ISP220, fall 2021: In-Class Project #4; 15 pts plus! a bonus for 10 pts

Quarks, Spacetime, and the Big Bang

Thursday, September 16, 2021

Name: KEY Student # _____

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1 Waterparks: 15 pts

Figure 1: Me on one of my favorite rides at one of my favorite waterparks in Ocean City, MD.

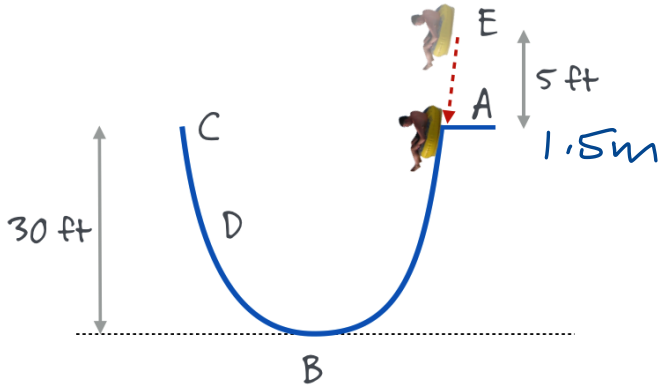

Figure 2: A sketch of my actual trajectory: A-B-D-C. And a sketch of a proposed trajectory: E-A-B-D-C-?

The right hand figure shows my trip down and up the slide. In the left hand photo, I'm at point D. Use $g = 10$ m/s^2. Take point B to be our zero of vertical coordinates. Remember that 1 Joule is 1 kg-m/s^2 and that Kinetic Energy is $K = 1/2mv^2$ and that gravitational potential energy is $U = mgh$. My mass is 100 kg.

What is the height of A and C in meters? You might ask Mr Google. 9.1 m

If D is halfway up, what is that height in meters? (1 point) [4.5] m

We'll pretend that this trip is perfect — no friction and no air (so you can't hear me scream). Then mechanical energy conservation holds and we can write:

$$K_X + U_X = K_Y + U_Y$$

Where X and Y can be any of the A, B, C, D, E points in the sketch.

I gently set my tube at point A and just slide off without any speed at the beginning.

Write the general conservation of energy equation specifically between points A and B using the general K_A, etc symbols. (1 point)

[$K_A + U_A = K_B + U_B$]

What are my potential [9000] J and kinetic [0] J energies at A? (1 point)

$U_A = mgh_A = (100)(10)(9) = 9000$

What are my potential [0] J and kinetic [9000] J energies at B? (1 point)

Write the general conservation of energy equation specifically between points B and C using the general K_B, etc symbols. (1 point)

[$K_B + U_B = K_C + U_C$]

What are my potential energies at C? (1 point) [9000] J and kinetic [0] J

What are my potential energies at D? (1 point) [4500] J and kinetic [4500] J

In order to add some excitement I might have jumped on the railing and dropped from point E to A and then started my trip down.

Write the general conservation of energy equation specifically between points E and B using the general K_B, etc symbols.

[$K_E + U_E = K_B + U_B$]

What are my potential energies at E? (2 points) [10,500] J and kinetic [0] J

$U_E = mgh_E$
$= mg(h_A + 1.5)$
$= (100)(10)(10.5)$
$= 10{,}500$

What are my potential energies at A? (2 points) [9000] J and kinetic [1500] J

What are my potential energies at D? (2 points) [4500] J and kinetic [6000] J

What are my potential energies at C? (2 points) [9000] J and kinetic [1500] J

What would be the extent of my injuries? (0 points)

serious

2 Two Body Scattering: 7 pts

Let's work out a two-body, completely elastic collision. Here is a link to the D2L page that has the demo of this collision: video of the collision (same one as Tuesday).

Figure 3 is that same situation:

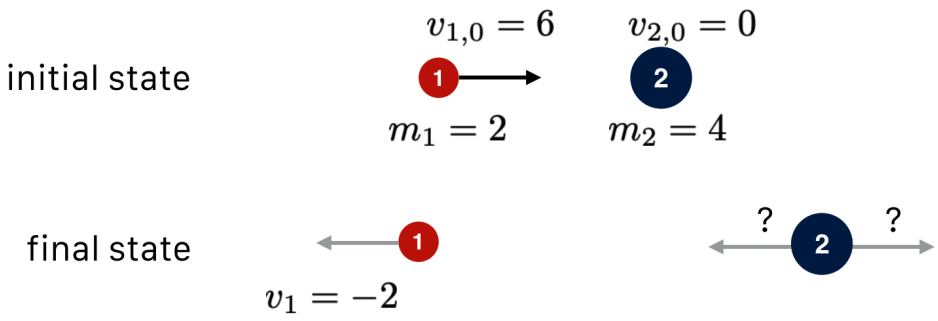

Figure 3: The initial state (top) and the final state (bottom) of a two body collision.

