

1 a) Show that for this friction model, the equations of motion are:

$$\frac{d^2x}{dt^2} = -k|v|^{n-1}v_x$$

$$\frac{d^2y}{dt^2} = -k|v|^{n-1}v_y - g$$

$$|v| = \sqrt{v_x^2 + v_y^2}$$

- By using newton's second law:

$$m \frac{d^2\vec{r}}{dt^2} = -mgy - km|v|^n \frac{\vec{v}}{|v|}$$

$$\frac{d^2y}{dt^2} (x + y) = -gy - k|v|^{n-1}(v_x + v_y)$$

$$\frac{d^2x}{dt^2} = -k|v|^{n-1}v_x$$

$$\frac{d^2y}{dt^2} = -k|v|^{n-1}v_y - g$$

Where  $\vec{r}$  is the position vector and  $|v| = \sqrt{v_x^2 + v_y^2}$  is the magnitude of velocity. Velocity written in a differential equation would be  $v_x = \frac{dx}{dt}$  and  $v_y = \frac{dy}{dt}$ .

Hence :

$$\frac{dv_x}{dt} = -k|v|^{n-1}v_x$$

$$\frac{dv_y}{dt} = -k|v|^{n-1}v_y - g$$