9.1

Ved avfyring

$$\left.\begin{aligned} mv &= MV_0 \\ Q &= \tfrac{1}{2} m v^2 + \tfrac{1}{2} M V_0^2 \end{aligned}\right\} \Rightarrow \quad \underline{V_0 = \sqrt{\frac{2mQ}{M(M+m)}}}.$$

$$MgH_0 = \tfrac{1}{2} M V_0^2 = \frac{mQ}{M+m} \quad \Rightarrow$$

$$\underline{H_0 = \frac{mQ}{M(M+m)g}}$$

b) Fart i pkt. b før avfyring

$$\tfrac{1}{2}(m+M)V_1^2 = (m+M)gh \qquad V_1 = \sqrt{2gh}$$

Etter avfyring

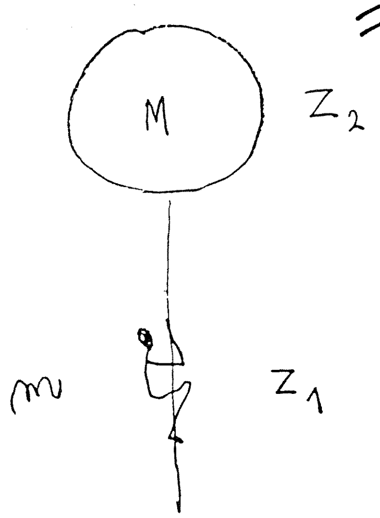
$$V_2 = V_1 + V_0 .$$

$$Mg(h+H) = \tfrac{1}{2} M V_2^2$$

$$H = \frac{V_2^2}{2g} - h = \frac{1}{2g}(V_0 + V_1)^2 - h$$

$$= \underbrace{\frac{V_0^2}{2g}}_{H_0} + \underbrace{\frac{V_1^2}{2g}}_{h} + \underbrace{\frac{V_0 V_1}{g}}_{2\sqrt{H_0 h}} - h$$

$$\underline{\underline{H = H_0 + 2\sqrt{H_0 h}}}$$



9.2 Ingen netto ytre kraft (oppdrift = tyngdekraft)

Masse-senter mann/ballong må forbli i ro.

$$Z = \frac{m z_1 + M z_2}{m + M}.$$

$$V_z = \frac{m v_{1z} + M v_{2z}}{m + M} =$$

$$m v_{1z} + M v_{2z} = 0$$

Gitt: Mannens hast. i forhold til ballongen

$$v = v_{1z} - v_{2z} \qquad (2)$$

Eliminerer v_{1z}:

$$m (v + v_{2z}) + M v_{2z} = 0.$$

$$v_{2z} = - \frac{m}{m + M} v < 0.$$

Ballongen beveger seg nedover.

Når mannen slutter å klatre blir $v = 0$ og følgelig $v_{2z} = 0$

Ballongen stopper.

9.3

$$p = \frac{mv}{\sqrt{1-v^2/c^2}} \quad \text{(Linear bar)}$$

$$F = \frac{dp}{dt} = m\frac{d}{dt}\left[\frac{v}{\sqrt{1-v^2/c^2}}\right]$$

$$= \frac{m}{1-v^2/c^2}\left[\frac{dv}{dt}\sqrt{1-\frac{v^2}{c^2}} + \frac{1}{2}\,\frac{2\frac{v}{c^2}\frac{dv}{dt}v}{\sqrt{1-v^2/c^2}}\right]$$

$$= \frac{m}{(1-v^2/c^2)^{3/2}}\left[1-\frac{v^3}{c^2}+\frac{v^3}{c^2}\right]\frac{dv}{dt}$$

$$\underline{F = \frac{m}{(1-v^2/c^2)^{3/2}}\,a}$$

$$m_{eff} = \frac{m}{(1-v^2/c^2)^{3/2}}$$