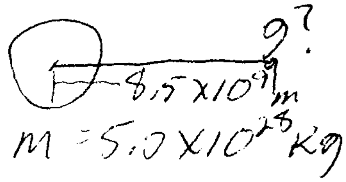
Gravitation Problems 24-31

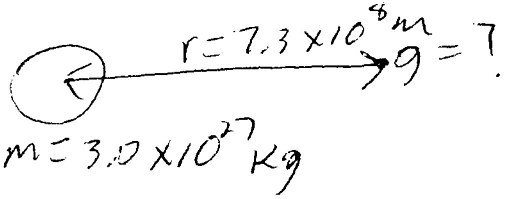
(24)



$$mg = \frac{GmM}{r^2} \;\therefore\; g = \frac{GM_{body}}{r^2} = \frac{\left(6.67\times10^{-11}\frac{N\cdot m^2}{Kg^2}\cdot 5.0\times10^{28}\,Kg\right)}{(8.5\times10^{9}\,m)^2}$$

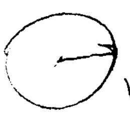
$$= 0.0462\,\frac{m}{s^2}$$
$$= 4.6\times10^{-2}\,\frac{m}{s^2}$$

(25)



$$g = \frac{GM}{r^2} = \frac{\left(6.67\times10^{-11}\frac{N\cdot m^2}{Kg^2}\cdot 3.0\times10^{27}\,Kg\right)}{(7.3\times10^{8}\,m)^2} = 0.375\,\frac{m}{s^2}$$
$$= 3.8\times10^{-1}\,\frac{m}{s^2}$$

(26)



$r_{merc} = 2.4\times10^{6}\,m$

$M_{merc} = 3.3\times10^{23}\,Kg$

$$g_{merc} = \frac{GM_{merc}}{r_{merc}^2} = \frac{\left(6.67\times10^{-11}\frac{N\cdot m^2}{Kg^2}\cdot 3.3\times10^{23}\,Kg\right)}{(2.4\times10^{6}\,m)^2} =$$

$$g_{merc} = 3.82\,\frac{m}{s^2}$$

(27) $m_{venus} = 4.9 \times 10^{24} Kg$ $r_{venus} = 6.0 \times 10^{6} m$

$$g_{venus} = \frac{G\, m_{venus}}{r_{venus}^2} = \frac{\left(6.67 \times 10^{-11} \frac{N \cdot m^2}{Kg^2}\, 4.9 \times 10^{24} Kg\right)}{\left(6.0 \times 10^{6} m\right)^2} =$$

$$g_{venus} = 9.08 \frac{m}{s^2}$$

(28) $m_{jupiter} = 1.9 \times 10^{27} Kg$ $r_{jupiter} = 7.1 \times 10^{7} m$

$$g_{jupiter} = \frac{G \cdot m_{jup}}{r_{jup}^2} = \frac{\left(6.67 \times 10^{-11} \frac{N \cdot m^2}{Kg^2} \cdot 1.9 \times 10^{27} Kg\right)}{\left(7.1 \times 10^{7} m\right)^2} =$$

$$g_{jupiter} = 25.13 \frac{m}{s^2}$$

(29) Compute g at ~~4R_E~~ $5R_E$

~~This ones simpler than it looks!~~

~~$g_{4R_E} = \frac{Gm}{r^2}$ Notice that quadrupling r will result in a reduction of g by $\frac{1}{4^2} = \frac{1}{16}$, so g at~~

~~$5\cancel{4}R_E = 9.81 \frac{m}{s^2} \cdot \left(\frac{1}{16}\right) = 0.61 \frac{m}{s^2}$~~

$$5R_E = 9.81 \frac{m}{s^2} \left(\frac{1}{5^2}\right) = 9.81 \frac{m}{s^2} \left(\frac{1}{25}\right) = 0.39 \frac{m}{s^2}$$

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(30) What is g at $5 R_E$ above the surface of the Earth?

Again, save the math by just realizing that gravity at $5 R_E$ will just be ~~proportional to~~ $\frac{1}{(5R_E + 1R_E)^2}$. So, take gravity at surface and multiply by $\frac{1}{(6\cancel{R_E})^2}$.

So, $9.81\frac{m}{s^2}\cdot\left(\frac{1}{6^2}\right) = 9.81\frac{m}{s^2}\left(\frac{1}{36}\right) = 0.27\frac{m}{s^2}$

(31) What is g on a planet with $r = 2R_E$ and $m = 2M_E$?

Again, Don't fret about lots of math here. Just realize that it is a ratio of g at surface of Earth, which is $9.81\frac{m}{s^2}$.

So, $\cancel{9.81\frac{m}{s^2}\left(\frac{2}{(1+2)^2}\right) = 9.81\frac{m}{s^2}\left(\frac{2}{(3)^2}\right) = 9.81\frac{m}{s^2}\left(\frac{2}{9}\right) =}$

$\cancel{2.18\frac{m}{s^2}}$

NO! My mistake! You're not adding to $1R_E$ like you did before.

$9.81\frac{m}{s^2}\left(\frac{\overset{\text{mass}}{2}}{\underset{\text{radius}}{(2)^2}}\right) = 9.81\frac{m}{s^2}\left(\frac{2}{4}\right) = 4.91\frac{m}{s^2}$ correct answer

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