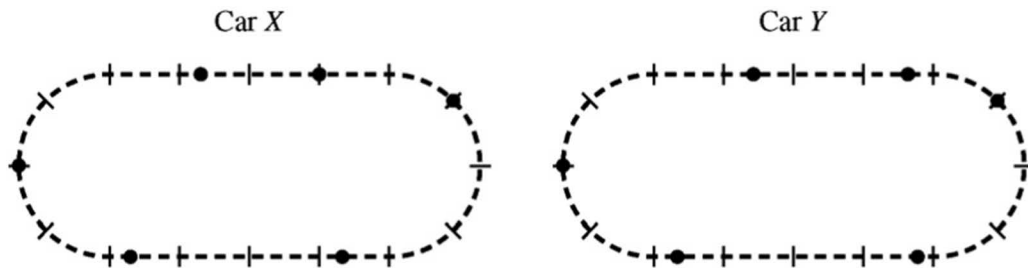


3. The figure above represents a racetrack with semicircular sections connected by straight sections. Each section has length d , and markers along the track are spaced $d/4$ apart. Two people drive cars counterclockwise around the track, as shown. Car X goes around the curves at constant speed v_c , increases speed at constant acceleration for half of each straight section to reach a maximum speed of $2v_c$, then brakes at constant acceleration for the other half of each straight section to return to speed v_c . Car Y also goes around the curves at constant speed v_c , increases speed at constant acceleration for one-fourth of each straight section to reach the same maximum speed $2v_c$, stays at that speed for half of each straight section, then brakes at constant acceleration for the remaining fourth of each straight section to return to speed v_c .
- (a) On the figures below, draw an arrow showing the direction of the net force on each of the cars at the positions noted by the dots. If the net force is zero at any position, label the dot with 0.



- (b) i. Indicate which car, if either, completes one trip around the track in less time, and justify your answer qualitatively without using equations.
 ii. Justify your answer about which car, if either, completes one trip around the track in less time quantitatively with appropriate equations.
- (c) Explain how your equations in part (b) ii reexpress your reasoning in part (b) i. Do not simply refer to any final results of your calculations, but instead indicate how terms in your equations correspond to concepts in your qualitative explanation.