14.20 A boat is being pulled into a dock by a rope that passes through a ring on the bow of the boat. The dock is 8 feet higher than the bow ring. How fast is the boat approaching the dock when the length of rope between the dock and the boat is 10 feet, if the rope is being pulled in at the rate of 3 feet per second?

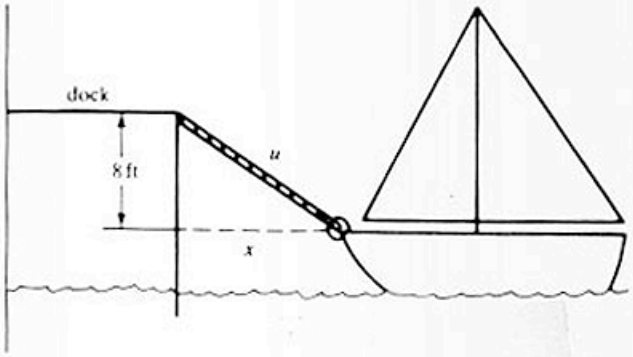

Fig. 14-8

14.21 A girl is flying a kite, which is at a height of 120 feet. The wind is carrying the kite horizontally away from the girl at a speed of 10 feet per second. How fast must the kite string be let out when the string is 150 feet long?

14.22 A rectangular trough is 8 feet long, 2 feet across the top, and 4 feet deep. If water flows in at a rate of 2 ft^3/min, how fast is the surface rising when the water is 1 ft deep?

14.23 A ladder 20 feet long leans against a house. Find the rate at which the top of the ladder is moving downward if the foot of the ladder is 12 feet away from the house and sliding along the ground away from the house at the rate of 2 feet per second?

14.24 In Problem 14.23, how fast is the angle α between the ladder and the ground changing at the given moment?

14.25 A train, starting at 11 a.m., travels east at 45 miles per hour, while another starting at noon from the same point travels south at 60 miles per hour. How fast is the distance between them increasing at 3 p.m.?

14.26 A light is at the top of a pole 80 feet high. A ball is dropped from the same height (80 ft) from a point 20 feet from the light. Assuming that the ball falls according to the law $s = 16t^2$, how fast is the shadow of the ball moving along the ground one second later?

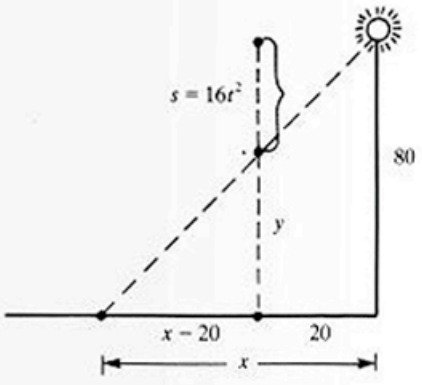

Fig. 14-9

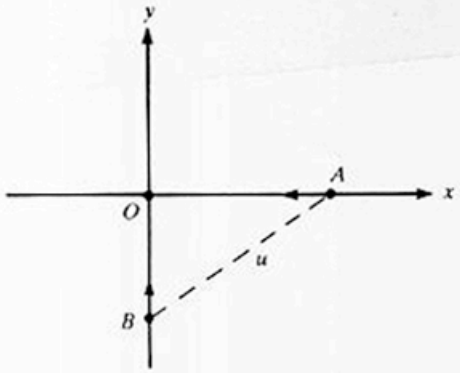

Fig. 14-10

14.27 Ship A is 15 miles east of point O and moving west at 20 miles per hour. Ship B is 60 miles south of O and moving north at 15 miles per hour. Are they approaching or separating after 1 hour, and at what rate?

