

Use this as a study guide for the types of questions that will be on Test #3.

**SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.**

- 1) A publishing company has published a new magazine for young adults. The monthly sales  $S$  (in thousands) is given by  $S(t) = \frac{800t}{t+2}$ , where  $t$  is the number of months since the first issue was published. Find  $S(3)$  and  $S'(3)$  and interpret the results. 1) \_\_\_\_\_

**Solve the problem.**

- 2) The decay of 363 mg of an isotope is given by  $A(t) = 363e^{-0.021t}$ , where  $t$  is time in years. Find the amount left after 92 years. 2) \_\_\_\_\_
- 3) A certain radioactive isotope has a half-life of approximately 1850 years. How many years to the nearest year would be required for a given amount of this isotope to decay to 35% of that amount? 3) \_\_\_\_\_
- 4) What rate of interest is required in order for a \$100 investment to double in 3 years if the interest is compounded continuously? 4) \_\_\_\_\_
- 5) How long will it take for the value of an account to be \$890 if \$350 is deposited at 11% interest compounded continuously? 5) \_\_\_\_\_
- 6) How long will it take money to double if it is invested at 5.25%, compounded continuously? 6) \_\_\_\_\_

**Solve the problem.**

- 7) At a local university, the number of students (in hundreds) who skip at least one class per week can be modeled by the function  
$$f(x) = 150\sqrt{16-x} \quad 1 \leq x \leq 16$$
where  $x$  represents the number of weeks into the semester and  $f(x)$  represents the number of students skipping classes in that week. Evaluate and interpret  $f'(8)$ . 7) \_\_\_\_\_
- 8) The life expectancy for pigeons in New Jersey can be modeled by  
$$f(x) = 2 + 2.13 \ln x, \quad 1 \leq x \leq 4$$
where  $x$  represents the birth year since 1994 and  $f(x)$  represents the life expectancy in years.  
i) Determine  $f'(x)$ .  
ii) Evaluate and interpret  $f(2)$  and  $f'(2)$ .  
iii) Write an equation for the tangent line at  $x = 2$ . 8) \_\_\_\_\_
- 9) A company has determined that the salvage value of its mainframe computer can be modeled by  
$$s(x) = 700,000e^{-1.45x}, \quad x > 0$$
where  $x$  is the number of years since the computer was purchased and  $s(x)$  is the value of the computer. Evaluate and interpret  $s'(6)$ . 9) \_\_\_\_\_

10) Assume that the temperature of a person during an illness is given by: 10) \_\_\_\_\_

$$T(t) = \frac{8t}{t^2 + 1} + 98.6,$$

where  $T$  = the temperature, in degrees Fahrenheit, at time  $t$ , in hours. Find the rate of change of the temperature with respect to time.

11) Management at a factory has found that the maximum number of units a worker can produce in a week is given by  $P(t) = 60(1 - e^{-0.4t})$ , where  $t$  is the number of weeks the worker has been on the job. Find the rate of change  $P'(t)$ . 11) \_\_\_\_\_

**Solve.**

12) The power supply of a satellite is a radioisotope. The power output  $P$ , in watts (W), decreases at a rate proportional to the amount present.  $P$  is given by  $P = 50e^{-0.003t}$ , where  $t$  is the time in days. 12) \_\_\_\_\_  
How much power will be available after 445 days? What is the half-life of the power supply? How much power did the satellite have to begin with?

**Solve the problem.**

13) \$2600 is deposited in an account with an interest rate of  $r\%$  per year, compounded monthly. At the end of 8 years, the balance in the account is given by 13) \_\_\_\_\_  
 $A = 2600 \left(1 + \frac{r}{1200}\right)^{96}$ . Find the rate of change of  $A$  with respect to  $r$  when  $r = 8$ . Round answer to the nearest hundredth, if necessary.

14) A business estimates that the salvage value  $V$  of a piece of machinery after  $t$  years is given by 14) \_\_\_\_\_

$$V(t) = \$20,000e^{-0.47t}.$$

After what amount of time will the salvage value be \$678?

15) Researchers have found that the maximum number of successful trials that a laboratory rat can complete in a week is given by 15) \_\_\_\_\_

$$P(t) = 58(1 - e^{-0.3t}),$$

where  $t$  is the number of weeks the rat has been trained. What is the maximum number of successful trials that a laboratory rat can complete in a week after being trained for 6 weeks.

