

MATH 1830

UNIT 2 DERIVATIVES

2.1 EXPONENTIAL AND LOGARITHMIC FUNCTION APPLICATIONS

Pre-Class:

- Take notes on the videos and readings (use the space below).
- Work and check problem #1 in the 2.1 NOTES section.
- Complete the 2.1 Pre-Class Quiz.

Introduction

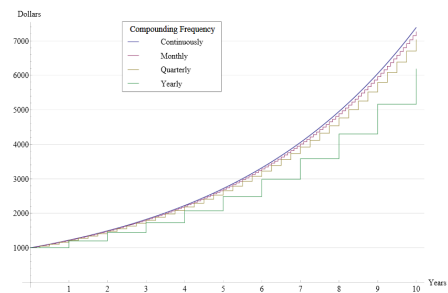
Exponential functions occur frequently in science and business and are commonly used in compound interest applications.

- The value of a \$1000 investment returning 8% interest compounded monthly after 12 years would be calculated using the formula

$$A = P \left(1 + \frac{r}{n} \right)^{nt},$$

where:

- A is the final amount in the account.
 - P is the principal.
 - r is the interest rate.
 - n is the number of compounding periods per year.
 - t is the number of years.
- The compounding frequency has a significant impact on the final amount of money (either saved or owed).



Compound Interest At Varying Frequencies
Starting with a principal of \$1000, interest rises exponentially. Notice also that as time passes, a gap forms between the lines as less frequently-compounding methods increase at a lesser rate than more frequently-compounding methods.

Compounding Frequency

- Yearly:

$$A = 1000\left(1 + \frac{.08}{1}\right)^1 = 1080$$

- Quarterly:

$$A = 1000\left(1 + \frac{.08}{4}\right)^4 = 1082.43$$

- Monthly:

$$A = 1000\left(1 + \frac{.08}{12}\right)^{12} = 1083$$

- Daily:

$$A = 1000\left(1 + \frac{.08}{365}\right)^{365} = 1083.28$$

- Continuously (at every instant):

$$A = 1000 \cdot \lim_{n \rightarrow \infty} \left(1 + \frac{.08}{n}\right)^n = 1083.29$$

Our focus will be on continuous compounding:

- What is e?
- Irrational number (similar to π)
- 2.718281828459.....
- Like π , e occurs frequently in natural phenomena
 - Growth of bacterial cultures
 - Decay of a radioactive substance
- Formal definition of e:

$$e = \lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n$$
$$\approx 2.718281829$$

Notes

Continuous Compounding Formula (appreciation and depreciation):

$$A = Pe^{rt}$$

CONTINUOUS COMPOUND INTEREST: Round all answers to two decimal places.

1. Hometown Bank offers a CD that earns 1.58% compounded continuously. If \$10,000 is invested in this CD, how much will it be worth in 3 years?
2. Hometown Bank offers a CD that earns 1.58% compounded continuously. If \$10,000 is invested in this CD, how long will it take the account to be worth \$11,000?

3. Doubling Time: How long will it take money to double if it is invested at 5% compounded continuously?

4. Doubling Rate: At what nominal rate compounded continuously must money be invested to double in 8 years?

5. How long will it take money to triple if it is invested at 10.5% compounded continuously?

6. Radioactive Decay: A mathematical model for the decay of radioactive substances is given by

$$Q = Q_0 e^{rt}.$$

The continuous compound rate of decay of carbon-14 per year is $r = -0.0001238$. How long will it take a certain amount of carbon-14 to decay to half the original amount?

7. The estimated resale value R (in dollars) of a company car after t years is given by:

$$R(t) = 20000(0.86)^t.$$

What will be the resale value of the car after 2 years? How long will it take the car to depreciate to half the original value?

2.1 THE CONSTANT e AND NATURAL LOG APPLICATIONS

Homework

Answer the following questions. Show all of your work. Round to two decimal places.

