Name: _____ Total Points: _____
      (Last)   (First)

Physics 201

Midterm 1

QUESTION 1 [25 points]

An object moves in 1 dimension
It starts at rest and uniformly accelerates at $5m/s^2$ for 2s
It then moves with constant velocity for 4s
It then uniformly accelerates at $-2m/s^2$ until it comes to rest

a) What is total time of the journey? [5 pts]

b) What distance has the object traveled? [5 pts]

c) What is the average velocity during the motion? [5 pts]

d) What is the average acceleration during the motion? [5 pts]

e) Draw the graph of the position versus time x(t) and velocity versus time v(t) for the **entire** motion. Include the values of x and v at t=2s, t=6s and at the end of the motion. [10 pts]

QUESTION 2 [25 points]

Parts A, B, and C are independent of one another.

A. Consider two displacement vectors: $\vec{A} = (5cm)\hat{x} - (2cm)\hat{y}$ and $\vec{B} = (-1cm)\hat{x} + (4cm)\hat{y}$.
   In the figure at right assume that each grid square represents 1 cm x 1 cm.

   i.   [2pt] Starting from the origin, sketch and label $\vec{A}$.
   ii.   [2pt] Starting from the origin, sketch and label $\vec{B}$.
   iii. [2pt] Starting from the origin, sketch and label $-\vec{B}$.
   iv.   [3pts] Using the graphical method, determine and
               label $\vec{A} - \vec{B}$ on the figure.
   v.   [2pts] Calculate the length of $\vec{A}$

   vi.   [2pts] Calculate the length of $\vec{B}$
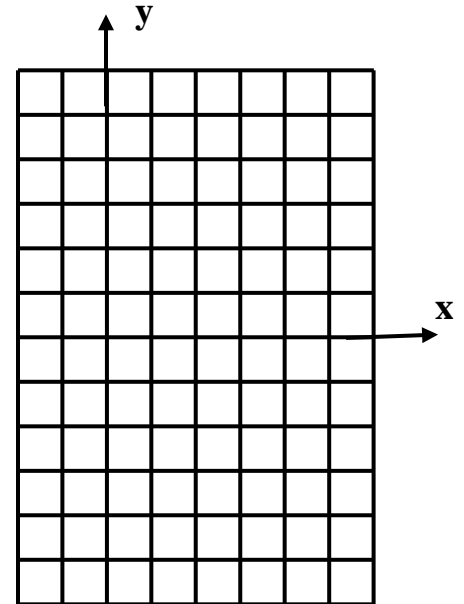
B Two displacement vectors, $\vec{C}$ and $\vec{D}$, are shown at right.
   i.   [2pts] Sketch $\vec{C} + \vec{D}$ in the diagram
   ii.   [5pts] Calculate $|\vec{C} + \vec{D}|$ (hint: express $\vec{C}$ and $\vec{D}$ in terms
   of the unit vectors $\hat{i}$ and $\hat{j}$).
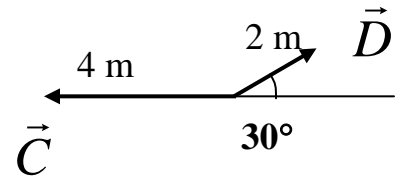
C [5pts] Let the symbols "v", "a", and "t" denote a velocity, an acceleration, and a
   time, respectively. Use dimensional analysis to show that the formula
   $t = 4\pi\left(\dfrac{v}{a}\right)^3$ cannot be physically valid. Explain your answer.

QUESTION 3 [25 points]

At time t=0 a ball is thrown with a speed of v_0 at an angle of θ from the horizontal from a height of h meters above the ground. Let g>0 denote the absolute value of the gravitational acceleration due to the Earth. Express each of your answers blow in terms of v_0, h, g and θ. You must show your work and/or explain your answers to get full credit. Ignore air friction. For all parts that ask for vector answers, you must specify either the direction and magnitude or the components of the vector.
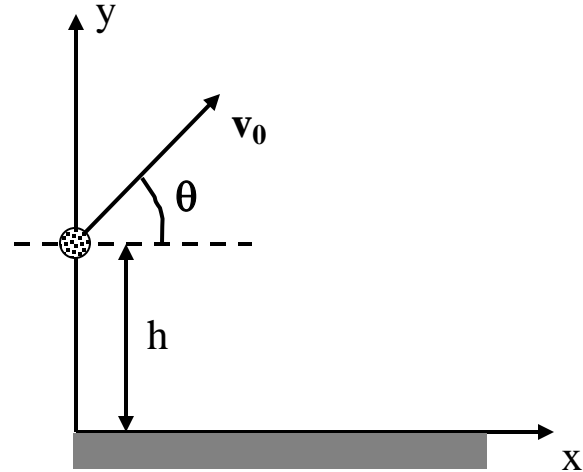
a) [6 pts] What is the instantaneous velocity vector when the ball is at the highest point of its trajectory?

b) [3 pts] What is the instantaneous acceleration vector when the ball is the highest point of its trajectory?

c) [5 pts] At what time does the ball reach the highest point of its trajectory?

d) [8 pts] What is the displacement vector when the ball is at the highest point of its trajectory?

e) [3 pts] Which (if any) of your answers to parts (a) through (d) above would change if the initial height h were doubled?

QUESTION 4 [25 points]

Parts A and B are independent.

A   [9 pts] In an amusement park ride, a spaceship starts from rest at point P and moves with increasing speed along the path shown in the *side view* diagram at right. Draw arrows to indicate the direction of the acceleration of the spaceship at points P, Q, and R. (No explanation necessary)
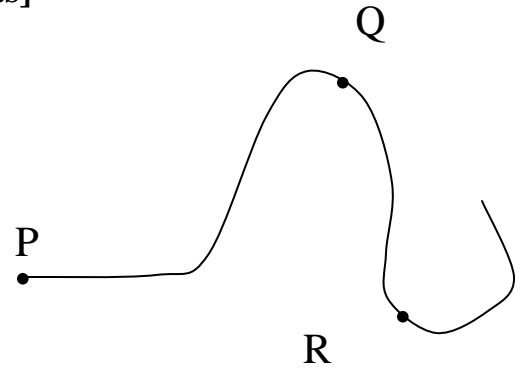
B   Two sprinters, A and B, train together on a horizontal straight track. The velocity vectors of the sprinters are shown for instants 1-4, separated by equal time intervals, in the table below. For the entire interval from instant 1 to instant 4, sprinter A is ahead of sprinter B (i.e., sprinter A is located to the left of sprinter B).

velocity vectors of sprinter A	velocity vectors of sprinter B

at instant 1

at instant 2

at instant 3

at instant 4

i.   [4 pts] In the boxes below, draw arrows to represent the direction of the average acceleration of each sprinter for the interval from instant 1 to instant 4.

Arrow showing the direction of the average acceleration of sprinter A	Arrow showing the direction of the average acceleration of sprinter B

ii.   [4pts] Is the magnitude of the average acceleration of sprinter A *greater than, less than* or *equal to* the magnitude of the average acceleration of sprinter B? Explain your reasoning.

(Question 4 continues on the next page)

iii.   [4 pts] For a small time interval starting at instant 1, does the distance between sprinter A and sprinter B *increase, decrease,* or *remain the same*? Explain your reasoning.

iv.   [4 pts] Is the distance between sprinter A and sprinter B at instant 3 *greater than, less than,* or *equal to* the distance between sprinter A and sprinter B at instant 2? Explain your reasoning.