Universal Gravity and Kepler's Laws Worksheet

① $F = \frac{GMm}{r^2}$

$= \frac{6.67\times10^{-11}(60)(6.5\times10^{7})}{(100)^2}$

$F = 2.6\times10^{-5}\ N$

② $F = \frac{GMm}{r^2}$

$= \frac{(6.67\times10^{-11})(50)(70)}{(.5)^2}$

$F = 9.3\times10^{-7} N$

③ $F = \frac{GMm}{r^2}$

$r = \sqrt{\frac{GMm}{F}} = \sqrt{\frac{(6.67\times10^{-11})(1\times10^{12})(5\times10^{12})}{10}}$

$r = 5.7\times10^{6}\ m$

(4)

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

$$r = \sqrt{\frac{GMm}{F}} = \sqrt{\frac{(6.67\times10^{-11})(700)(650)}{3\times10^{-7}}}$$

$r = 10.1\ m$

(5)

$$W = mg = \frac{GMm}{r^2}$$

Student's mass at surface.

$$m = \frac{W}{g} = \frac{450}{9.8} = 45.9\ kg.$$

weight at twice the radius.

$$W = \frac{GMm}{r^2} = \frac{(6.67\times10^{-11})(5.98\times10^{24})(45.9)}{(2\times6.38\times10^{6})^2}$$

$W = 112\ N$

(6) at X $F = \frac{GMm}{r_x^2} = 100N$ at Y $F = \frac{GMm}{r_y^2} = 25N$

$$r_x^2 = \frac{GMm}{100} \qquad r_y^2 = \frac{GMm}{25}$$

$$\frac{r_y^2}{r_x^2} = \frac{\frac{GMm}{25}}{\frac{GMm}{100}} = \frac{100}{25} = 4$$

$\frac{r_y}{r_x} = 4$ → It is 4 time farther away

(7)

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

The circular motion is caused by the gravitational force.

$$r = \frac{GM}{v^2} = \frac{(6.67\times10^{-11})(5.98\times10^{24})}{(7500)^2}$$

27000 km/h = 7500 m/s

$$r = 7.1\times10^{6}\ m$$

(8)

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

$$v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{(6.67\times10^{-11})(5.98\times10^{24})}{1.74\times10^{6}}}$$

$$v = 1.5\times10^{4}\ m/s$$

(9)

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

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

$$r = \sqrt[3]{\frac{GMT^2}{4\pi^2}}$$

$$= \sqrt[3]{\frac{(6.67\times10^{-11})(5.98\times10^{24})(24\times3600)^2}{4\pi^2}}$$

$$r = 4.23\times10^{7}\ m$$

(10)

$$\frac{T_{moon}^2}{r_{moon}^3} = \frac{T_{space\ station}^2}{r_{space\ station}^3}$$

$$r_s = \sqrt[3]{\frac{T_s^2\, r_m^3}{T_m^2}}$$

$$= \sqrt[3]{\frac{(90 \times 60)^2 (3.8 \times 10^8)^3}{(27.3 \times 24 \times 3600)^2}}$$

$$r_s = 1.77 \times 10^4\ m \qquad (17.7\ km)$$