

Differentiation of Transcendental Functions

20. The *apparent power* P_a (in W) in an electric circuit whose power is P and whose impedance phase angle is θ is given by $P_a = P \sec \theta$. Given that P is constant at 12 W, find the time rate of change of P_a if θ is changing at the rate of 0.050 rad/min, when $\theta = 40.0^\circ$.
21. A point on the outer edge of a 38.0-cm wheel can be described by the equations $x = 19.0 \cos 6\pi t$ and $y = 19.0 \sin 6\pi t$. Find the velocity of the point for $t = 0.600$ s.
22. A machine is programmed to move an etching tool such that the position (in cm) of the tool is given by $x = 2 \cos 3t$ and $y = \cos 2t$, where t is the time (in s). Find the velocity of the tool for $t = 4.1$ s.
23. Find the acceleration of the tool of Exercise 22 for $t = 4.1$ s.
24. The volume V (in m^3) of water used each day by a community during the summer is found to be $V = 2500 + 480 \sin(\pi t/90)$, where t is the number of the summer day, and $t = 0$ is the first day of summer. On what summer day is the water usage the greatest?
25. A person observes an object dropped from the top of a building 100 ft away. If the top of the building is 200 ft above the person's eye level, how fast is the angle of elevation of the object changing after 1.0 s? (The distance the object drops is given by $s = 16t^2$.) See Fig. 24.

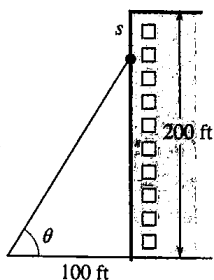


Fig. 24

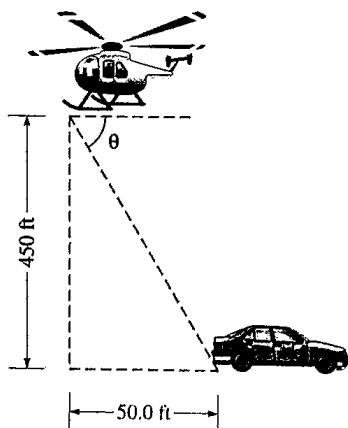


Fig. 25

26. A car passes directly under a police helicopter 450 ft above a straight and level highway. After the car travels another 50.0 ft, the angle of depression of the car from the helicopter is decreasing at 0.215 rad/s. What is the speed of the car? See Fig. 25.
27. A searchlight is 225 ft from a straight wall. As the beam moves along the wall, the angle between the beam and the perpendicular to the wall is increasing at the rate of 1.5°/s. How fast is the length of the beam increasing when it is 315 ft long? See Fig. 26.

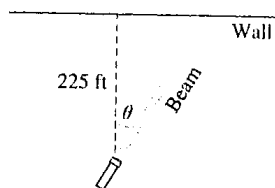


Fig. 26

28. In a modern hotel, where the elevators are directly observable from the lobby area (and a person can see from the elevators), a person in the lobby observes one of the elevators rising at the rate

of 12.0 ft/s. If the person was 50.0 ft from the elevator when it left the lobby, how fast is the angle of elevation of the line of sight to the elevator increasing 10.0 s later?

29. A crate of weight w is being pulled along a level floor by a force F that is at an angle θ with the floor. The force is given by $F = \frac{0.25w}{0.25 \sin \theta + \cos \theta}$. Find θ for the minimum value of F .
30. The electric power p (in W) developed in a resistor in an FM receiver circuit is $p = 0.0307 \cos^2 120\pi t$, where t is the time (in s). Linearize p for $t = 0.0010$ s.
31. When an astronaut views the horizon of earth from a spacecraft at an altitude of 610 km, the angle θ in Fig. 27 is found to be $65.8^\circ \pm 0.5^\circ$. Use differentials to approximate the possible error in the astronaut's calculation of earth's radius.

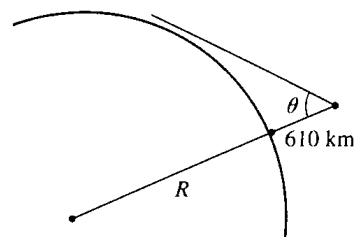


Fig. 27

32. A surveyor measures two sides and the included angle of a triangular parcel of land to be 82.04 m, 75.37 m, and 38.38° . What error is caused in the calculation of the third side by an error of 0.15° in the angle?
33. The volume V (in L) of air in a person's lungs during one normal cycle of inhaling and exhaling at any time t is $V = 0.48(1.2 - \cos 1.26t)$. What is the maximum flow rate (in L/s) of air?
34. To connect the four vertices of a square with the minimum amount of electric wire requires using the wiring pattern shown in Fig. 28. Find θ for the total length of wire ($L = 4x + y$) to be a minimum.

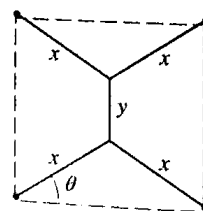


Fig. 28

35. The strength S of a rectangular beam is directly proportional to the product of its width w and the square of its depth d . Use trigonometric functions to find the dimensions of the strongest beam that can be cut from a circular log 16.0 in. in diameter.
36. An architect is designing a window in the shape of an isosceles triangle with a perimeter of 60 in. What is the vertex angle of the window of greatest area?
37. A camera is on the starting line of a drag race 15.0 m from a racing car. After 1.5 s the car has traveled 30.0 m and the camera is rotating at 0.75 rad/s while filming the car. What is the speed of the car at this time?
38. What is the vertex angle at the bottom of an ice cream cone such that the cone holds a given amount of ice cream (within the cone itself) and the cone requires the least possible surface? (Hint: Set up equations using half the angle.)