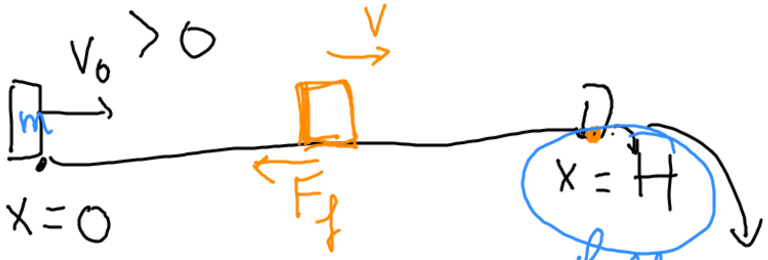
10.10:



a/ glass fall off : $\underline{v} = 0$.

$$\boxed{m\frac{d^2x}{dt^2} = F_f = -\gamma}$$

Want velocity :

$$m\frac{dv}{dt} = -\gamma \quad (*)$$

initial condition : $v(0) = v_0$

Solve $(*)$: $mv' = -\gamma$

(integrate

$$mv = -\gamma t + K \quad \text{const}$$

Find v_0 in terms of H, γ, m to make glass fall

↓ Fall off: Gravity

$$mv_0 = -\gamma \cdot 0 + K$$

$$K = mv_0$$

$$mv = -\gamma t + mv_0$$

$\div m$

$$\boxed{v = -\frac{\gamma}{m}t + v_0} \quad (*)$$

Fall off when $v = 0$

$$-\frac{\gamma}{m}t + v_0 = 0$$

$$t = \frac{mv_0}{\gamma} \quad (*)$$

$$\frac{dx}{dt} = v = -\frac{\gamma}{m}t + v_0$$

$$\Rightarrow \boxed{x = \frac{-\gamma}{2m}t^2 + v_0 t}$$

plug in $t = \frac{mv_0}{\gamma}$

$$x = \frac{mv_0^2}{2\gamma}$$

Fall off : $\boxed{x > H}$

$$\frac{mv_0^2}{2\gamma} > H$$

$$v_0^2 > \frac{2\gamma H}{m}$$

$$v_0 > \sqrt{\frac{2\gamma H}{m}}$$

10.8:

$$m\frac{d^2y}{dt^2} = \underbrace{-c\overbrace{\frac{dy}{dt}}^{v = \text{velocity}}}_{\text{friction}} - mg$$

y

$$\boxed{\underline{\text{velocity}}: \quad m\frac{dv}{dt} = -cv - mg}$$

terminal velocity

$t \to \infty$

solve for

$\underline{\text{initial}}$: $t = 0$: $v_0 = -\frac{mg}{c} + K$

$$v = -\frac{mg}{c} + Ke^{-\frac{c}{m}t} \xrightarrow[t \to \infty]{} \boxed{v = -\frac{mg}{c}}$$

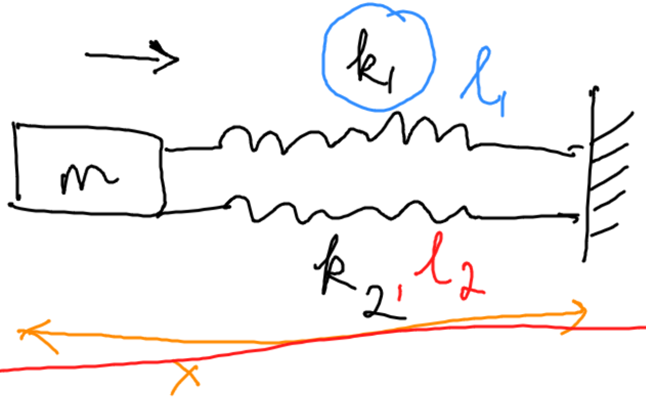
(general solution)

terminal velocity

$$\boxed{my' = -cy - mg}$$

Review 046 to solve for this

9.4:



a/ $$\boxed{m\frac{d^2x}{dt^2} = -k_1(x-\ell_1) - k_2(x-\ell_2)}$$

equilibrium: $-k_1(x-\ell_1) - k_2(x-\ell_2) = 0$

$$x = \frac{k_1\ell_1 + k_2\ell_2}{k_1 + k_2}$$

b/ $$m\frac{d^2x}{dt^2} + (k_1+k_2)x = k_1\ell_1 + k_2\ell_2$$

$$x = [\text{const}] + C_1\cos wt + C_2\sin wt$$

const = ?

$$w = \sqrt{\frac{\square}{\square}}$$

$$my'' + (k_1+k_2)y = k_1\ell_1 + k_2 l_2$$

Math 46 $\quad mr^2 + (k_1+k_2)r = 0$