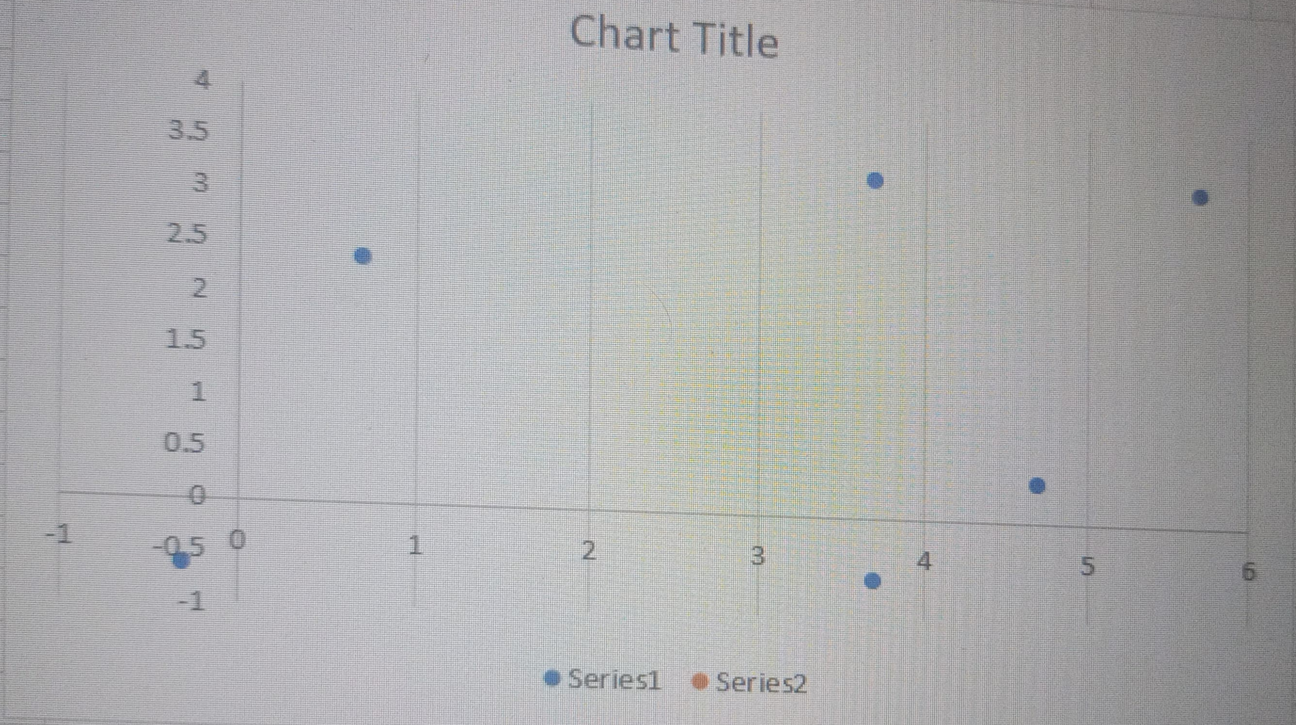


Chart Title
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1
0
1
2
3
4
5
6
Series1
Series2

(2a)

