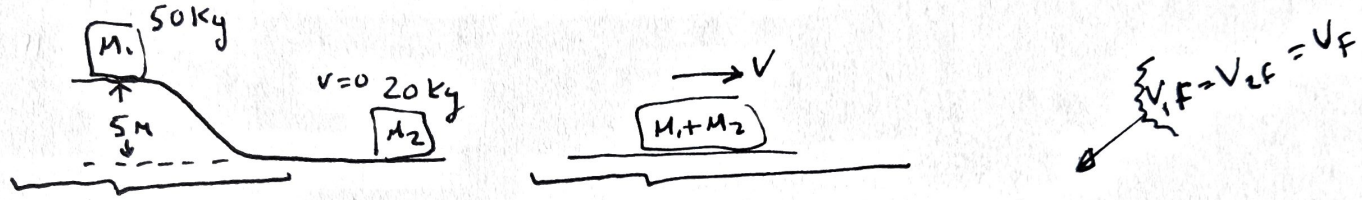
/15

Energy & Momentum – Inelastic Collision Problems

Name: _____ Date: _____

1. [5 marks] A 50kg cart rolls down a 5m high hill. It inelastically collides with a 20kg cart at the bottom. What is the combined speed of the two carts after the collision? Assume a frictionless environment and include a well labelled diagram.



$M_1gh = \frac{M_1V^2}{2}$

$V=\sqrt{2gh}$ @ bottom of hill so it is V_{1i}

$M_1V_{1i} + M_2V_{2i} = M_1V_{1F} + M_2V_{2F}$

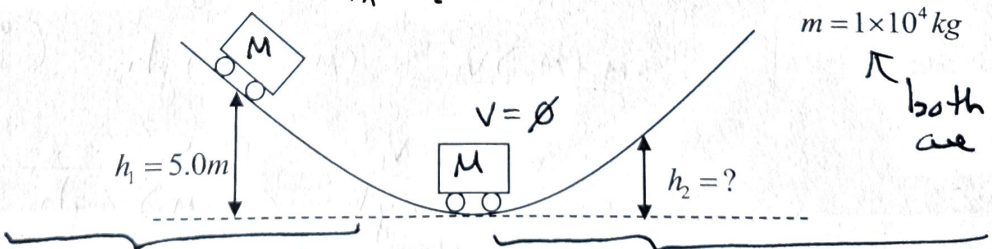
$= (M_1+M_2)V_F$

$V_F = \frac{M_1V_{1i} + M_2V_{2i}}{(M_1+M_2)} = \frac{M_1\sqrt{2gh} + M_2(0)}{(M_1+M_2)}$

$V_F \doteq 7.1\ m/s$

2. [5 marks] Two identical railway cars shown below are initially at rest. The left car rolls downhill, collides with the stationary car, and remains coupled to it. Together they continue up the right side of the hill. Ignoring friction, how far should they rise up the hill before coming to a stop?

$M_1 = M_2 = M$



① same as above. all of the E_g becomes E_k at the bottom.

$V=\sqrt{2gh_1}=V_{1i}$

② $MV_{1i} + MV_{2i} = MV_{1F} + MV_{2F}$

$M\sqrt{2gh_1} = (M+M)V_F$

$M\sqrt{2gh_1} \doteq 2MV_F$

$V_F = \frac{\sqrt{2gh_1}}{2}$ @ bottom combined speed

③ combined mass

$(M+M)gh_2 = \frac{(M+M)V_F^2}{2}$ ← all of this E_K will be stored as E_g.

$2gh_2 = \frac{2gh_1}{4}$

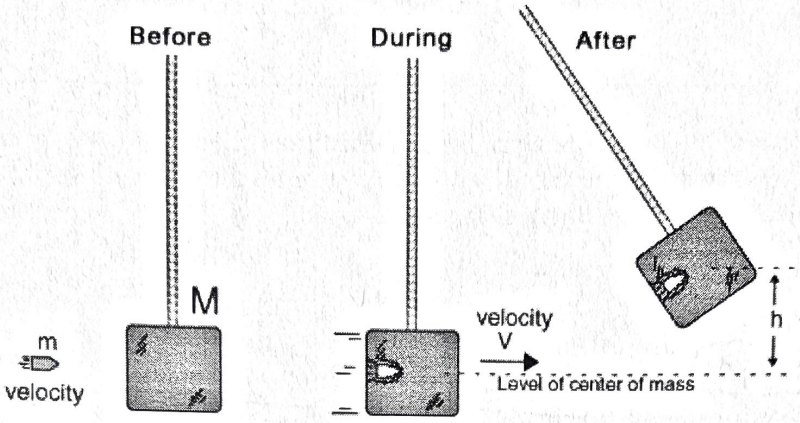
$h_2 = \frac{h_1}{4}$

$\doteq 1.25M$

BALLISTIC PENDULUM – A classic physics experiment/problem

[Try problem first – then watch this solution video]

watch this as well.



3. [5 marks] The ballistic pendulum can be used to determine the initial velocity of a bullet. A bullet is fired at a block with an initial speed. It hits the block and sticks inside it. The combined mass is now moving at a new slower speed. Energy is conserved and the block rises up.

$m = M_1$ (bullet)
$M = M_2$ (block)

a) Determine the height reached by the block due to the impact by the bullet; initial velocity of the bullet is *500m/s*. (*m = 0.05kg* and *M = 10kg*)

Find V_F: $M_1 V_{1i} + M_2 V_{2i}^{0} = (M_1 + M_2) V_F$ ← as usual for inelastic collisions.

$$(*) \quad V_F = \frac{M_1 V_{1i}}{(M_1 + M_2)}$$

This E_k will become E_g.

$$\frac{(M_1+M_2)V_F^2}{2} = (M_1+M_2)gh \quad \text{(where mass is the combined mass } M_1+M_2\text{)}$$

$$h = \frac{V_F^2}{2g} = \frac{M_1^2 V_{1i}^2}{(M_1+M_2)^2 2g}$$

$$\boxed{h = 0.31\,m}$$

b) Determine the initial velocity of the bullet if the block and bullet combined rise to a height of *0.40m*.

rearranged from (*) above.

$$V_{1i} = \frac{(M_1+M_2)}{M_1} V_F \quad \text{where } V_F = \sqrt{2gh}$$

$$V_{1i} = \frac{(M_1+M_2)}{M_1}\sqrt{2gh}$$

$$= \frac{(0.05+10)}{(0.05}\sqrt{2(9.8)(0.4)} \approx \boxed{563\ m/s}$$

which make sense since 0.4 is higher than 0.31 and the bullet was fired at 500 m/s