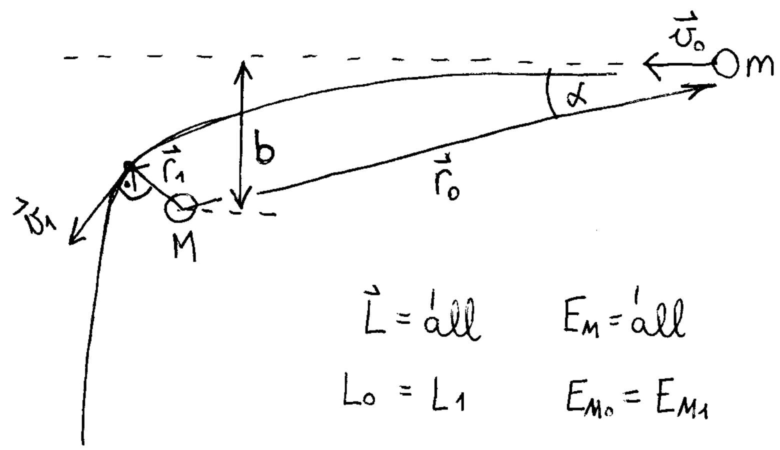
23.) $M = 6 \cdot 10^{29}\,kg$ $\quad v_0 = 5 \cdot 10^{3}\,\frac{m}{s}$ $\quad b = 6{,}67 \cdot 10^{11}\,m$ $\quad d_{min} = ?$



$\vec{L} = \vec{r} \times \vec{p}$ $\quad \vec{p} = m\vec{v}$

$E_M = E_p + E_k$

$E_p = -G\frac{Mm}{r}$ $\quad E_k = \frac{1}{2}mv^2$

$\vec{L} = \text{áll}$ $\quad E_M = \text{áll}$

$L_0 = L_1$ $\quad E_{M0} = E_{M1}$

$r_1 = d_{min} \rightarrow v_1 = v_{max}$ $\quad \vec{r}_1 \perp \vec{v}_1$

$L_0 = r_0 m v_0 \sin\alpha = b m v_0$ $\qquad L_1 = m r_1 v_1 \sin 90^\circ = m d_{min} \cdot v_{max}$

$$m v_0 b = m v_{max} d_{min}$$

$$v_{max} = \frac{v_0 b}{d_{min}}$$

$r_0 \rightarrow \infty$ tehát $E_{p0} \approx 0$

$$E_{M0} = E_{M1} \longrightarrow E_{k0} = E_{p1} + E_{k1}$$

$$\frac{1}{2}mv_0^2 = -G\frac{Mm}{d_{min}} + \frac{1}{2}mv_{max}^2$$

$$v_0^2 + 2G\frac{M}{d_{min}} = v_{max}^2$$

$$v_0^2 + 2G\frac{M}{d_{min}} = \frac{v_0^2 b^2}{d_{min}^2}$$

$$\Downarrow$$

$$\underline{\underline{d_{min}}}$$