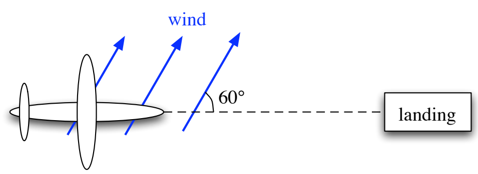
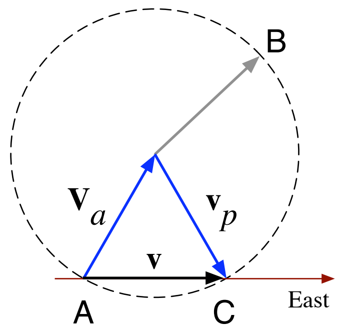


Problem 1 An ultralight aircraft is 5 miles due west of the landing field. It can fly 25 miles per hour in stationary air. However, the wind is blowing at 25 miles per hour from the southwest at a 60° angle to the direction toward the landing field. (a) At what angle relative to the east must the pilot aim her craft to reach the landing field? Explain. (b) How long will it take her to reach the landing field is she flies as described in part (a)?

Solution: Consider two frames of reference, the frame of the ground and the frame of the air. The relative velocity of the two frames is $\mathbf{V}_a$, which has magnitude 25 mph and points 60° north of east. The airplane flies with respect to the air with velocity $\mathbf{v}_p$ whose magnitude is 25 mph and whose direction we must determine.



The velocity of the plane in the frame of the ground is $\mathbf{v} = \mathbf{V}_a + \mathbf{v}_p$, which needs to point due east. A possible values of $\mathbf{v}$ is shown in the figure at the right by the arrow ending at point B on the dotted circle, which is the sum of $\mathbf{V}_a$ and $\mathbf{v}_p$ when it points up and to the right. All possible values of the sum of the two velocities are represented by the dotted circle, which is centered on the end of $\mathbf{V}_a$ and has radius equal to 25 mph.

This circle intersects the east-west line at two points. The first point at A is the tail of $\mathbf{V}_a$ and corresponds to the plane flying exactly into the wind. Since the wind moves at 25 mph and the plane flies at 25 mph with respect to the wind, the plane's velocity with respect to the ground in this case is precisely zero. The plane hovers in place! Therefore, it will never make it to the landing area.

The second intersection point at C corresponds to a net eastward velocity whose magnitude we can easily determine by noting that $\mathbf{V}_a$, $\mathbf{v}_p$, and $\mathbf{v}$ form an equilateral triangle; it is the same as V_a and V_p, or 25 mph. Hence, the pilot must aim the plane 60° south of east so that the net north-south velocity vanishes and the resultant velocity is purely in the eastward direction.
(b) The time taken to reach the landing field is the distance divided by the speed:

$$t = \frac{5 \text{ miles}}{25 \text{ miles/h}} = \frac{1}{5} \text{ h} = 12 \text{ min}$$