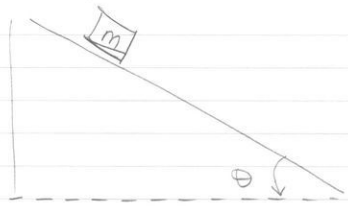


$H = L\sin\theta = 6.84\ m$

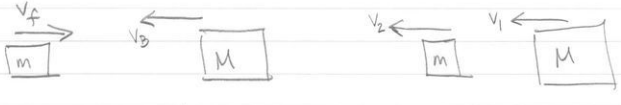
$$KE_i + GPE_i = KE_f + GPE_f + \omega(\text{friction})$$

$$0 + mgH = \tfrac{1}{2}mv_f^2 + 0 + mgL\cos\theta\mu$$

$$0 + 134\ J = \tfrac{1}{2}mv_f^2 + 36.8\ J$$

$$\tfrac{1}{2}mv_f^2 = 97.2\ J$$

$$\boxed{v_f = 9.86\ m/s}$$ speed at bottom of hill



before after

momentum $mv_f - Mv_B = -mv_2 - Mv_1$

energy $\tfrac{1}{2}mv_f^2 + \tfrac{1}{2}Mv_B^2 = \tfrac{1}{2}mv_2^2 + \tfrac{1}{2}Mv_1^2$

$$\rightarrow \quad v_1 = \frac{-mv_f + Mv_B - mv_2}{M} = v_B - \left(\frac{m}{M}\right)v_f - \left(\frac{m}{M}\right)v_2$$

$$\tfrac{1}{2}mv_f^2 + \tfrac{1}{2}Mv_B^2 = \tfrac{1}{2}mv_2^2 + \tfrac{1}{2}M\left(v_B - \left(\tfrac{m}{M}\right)v_f - \left(\tfrac{m}{M}\right)v_2\right)^2$$

Let $C_1 = \tfrac{1}{2}mv_f^2 + \tfrac{1}{2}Mv_B^2$ we know this $= 2347\ \text{J}$

$C_2 = v_B - \left(\tfrac{m}{M}\right)v_f$ we know this $= 26.06\ \tfrac{\text{m}}{\text{s}}$

$$C_1 = \tfrac{1}{2}mv_2^2 + \tfrac{1}{2}M\left(C_2 - \left(\tfrac{m}{M}\right)v_2\right)^2$$

$$= \tfrac{1}{2}mv_2^2 + \tfrac{1}{2}M\left(C_2^2 - 2\tfrac{m}{M}C_2v_2 + \left(\tfrac{m}{M}\right)^2 v_2^2\right)$$

$$= \tfrac{1}{2}mv_2^2 + \tfrac{1}{2}MC_2^2 - mC_2v_2 + \tfrac{1}{2}\tfrac{m^2}{M}v_2^2$$

$$C_1 = \tfrac{1}{2}\left(m + \tfrac{m^2}{M}\right)v_2^2 - \left(mC_2\right)v_2 + \tfrac{1}{2}MC_2^2$$

$$\rightarrow \quad 0 = \tfrac{1}{2}\left(m + \tfrac{m^2}{M}\right)v_2^2 - \left(mC_2\right)v_2 + \left(\tfrac{1}{2}MC_2^2 - C_1\right)$$

$$v_2 = \frac{+mC_2 \pm \sqrt{m^2C_2^2 - 2\left(m + \frac{m^2}{M}\right)\left(\frac{1}{2}MC_2^2 - C_1\right)}}{\left(m + \frac{m^2}{M}\right)}$$

$$\frac{52.1\ \frac{\text{kg m}}{\text{s}} \pm 79.7\ \frac{\text{kg m}}{\text{s}}}{2.8\ \text{kg}}$$

$$= \begin{cases} +\ 47.1\ \frac{\text{m}}{\text{s}} & \text{corresponds to } \underline{\text{after}} \text{ collision} \\ -\ 9.86\ \frac{\text{m}}{\text{s}} & \text{corresponds to } \underline{\text{before}} \text{ collision} \end{cases}$$

So speed of block after collision is

$$v_2 = \boxed{47.1 \ \tfrac{m}{s} \quad \text{back up ramp}}$$

and

$$v_1 = v_B - \left(\tfrac{m}{M}\right)v_f - \left(\tfrac{m}{M}\right)v_2 = \underline{+7.2 \ \tfrac{m}{s} \ \text{towards ramp}}$$

Check: Thus

$$KE_{\text{after}} = \tfrac{1}{2}mv_2^2 + \tfrac{1}{2}Mv_1^2 = 2348 \text{ J}$$

$$KE_{\text{before}} = \tfrac{1}{2}mv_f^2 + \tfrac{1}{2}Mv_B^2 = 2347 \text{ J}$$

} close enough

Now block goes back up ramp.

$$KE_i + GPE_i = KE_f + GPE_f + W(\text{friction})$$

$$\tfrac{1}{2}mv_2^2 + 0 = \tfrac{1}{2}mv_f^2 + mgH + mgL\cos\theta\mu$$

$$2218 \text{ J} = \tfrac{1}{2}mv_f^2 + 134 \text{ J} + 36.8 \text{ J}$$

$$\tfrac{1}{2}mv_f^2 = 2048 \text{ J}$$

$$\rightarrow \boxed{v_f = 45.3 \ \tfrac{m}{s}} \text{ at top of ramp}$$