1. If you invested \$1,000 in an account paying an annual percentage rate (quoted rate) of 2%, compounded continuously, how much would you have in your account at the end of
 - a. 1 year
 - b. 10 years
 - c. 20 years
 - d. 50 years
2. A \$1,000 investment is made in a trust fund at an annual percentage rate of 12%, compounded continuously. How long will it take the investment to
 - a. Double
 - b. Triple
3. If \$500 is invested in an account which offers 0.75%, compounded continuously find:
 - a. The amount A in the account after t years.
 - b. Determine how much is in the account after 5 years, 10 years, 30 years, and 35 years.
 - c. Determine how long it will take for the initial investment to double.
 - d. Find and interpret the average rate of change of the amount in the account from the end of the fourth year ($t=4$) to the end of the fifth year ($t=5$).
4. If \$5000 is invested in an account which offers 2.125%, compounded continuously, find:
 - a. The amount A in the account after t years.
 - b. Determine how much is in the account after 5 years, 10 years, 30 years, and 35 years.
 - c. Determine how long it will take for the initial investment to double.
 - d. Find and interpret the average rate of change of the amount in the account from the end of the fourth year ($t=4$) to the end of the fifth year ($t=5$).
5. How much money needs to be invested now to obtain \$5000 in 10 years if the interest rate in a CD is 2.25%, compounded continuously?
6. A mathematical model for depreciation of a car is given by $A = P(1 - r)^t$, where A is defined as the value of the car after t years, P is defined as the original value of the car, and r is the rate of depreciation per year. The cost of a new car is \$32,000. It depreciates at a rate of 15% per year. This means that it loses 15% of its value each year.
 - a. Find the formula that gives the value of the car in terms of time.
 - b. Find the value of the car when it is four years old.

7. A mathematical model for depreciation of an ATV (all-terrain vehicle) is given by $A = P(1 - r)^t$, where A is defined as the value of the vehicle after t years, P is defined as the original value of the vehicle, and r is the rate of depreciation per year. The cost of a new ATV (all-terrain vehicle) is \$7200. It depreciates at 18% per year.
- Find the formula that gives the value of the ATV in terms of time.
 - Find the value of the ATV when it is ten years old.
8. Michigan's population is declining at a rate of 0.5% per year. In 2004, the state had a population of 10,112,620.
- Write a function to express this situation.
 - If this rate continues, what will the population be in 2012?
 - When will the population of Michigan reach 9,900,000?
 - What was the population in the year 2000, according to this model?

https://sccmath.files.wordpress.com/2012/01/scc_open_source_intermediate_algebra.pdf

MATH 1830

UNIT 2 DERIVATIVES

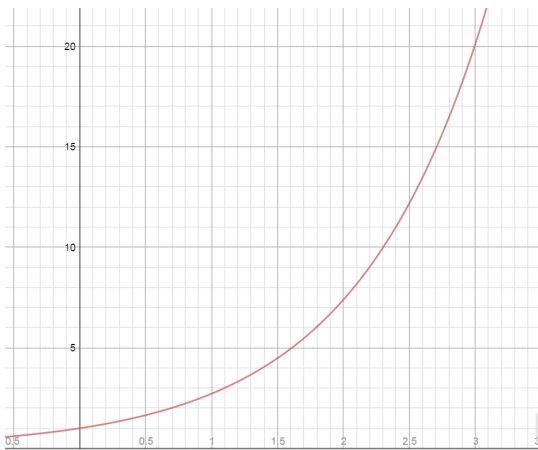
2.2 DERIVATIVES OF EXPONENTIAL AND LOGARITHMIC FUNCTIONS

Pre-Class:

- Complete 2.1 Homework assignment: check and correct.
- Take notes on the videos and readings (use the space below).
- Work and check problems #1-4 in the 2.2 NOTES section.
- Complete the 2.2 Pre-Class Quiz.

