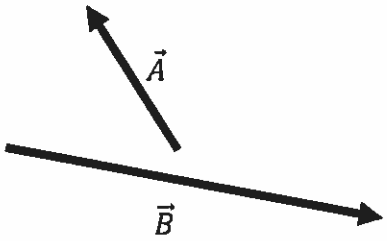
Name (please print): _____
Last *First*

Section Number (e.g. M003) _____ SUID _____

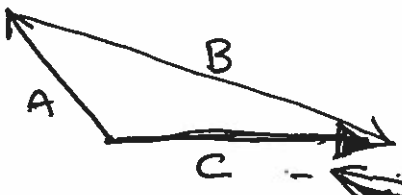
Physics 211, Fall 2019 Exam 1

Document your work or earn no credit. *Use the back of each sheet if you run out of space. Cross out any parts that correspond to given up thoughts.* ***For numerical answers give at least 2 significant digits and specify units.***

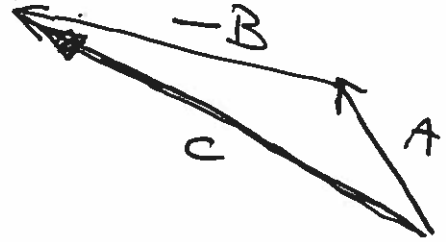
1. [20pts total] Vectors $\vec{A}$ and $\vec{B}$ are shown below. Using graphical method to perform vector algebra find a vector $\vec{C}$ (sketch your method, not just the final result; label each vector drawn e.g. $\vec{A}$, $3\vec{A}$, $\vec{C}$ etc., what you draw needs to reflect both magnitude and direction of each vector).



