Sabrina Fox

32/33

P20 Unit B: VA pt. B - Gravity.

Due: Nov. 14, 2012

1. Galileo

Galileo was a scientist that mainly dealt with the stars and celestial bodies, but he also made a contribution to our understanding of gravity. In the 16th century, Galileo saw a relationship between the rate at which objects fell and the force of gravity acting on the object. Galileo then conducted experiments to test this relationship. He demonstrated that the force of gravity causes objects to move with a constant acceleration with a magnitude of $-9.81 m/s^2$. This is called the acceleration due to gravity, and explains how objects towards the centre of the Earth due to the force of gravity.

2

Newton

Newton found a way to express the gravitational force two objects exert on one another; he discovered that the force of gravity was directly proportional to the product of the masses of the objects ($\vec{F}_g \propto m_1 m_2$), and the force of gravity was inversely proportional to the square of the distance they are seperated ($\vec{F}_g \propto 1/r^2$). From these proportionalities, Newton came up with the statement $\vec{F}_g = \frac{G m_1 m_2}{r^2}$. The only thing he was missing was the value of G... dun dun DUN...

2

Cavendish

Henry Cavendish conducted an experiment that could determine the universal gravitational constant; he built a torsion balance, which consisted of two large masses, two smaller masses, and a delicate fibre. The two small masses were attached to a pole and suspended with the delicate fibre. The other masses were placed perpendicular to the small masses. When the small masses are released, they are acted on by the large masses, causing them to move, which makes the fibre twist. The amound of twist in the fibre was used to calculate G.

2

5. $\vec{F}_g = \frac{Gm_1m_2}{r^2}$

$\vec{F}_g = \frac{(6.67\times10^{-11}\,Nm^2/Kg^2)(70\,kg)(50\,kg)}{(4.0\,m)^2}$

$\vec{F}_g = \frac{(2.33\times10^{-7}\,Nm^2)}{(4.0\,m)^2}$

✓ $\vec{F}_g = 1.5\times10^{-8}\,N$

↓

2

$\vec{F}_g = \frac{Gm_1m_2}{r^2}$

$\vec{F}_g \propto \frac{(1)(1)(1)}{(1/4)^2}$

$\vec{F}_g \propto 16$

The attraction between the spheres will be 16x stronger when they are 1.0m apart.

6. a) $\vec{g} = \frac{Gm}{r^2}$

$\vec{g} = \frac{(6.67\times10^{-11}\,Nm^2/kg^2)(1.50\times10^{24}\,kg)}{(18000000\,m)^2}$

2

$\vec{g} = \frac{(1.00\times10^{14}\,Nm^2/kg)}{(18000000\,m)^2}$

$\vec{g} = 0.309\,N/kg$

b) $\vec{F} = m\vec{a}$

2

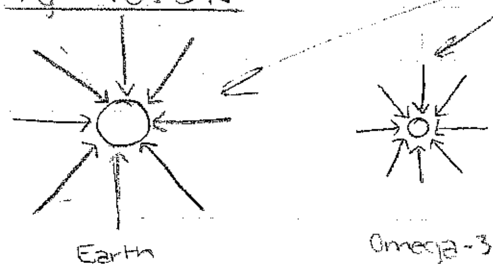
$\vec{F}_g = m\vec{g}$

$\vec{F}_g = (60.0\,kg)(0.309\,N/kg)$

$\vec{F}_g = 18.5\,N$

For Earth, the lines should be closer together.

$\frac{1}{2}$ c)



Earth has both a bigger mass and radius than Omega-3. This means that the value of $\vec{g}$ will be larger, as both of those values are proportional to $\vec{g}$.

$$(1.64\ N/kg) = \frac{(6.67\times10^{-11}\ Nm^2/kg)\, m_2}{(3.03\times10^{12} m^2)}$$

$$\frac{(1.64\ N/kg)(3.03\times10^{12} m^2)}{(6.67\times10^{-11}\ Nm^2/kg)} = m_2$$

2 $7.4\times10^{22} kg = m_2$

The moon has a mass of 7.4×10^{22} kg.

9. $$\vec{g} = \frac{Gm}{r^2}$$

$$\vec{g} = \frac{(6.67\times Nm^2/kg^2 \times10^{-11})(5.97\times10^{24} kg)}{[(6.37\times10^6 m)+(160000m)]^2}$$

$\vec{g} = 9.34\ N/kg$

2 $\vec{F}_g = m\vec{g}$

$\vec{F}_g = (20.0kg)(9.34\ N/kg)$

$\vec{F}_g = 187\ N$

10. $$\vec{F}_g = \frac{Gm_1m_2}{r^2}$$

$$(5.44\times10^{-8} N) = \frac{(6.67\times10^{-11}\ Nm^2/kg^2)\, m^2}{((0.75\ m)^2)}$$

$3.06E-8\ Nm^2 = (6.67\times10^{-11}\ Nm^2/kg^2)\, m^2$

$(458\ kg^2) = m^2$

2 $21.4 kg = m$

The mass of each object is 21.4 kg.