Introduction

Finding the derivative of $f(x) = e^x$



x	f(x)=e^x
0	1
1	2.7183
2	7.3891
3	20.086
4	54.598
5	148.41
6	403.43

1. Calculate the slope of the secant line for each of the following intervals for the function $f(x) = e^x$.

a. $[1, 3]$

b. $[1, 2]$

c. $[1, 1.5]$

2. What does the slope of the secant line represent?

3. Draw a tangent line at the point on the graph corresponding to $x = 1$ and calculate the slope.

4. What does the slope of the tangent line represent?

5. Compare the values of $f(1)$ and $f'(1)$. What do you notice?

Finding the derivative of $f(x) = \ln x$

6. Try to find the derivative of $f(x) = \ln x$ using the limit definition of the derivative, $\lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$.

7. Complete the table below to try to find the derivative of $f(x) = \ln x$.

(Use your calculator and let $h=0.00001$ to represent $h \rightarrow 0$)

x	$\frac{\ln(x+h) - \ln x}{h}$	$\lim_{h \rightarrow 0} \frac{\ln(x+h) - \ln x}{h}$
1	$\frac{\ln(1 + 0.00001) - \ln 1}{0.00001}$	1
2		
3		
4		
5		

8. Based on your results what do you think the rule for the derivative of $f(x) = \ln x$ is?

Notes

DERIVATIVES OF EXPONENTIALS AND LOGARITHMS

$$\frac{d}{dx} e^x = e^x$$

$$\frac{d}{dx} b^x = b^x \ln b \quad (b > 0, b \neq 1)$$

$$\frac{d}{dx} \ln x = \frac{1}{x} \quad (x > 0)$$

$$\frac{d}{dx} \log_b x = \left(\frac{1}{\ln b} \right) \left(\frac{1}{x} \right) \quad (x > 0, b > 0, b \neq 1)$$

1. Find $f'(x)$ when $f(x) = 3x^3 + 4x^2 - 5x + 8$.

2. Find $f'(x)$ when $f(x) = \ln x - x^3 + 2x + e^x$.

3. Find $f'(x)$ when $f(x) = 4 \ln x + 5e^x - 7x^2$.

4. Find $f'(x)$ when $f(x) = \ln x^8 - 3 \ln x$.

Properties of Logarithms:

Use appropriate properties of logarithms to expand $f(x)$ and then find $f'(x)$.

5. $f(x) = 9 + 5 \ln \frac{1}{x}$

6. $f(x) = x - 2 \ln(5x)$

Tangent Lines:

Find the equation of the line tangent to the graph of f at the indicated value of x .

7. $f(x) = e^x + 2$ at $x = 0$

8. $f(x) = 1 + \ln x^6$ at $x = e$

Applications:

9. The estimated resale value R (in dollars) of a company car after t years is given by

$$R(t) = 24000(0.84)^t$$

What is the instantaneous rate of depreciation (in dollars per year) after:

- 1 year?
- 2 years?
- 3 years?

2.2 DERIVATIVES OF EXPONENTIAL AND LOGARITHMIC FUNCTIONS

Homework

Find the derivative of each of the following.

1. $f(x) = e^x + \ln x - 2x^5 + 12$

2. $y = 7 \ln x + 14x - \frac{1}{2}$

3. $g(x) = -5e^x - 12 \ln x + 3x^3$

4. $f(x) = 8\sqrt{x} + 7e^x$

5. $y = \ln x^7 - 3 \ln x$

6. $f(x) = 4 \ln \frac{1}{x} + 8$

7. $y = e^x - 7 \ln 5x + 14$

8. Find the equation of the line tangent to the graph of f at the indicated value of x .

$$f(x) = 2e^x - 1 \quad \text{at } x = 0$$

9. Find the equation of the line tangent to the graph of f at the indicated value of x .

$$f(x) = 8 \ln(x) \quad \text{at } x = e$$

10. An editor of college textbooks has determined that the equation below models the sales of a calculus textbook, B (in thousands), based on the number of complimentary books sent to professors, x (also in thousands).

$$B(x) = 3.24 + 1.6 \ln(x)$$

Find and interpret the instantaneous rate of change when 6000 complimentary books are sent to professors, $x=6$.

