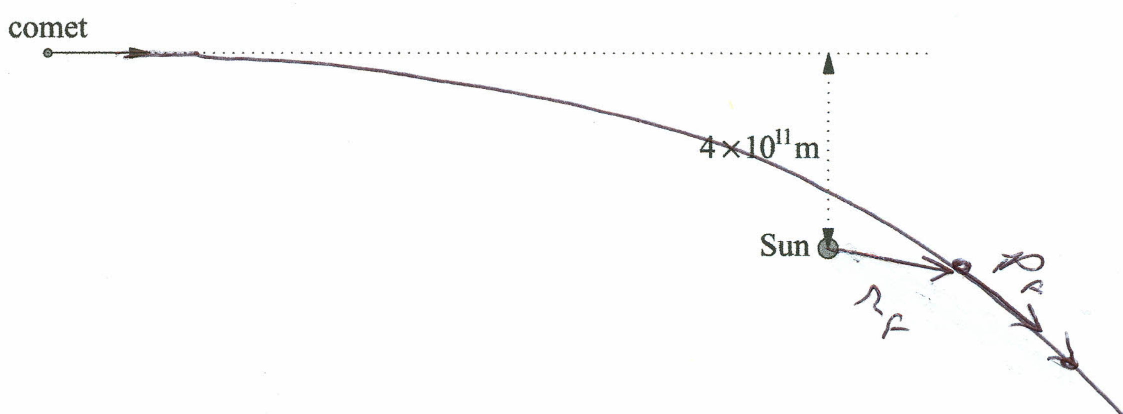
5. (30 pts.) A comet is approaching the Sun as shown in the figure. When it is very far away—where the gravitational force and potential energy can be neglected—the object moves with a velocity of 12,000 m/s in a straight line. By straight-line extrapolation, the closest this line would come to the sun is 4×10^{11} m. Of course, the comet doesn't continue in a straight line. Instead, it bends around the Sun in a path as shown. Your goal will be to find the speed of the comet when it is a distance of 1×10^{11} m away from the sun. The mass of the sun is $M_s = 1.99\times10^{30}$ kg.

a. (10 pts.) What fundamental physics principle (or principles) will you use to solve this problem? Justify your answer briefly but clearly.

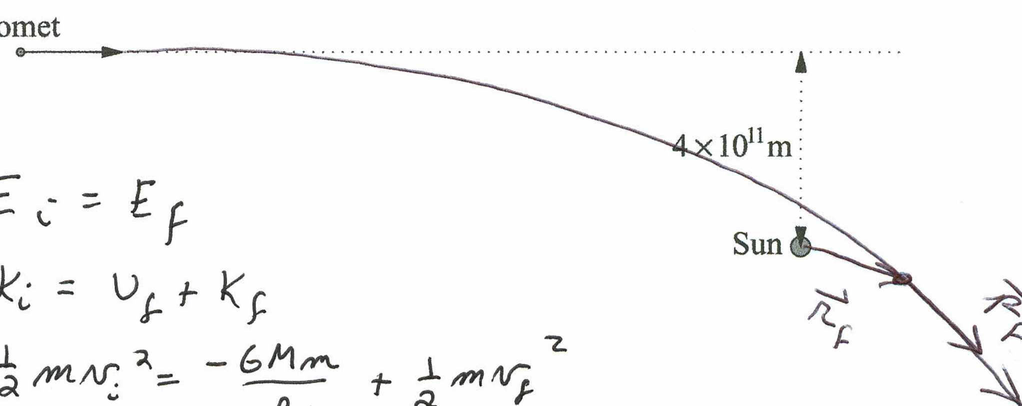
b. (20 pts.) What is the speed of the comet when it is 1×10^{11}m from the sun?



5. (30 pts.) A comet is approaching the Sun as shown in the figure. When it is very far away—where the gravitational force and potential energy can be neglected—the object moves with a velocity of 12,000 m/s in a straight line. By straight-line extrapolation, the closest this line would come to the sun is 4×10^{11} m. Of course, the comet doesn't continue in a straight line. Instead, it bends around the Sun in a path as shown. Your goal will be to find the speed of the comet when it is a distance of 1×10^{11} m away from the sun. The mass of the sun is $M_s = 1.99\times10^{30}$ kg.

a. (10 pts.) What fundamental physics principle (or principles) will you use to solve this problem? Justify your answer briefly but clearly. Both energy and angular momentum are conserved, since there is no external torque and gravity is a conservative force. However, $\vec{L} = \vec{r}\times\vec{p}$ isn't useful because we don't know the angle between $\vec{r}$ and $\vec{p}$. ∴ Use conservation of energy

b. (20 pts.) What is the speed of the comet when it is 1×10^{11}m from the sun?



$$E_i = E_f$$

$$U_i + K_i = U_f + K_f$$

$$0 + \frac{1}{2}mv_i^2 = -\frac{GMm}{r_f} + \frac{1}{2}mv_f^2$$

$$v_f = \sqrt{v_i^2 + \frac{2GM}{r_f}} = \sqrt{(12{,}000\ \text{m/s})^2 + \frac{2(6.67\times10^{-11})(1.99\times10^{30})}{10^{11}}\ \frac{\text{m}^2}{\text{s}^2}}$$

$$\boxed{v_f = 52{,}900\ \text{m/s}}$$