

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

$$F = ma$$

$$a = \frac{v^2}{r}.$$

$$F = m\frac{v^2}{r}.$$

$$F = \frac{GmM}{r^2},$$

$$G = 6.67 \times 10^{-11} \frac{\text{m}^3}{\text{kg s}^2}.$$

$$\text{Unit of length: } U_L = a \text{ m}$$

$$\text{Unit of mass: } U_M = b \text{ kg}$$

$$\text{Unit of time: } U_T = c \text{ s},$$

$$G = 1 \frac{U_L^3}{U_M U_T^2}.$$

$$G = \frac{(a \text{ m})^3}{(b \text{ kg}) (c \text{ s})^2} = \frac{a^3}{bc^2} \frac{\text{m}^3}{\text{kg s}^2}.$$

$$\frac{a^3}{bc^2} \frac{\cancel{\text{m}^3}}{\cancel{\text{kg}} \text{s}^2} = 6.67 \times 10^{-11} \frac{\cancel{m^3}}{\cancel{kg} \text{s}^2}.$$

$$\frac{a^3}{bc^2} = 6.67 \times 10^{-11}.$$

$$1 \text{ pc} = 3.086 \times 10^{16} \text{ m}.$$

$$U_L = 1000 \text{ pc}.$$

$$a \text{ m} = 1000 \text{ pc} \frac{3.086 \times 10^{16} \text{ m}}{1 \text{ pc}} \quad (1)$$

$$a = 3.086 \times 10^{19}. \quad (2)$$

$$U_T = 10^9 \text{ y}.$$

$$U_T = \frac{10^9 \text{ y}}{1} \frac{365 \text{ d}}{\text{y}} \frac{24 \text{ h}}{1 \text{ d}} \frac{60 \text{ m}}{1 \text{ h}} \frac{60 \text{ s}}{1 \text{ m}} = 3.15 \times 10^{16} \text{ s}.$$

$$c \text{ s} = 3.15 \times 10^{16} \text{ s}$$

$$c = 3.15 \times 10^{16}.$$

$$\begin{aligned} b &= \frac{a^3}{c^2(6.67 \times 10^{-11})} \\ &= \frac{(3.086 \times 10^{19})^3}{(3.15 \times 10^{16})^2(6.67 \times 10^{-11})} \\ &= 4.4 \times 10^{35}. \end{aligned}$$

$$U_M = 4.4 \times 10^{35} \text{ kg}.$$

$$F = \frac{mM}{r^2},$$

$$m \frac{v^2}{r} = \frac{GmM}{r^2}$$

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

$$v = \sqrt{\frac{GM}{r}}.$$

Unit of length: $U_L = 1000 \text{ pc} = 3.086 \times 10^{19} \text{ m}$

Unit of mass: $U_M = 4.4 \times 10^{35} \text{ kg}$

Unit of time: $U_T = 10^9 \text{ y} = 3.15 \times 10^{16} \text{ s}.$