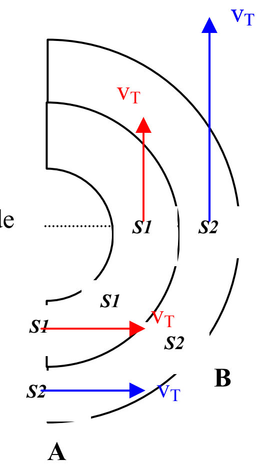
1. Two speed skaters (*S1* and *S2*) enter the final curve (point A) with exactly the same velocity (say, 20 m/s). At this instant they are tied. Throughout the first half of the curve (points A-C), it appears that the athlete in the outside lane (*S2*) remains tied with the athlete in the inside lane (*S1*). Assume that the athlete in the inside lane maintains a constant speed. Using relative terms like "constant", "zero", "greater than", "less than", "stays the same", etc. answer the following questions.

a) Briefly discuss the differences between the linear distances traveled by the athletes between points A and C.

Since S2 is on the outside lane, for any similar angular distance traveled, θ, the larger radius results in an increase in the linear distance traveled.

Key relationship: $d = \theta r$

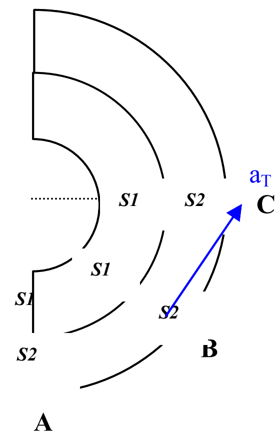
b) Briefly discuss the differences between the tangential velocities of the athletes at points A and C. On the figure to the right, draw the tangential velocity vectors (arrows) for each athlete at points A and C. Indicate relative differences in magnitude by the relative lengths of the vectors (arrows). Be sure to orient your vector in the correct direction.



According to the problem, both athletes are moving with exactly the same linear velocity at point A (i.e., 20 m/s). However, since the athlete in the outside lane must travel a longer distance (see problem *a* above) in the same time, this athlete must be traveling with a higher linear velocity at points B and C. This is reflected by the longer velocity vector for S2 at point C.

Key relationship: $v = d/t$

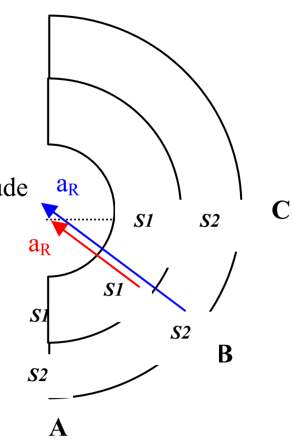
c) Briefly discuss the differences between the tangential accelerations of athletes between points A and C. On the figure to the right, draw the tangential acceleration vectors (arrows) for each athlete at point B. Indicate relative differences in magnitude by the relative lengths of the vectors (arrows). Be sure to orient your vector in the correct direction.



By definition, tangential velocity results from an increase or decrease in the magnitude of the instantaneous linear (tangential) velocity. According to the problem, S1 maintains a constant velocity of 20 m/s throughout the entire curve and therefore experiences *no* tangential acceleration. However, since S2 starts with a speed of 20 m/s at point A, but then must increase their speed throughout the corner to remain even with S1 (see part *b*), they experience a positive tangential acceleration.

Key relationship: $a_T = (v_{Tf}-v_{Ti})/t$

d) Briefly discuss the differences between the radial accelerations of the athletes between points A and C. On the figure to the right, draw the radial acceleration vectors (arrows) for each athlete at point B. Indicate relative differences in magnitude by the relative lengths of the vectors (arrows). Be sure to orient your vector in the correct direction.



If both athletes were traveling at the same speed, the radial acceleration would be greater for S1 since the radius on the inside lane is smaller. However, S2 is actually moving much faster than S1 (see part *b*) and since a_R is affected by the square of the velocity, it is likely that the radial acceleration is higher for S2 than for S1.

Key relationship: $a_R = v_T^2/r$