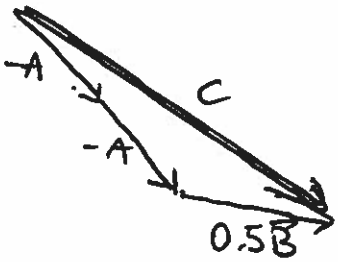
a) [5pts] $\vec{C} = \vec{A} + \vec{B}$



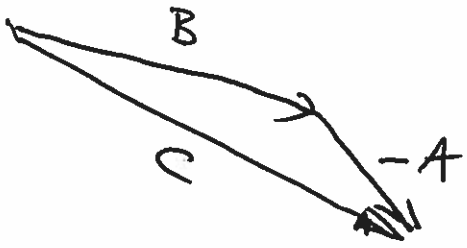
b) [5pts] $\vec{C} = \vec{A} - \vec{B}$



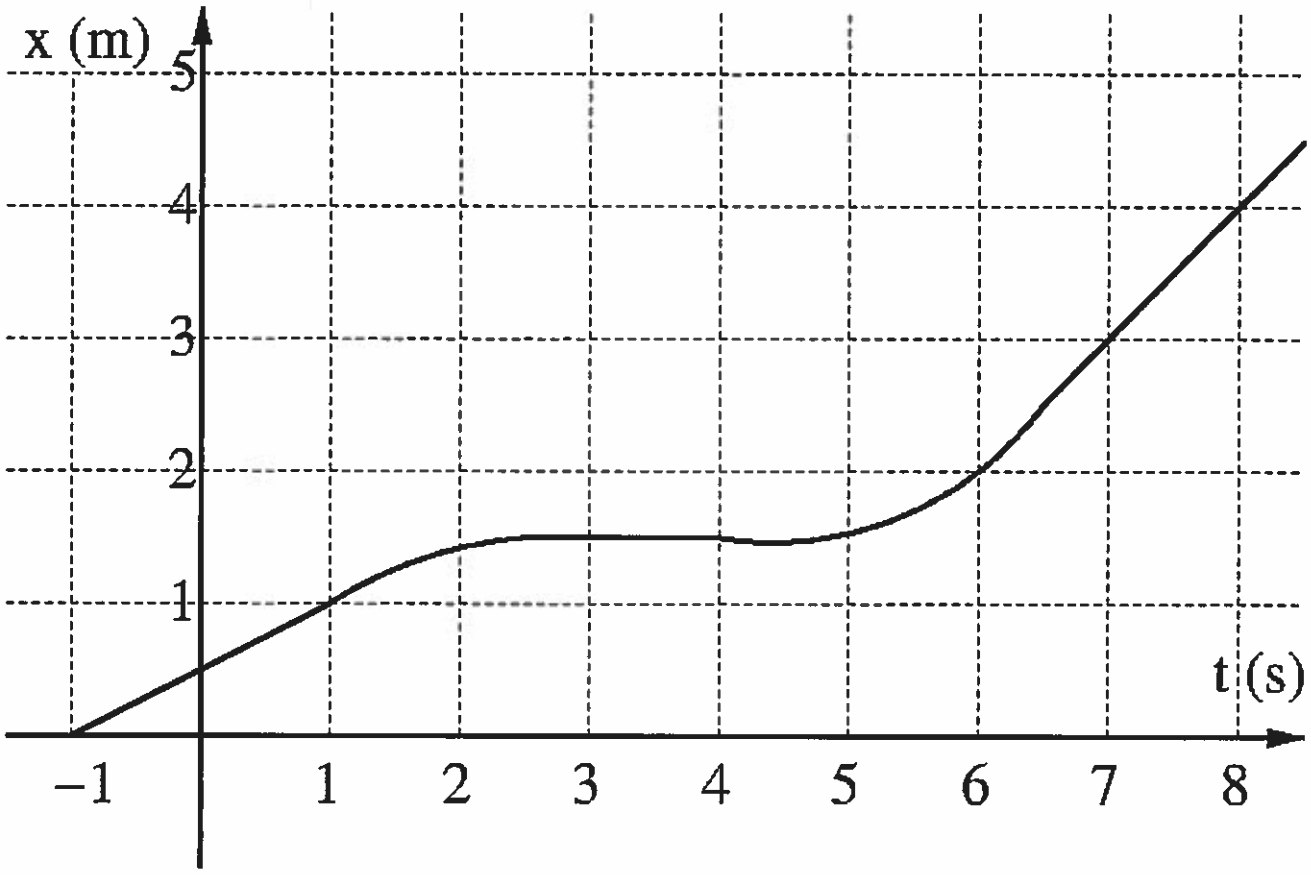
c) [5pts] $\vec{C} = -2\vec{A} + 0.5\vec{B}$



d) [5pts] $\vec{C} = \vec{A} + \vec{B} - 2\vec{A}$



2. [20 pts total] A graph of position (x) versus time (t) for an object in straight-line motion is shown below.



a) [4 pts] What is the average velocity of the object between t=0 s and t=7 s?

$$v_{ave} = \frac{\Delta x}{\Delta t} = \frac{x(t=7) - x(t=0)}{7-0} = \frac{3-0.5}{7} = \frac{2.5}{7} = 0.36 \frac{m}{s}$$

b) [4 pts] What is the instantaneous velocity of the object at t=0 s?

$$v(t=0) = \text{slope of line tangent to the graph at } t=0 = 0.5 \frac{m}{s}$$

c) [4 pts] What is the instantaneous velocity of the object at t=3 s?

$$v(t=3) = \text{slope (see above)} = 0$$

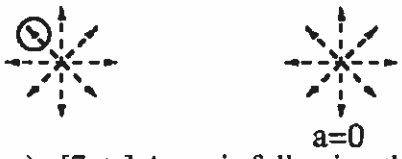
d) [4 pts] What is the average acceleration of the object between t=0 s and t=7 s?

$$a_{ave} = \frac{\Delta v}{\Delta t} = \frac{v(t=7) - v(t=0)}{\Delta t} = \frac{1-0.5}{7} = \frac{1}{14} = 0.071 \frac{m}{s^2}$$

