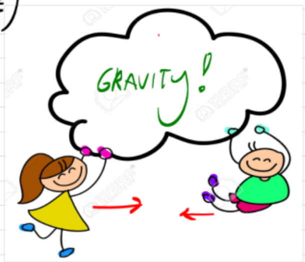
Universal Gravitation and Orbits Examples

EXAMPLES CONTINUED (FORCE)

#1 $F = \frac{GMm}{r^2}$

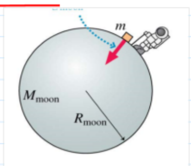
$F = \frac{(6.67\times10^{-11})(80)(40)}{2^2}$

$F = 5.3\times10^{-8} N$ (VERY SMALL FORCE)



GRAVITATIONAL FIELD STRENGTH

#1 $g = \frac{GM}{r^2}$



$g = \frac{(6.67\times10^{-11})(7.35\times10^{22})}{(1.74\times10^{6})^2}$

$g = 1.62$ N/kg

$g =$ ___ m/s^2

$g =$ ___ N/kg

#2 $g = \frac{FORCE}{MASS}$ N/kg

$g = \frac{400N}{3kg}$

$g = 133.33$ N/kg or 133 m/s^2

#3 $g = \frac{GM}{r^2}$

EXPERIMENT

$9.8 m/s^2 = \frac{6.67\times10^{-11}(M)}{(6.38\times10^{6})^2}$

EXPERIMENT

GREEKS

$M = 5.98\times10^{24}$ kg

#4 $g = \frac{GM}{r^2}$

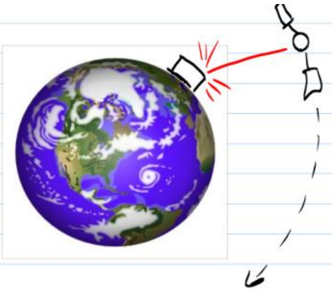
$g = \frac{(6.67\times10^{-11})(5.98\times10^{24})}{(6.38\times10^{6})^2}$

$g = 9.8$ N/kg or m/s^2

#5

Always simplify this equation before you begin to substitute numbers in

$$\frac{GMm}{r^2} = \frac{mv^2}{r}$$



$$\frac{GMm}{r^2} = \frac{mv^2}{r}$$

BEST TO SIMPLIFY FIRST (GETS RID OF SOME BIG NUMBERS)

① $\frac{GM}{r} = v^2$ (CANCEL "m" AND MULTIPLY BOTH SIDES BY "r")

② $v = \sqrt{\frac{GM}{r}}$ ← $r = (\underbrace{4.4 \times 10^5}_{\text{ABOVE EARTH}} + \underbrace{6.38 \times 10^6 m}_{\text{RADIUS OF EARTH}})$

③ $\boxed{v = 7647 \ m/s}$

#6

$$\frac{GMm}{r^2} = \frac{4m\pi^2 r}{T^2}$$

① $$\frac{GMm}{r^2}\left(\frac{1}{r}\right) = \frac{4m\pi^2 r}{T^2}\left(\frac{1}{r}\right)$$

(GET RID OF m + r FIRST.... THEN SUB IN NUMBERS)

② $$\frac{GM\cancel{m}}{r^3} = \frac{4\cancel{m}\pi^2}{T^2}$$

③ $$\frac{GM}{r^3} = \frac{4\pi^2}{T^2}$$

④ $$\frac{1}{r^3} = \frac{4\pi^2}{GMT^2}$$

⑤ $$\boxed{r^3 = \frac{GMT^2}{4\pi^2}}$$

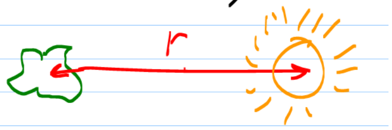
T - PERIOD MUST BE IN SECONDS

$T = 187 \times 24 \times 60 \times 60$

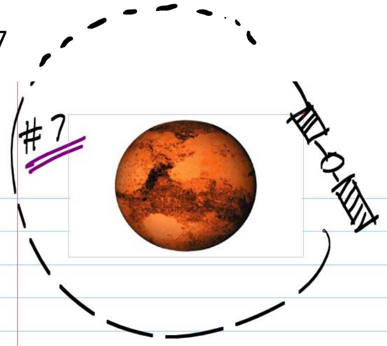
$T = 1.616 \times 10^7$

$$\boxed{r = 8.7 \times 10^{10}\,m}$$

(DISTANCE BETWEEN CENTRE OF KOKO AND IT'S STAR.)



#7



$$\frac{GMm}{r^2} = \frac{mv^2}{r}$$

$$\frac{GM\cancel{m}}{\cancel{r}^2} = \frac{\cancel{m}v^2}{\cancel{r}}$$

SIMPLFY, THEN SUB

$$\frac{GM}{r} = v^2$$

$$r = \frac{GM}{v^2}$$

$$r = \frac{(6.67\times10^{-11})(6.37\times10^{23}\,kg)}{(2000)^2}$$

a) $r = 1.062 \times 10^7$ m

b) RADIUS OF MARS (INTERNET) (3.39×10^6 m) → $1.062 \times 10^7 m - 3.39 \times 10^6 m$

$= 7.23 \times 10^6$ m (ABOVE MARS)