

EXAM 1

16 and 17 October 2001

Directions

- This exam is open notes, open book.
 - You may not collaborate on this exam; do not work with others.
 - 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 10 pm on Wednesday 17 October.
 - 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 north of west. Let \vec{v}_2 have a magnitude of 20m/s and point due south.
 - (a) Find \vec{v}_3 where $\vec{v}_3 = 2\vec{v}_1 - \frac{1}{2}\vec{v}_2$.
 - (b) Find the magnitude and direction of \vec{v}_3 .
 - (c) Compute $\vec{v}_1 \cdot \vec{v}_2$.
 - (d) What is the angle between \vec{v}_3 and \vec{v}_2 ?
 2. Consider a spring with a spring constant $k_s = 100J/m^2$. When relaxed, the spring has a length of 10 cm.
 - (a) In 2 seconds the spring is compressed 3 cm. The spring then shoots a 10 g marble straight up in the air. What is the marble's maximum height? Be careful with units.
 - (b) Now suppose that you want to shoot a 20g marble twice as high as the 10 g marble. What spring constant would you need?

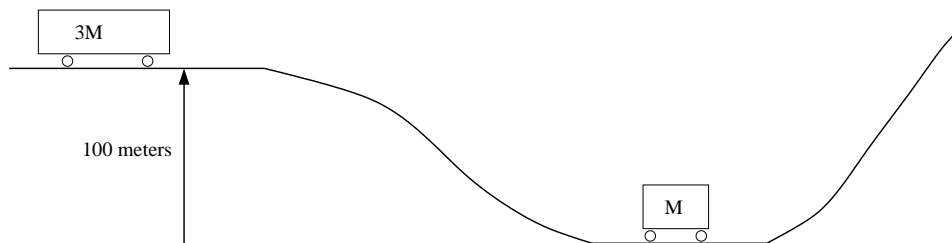


Figure 1:

3. A student throws a TAB mug off a 40 meter building at 10 m/s. What is the speed of the mug right before it hits the ground?
4. The mass of the moon is 7.35×10^{22} kg. The radius of the moon is 1740km. An astronaut drops a 2 kg bowl of oatmeal in a spaceship 100 km above the surface of the moon. The oatmeal falls out of the ship and lands on the surface of the moon. What is the oatmeal's speed right before it hits the moon?
5. Two pucks collide on a frictionless surface. One puck has a mass of 10 kg and is moving due east at 3 m/s. The second puck has a mass of 3 kg and is moving 5 m/s, 37 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?
6. Consider the scenario in the Figure. 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 three times that of the smaller car.