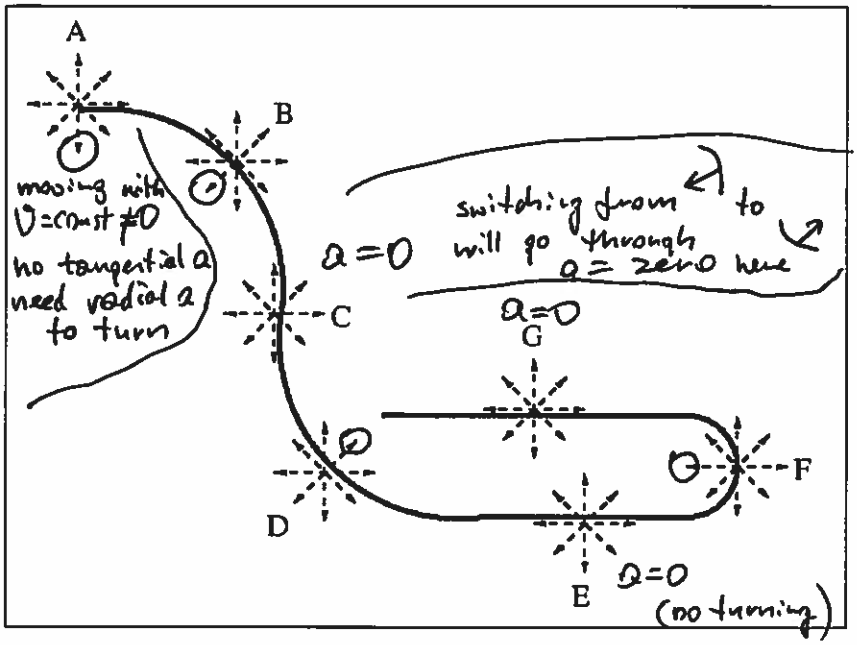
e) [4 pts] What is the instantaneous acceleration of the object at t=7 s?

$$a = \frac{dv}{dt} = 0 \quad (\text{since } v = \text{const around } t=7s)$$

3. [20pts total] Circle one of the eight arrows at each point (A,B,C,D,E,F and G) of the car track shown below, which best describes the direction of the total acceleration vector at that point for two different situations described in a) and c). No credit will be given if it is not clear which direction you have selected. If the acceleration is zero and has no direction, write "a=0" next to that point instead. Examples of correctly marked answers:



a) [7pts] A car is following the track with constant speed. Point A is already on the segment curved to the right. Point C is exactly in between the segments curved to the right and curved to the left, which have the same radius of curvature.



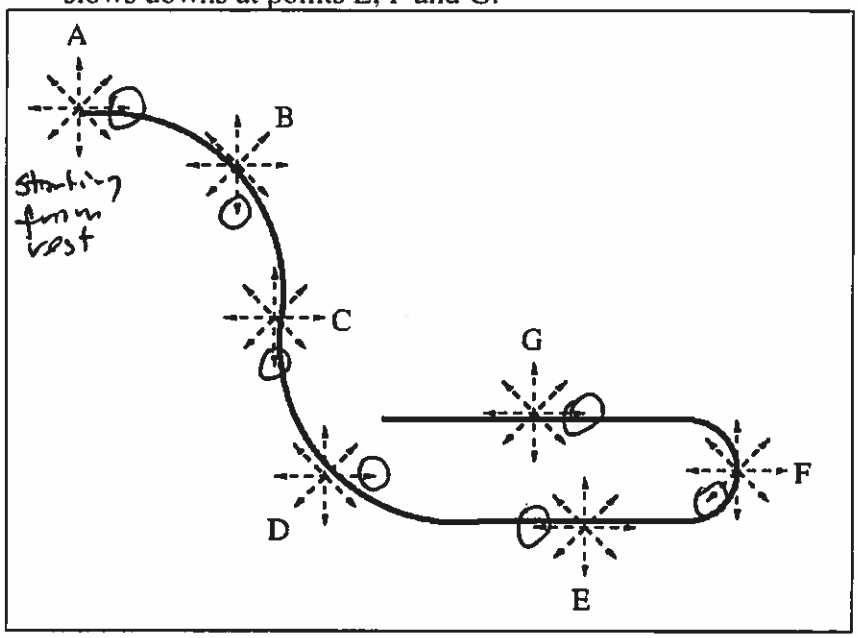
b) [3pts] At which point, B or F, is the magnitude of acceleration larger, or are they equal?

