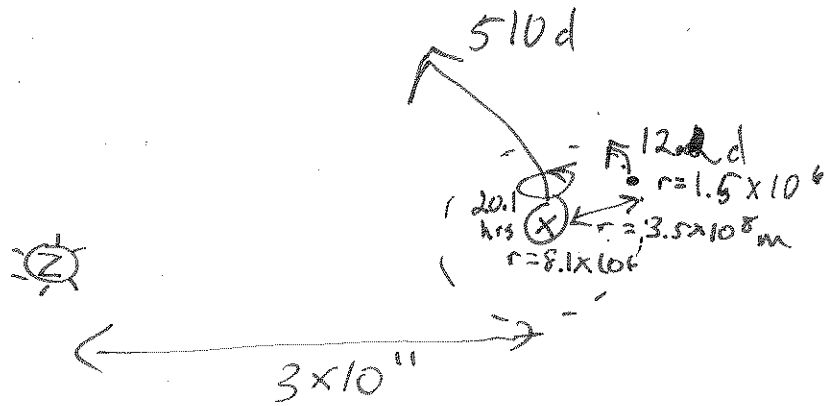


# Orbits & Gravity Key

①



$$a) \quad \frac{R^3}{T^2} = \frac{Gm}{4\pi^2} \quad \frac{(3 \times 10^{11})^3}{(510 \times 24 \times 3600)^2} = \frac{Gm}{4\pi^2}$$

$$m = 8.2 \times 10^{30} \text{ kg}$$

b)

$$\frac{R^3}{T^2} = \frac{Gm}{4\pi^2} \quad \frac{(3.5 \times 10^8)^3}{(12.2 \times 24 \times 3600)^2} = \frac{Gm}{4\pi^2}$$

$$m = 2.3 \times 10^{25} \text{ kg}$$

c)

$$g \text{ at pole} = mg = \frac{GmM}{r^2} \quad g = \frac{6.67 \times 10^{-11} (2.3 \times 10^{25})}{(8.1 \times 10^6)^2}$$

$$g = 23.21 \text{ m/s}^2$$

d)

$$g \text{ at eqtr} = 23.21 - \frac{v^2}{r}$$

$$v = \frac{2\pi r}{T} = \frac{2\pi (8.1 \times 10^6)}{20.1 \times 3600} = 703 \text{ m/s}$$

$$g = 23.21 - \frac{703^2}{8.1 \times 10^6} = 23.21 - .06 = \boxed{23.15 \text{ m/s}^2}$$

e)

$$\frac{R^3}{T^2} = \frac{Gm}{4\pi^2}$$

$$T = 1 \text{ day} = 20.1 \text{ hrs}$$

$$\left( \frac{R^3}{20.1 \times 3600} \right)^2 = \frac{G (2.3 \times 10^{25})}{4\pi^2} \quad \boxed{r = 5.9 \times 10^7 \text{ m}}$$

f) escape velocity

$$v = \sqrt{\frac{2Gm}{r}}$$

$$v = \sqrt{\frac{2(6.67 \times 10^{-11})(2.3 \times 10^{25})}{8.1 \times 10^6}} = 19,500 \text{ m/s}$$

g)

$$g = \frac{Gm}{r^2}$$

$$1.05 = \frac{6.67 \times 10^{-11} m}{(1.5 \times 10^6)^2}$$

$$m = 3.5 \times 10^{22} \text{ kg}$$

h)

$$2.0 = \frac{G(2.3 \times 10^{25})}{r^2}$$

$$r = 2.77 \times 10^7 \text{ m}$$