Midterm Examination Physics 100

October 24, 2012

Name/Student #:

Instructions: Formulas at the back (you can rip that sheet off). Questions are on both sides. Calculator permitted. Put your name and student number at the top of the question sheet and complete all questions on the question sheet. Point values are shown with the questions. Complete the questions in any order. Total exam is worth 60 points.

1. (a) Draw a motion diagram for a child on a sled that is sliding down a 30° slope to the east at a constant speed, then slides on the level for a short distance at the same constant speed, and then gently comes to a stop. You don't need absolute scales for this, but if it helps you solve the problem, consider the constant speed to be 2 m/s, the length of the slope to be 8 m, the level region of constant speed to be 8 m, and the stopping region to be 8 m. (6 points) (b) Indicate the region where a_y is positive if we take y to be vertical (i.e. not sloped coordinates). (2 points)

2. Vectors $\vec{A}$ and $\vec{B}$ are given in Figure 1. Use graphical methods to draw $\vec{C} = \vec{A} + \vec{B}$ and $\vec{D} = \vec{A} - \vec{B}$. Label the vectors and make sure I can see the arrowheads. If you change a vector to its "negative" label it with a negative e.g. label as $-\vec{A}$. (5 points)

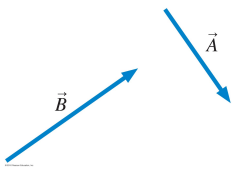

Figure 1: Figure for question 2

3. A position vector with magnitude 10 m points to the right and up. Its x-component is 6.0 m. What is the value of its y-component? (Hint: draw a picture to give a right-angled triangle.) (5 points).

4. You throw a ball straight up into the air and catch it when it comes back. Assume there is no drag force. Give $y(t)$, $v_y(t)$, and $a_y(t)$ graphs for the time interval when the ball is not in your hand. (6 points) How can we find the $v_y(t)$ graph from the $y(t)$ graph? (2 points) Compare points on the $y(t)$ graph at $t = 0$, when the ball is part way up and when the ball has reached its maximum height to show how this matches the $v_y(t)$ graph. (4 points)

5. King Arthur's knights use a catapult to launch a rock but this time they are outside the castle on level ground ($y_i = 0$ m and $y_f = 0$ m). The rock is launched at a speed of 25 m/s and an angle of 25° above the horizontal. Ignore the effects of air resistance. (a) How long does the rock spend in the air? (3 points) (b) How far away does the rock land? (3 points) (c) Is the rock in "free-fall" while in flight? (2 points) (d) What is its acceleration? (2 points)

6. A 4000 kg truck is parked on a 15° slope. $\mu_S = 1.00$, $\mu_k = 0.80$, and $\mu_r = 0.02$. (a) Draw a free-body diagram and clearly indicate the $x - y$ axes and $\vec{F}_{\text{net}}$. (3 points) (b) Write the expression for $F_{\text{net},y}$ using n, mg, and θ. (2 points) (c) What is the friction force on the truck? (5 points)

7. A very smart 3-year old child with a mass of 15 kg is given a wagon for her birthday. The mass of the wagon is 10 kg. She refuses to use it . "After all," she says, "Newton's third law says that no matter how hard I pull, the wagon will exert an equal but opposite force on me. So I will never be able to get it to move forward." What would you say to her in reply? (Good diagrams are worth many words!) (10 points)

———Space for extra notes———