16) The population of a small country increases according to the function  $B = 1,100,000e^{0.05t}$ , where  $t$  is measured in years. How many people will the country have after 4 years? 16) \_\_\_\_\_

- 17) The following formula accurately models the relationship between the size of a certain type of tumor and the amount of time that it has been growing: 17) \_\_\_\_\_

$$V(t) = 400(1 - e^{-.0020t})^3,$$

where  $t$  is in months and  $V(t)$  is measured in cubic centimeters. Calculate the rate of change of tumor volume at 150 months.

- 18) Murrel's formula for calculating the total amount of rest, in minutes, required after performing a particular type of work activity for 30 minutes is given by the formula  $R(w) = \frac{30(w - 4)}{w - 1.5}$ , where  $w$  is the work expended in kilocalories per min. A bicyclist expends 7 kcal/min as she cycles home from work. Find  $R'(w)$  for the cyclist; that is, find  $R'(7)$ . Round to the nearest hundredth. 18) \_\_\_\_\_

**Provide an appropriate response.**

- 19) The sales in thousands of a new type of product are given by  $S(t) = 30 - 80e^{-.2t}$ , where  $t$  represents time in years. Find the rate of change of sales at the time when  $t = 2$ . 19) \_\_\_\_\_

**Solve the problem.**

- 20) The formula  $E = 1000(100 - T) + 580(100 - T)^2$  is used to approximate the elevation (in meters) above sea level at which water boils at a temperature of  $T$  (in degrees Celsius). Find the rate of change of  $E$  with respect to  $T$  for a temperature of  $92^\circ\text{C}$ . 20) \_\_\_\_\_

- 21) Determine the percentage rate of change of  $F(t) = e^{-0.09t^2}$  at  $t = 1$  and  $t = 5$ . 21) \_\_\_\_\_

- 22) For the demand function  $q = 150(245 - p^2)$ , find  $E(p)$  and determine if the demand is elastic or inelastic (or neither) at the price  $p = 7$ . 22) \_\_\_\_\_

- 23) Suppose a manufacturer can sell  $q = \frac{1000}{(p + 2)^2} - 6$  units of a product when the price is  $p$  dollars per unit. Determine the elasticity of demand,  $E(p)$ , when the price is  $p = 8$  dollars. Enter just an integer. 23) \_\_\_\_\_

- 24) Suppose that the value in billions of dollars of a company is determined to be  $f(t) = 0.5t + 0.2e^{-t}$  where  $t$  is measured in years. What is the percentage rate of growth of the company at time  $t = 0$ ? Enter just an integer (no units). 24) \_\_\_\_\_

## Answer Key

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- 1) At three months, the monthly sales are \$480,000 and increasing at 64,000 magazines per month.
- 2) 53 mg
- 3) 2802 years
- 4) 23.1%
- 5) 8.48 years
- 6) 13.2 years
- 7)  $f'(8) = -26.52$ ; In the 8<sup>th</sup> week of the semester, the number of students skipping at least one class per week was decreasing at the rate of 2652 students per week.
- 8) i)  $f'(x) = \frac{2.13}{x}$ 
  - ii)  $f(2) = 3.47$ ,  $f'(2) = 1.06$ ; In 1996, the life expectancy of pigeons in New Jersey was 3.47 years and the life expectancy was increasing at a rate of 1.06 years per birth year.
  - iii)  $y = 1.06x + 1.35$
- 9)  $s'(6) \approx -169$ ; After 6 years, the computer is depreciating at the rate of \$169 dollars per year.
- 10)  $\frac{dT}{dt} = \frac{8(1-t^2)}{(t^2+1)^2}$
- 11)  $P'(t) = 24e^{-0.4t}$
- 12) 13.158 W; 231 days; 50 W
- 13)  $\frac{dA}{dr} = 391.02$
- 14) After 7.2 years
- 15) 48
- 16) 1,343,543
- 17) 0.119 cm<sup>3</sup>/month
- 18) 2.48 min<sup>2</sup>/kcal
- 19) 10.7 thousand per year
- 20) -10,280 m/°C
- 21)  $\frac{F'(1)}{F(1)} = -18\%$ ,  $\frac{F'(5)}{F(5)} = -90\%$
- 22)  $E(p) = \frac{2p^2}{245 - p^2}$ , inelastic
- 23) 4
- 24) 150