KEY

Universal Gravitation and Gravitational Fields

Name - ________________

Use Table 8-1 on page 159 for some of the questions below.

1.) What is the force of gravity on the following masses at the earth's surface, use Universal Gravitation.

a.) $75\ kg$.

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

$\vec{F}_g = \frac{(6.67\times10^{-11})(5.98\times10^{24})(75)}{(6.38\times10^6)^2}$

$\vec{F}_g = 735\ N$

b.) $500\ g$.

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

$\vec{F}_g = \frac{(6.67\times10^{-11})(5.98\times10^{24})(0.5)}{(6.38\times10^6)^2}$

$\vec{F}_g = 4.90\ N$

2.) The force of gravity on a mass is known to be $12\ 000\ N$ at earth's surface. What is the force of gravity at the following distances:

a.) 2.5 radii.

Answer - $\vec{F}_g = m \times \frac{1}{d^2}$

$\vec{F}_g = 12000 \times \frac{1}{(2.5)^2}$

$\vec{F}_g = 1920\ N$

b.) 3 radii.

$\vec{F}_g = m \times \frac{1}{d^2}$

$\vec{F}_g = 12000 \times \frac{1}{(3)^2}$

$\vec{F}_g = 1.33 \times 10^3 N$

c.) 4 radii.

$\vec{F}_g = m \times \frac{1}{d^2}$

$\vec{F}_g = 12000 \times \frac{1}{(4)^2}$

$\vec{F}_g = 750\ N$

3.) Find the mass of a person who experiences a force of gravity of $281\ N$ on the surface of Mars.

Answer - $\vec{F}_g = \frac{Gm_1m_2}{r^2}$ $\quad 281 = \frac{(6.67\times10^{-11})(6.42\times10^{23})(m)}{(3.38\times10^6)^2}$ $\quad m = 75\ N$

4.) What is the mass of the moon if a person on earth experiences a force of gravity of $735\ N$, the radius of the moon is 1.74×10^6 m and the force of gravity on the moon is $122\ N$.

Answer - $\vec{F}_{net} = m\vec{a}$ $\quad \vec{F}_g = m\vec{g}$ $\quad 735 = m(-9.81)$ $\quad m = 74.9235\ kg$

$\vec{F}_g = \frac{Gm_1m_2}{r^2}$ $\quad 122 = \frac{(6.67\times10^{-11})(74.9235)(m)}{(1.74\times10^6)^2}$ $\quad m = 7.4 \times 10^{22} kg$

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5.) Show by calculation the gravitational field strength at:

a.) the earth's surface. b.) five radii. c.) the surface of the sun.

Answer - $\vec{F}_g = \frac{Gm_1m_2}{r^2}$ and $\vec{F}_g = mg$ $mg = \frac{Gm_1m_2}{r^2}$ solve for g $g = \frac{Gm}{r^2}$

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

$g = \frac{(6.67\times10^{-11})(5.98\times10^{24})}{(6.38\times10^{6})^2}$

$\vec{F}_g = 9.80\frac{N}{kg}$

b.) $g = \frac{Gm}{r^2}$

$g = \frac{(6.67\times10^{-11})(5.98\times10^{24})}{(6.38\times10^{6}\times5)^2}$

$\vec{F}_g = 0.392\frac{N}{kg}$

c.) $g = \frac{Gm}{r^2}$

$g = \frac{(6.67\times10^{-11})(1.991\times10^{30})}{(6.960\times10^{8})^2}$

$\vec{F}_g = 274\frac{N}{kg}$

6.) A spaceship experiences a gravitational field toward the earth of $2.0\frac{N}{kg}$, what would the same field strength be when the ship is half that distance from the earth?

Answer - $g = \frac{Gm}{r^2}$ $2 = \frac{1}{r^2}$ $r = 0.707\ m$

$g = \frac{Gm}{r^2}$ $g = \frac{1}{(0.707\div2)^2}$ $r = 8\frac{N}{kg}$ four times stronger!!

7.) 1 pound is about $4.5\ N$, how much would a $10\ kg$ cat weigh on Mars, Earth, and Jupiter?

Answer - Mars $\vec{F}_g = \frac{Gm_1m_2}{r^2}$ $\vec{F}_g = \frac{(6.67\times10^{-11})(6.42\times10^{23})(10)}{(3.38\times10^{6})^2}$ $\vec{F}_g = 37.48\ N$

$w = 37.48\times\frac{1}{4.5}$ $\vec{F}_g = 8.3\ lbs$

Earth $\vec{F}_g = \frac{Gm_1m_2}{r^2}$ $\vec{F}_g = \frac{(6.67\times10^{-11})(5.98\times10^{23})(10)}{(6.38\times10^{6})^2}$ $\vec{F}_g = 97.99\ N$

$w = 97.99\times\frac{1}{4.5}$ $\vec{F}_g = 22\ lbs$

Jupiter $\vec{F}_g = \frac{Gm_1m_2}{r^2}$ $\vec{F}_g = \frac{(6.67\times10^{-11})(1.901\times10^{27})(10)}{(6.98\times10^{7})^2}$ $\vec{F}_g = 260.253\ N$

$w = 260.25\times\frac{1}{4.5}$ $\vec{F}_g = 57.83\ lb$ $\vec{F}_g = 58\ lbs$

Answers - 1.) $735\ N, 4.9\ N$ 2.) $1920\ N, 1333\ N, 750\ N$ 3.) $75\ kg$ 4.) $7.4\times10^{22}kg$ 5.) $9.8\frac{N}{kg}, 0.392\frac{N}{kg}, 274\frac{N}{kg}$ 6.) $8\frac{N}{kg}$ 7.) $8.3\ lb, 22\ lb, 58\ lb$