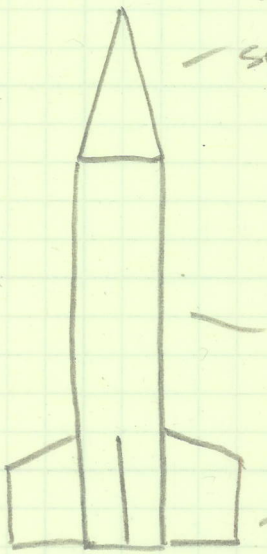
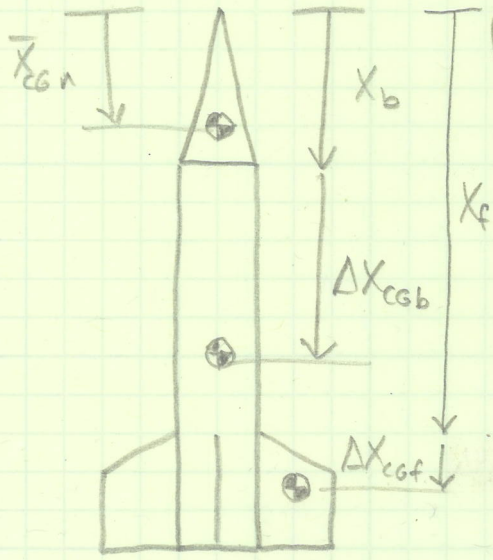
AEM 1905 - High Power Rocketry
Sample CG & CP calculation

simple rocket



- solid conical nosecone
  4" tall, 2" base diameter
  weighs 3.0z
- cylindrical body 10" tall
  2" diameter
  4 oz (evenly distributed)
- four clipped delta fins
  a = 3" - root length
  b = 2" - tip length
  s = 2" - height
  m = 1" - sweep
  r = 1" - radius of body
  $\frac{1}{2}$ oz each fin

CG calculation



nose cone

$\bar{X}_{CGn} = \frac{3}{4} * 4" = 3"$

$W_n = 3oz$

cylindrical body (symmetrical weight)

$\bar{X}_{CGb} = X_b + \Delta X_{CGb} = 4" + \frac{1}{2} * 10" = 9"$

$W_b = 4oz$

one fin

$X_f = 4" + 10" - 3" = 11"$

$$\Delta X_{CGf} = \frac{b^2 + \frac{2}{3}m^2 + 2mb}{2b + m}$$

$$= \left(\frac{2^2 + \frac{2}{3}1^2 + 2*1*2}{2*2 + 1} \right)" = \frac{8\frac{2}{3}"}{5}$$

$= 1.73"$

Thus $\bar{X}_{CGf} = 11" + 1.73" = 12.73"$

$W_f = \frac{1}{2} oz$

Total weight (includes 4 fins)

$W_{tot} = 3oz + 4oz + 4 * \frac{1}{2} oz = 9oz$

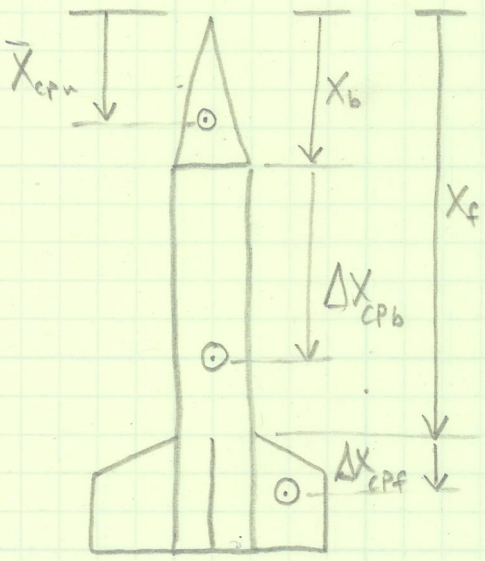
Sum of CG station * weight

$\bar{X}_{CG} * W_{tot} = 3" * 3oz + 9" * 4oz + 4 * 12.73" * \frac{1}{2} oz$

$= 70.47 inch * oz$

Thus $\bar{X}_{CG} = 70.47 inch * oz / 9oz = 7.83"$ - measure down from nose tip.

CP calculation



nose cone

$\bar{X}_{cpn} = \frac{2}{3} * 4'' = 2\frac{2}{3}''$

$C_{Nn} = 2$

cylindrical body

No need to calculate $\bar{X}_{cpb}$ since $C_{Nb} = 0$ for small angles anyway.

one fin

$X_f = 11''$ (as before)

$$\Delta X_{cpf} = \frac{m(a+2b)}{3(a+b)} + \frac{1}{6}\left(a+b-\left(\frac{ab}{a+b}\right)\right)$$

$$= \left(\frac{1*(3+2*2)}{3(3+2)} + \frac{1}{6}\left(3+2-\left(\frac{3*2}{3+2}\right)\right)\right)''$$

$$= (0.4\bar{6} + 0.6\bar{3})''$$

$$= 1.0\bar{9}''$$ Thus $\bar{X}_{cpf} = 11'' + 1.1'' = 12.1''$

normal coeff. for 4 fins

$$C_{Nf} = \frac{4*4*(s/d)^2}{1+\sqrt{1+\left(\frac{2l}{(a+b)}\right)^2}}$$

$$= \frac{4*4*(2/2)^2}{1+\sqrt{1+\left(\frac{2*2.06}{3+2}\right)^2}}$$

$$= 6.97$$

body interference factor

$$K_{fb} = 1 + \frac{r}{s+r}$$

$$= 1 + \frac{1}{2+1}$$

$$= 1.\overline{3}$$

adjusted normal coefficient

$$C_{Nfb} = K_{fb} * C_{Nf}$$

$$= 1.\overline{3} * 6.97$$

$$= 9.29$$

Total normal coefficient (all point in same direction so none are negative in this case).

$$C_{Ntot} = 2 + 0 + 9.29$$

$$= 11.29$$

Sum of CP station * normal coeff.

$$\bar{X}_{cp} * C_{Ntot} = 2.\overline{6}" * 2 + 0 + 12.1" * 9.29$$

$$= 117.7"$$

Thus $\bar{X}_{cp} = \frac{117.7}{11.29} = 10.43"$ - measured down from tip of nose.

Static Margin $SM = \frac{\bar{X}_{cp} - \bar{X}_{CG}}{d} = \frac{10.43" - 7.83"}{2"}$

$SM = 1.3 \Longrightarrow$ "stable"

Note: SM negative is unstable; SM positive but less than 1 is marginal. SM larger than 2.5 is "overstable" according to RockSim.