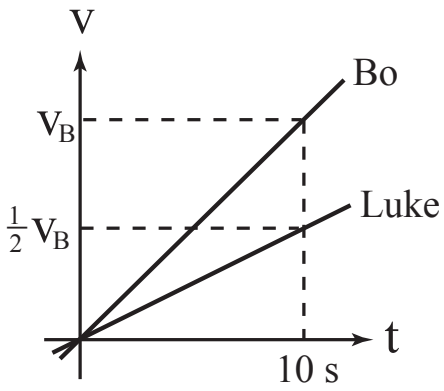
Physics 103

Midterm Exam #1

1. Bo and Luke have a drag race. Each starts from rest and accelerates at a constant rate towards a finish line located 400 m from the starting line. It takes Bo 10 seconds flat to pass the finish line. Daisy records the velocity versus time behavior of her siblings during the race. The results are shown to the right. Notice that Luke is traveling at half of Bo's speed at the time Bo passes the finish line.



a) What is the acceleration of Bo's car? (5 points)

b) What is Bo's speed as he passes the finish line. (5 points)

c) What is the acceleration of Luke's car? (5 points)

d) Write an expression for x_L as a function of t, where x_L is the coordinate of Luke's car? (5 points)

e) How many meters behind Bo is Luke when Bo crosses the finish line? (5 points)

2. It takes 5.5 seconds for a 1 kg rock to fall from the top to the bottom of a well.

a) How long would it take a 2 kg rock to fall from the top to the bottom of the same well? (5 points)

b) How deep is the well? (5 points)

c) What is the stone's speed as it splashes into the water at the bottom of the well? (5 points)

d) What is the magnitude of the stone's acceleration when it is one third of the way down the well? (5 points)

e) If "up" is positive then what is the average velocity of the stone during its fall? (5 points)

3. Consider the following vectors:

$$\vec{\mathbf{A}} = \sqrt{3}\,\hat{\imath} + \hat{\jmath}$$

$$\vec{\mathbf{B}} = -\hat{\imath} + \sqrt{3}\,\hat{\jmath}.$$

a) Make a sketch showing these vectors on a Cartesian coordinate system. (5 points)

b) What is the magnitude $|\,\vec{\mathbf{B}}\,|$. (5 points)

c) What angle does vector $\vec{\mathbf{A}}$ make with vector $\vec{\mathbf{B}}$? (5 points)

d) What angle does vector $\vec{\mathbf{B}}$ make with the positive x axis? (5 points)

e) Compute $\sqrt{3}\,\vec{\mathbf{A}} - \vec{\mathbf{B}}$? (5 points)

4. A football is kicked at an angle 45° above the horizontal and takes 3 seconds to land exactly 45 m downfield. Use a coordinate x to measure distance downfield and a coordinate y to measure the height above the field.

a) What is the x component of the football's initial velocity, v_{0x}? (5 points)

b) What is the y component of the football's initial velocity, v_{0y}? (5 points)

c) What is the football's acceleration one second after being kicked? (5 points)

d) What is the maximum height above the field which the football achieves? (5 points)

e) What is the football's velocity, expressed as a vector, at the instant it is at its maximum height? (5 points).