$a = \frac{v^2}{R}$ ← v^2 = const, radius of local curvature

$R_F < R_B$

$a_F > a_B$

c) [10pts] Now assume that the car starts from rest at point A, speeds up at points B, C and D, and slows downs at points E, F and G.



4. [20pts total] Assuming that cyclists can break with a constant deceleration of 0.5 g (assume g=10 m/s^2), what is the stopping distance for a cyclist initially moving at 30 km/h?

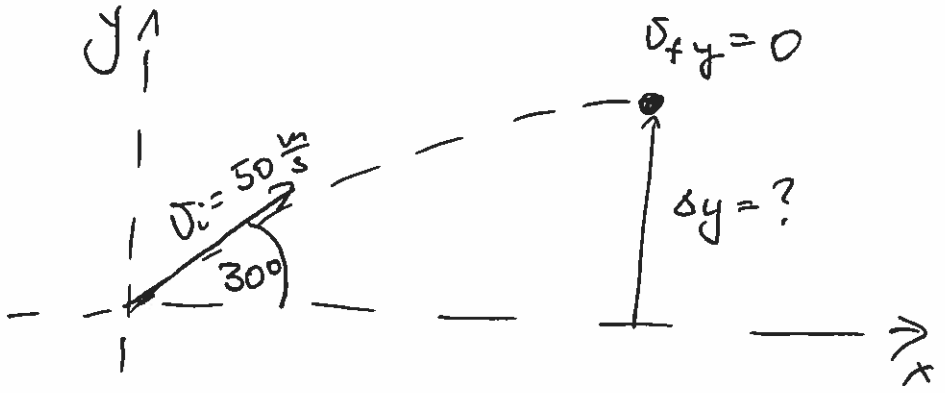
$$\begin{cases} v_f = v_i + a\,\Delta t \\ \| \quad\quad \| \quad\quad \| \\ 0 \quad 30\frac{km}{h} \quad -0.5g \\ \quad\quad \| \quad\quad\quad \| \\ \quad 30\frac{km}{h}\cdot\frac{1000\,m}{1\,km}\cdot\frac{1\,h}{3600\,s} \quad -5\frac{m}{s^2} \\ \quad\quad \| \\ \quad 8.33\frac{m}{s} \\ \Delta x = v_i\,\Delta t + \frac{1}{2}a\,\Delta t^2 \end{cases}$$

Unknown $\Delta t, \Delta x$

$$\Delta t = -\frac{v_i}{a} = \frac{8.33}{5} = 1.67\,s$$

$$\Delta x = 8.33 \cdot 1.67 + \frac{1}{2}(-5)\,1.67^2 = 6.9\,m$$

5. [20pts] A cannonball is shot at 30 degrees above the horizontal with a speed of 50 m/s. How high above the ground will the cannonball reach? Assume g=10 m/s^2 and no resistance from the air. ($\sin 30^0 = 0.5,\ \cos 30^0 = 0.866$).



Unknown $\Delta t, \Delta y$

$$\begin{cases} v_{fy} = v_{iy} - g\,\Delta t \\ \quad\ 0 \quad\ 50\cdot\sin 30^\circ \quad 10 \\ \Delta y = v_{iy}\,\Delta t - \frac{1}{2} g\,\Delta t^2 \\ \qquad\ 50\cdot\sin 30^\circ \end{cases}$$

$$\Delta t = \frac{v_i \sin 30^\circ}{g} = \frac{50\cdot 0.5}{10} = 2.5\ s$$

$$\Delta y = 50\cdot 0.5\cdot 2.5 - \frac{1}{2}\cdot 10\cdot 2.5^2 = 31.3\ m$$