Principles of Calculus Modeling: An Interactive Approach by Donald Kreider, Dwight Lahr, and Susan Diesel
Exercises for Section 2.17

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1. (1 pt)
Refer to the baseball example in 2.17 on the Web site. Suppose that at the moment the ball is pitched, a runner on first steals home, running at a speed of 17.6 miles per hour. How fast is the distance between the catcher and the runner changing at the moment the catcher catches the ball?

__________ miles per hour

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2. (1 pt)
Consider the inflating balloon example in 2.17 on the Web site. The formula for surface area of a sphere of radius r is $4\pi r^2$. Assume the radius of the balloon is changing at a rate of 3 centimeters per second. How fast is the surface area of the balloon increasing when the radius is 12 centimeters?

__________ square centimeters per second

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3. (1 pt)
The strength of the material the balloon is made of is such that the balloon bursts when its surface area exceeds 2200 square centimeters. If the rate of change of the radius of the balloon is still constant at 3 centimeters per second, how much air is being pumped into the balloon at the instant it bursts?

__________ cubic centimeters per second

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4. (1 pt)
A ladder 10 feet long is resting against a wall. The bottom of the ladder is sliding away from the wall at a rate of 1 foot per second. At the moment the base of the ladder is 5.6 feet from the wall, what is the cosine of the angle in radians between the ladder and the ground?

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What is the rate of change in the angle with respect to the distance between the top of the ladder and the ground when the base of the ladder is 5.6 feet from the wall?

__________ radians per foot

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5. (1 pt)
Kepler's third law of planetary motion states: The square of the orbital period of any planet is proportional to the cube of the orbital radius or semimajor axis for an elliptical orbit. Assuming the orbit of the Earth is circular around the Sun, if T is the period of orbit of the Earth (equal to 1 year) and r is the radius of the orbit (93 million miles) the equation relating T and r is

$$T^2 = \frac{4\pi^2}{GM} r^3$$

where G is the universal gravitational constant and M is the mass of the Sun.

Find the formula for the rate of change of the period of Earth's orbit with respect to a change of radius.

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How much does the period change if the distance between the Earth and the Sun increases by 18 million miles?

__________ years

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6. (1 pt)
Pressure P on a scuba diver is a function of the diver's depth d: $P = kd + 1$, where k is a constant. The pressure is 1 atmosphere at the surface, and about 11 atmospheres at a depth of 100 meters. Suppose a diver descends into the water at a rate of 1.1 meters per second. What is the rate of change of pressure with respect to time?

__________ atmospheres per second

If the diver descends more slowly the further he goes down, following the formula $d(t) = 1 + 10\ln(t)$, what is the rate of change of pressure with respect to time when the diver is at a depth of 25 meters?

__________ atmospheres per second

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7. (1 pt)
To put trigonometric functions in a geometric context, we typically draw a unit circle with a triangle whose hypotenuse is the radius and which has one corner anchored at the origin. The base and height of the triangle have lengths equal to the cosine and sine of the central angle x created by the hypotenuse and the positive x axis.

What is the rate of change of the cosine of the angle with respect to the sine of the angle when the angle is changing at a constant rate of k radians per second?

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8. (1 pt)
Given $y = 9x^3 + 3x^2 + 5$ and $x = 7t^2 + 10t + 2$, find dy/dt.

$dy/dt =$ __________

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9. (1 pt)
Given $R = \sqrt{1+\sin(x)}$ and $V = e^{R/7}$, find dV/dx.

$dV/dx =$ __________

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10. (1 pt)
If $f = \sin(\theta)$ and $\theta = 2t + 1/t^2$, which of the following could be and expression for df/dt?

- A. $\cos\left(2 - \frac{2}{t^3}\right)\left(2 - \frac{2}{t^3}\right)$
- B. $\sin\left(2t + \frac{1}{t^2}\right)\left(2 - \frac{2}{t^3}\right)$
- C. $\cos(\theta)\left(2 - \frac{2}{t^3}\right)$
- D. $2\cos\left(2t + \frac{1}{t^2}\right)\left(1 - \frac{1}{t^3}\right)$
- E. $\frac{d\theta}{dt}\frac{df}{d\theta}$