$$\frac{d^2y}{dt^2} = -g$$

$$E = mgy + \frac{1}{2}mv^2$$

$$\bar{E} = \frac{1}{E_0} mgy_0\bar{y} + \frac{1}{2}\frac{1}{E_0} mv_0^2\bar{v}^2$$

$$y_0 = \frac{E_0}{mg}$$

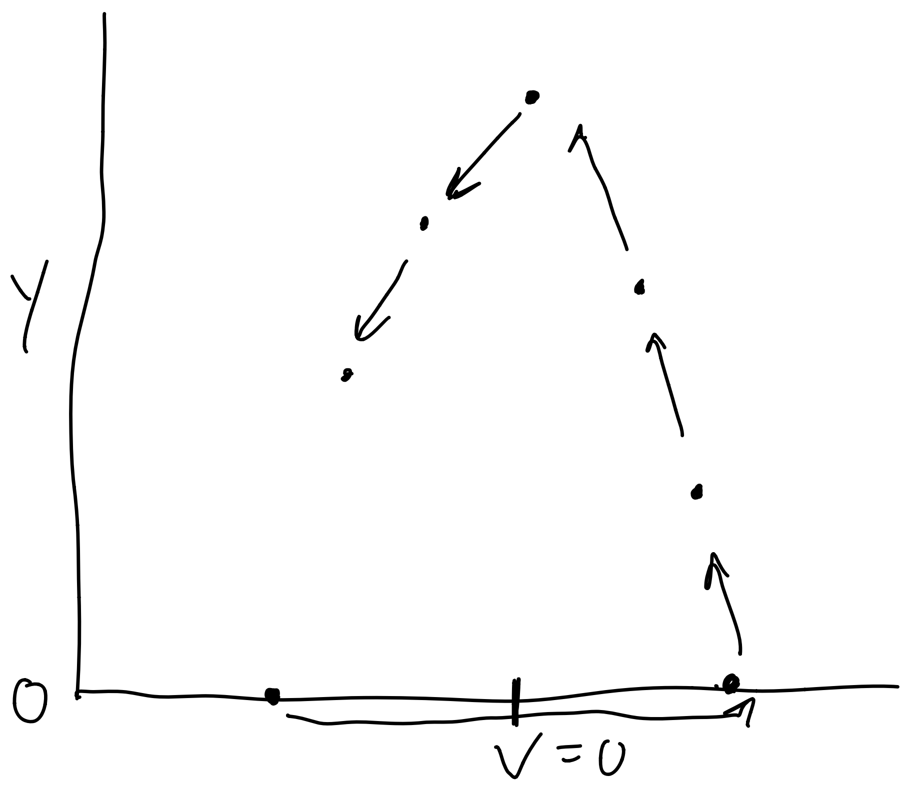
$$U_0 = mgy_0 = E_0, \quad E_0 = mgy(0)$$

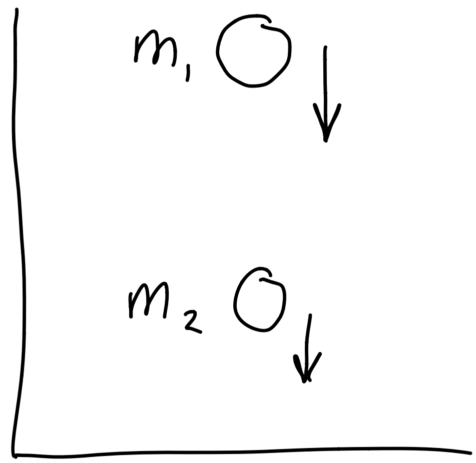
$$y_0 = \frac{mgy_i}{mg} = y_i$$

$$V_0^2 = \frac{E_0}{m} \Rightarrow V_0 = \sqrt{\frac{E_0}{m}}$$

$$\bar{E} = \bar{y} + \frac{1}{2}\bar{v}^2 \qquad \bar{y} = 1 - \frac{1}{2}v^2$$

Phase Space ?





$$F = -mg$$

$$\frac{dy^2}{dt^2} = -g$$

$$E = m_1 g y_1 + m_2 g y_2 + \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

$$E_0 = m_1 g y_{1,0} + m_2 g y_{2,0}$$

$$\bar{E} = \frac{E}{E_0}$$

$$\bar{E} = \frac{m_1 g r_0 \bar{y}_1}{E_0} + \frac{m_2 g r_0 \bar{y}_2}{E_0} + \frac{1}{2} \frac{m_1 v_0^2 \bar{v}_1^2}{E_0} + \frac{1}{2} \frac{m_2 v_0^2 \bar{v}_1^2}{E_0}$$

$$r_0 = \frac{E_0}{(m_1+m_2)g} = \frac{E_0}{Mg}$$

$$V_0^2 = \frac{E_0}{M} \Rightarrow V_0 = \left(\frac{E_0}{M}\right)^{1/2}$$

$$\bar{E} = \frac{m_1}{M}\bar{y}_1 + \frac{m_2}{M}\bar{y}_2 + \frac{1}{2}\frac{m_1}{M}\bar{v}_1^2 + \frac{1}{2}\frac{m_2}{M}\bar{v}_2^2$$

$$\bar{E} = \bar{m}_1\bar{y}_1 + \bar{m}_2\bar{y}_2 + \frac{1}{2}\bar{m}_1\bar{v}_1^2 + \frac{1}{2}\bar{m}_2\bar{v}_2^2$$

$$r \equiv \frac{m_2}{m_1} \qquad \bar{m}_1 = \frac{m_1}{m_1+m_2} = \frac{m_1}{m_1 + rm_1}$$

$$\bar{m}_1 = \frac{1}{1+r}$$

$$\bar{m}_2 = \frac{m_2}{m_1+m_2} = \frac{m_2}{\frac{1}{r}m_2+m_2} = \frac{r}{r+1}$$

$$\bar{E} = \frac{1}{r+1}\left[\bar{y}_1 + r\bar{y}_2 + \frac{1}{2}\bar{v}_1^2 + \frac{1}{2}r\bar{v}_2^2\right]$$

$$\frac{d^2 y}{dt^2} = -g \qquad \frac{y_0}{t_0^2}\frac{d^2 \bar{y}}{d\bar{t}^2} = -g$$

$$y_0 = \frac{E_0}{Mg} \qquad V_0 = \left(\frac{E_0}{M}\right)^{1/2}$$

$$t_0 = \frac{y_0}{V_0} = \frac{E_0}{Mg}\left(\frac{M}{E_0}\right)^{1/2} = \sqrt{\frac{E_0}{Mg^2}}$$

$$\frac{y_0}{t_0^2} = \frac{E_0}{Mg}\frac{Mg^2}{E_0} = g$$

$$\frac{d^2 \bar{y}}{d\bar{t}^2} = -1$$