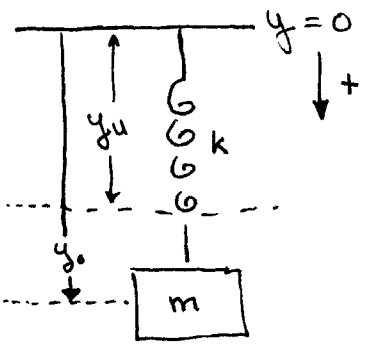
• MASS ON A SPRING

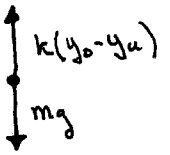


• EQUILIBRIUM: $\Sigma F = 0$

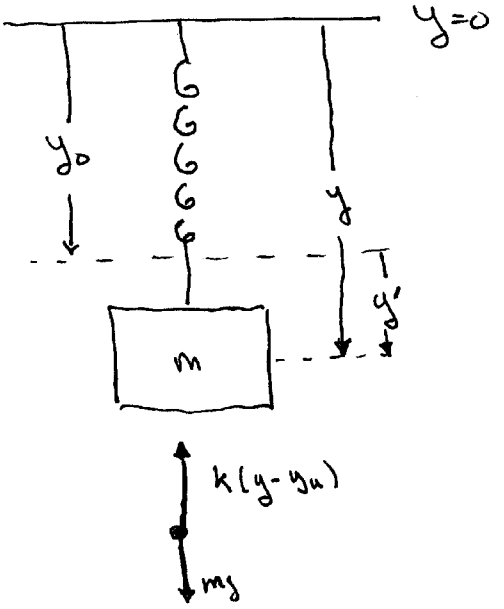
$$+mg - k(y_0 - y_u) = 0$$

$$\Rightarrow \quad mg - ky_0 + ky_u = 0$$

$$\therefore \quad \boxed{y_0 = \frac{mg}{k} + y_u} \qquad (1)$$



• MOTION AROUND EQUILIBRIUM: LET'S CHOOSE THE SAME ZERO PT. FOR y.



• NEWTON'S 2ND GIVES

$$+mg - k(y - y_u) = m\frac{d^2y}{dt^2}$$

NOW, $y = y_0 + y'$ ← DISPLACEMENT FROM EQUILIBRIUM POSITION

HENCE,

$$mg - k(y_0 + y' - y_u) = m\frac{d^2y}{dt^2}$$

FROM EQUN (1) WE HAVE $\cancel{mg - ky_0}^{\,0} + ky_u - ky' = m\frac{d^2y}{dt^2}$

SO THAT $\quad ky' = m\frac{d^2y}{dt^2}$

NOW $\frac{d^2y'}{dt^2} = \frac{d^2y}{dt^2}$ SO

$$\boxed{\frac{d^2y'}{dt^2} + \frac{k}{m}y' = 0}$$

SHM !