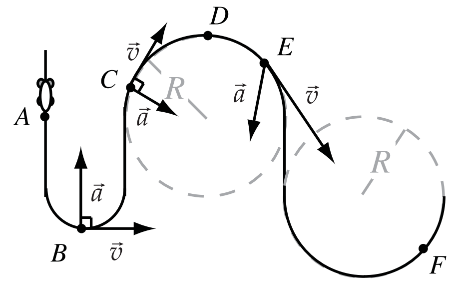
Name ______________________________________**Student ID** _____________ **Score**______

last *first*

IV. [25 points]

A car moves on a track as shown at right. The car is moving with constant speed when it passes point *A,* and continues with constant speed until it reaches point *D*. At point *D,* the car begins to speed up. It speeds up at a constant rate along the rest of the track.



A. [9 pts] Draw vectors to represent the direction of the velocity and the acceleration at each of the following points. If the acceleration at any of these points is zero, state so explicitly. Explain why you drew the vectors as you did.

Point *B:* The velocity vector is always tangent to the path. Since the car is moving with constant speed but changing direction, its acceleration vector is perpendicular to its velocity vector, and points inward on the curve.

Point *C:* Again, the velocity vector is tangent to the path, and the car is moving with constant speed, so its acceleration vector is perpendicular to its velocity vector, and points inward on the curve.

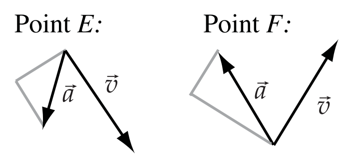
Point *E:* The car's velocity is still tangent to the curve, but the angle between its acceleration and velocity vectors must be < 90° because the car is speeding up and changing direction.

B. [5 pts] Is the magnitude of the acceleration when the car is at point *F* ***greater than***, *less than,* or *equal to* the magnitude of the acceleration when the car is at point *E?* Explain.

The car is speeding up at the same constant rate at both points E and F, so the tangential component of its acceleration is the same at both points. Since the car is going faster at point F, however, it has a larger radial acceleration at that point (see figure below). Since the total acceleration is equal to the vector sum of the tangential and radial components, the car has a larger total acceleration at point F.

C. [6 pts] Is the angle between the acceleration and velocity vectors when the car is at point *F* ***greater than***, *less than,* or *equal to* the angle between the acceleration and velocity vectors when the car is at point *E?* Explain.

Again, the tangential component of the acceleration is the same at both points, but the radial component is larger at point F, as shown at right. This means that the angle between the acceleration and velocity vectors at point F must be *greater than* at point E.



D. [5 pts] At some time later, the motion is repeated by a motorcycle that has ¼ the mass of the car (*i.e.,* $m_{motorcycle} = \frac{1}{4} m_{car}$). The motorcycle moves in exactly the same way as the car (*i.e.,* it has the same initial velocity and its speed begins to increase at the same rate once it reaches point *D*).

When the motorcycle is at point *E,* is the magnitude of its acceleration *greater than, less than,* or ***equal to*** the magnitude of the car's acceleration at point *E?*

The acceleration may be determined solely from the motion of the motorcycle. Since the motorcycle and the car have the same motion, they must have the same acceleration at point E. The different masses will only affect the net forces on the car or motorcycle required to produce the acceleration.