ESP Math 179

Worksheet 13

Related Rates

27 February 2020

Spring 2020

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1. (**Warm-up**) Find the equation of the tangent line to $y = y^2 + \sin(x)$ at $(0, 1)$.

2. (**Warm-up**) Evaluate the following limit.

$$\lim_{x \to 3^-} \frac{x^2 - 8x + 15}{x^2 - x - 6}$$

3. In physics, the kinetic energy of a moving object is given by the formula

$$K = \frac{1}{2}mv^2$$

where m is the mass and v is the velocity.

Suppose a rock weighing 1 kg is dropped from cliff and accelerates at a rate of approximately 10 m/s^2. How quickly is the kinetic energy of the rock changing when the velocity is 20 m/s?

4. Boyle's law describes the relationship between the pressure P and volume V of a fixed quantity of gas maintained at a constant temperature. The law states that

$$PV = \text{a constant}$$

A sample of gas is placed in a piston. At the beginning of the experiment, the gas occupies a volume of 250 cm^3, and has a pressure of 100 kPa. The piston is slowly compressed, decreasing the volume of the gas at a rate of 50 cm^3/min. How quickly will the pressure of the gas initially increase?

5. Ohm's law describes the relationship between the voltage V across a resistor, the electrical current I passing through the resistor, and the resistance R of the resistor. The law states that

$$V = IR$$

(a) Suppose the current is increasing at a rate of 3 amps/sec, while the resistance stays constant at 4 ohms. How quickly is the voltage across the resistor changing?

Now suppose that the voltage is kept constant at 20 volts, while the resistance is increased at a rate of 4 ohms/sec.

(b) What is the current through the resistor when the resistance is at 10 ohms?

(c) What is the rate of change of the current at that time? Is it increasing or decreasing?

6. A ladder is leaning against a wall, when it begins to slip down the wall. If the point where the ladder touches the ground is moving away from the wall at a constant rate, does the point where the ladder touches the wall also move at a constant rate? Justify your answer.

7. Doppler radar (used by police officers in radar guns) measure the rate of change of the distance between an object and the observer. Suppose you're speeding down the Kennedy Expressway at 70 mph, over the speed limit of 60 mph. A policewoman sitting in her patrol car 30 feet from the highway points her radar gun at you when you're 50 feet from her. Will you get away with speeding (i.e., will her radar gun reading be below 60 mph)?