SPH4U

/10

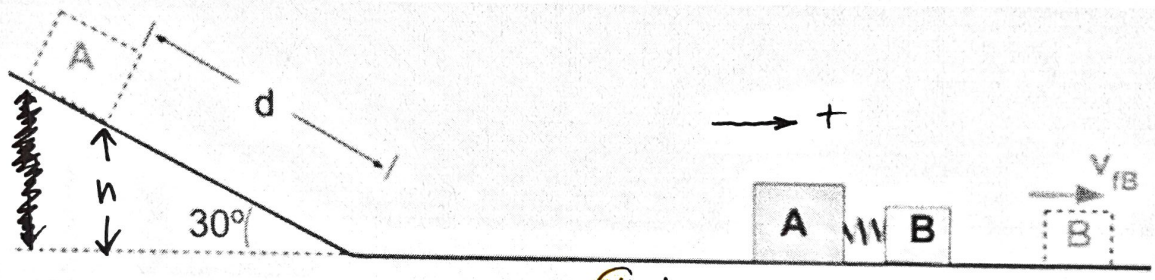
# Energy & Momentum Problems – Elastic Collisions

Name: _____ Date: _____

**Gravitational Potential Energy:** $E_g = mgh$ **Kinetic Energy:** $E_k = \frac{1}{2}mv^2$

**Momentum:** $p = mv$

1. [ 5 marks ] Blocks A and B are pressed together with a spring between them. When the blocks are released from rest, the spring pushes the blocks apart so the 0.75kg block A moves up the 30° ramp to the left and the 0.25 kg block B moves to the right at $v_{fB}$ = 3.0 m/s. Assume friction is negligible.




(4)

BLOCK A: $E_K$

$$E_K = \frac{M_A (V_{AF})^2}{2}$$

@ max height $E_K = \emptyset$ and all energy is stored as potential energy.

$$E_K = E_g$$

$$\frac{M_A (V_{AF})^2}{2} = M_A g h$$

$$h = \frac{(V_{AF})^2}{2g} = \frac{(-1)^2}{2(9.8)}$$

$$\approx 0.051 \text{ m}$$

(3)

$$\sin\theta = \frac{h}{d}$$

$$d = \frac{h}{\sin\theta} = \frac{(V_{AF})^2}{2g\sin\theta} = \frac{(-1)^2}{2(9.8)\sin 30^\circ}$$

$$d = 0.1 \text{ m} \checkmark$$

$$\approx 10 \text{ cm}$$

(1)

$P_{Ti} = P_{TF} = \emptyset$ (both at rest)

$M_A V_{Ai} + M_B V_{Bi} = M_A V_{AF} + M_B V_{BF}$

$\emptyset = (0.75) V_{AF} + (0.25)(3)$

$V_{AF} = -1 \text{ m/s}$

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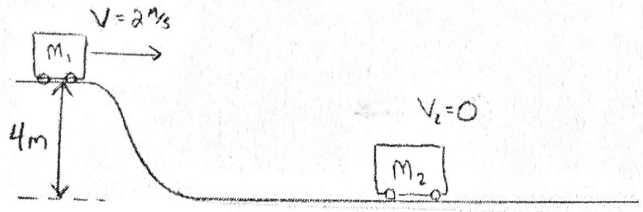
2. [ 5 marks ] A cart is moving at 2 m/s at the top of a hill. It then rolls down the hill undergoes a completely elastic collision with a second cart that is also initially at rest. Determine the speeds of *cart 1* (5 kg) and *cart 2* (15 kg) after the collision. Assume a frictionless environment. Will *cart 1* make it back up the hill?




(1)

$E_T = E_K + E_g$ @ top

$= \frac{M_1 V^2}{2} + M_1 g h$

$= \frac{(5)(2)^2}{2} + (5)(9.8)(4)$

$= 206\ J$

$E_T = E_K$ @ bottom (no $E_g$)

$E_K = 206\ J$

$\frac{M_1 V^2}{2} = 206$

$V = 9.0774\ m/s$

↓

just before hitting the other cart.

(2)

elastic collision

① algebraic solution

② wolfram alpha

③ change in reference frame. (Easiest since one object is stationary)

$V_{1F} = \left(\frac{M_1 - M_2}{M_1 + M_2}\right) V_{1i}$

$= \left(\frac{5 - 15}{20}\right)(9.0774)$

$V_{1F} = -4.5387\ m/s$ →

$V_{2F} = \left(\frac{2M_1}{M_1 + M_2}\right) V_{1i}$

$= \left(\frac{2(5)}{20}\right)(9.0774)$

$V_{2F} = 4.5387\ m/s$

$E_K = 51.49949\ J$

↓

all converts to $E_g$.

$M g h = 51.49949$

$h = 1.05\ m$

∴ does not make it back up the 4m high hill.