14.28 Under the same hypotheses as in Problem 14.27, when are the ships nearest each other?

14.29 Water, at the rate of 10 cubic feet per minute, is pouring into a leaky cistern whose shape is a cone 16 feet deep and

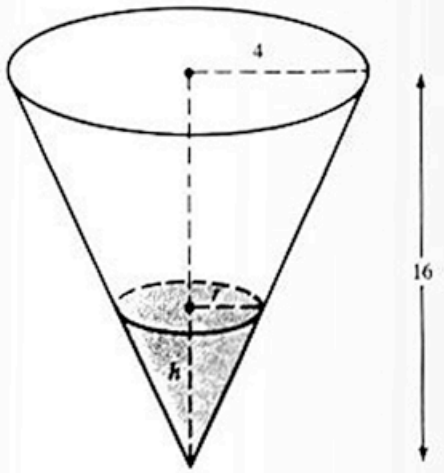

Fig. 14-11

8 feet in diameter at the top. At the time the water is 12 feet deep, the water level is observed to be rising 4 inches per minute. How fast is the water leaking out?

14.30 An airplane is ascending at a speed of 400 kilometers per hour along a line making an angle of 60° with the ground. How fast is the altitude of the plane changing?

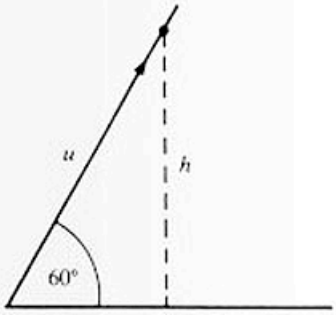

Fig. 14-12

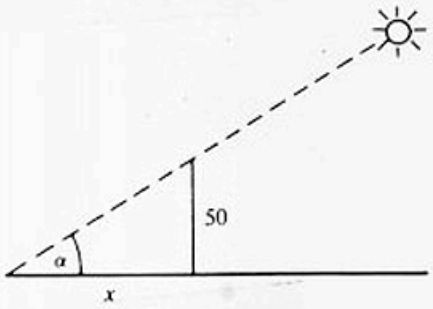

Fig. 14-13

14.31 How fast is the shadow cast on level ground by a pole 50 feet tall lengthening when the angle α of elevation of the sun is 45° and is decreasing by $\frac{1}{4}$ radian per hour? (See Fig. 14.13.)

14.32 A revolving beacon is situated 3600 feet off a straight shore. If the beacon turns at 4π radians per minute, how fast does its beam sweep along the shore at its nearest point A?

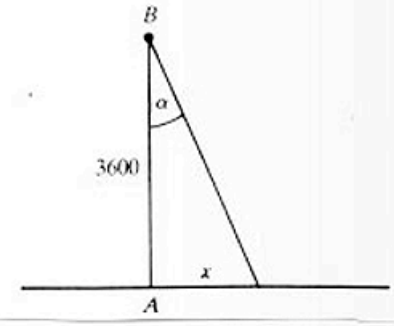

Fig. 14-14

14.33 Two sides of a triangle are 15 and 20 feet long, respectively. How fast is the third side increasing when the angle α between the given sides is 60° and is increasing at the rate of 2° per second?

14.34 The area of an expanding rectangle is increasing at the rate of 48 square centimeters per second. The length of the rectangle is always equal to the square of its width (in centimeters). At what rate is the length increasing at the instant when the width is 2 cm?

14.35 A spherical snowball is melting (symmetrically) at the rate of 4π cubic centimeters per hour. How fast is the diameter changing when it is 20 centimeters?

14.36 A trough is 10 feet long and has a cross section in the shape of an equilateral triangle 2 feet on each side (Fig. 14-15). If water is being pumped in at the rate of 20 ft^3/min, how fast is the water level rising when the water is 1 ft deep?

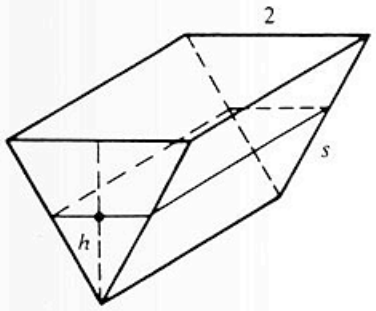

Fig. 14-15