

A comet traveling 24.3 km/s is 1.50 AU from the sun. Is the orbit bound

~~or~~ or unbound.

$$M_{\text{sun}} = 1.99 \times 10^{30} \text{ kg}$$

$$v = 24.3 \frac{\text{km}}{\text{s}} = 2.43 \times 10^4 \text{ m/s}$$

$$r = 1.50 \text{ AU} \left( \frac{1.496 \times 10^{11} \text{ m}}{1 \text{ AU}} \right) = 2.244 \times 10^{11} \text{ m}$$

If a comet is bound, its total energy will be negative.

$$E = K + U = \frac{1}{2} m v^2 - \frac{GMm}{r}$$

$$= m \left[ \frac{v^2}{2} - \frac{GM}{r} \right]$$

$$E = m \left[ \frac{(2.43 \times 10^4 \text{ m/s})^2}{2} - \frac{(6.67 \times 10^{-11} \frac{\text{N m}^2}{\text{kg}^2})(1.99 \times 10^{30} \text{ kg})}{2.244 \times 10^{11} \text{ m}} \right]$$

$$= m \left[ 2.95 \times 10^8 \text{ J} - 5.92 \times 10^8 \text{ J} \right]$$

$$= m \left[ \underbrace{-2.97 \times 10^8 \text{ J}}_{\text{negative}} \right]$$

∴ The orbit is bound.