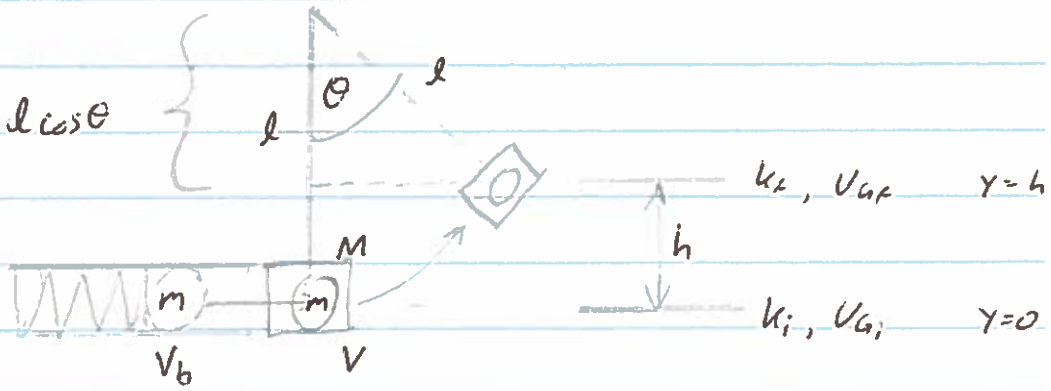
Ballistic Pendulum



A ball of mass m is fired into a swinging block with mass M.
- ball's initial velocity is V_b

Velocity of ball & block combination is found by conserving momentum:

$$\Delta p_{tot} = p_{tot,f} - p_{tot,i} = 0$$

$$(M+m)V = mV_b$$

$$V = \frac{m}{(M+m)} V_b \qquad (A)$$

The ball & block then swing on a pendulum of length l around an angle θ up to a height h,

$$h = h - l\cos\theta = l(1-\cos\theta) \qquad (B)$$

The height is found by conserving energy at the start & end of the swing.

$$\Delta K + \Delta U_G = 0$$

$$K_f - K_i + U_{Gf} - U_{Gi} = 0$$

$$U_{Gf} = K_i$$

$$(M+m)gh = \tfrac{1}{2}(M+m)v^2$$

$$\therefore \quad v = \sqrt{2gh}$$

Sub into (A), rearrange for V_b:

$$V_b = \frac{(M+m)}{m}\sqrt{2gh}$$

or

$$V_b = \frac{(M+m)}{m}\sqrt{2gl(1-\cos\theta)}$$

See upcoming lab!