$-0.30738, -0.62208$

$5.69262,$
3.37892

Length $2a = \sqrt{6^2+4^2} = \sqrt{52}$

of ~~semi~~ major axis $a = \frac{\sqrt{52}}{2} = \sqrt{13}$

$$\text{centre}_x = \frac{5.69262 - 0.30738}{2} = 2.69262$$

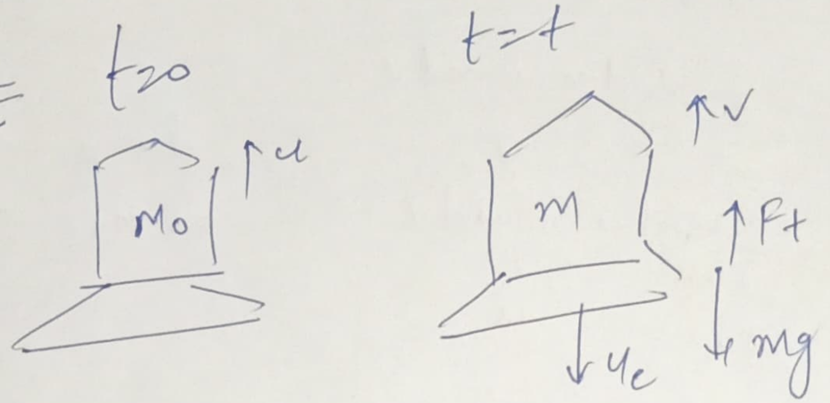
$$\text{centre}_y = \frac{3.37892 - 0.62208}{2} = 1.37892$$

we got centre now

$$\frac{(x-x_1)^2}{a^2} + \frac{(y-y_1)^2}{b^2} = 1$$

put x_1, y_1 and other points
we can get eqn of trajectory

$\underline{\underline{\text{or}}}$



$F_{thrust} = -u_e \frac{dm}{dt}$

weight $= mg$

$$F_{net} = F_{thrust} - mg$$

$$m\frac{dv}{dt} = -u_e\frac{dm}{dt} - mg$$

$$\frac{dv}{dt} = \frac{-u_e}{m}\frac{dm}{dt} - g \qquad \text{—— (1)}$$

$$\int_u^v dv = \int_{M_o}^{M} \frac{-u_e}{m}dm \int_0^t -g\,dt$$

$$v - u = \frac{-u_e}{\cancel{m}} \ln \frac{M}{M_o} - gt$$

$$v - u = \frac{u_e}{\cancel{m}} \ln \frac{M_o}{m} - gt$$

$$\Delta u = \frac{u_e}{\cancel{m}} \ln \frac{M_o}{m} - gt$$

Now $\frac{dm}{dt}$ = constant $= -k$

$dm = -k\,dt$ or $dt = -\frac{dm}{k}$

By eqn (1)

$$m\frac{dv}{dt} = -u_e\frac{dm}{dt} - mg$$

$$m\,dv = -u_e\,dm - mg\,dt$$

$$-mg\,dt = u_e\,dm + m\,dv$$

$$-mg\left(-\frac{dm}{k}\right) = u_e\,dm + m\,dv$$

$dm = -k\,dt$

$m - m_0 = -kt$

$$\int_{m_0}^{m} \frac{g}{k}\,dm = \int_{m_0}^{m} \frac{u_e\,dm}{m} + \int_{u}^{v} dv$$

$$\frac{g}{k}(m-m_0) = u_e \ln\frac{m}{m_0} + v - u$$

$$v(t) = u - u_e \ln\frac{m}{m_0} + \frac{g}{k}(m-m_0)$$

$$v(t) = u - u_e \ln\frac{m}{m_0} - gt$$

consider $u=0$ a special case for easy calculation

$$v(t) = -u_e \ln\frac{m}{m_0} - gt$$

$$dr = v(t)\,dt$$

$$y = -\int_0^{t_b} gt\,dt - \int_0^{t_b} u_e \ln\frac{m}{m_0}\,dt$$

$$y = -g\,t_b^2 - u_e \ln\frac{m}{m_0}\,t_b \quad \text{--- } 2$$

$\downarrow$

burnout altitude

Now after burnout altitude thrust $=0$

Now

$$a = -g$$

$$\frac{dv}{dt} = -g$$

$$\int_{v(t)}^{0} v\,dv = \int_0^{h} -g\,dh$$

$$0 - \frac{v^2(t)}{2} = -gh$$

$$h = \frac{v^2(t)}{2g}$$

$$-mg\,dt = u_e\,dm + m\,dv$$

$$h = \frac{\left(-gt_b - u_e \ln \frac{m}{m_0}\right)^2}{2g} \quad \text{——} (3)$$

$-k\,dt$

$-kt$

hence max altitude

$$\Rightarrow \boxed{y + h}$$