- $m(1) = 2$
- $v_{1,0} = 6$
- $m(2) = 4$
- $v_{2,0} = 0$

(1 point) $K_{1,0} =$ [ ]

(1 point) $K_{2,0} =$ [ ]

(1 point) $K_{\text{initial, total}} =$ [ ]

Furthermore, after they collide the velocity of ball #1 is:

- $m(1) = 2$
- $v_1 = -2$

So the final kinetic energy of ball #1 is:

(1 point) $K_1 =$ [ ]

Let's work out what happens to ball #2.

Figure 4 shows a thermometer diagram we'll use to solve for kinetic energies conservation in this collision.

Add to the plots:

1. The "thermometer" for the initial kinetic energy of #1 (1 point)
2. The "thermometer" for the initial kinetic energy of #2 (1 point)
3. The total energy in the initial state at the T location (1 point)
4. Propagate that Total "thermometer" to the final state T location (1 point)
5. Analyze the graph and draw in the final energies of #1 and #2

Finally, what's the velocity of #2?

(2 points) $v_2 =$ [ ]

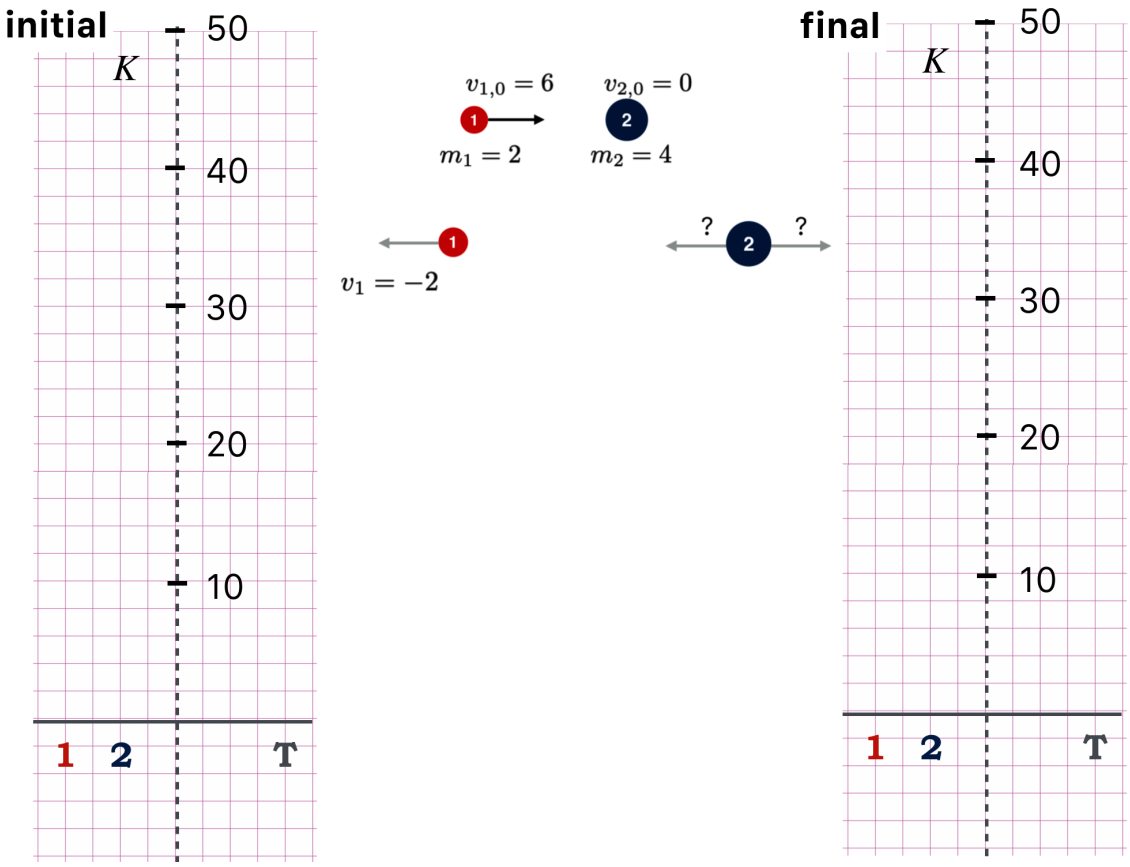

Figure 4: Momentum conservation using thermometers.