w = (65)(10)$

$= 650\ N$

New way: $F_g = G\frac{(65)(6 \times 10^{24})}{(6.4 \times 10^{6})^2}$

$F_g = 635\ N$

Remember: g = 10 is rounded up! either answer would be fine.

4. If you were somehow floating in space 6.4 x 10[6] m above the surface of the earth, what would be the gravitational force on you? (Still use 65 kg)

Old way: If d is doubled, the force is $(\frac{1}{2})^2 = \frac{1}{4}$

$\therefore \frac{1}{4}(650) = 163 N$

New way: $F_g = G\frac{(65)(6 \times 10^{24})}{[12.8 \times 10^{6}]^2}$

$F_g = 159\ N$

5. There is a gravitational force of 100 N between two objects. What would be the gravitational force if

$G\frac{m_1 m_2}{d^2} = 100$

a. the distance between them were doubled. $\frac{(1)(1)}{(2)^2} = \frac{1}{4}x \rightarrow 25 N$

b. the distance between them were halved. $\frac{(1)(1)}{(\frac{1}{2})^2} = 4x \rightarrow 400\ N$

c. the distance between them were tripled. $\frac{(1)(1)}{(3)^2} = \frac{1}{9}x \rightarrow 11.1\ N$

d. if the mass of one of the objects doubled. $\frac{(2)(1)}{(1)^2} = 2x \rightarrow 200\ N$

e. if the mass of both of the objects doubled. $\frac{(2)(2)}{(1)^2} = 4x \rightarrow 400\ N$

f. if the mass of one of the objects were halved. $\frac{(\frac{1}{2})(1)}{(1)^2} = \frac{1}{2}x \rightarrow 50\ N$

g. if the size of one of the objects were doubled (and the mass stayed the same.)

$\frac{(1)(1)}{(1)^2} = 1x \rightarrow 100\ N$

h. if the size of both of the objects were doubled (and the mass stayed the same.)

$\frac{(1)(1)}{(1)^2} = 1x \rightarrow 100\ N$

Answers: 1. a) 2.05 x 10^{20} N b) the same c) the moon d) because it moves really fast in a nearly circular orbit; its acceleration is changing its direction of travel. 2. a) 3 x 10^{-7} N b) really, really small c) not a bit 3) 635 N 4) 159 N 5. a) 25 N b) 400 N c) 11.1 N d) 200 N e) 400 N f) 50 N g) 100 N h) 100 N