11. The percentage of mothers who returned to the work force within one year after they had a child for the years 1976 through 1998 can be modeled by

$$P(t) = 36.025 + 6.27 \ln(t)$$

where t is years after 1977. (Source: Based on data from the Associated Press)

- What percentage of mothers returned to the work force within one year in 1998 and how rapidly was that percentage changing in 1998?
- On average, how rapidly did the percentage change from 1980 to 1990? c. What happens to the rate at which the percentage is growing as more years go by?

MATH 1830

UNIT 2 DERIVATIVES

2.3 DERIVATIVES OF PRODUCTS

Pre-Class:

- Complete 2.2 Homework assignment: check and correct.
- Take notes on the videos and readings (use the space below).
- Work and check problems #1-2 in the 2.3 NOTES section.
- Complete the 2.3 Pre-Class Quiz.

Introduction

1. The manager of a miniature golf course is planning to raise the ticket price per game. At the current price of \$6.50, an average of 81 rounds is played each day. The manager's research suggests that for every \$0.50 increase in price, an average of four fewer games will be played each day. Based on this information, find the function that represents revenue from rounds of mini golf, where n represents the number of \$0.50 increases in ticket price.
 - a. What must you do with this revenue function in order to find the rate of change?
 - b. Find the rate of change for this revenue function when the manager increases the price of a round of mini golf by \$1.50.
2. Find the rate of change for the function $y = (x^2 + 1)(x^2 - 2x + 1)$.

Notes

Derivatives of Products

THE PRODUCT RULE

$$\text{If } y = f(x) \cdot g(x),$$

$$\text{then } y' = f'(x) \cdot g(x) + f(x) \cdot g'(x).$$

Two Methods for Finding the Derivative:

Find the derivative two different ways.

- Simplify first and use the power rule.
- Use the product rule.

1. $m(x) = 2x^3 (x^5 - 2)$

a.

b.

Find the derivative using the Product Rule.

2. $n(x) = 7x^2 (2x^3 + 5)$

3. $h(x) = 4x^3 e^x$

4. $s(x) = 2x^5 \ln x$

5. $v(x) = (8x + 1)(3x^2 - 7)$

Tangent Lines

6. $r(x) = (5 - 4x)(1 + 3x)$

a. Find $r'(x)$.

b. Find the equation of the line tangent to the graph of r at $x = 2$.

c. Find the values of x where $r'(x) = 0$.

Derivatives with Radicals

7. Find y' for $y = \sqrt{x} (x^2 + 3x - 1)$.

8. Find $\frac{dy}{dx}$ for $y = \sqrt[3]{x} (x^6 + x^3)$.

Applications

9. Calculators are sold to students for 100 dollars each. Three hundred students are willing to buy them at that price. For every 5 dollar decrease in price, there are 30 more students willing to buy the calculator. The revenue function is given by the formula $R(d) = (100 - 5d)(300 + 30d)$.

a. Find $R'(d)$.

b. Find $R(3)$ and $R'(3)$. Write a brief interpretation of these results.

c. Use the results above to estimate the total revenue after four \$5 reductions in price.

2.3 DERIVATIVES OF PRODUCTS

Homework

Find the derivative of each of the following.

1. $p(x) = (6x - 1)(5x + 2)$

2. $p(t) = 2t^2(t^3 + 4t)$

3. $h(z) = 3z^2e^z$

4. $p(x) = 2e^x(x^2 - 3x + 5)$

5. $y = -x^2 \ln x$

6. $r(x) = (x^3 + x) \ln x$

7. $k(x) = (2x - 5)(x^2 + 1)$

8. $p(a) = (a^2 - 2a + 7)(2a^2 - a + 1)$

9. $p(t) = \sqrt{t}(t^2 + 5t - 2)$

10. $q(x) = (\sqrt{x} + 1)(\sqrt{x} - 3)$

11. $y = x^{-4}(x^2 - 7x + 1)$

12. $y = \frac{2}{x^2}(3x^4 - 6x + 2)$

13. If $z(x) = x^2(x^3 + 1)$, find the slope of that tangent line at $x = 1$.

MATH 1830

UNIT 2 DERIVATIVES

2.4 DERIVATIVES OF QUOTIENTS

Pre-Class:

- Complete 2.3 Homework assignment: check and correct.
- Take notes on the videos and readings (use the space below).
- Work and check problem #1 in the 2.4 NOTES section.
- Complete the 2.4 Pre-Class Quiz.

