Physics I, Exam 1

College of the Atlantic

October 17–19, 2011

Directions

- This exam is open notes, open book.
- You may not collaborate on this exam; do not work with others. Do not discuss any aspects of this exam with anyone.
- Do not ask the TAs any questions about physics or math while you are taking the exam. If you have any questions, ask me.
- When you are done with the exam, give it to me or put it in my office. Don't put it in my mailbox.
- Unless other arrangements are made, you should get this exam back to me by 5:00pm on Wednesday October 19, 2011.
- Remember to include units.
- To receive full credit on these problems you must show your work clearly.

1. Consider two velocity vectors, $\vec{v_1}$ and $\vec{v_2}$. Let $\vec{v_1}$ have a magnitude of 10m/s and a direction of 53 degrees south of west. Let $\vec{v_2}$ have a magnitude of 20m/s and point due east.

   (a) Sketch the two vectors.
   (b) Find the components of $\vec{v_3}$ where $\vec{v_3} = \vec{v_1} - 2.5\vec{v_2}$.
   (c) Find the magnitude and direction of $\vec{v_3}$.
   (d) Find $\vec{v_1} \cdot \vec{v_2}$.

2. Two pucks collide on a frictionless surface. One puck has a mass of 2 kg and is moving due east at 4 m/s. The second puck has a mass of 3 kg and is moving 5 m/s, 45 degrees south of east. The two pucks collide and stick together. What is the velocity (magnitude and direction) of the two pucks immediately after the collision? Please be sure to draw a clear diagram.

3. Steve Ressel has sent you on a mission to Pluto to look for lizards. You are hovering in a spacecraft 4 km above Pluto's surface. You need to get to the surface to begin your search. Would it be safe to jump off the spaceship at this altitude? The mass of Pluto is around 1.45×10^{22} kg. The radius of Pluto is 3500 km.

4. The earth spins on its axis once a day.

   (a) What is the earth's angular speed, in radians per second?
   (b) What is the velocity of a person standing on the equator?
   (c) What is the velocity of a person standing on the South Pole?

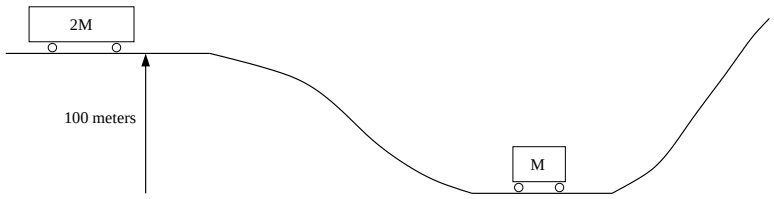

Figure 1:

5. Consider the scenario in the Fig 1. A train car starts at rest 100 meters above the ground. It rolls down and sticks to the smaller car. How high up the incline do the two trains go? The large car has a mass twice that of the smaller car.

6. A certain spring has a spring constant of $k_s = 400$ J/m^2. The spring is compressed 4 cm and then used to shoot a 125 gram marble.

   (a) With what speed does the spring shoot the marble? I.e., what is the marble's speed when it leaves the spring?

   (b) How high in the air does the marble go?

7. A piece of Aluminum at 100 C is placed in 2 kg of 25 degree Celsius water in a well insulated container. After a while the Aluminum and water are both at 40 C. What is the mass of the Aluminum?

8. You are standing at the base of a building. On the second story of the building is a bowling alley owned by a friend of yours. It's time to take the bowling balls to get cleaned. Your friend has the following idea: Construct a ramp that goes out of the window and then onto the ground. The bowling balls can then be rolled down the ramp onto the level ground and you can stop them. This will be a lot easier than carrying the bowling balls down the stairs. Is this safe?

   (a) Estimate the speed of the bowling balls when they reach you at ground level. State any assumptions you need to make to do the problem. (If something doesn't affect the final solution (perhaps the mass of the ball), you should state that, too.)

   (b) Do you think the final speed poses a hazard?

   (c) If the bowling balls slid instead of rolled down, would they reach the bottom with a greater speed? Why or why not? (No calculations are necessary for this part of the question.)