Related Rates Supplementary Problems

This consists of a collection of supplementary and more challenging related rates questions. There currently is no solutions document to distribute; to discuss solutions attend office hours or go to the calculus tutoring center.

1. A cat watches a moth fluttering by overhead. If the moth is flying horizontally at 5 feet per second at a height of 4 feet above the cat, how fast does the angle between the horizontal and the cat's line of sight to the moth decrease when the moth is 3 feet away from the point directly over the cat's head?

2. Two dogs are playing in a field. A ball is thrown and lands at a position that is 20 meters from one dog, and 25 meters from the other dog. The dogs simultaneously begin running straight for the ball. The dog starting 20 meters away from the ball runs at 10 meters per second, while the other dog runs at 12 meters per second. If the angle between their paths, as measured from the ball, is 120°, find the rate at which the distance between the dogs is decreasing 1 second after they begin running.

3. A cyclist is riding so that the crank that they turn by pedaling completes 2.5 rotations per second. They are in a high gear, so that the chain goes over a crank gear with 52 teeth and a cassette gear with 13 teeth which drives the wheel. If the radius of the driving wheel (including the tires) is 0.7 meters how fast in meters per second is the bicyclist traveling?

4. A 12 foot long roof gutter has the shape of a trapezoidal prism with lower base length 3 inches, upper base length 5 inches, and height 3 inches. The section of roof it is attached to has an area of 180 square feet and is angled at 45°. During rainstorms the water runs off of the roof and into the gutter, adding to the rain water that falls directly into the gutter. If during an intense rainstorm it is raining 2 inches per hour, how quickly, in cubic inches per minute, must the gutter evacuate water to prevent overflowing?

5. On an equinox, at any point on the equator, the sun moves along an arc of the sky that goes through the zenith, which is point of the celestial sphere directly above. Assuming 12 hours of daylight on an equinox, how fast is the shadow of a 10 meter tall equatorial tree growing when the sun makes an angle of 30 degrees with the horizon in the afternoon?

6. A pair of 6 inch long scissor blades are being closed so that the angle between the blade edges decreases at a rate of $\pi/4$ radians per second. If the distance from the center of the hinge to a blade edge is $3/8$ of an inch, how fast does the point where the blades meet advance along the blades when the angle between the blades is $\pi/8$ radians? Describe the velocity of this point as a function of time.

7. Assuming smooth motion of a pair of analogue clock hands, at what times do the distances between the tips of the minute and hour hands grow most rapidly? Least rapidly?