Introduction

1. The cost of manufacturing x MP3 players per day is represented by the function

$$C(x) = 0.01x^2 + 42x + 300 \quad 0 \leq x \leq 300.$$

- a. Determine the average cost function.
- b. Determine the marginal average cost function. What did you have to do to the average cost function in order to find the marginal average cost function?

2. Suppose the function $V(t) = \frac{50,000+6t}{1+0.4t}$ represents the value, in dollars, of a new car t years after it is purchased. Determine the rate of change in the value of the car.
-

Notes

Derivatives of Quotients

Rewriting a Function as a Quotient

THE QUOTIENT RULE

$$\text{If } y = \frac{f(x)}{g(x)},$$

$$\text{then } y' = \frac{f'(x) g(x) - f(x) g'(x)}{[g(x)]^2}.$$

Two Methods for Finding the Derivative:

Find the derivative two different ways.

- a. Simplify first and use the power rule.
- b. Use the quotient rule.

1. $r(x) = \frac{x^5+4}{x^2}$

a.

b.

Find the Derivative of each Function using the Quotient Rule.

2. $b(x) = \frac{4x}{3x+8}$

3. $c(x) = \frac{x^2-9}{x^2+1}$

$$4. \, h(x) = \frac{1+e^x}{1-e^x}$$

$$5. \, j(x) = \frac{3x}{4+\ln x}$$

6. Find $\frac{dy}{dw}$ for $y = \frac{2w^4 - w^3}{6w-1}$

7. Explain how $f'(x)$ can be found without using the quotient rule: $f(x) = \frac{4}{x^3}$.

Tangent Lines

8. $h(x) = \frac{3x-7}{2x-1}$

a. Find $h'(x)$.

b. Find the equation of the line tangent to the graph of h at $x = 2$.

c. Find the values of x where $h'(x) = 0$.

Derivatives with Radicals

9. Find y' for $y = \frac{6\sqrt[3]{x}}{2x^2 - 5x + 1}$.

10. Find $\frac{dy}{dx}$ for $y = \frac{2x^2 - 2x + 3}{\sqrt[4]{x}}$.

Applications

11. A cable company has installed a new television system in a city. The total number N (in thousands) of subscribers t months after the installation of the system is given by $N(t) = \frac{178t}{t+5}$.

a. Find $N'(t)$.

b. Find $N(12)$ and $N'(12)$. Write a brief interpretation of these results.

c. Use the results above to estimate the total number of subscribers after 13 months.

12. According to economic theory, the supply x of a quantity in a free market increases as the price p increases.

Suppose the number x of baseball gloves a retail chain is willing to sell per week at a price of \$ p is given by

$$x = \frac{100p}{0.1p + 1} \quad 30.00 \leq p \leq 190.00.$$

a. Find $\frac{dx}{dp}$.

b. Find the supply and the instantaneous rate of change (IRC) of supply with respect to price when the price is \$40. Write a brief verbal interpretation of these results.

c. Use the results above to estimate the supply if the price is increased to \$41.

MATH 1830

UNIT 2 DERIVATIVES

2.5 THE CHAIN RULE

Pre-Class 1.5A:

- Complete 2.4 homework assignment: check and correct.
- Take notes on the videos and readings (use the space below).
- Work and check problems #1-4 in the 2.5 NOTES section.
- Complete the 2.5A Pre-Class Quiz

Pre-Class 2.5B:

- Complete 1.5A Homework assignment: check and correct.
- Take notes on the videos and readings (use the space below).
- 1.5B Work and check problems #13 in the 2.5 NOTES section.
- Complete 2.5B Pre-Class Quiz

Introduction

1. The gas tank of a parked pickup truck develops a leak. The amount of gas, in liters, remaining in the tank after t hours is represented by the function $V(t) = 90\left(1 - \frac{t}{18}\right)^2$ $0 \leq t \leq 18$. How fast is the gas leaking from the tank after 12 hours?

