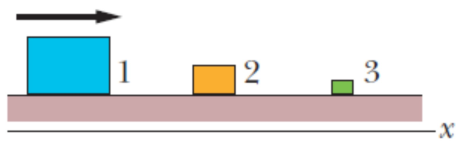
Assignment VIII, PHYS 101 (Introductory Physics I)
Fall 2020
Due via pdf upload to OAKS prior to Thursday, November 5th at 9:25 AM

General instructions:
For this, and all other homework assignments, please turn in your solutions with all supporting work; answers without supporting work will not earn credit. You do not need to upload the sheet with the questions on it, but please clearly number your problems and circle or box your final answers. I encourage you to collaborate with classmates to discuss how to approach a particular question, but the mathematical steps to generate your final answer on your submitted work should be your own. If I see the same simple mistake on multiple homework assignments, I will take off more points for that error than I normally would. Please include *words* in your answers. When you get answer keys back from me, you'll see that there are explanations, ideas, commentary, and thought processes included – not just a set of equations one after another. Finally, please ensure that all numerical answers have units. As always, if you have questions feel free to email me or send me a DM in the slack.

Suggested additional (ungraded) practice problems (Chapter 8): https://openstax.org/books/college-physics/pages/8-problems-exercisess
Problems from all of chapter 8 (sections 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7)

1. A neutron in a reactor makes a collision with the nucleus of a carbon atom initially at rest. (Assume that the nucleus of a carbon atom is initially equal to 12 times the mass of a neutron). (You might need to look up the mass of a neutron – it shouldn't be hard to find). You may assume that this problem is fully 1-dimensional.
   a) If the collision was completely inelastic (in other words, the neutron combines with the carbon nucleus), what fraction of the initial kinetic energy is lost?
   b) If the collision was perfectly elastic, the what fraction of the neutron's initial kinetic energy was transferred to the carbon nucleus?

2. The figure below shows block 1 (with mass m_1) sliding along the x axis of a frictionless floor with speed $v_{1i} = 4.00$ m/s. Then block 1 undergoes an elastic collision with a stationary block of mass $m_2 = \frac{m_1}{2}$. Next, block 2 undergoes a one-dimensional elastic collision with stationary block 3 having mass $m_3 = \frac{m_2}{2}$.

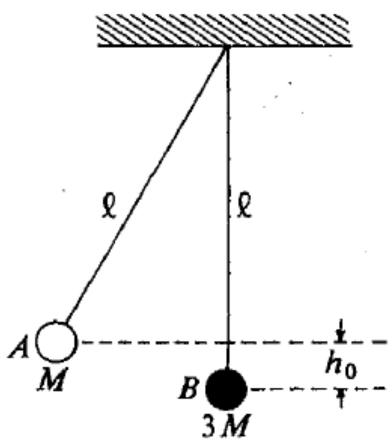


a) What then is the final speed of block 3?

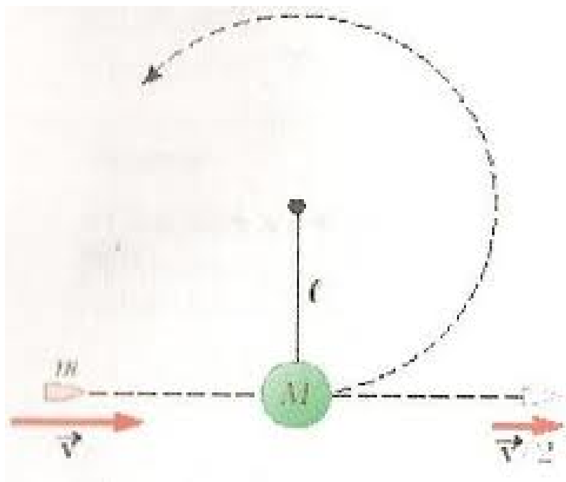
b) What fraction of the initial kinetic energy is transferred to block 3? (In other words, if the initial kinetic energy is K_i, you can write that the final kinetic energy of block 3 as $(K_f)_3 = \gamma K_i$ with γ some constant between 0 and 1. Find γ).

c) What fraction of the initial momentum is transferred to block 3? (In other words, if the initial momentum is p_i, you can write the final momentum of block 3 as $(p_f)_3 = \beta p_i$ with β some constant. Find β).

3. Two small spheres of putty, A and B of masses M and $3M$ respectively, hang from the ceiling on strings of equal length ℓ. Sphere A is drawn aside so that it is raised to a height $h_\circ$ as shown below and then released. Sphere A collides with sphere B and then they stick together and (while attached to each other) swing to a maximum height h, when the two spheres are momentarily at rest. If $M = 350$ g, $\ell = 3.5$ m, and $h_\circ = 24$ cm, what is h?



4. A bullet of mass m and initial speed $v = 330$ m/s passes completely through an initially stationary mass at the end of a (massless) string with the mass at the bottom having mass $M = 1.1$ kg and the string having length $\ell = 0.85$ m. The bullet emerges with speed $\frac{v}{2} = 165$ m/s. What is the required value of m so that mass M will barely swing through a complete vertical circle?



5. Consider the following three masses and their associated coordinates:

$$\begin{aligned} m_1 &= 2.3 \text{ kg} & (r_1)_x &= 13.2 \text{ m} & (r_1)_y &= 2.5 \text{ m} \\ m_2 &= 13.2 \text{ kg} & (r_2)_x &= -2.3 \text{ m} & (r_2)_y &= 17.2 \text{ m} \\ m_3 &= 8.3 \text{ kg} & (r_3)_x &= 15.2 \text{ m} & (r_3)_y &= -7.3 \text{ m} \end{aligned}$$

where $(r_i)_x$ is the x coordinate of mass m_i, etc.

a) How far from the origin of this coordinate system is the center of mass?

b) Where could you put a 22.0kg mass so that the center of mass would be at $x = 3.5$ m and $y = -2.4$ m?