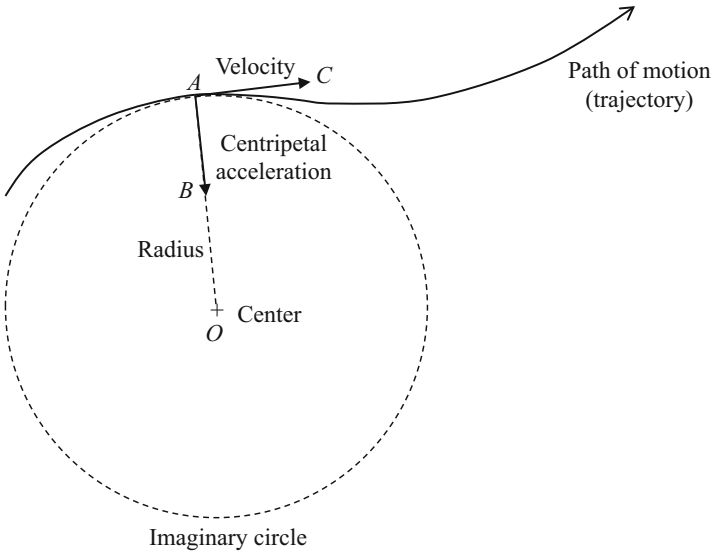

Fig. 1.3 Curvilinear motion in a plane. A particle follows a curved path if at every point, there exists a force component normal to the direction of motion, called the centripetal force. At a given point *A* along the trajectory, the centripetal acceleration, *AB*, acts toward the center *O* of an imaginary circle, a tangent to which at *A* gives the velocity vector, *AC*. The radius of curvature of the path at a given instant is the radius of the imaginary circle, which may keep on varying with time

Let us consider the simplest case of curved motion, namely a particle moving in a circular path. In this special case, the force is applied continuously toward the center (i.e., in the centripetal direction) of a fixed circle traced by the point mass. If we break down the time into many infinitesimal intervals (or instants), then at each instant, it is as if the force is applied at a 90° angle (i.e., normal) to the instantaneous direction of motion. Consequently, there is no change in the speed of the object. However, the direction keeps on changing at every instant due to the normally applied force, and the result is a circular motion. The centripetal force must always act in order to maintain such a motion.

By the second law of motion, the magnitude of the force increases in proportion with the acceleration, that is, the time rate of change of velocity. In a circular motion, the acceleration is proportional to the square of the angular speed (revolutions per second). Now, let us also consider how the centripetal force is applied to the particle. Suppose there is another object (or person) applying the centripetal force on the moving particle. When children play with a rock tied to a string, they make it move in a circle. At every instant, the person holding the string applies a pulling force on the moving rock. However, by the third law of motion, the rock applies an equal and *opposite* force (i.e., the *centrifugal force*) on the person, and we feel the tug on the string which keeps it straight and taut. Now suppose in order to make the rock move faster, the person applies such a large force that the string breaks at a point in