2. Andrew and David are training to run a marathon. They both go on a run on Sunday mornings at precisely 7 A.M. Andrew's house is 22 km south of David's. One Sunday morning, Andrew leaves his house and runs west at 7 km/hr. The distance between the two runners can be modeled by the function

$$s(t) = \sqrt{130t^2 - 396t + 484},$$

where s is in kilometers and t is in hours. Determine the rate at which the distance between the two runners is changing.

Notes

GENERAL DERIVATIVE RULES USING THE CHAIN RULE

$$\frac{d}{dx} [f(x)]^n = n[f(x)]^{n-1} \cdot f'(x)$$

$$\frac{d}{dx} \ln[f(x)] = \frac{1}{f(x)} \cdot f'(x)$$

$$\frac{d}{dx} e^{f(x)} = e^{f(x)} \cdot f'(x)$$

Fill in the blank with an expression that will make the indicated equation valid. Then simplify.

1. $\frac{d}{dx} (3 - 7x)^6 = 6(3 - 7x)^5$ _____

2. $\frac{d}{dx} e^{5x-3} = e^{5x-3}$ _____

3. $\frac{d}{dx} \ln(x^2 - x^4) = \frac{1}{x^2 - x^4}$ _____

Find $f'(x)$ and simplify.

4. $f(x) = (8x^2 - 7)^5$

5. $f(x) = e^{3x^2 + 2x + 5}$

6. $f(x) = 2 \ln(9x^2 - 5x + 21)$

7. $f(x) = (4x - 5 \ln x)^7$

Horizontal Tangents

Finding the Equation of the Tangent Line, at $x = a$:

- a. Find the y value by calculating $f(a)$: $(a, f(a))$.
- b. Find the slope of the tangent line by calculating $f'(a)$: $m_{tan} = f'(a)$.
- c. Equation of the tangent line: $y - f(a) = f'(a)(x - a)$.

Finding the Value(s) where the Tangent Line is Horizontal:

- a. Set $f'(x) = 0$.
- b. Solve for x .
- c. Verify that each x is in the domain of $f(x)$ and $f'(x)$.

Find $f'(x)$ and simplify. Then find the equation of the tangent line to the graph of $f(x)$ at the given value of x .

Find the values of x where the tangent line is horizontal.

8. $f(x) = (3x + 13)^{1/2}$ at $x = 4$

Horizontal Tangent

9. $f(x) = 3e^{2x^2 + 5x - 4} \quad x = 0$

Horizontal Tangents:

10. $f(x) = \ln(1 - x^2 + 2x^4)$ at $x = 1$

Horizontal Tangent

Set each factor equal to zero.

Find the indicated derivative and simplify.

11. $\frac{d}{dt} 3(2t^4 + t^2)^{-5}$

12. $\frac{dh}{dw}$ if $h(w) = \sqrt[5]{8w-1}$

13. $h'(x)$ if $h(x) = \frac{e^{4x}}{x^3 + 9x}$

14. $\frac{d}{dx} [x^5 \ln(3 + x^5)]$

$$15. G'(t) \text{ if } G(t) = (t - e^{9t})^2$$

$$16. y' \quad \text{if} \quad y = [\ln(x^2 + 7)]^{4/5}$$

$$17. \frac{d}{dw} \frac{1}{(w^2 - 5)^3}$$

Horizontal Tangents

Find $f'(x)$ and simplify. Then find the equation of the tangent line to the graph of $f(x)$ at the given value of x .

Find the values of x where the tangent line is horizontal.

18. $f(x) = x^2 (3 - 2x)^4 \quad x = 1$

Horizontal Tangent

19. $f(x) = \frac{x^4}{(2x-5)^2}$ $x = 2$

Horizontal Tangent

20. $f(x) = e^{\sqrt{x}}$ when $x = 1$

Horizontal tangent

21. $f(x) = \sqrt{x^2 + 4x + 5}$ at $x = 0$

Horizontal tangent

Applications

22. COST FUNCTION: The total cost (in hundreds of dollars) of producing x pairs of sandals per week is:

$$C(x) = 6 + \sqrt{3x + 25} \text{ when } 0 \leq x \leq 30.$$

a. Find $C'(x)$.

b. Find $C'(17)$ and $C'(26)$. Interpret the results.

23. PRICE DEMAND EQUATION: The number of large pumpkin spice drinks (x) people are willing to buy per week from a local coffee shop at a price of p (in dollars) is given by:

$$x = 1000 - 60(p + 25)^{1/2}$$

when $3.50 \leq p \leq 6.25$.

a. Find $\frac{dx}{dp}$.

b. Find the demand and the instantaneous rate of change of demand with respect to price when the price is \$4.50. Write a brief interpretation of these results.

24. BIOLOGY: A yeast culture at room temperature (68°F) is placed in a refrigerator set at a constant temperature of 38°F. After t hours, the temperature, T , of the culture is given approximately by

$$T = 25e^{-0.62t} + 38 \quad 0 \leq t \leq 4.$$

What is the rate of change of temperature of the culture at the end of 1 hour? At the end of 4 hours?

2.5A THE CHAIN RULE

Homework

Find the derivative of each of the following.

1. $p(t) = (t^3 + 4)^5$

2. $f(x) = \sqrt{x^2 - 144}$

3. $g(x) = e^{2x^2 - 5x + 4}$

4. $p(a) = \ln(a^4 + 4a)$

5. $y = \frac{1}{\sqrt[3]{x-x^3}}$

6. $g(x) = 9(2x^2 + x - 7)^{-3}$

7. $y = (7 - 5 \ln x)^3$

8. $q(t) = \ln(\ln 5t)$

9. Find the equation for the tangent line to the curve $y = \sqrt{e^x + 8}$ at the point where $x = 0$.

10. The concentration of toxic material in a lake is related to the number of months that an manufacturing plant has been operating near the lake. This concentration of toxic material can be modeled by $A(t) = (0.7t^{1/4} + 5)^3$ where A is measured in parts per million (ppm).

- Find the model for the rate of change in the concentration of the toxic material in the lake.
- Find $A(20)$ and $A'(20)$ and interpret the results.
- Use the results from part b to estimate the total amount of toxic material in the lake at 21 months.

2.5B THE CHAIN RULE

Homework

Find the derivative of each of the following.

1. $p(t) = t^2(5t + 1)^3$

2. $r(x) = (2x^2 - 3)(7x + 4)^3$

3. $p(a) = a^3 \ln(a^5)$

4. $y = \frac{e^{x^2+x}}{4x-7}$

5. $h(x) = (6x + 5)(x^2 + 4x + 8)^{-2}$

6. $y = \frac{\ln(9x+2)^2}{x}$

7. $q(x) = \frac{e^{2x}}{e^{3x}+1}$

8. $h(x) = \frac{2\sqrt{x}}{(x^2-36)^3}$

9. Find an equation for the tangent line to the curve $n(x) = x^2 \ln x$ at the point where $x = e$.

10. The number of people in Knoxville who contract the flu can be modeled by $P(t) = \frac{15,000}{50e^{-0.3t}+1}$, where P is the number of people who contract the flu and t is the number of days after the outbreak began.

a. Find the model for the rate of change of the number of people with the flu.

b. Find $P(4)$ and $P'(4)$ and interpret the results.

c. Use the results from part b to estimate the total number of people with the flu in Knoxville after 5 days.

UNIT 2 IN-CLASS REVIEW PROBLEMS

Find the derivative of each function. Show all of your work and simplify your answer.

1. $h(x) = \left(\frac{5}{x^2} - 3\right)(6x^2 + 1)$

2. $y = \sqrt[5]{(7x - 8)^3}$

3. $k(n) = \frac{4n-7}{(2n^4+5)^2}$

4. $f(x) = \ln(5x^2 + 3x)$

5. $r(w) = (w^2 - 2)e^{3w^2-7}$