

NORTHEASTERN UNIVERSITY

Department of Mathematics

FINAL EXAMINATION

MTH U121

Fall 2003

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Name: _____

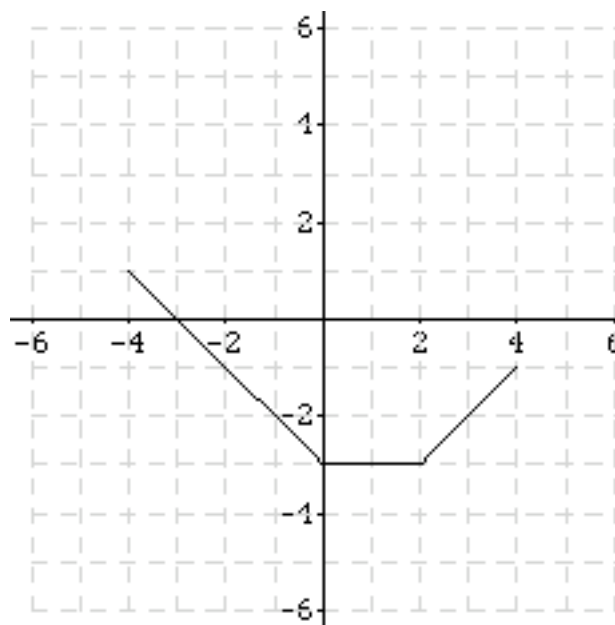
Instructor: _____

1. A botanist is recording the movements of a monarch butterfly in a large field of clover. For the first 10 minutes, the butterfly travels straight up a hill for 200 feet. The butterfly then returns back down the hill in 3 minutes. The next 500 feet the butterfly covers in 20 minutes. At which point the butterfly lands on a flower and remains there for 15 minutes. Finally, the butterfly goes 1,000 feet in 30 minutes and the botanist loses track of the butterfly.
 - a) What is the total distance the butterfly traveled?
 - b) What is the total time the botanist watched the butterfly's flight?
 - c) Draw a graph of the butterfly's distance traveled as a function of time. Clearly indicate the scales you use on your graph. Indicate with the letter F the point on the graph representing when the butterfly first landed on the flower.

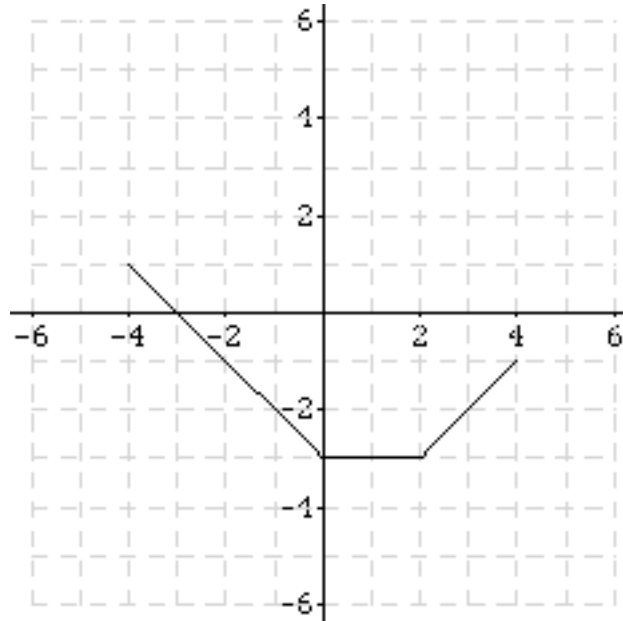
2. The sketches below show the graph of a piecewise linear function $y = f(x)$.

a) What is $f(-2) =$

b) Add to the sketch the graph of $y = f(x-2)+3$.



c) Add to the sketch the graph of $y = 2 \cdot f(x)$.

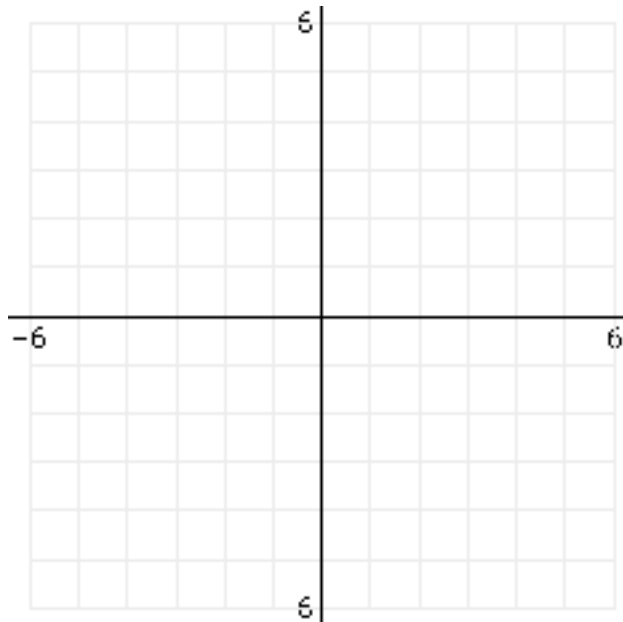


3a. Pretzel Annie sells large chocolate covered pretzels from a pushcart down in the theatre district. It costs her 45¢ to manufacture a pretzel and she has a fixed daily cost of \$9. Write down a linear function that expresses the cost of manufacturing x pretzels in a day.

3b. What is the cost of manufacturing 100 pretzels in a day?

3c. Last thursday, Annie had only thirty-six dollars to cover her costs. How many pretzels could she manufacture that day?

3d. Graph the linear function with a slope of $-\frac{5}{3}$ and with an x -intercept of $(3, 0)$, and find the equation of the linear function in the form $y = mx + b$.

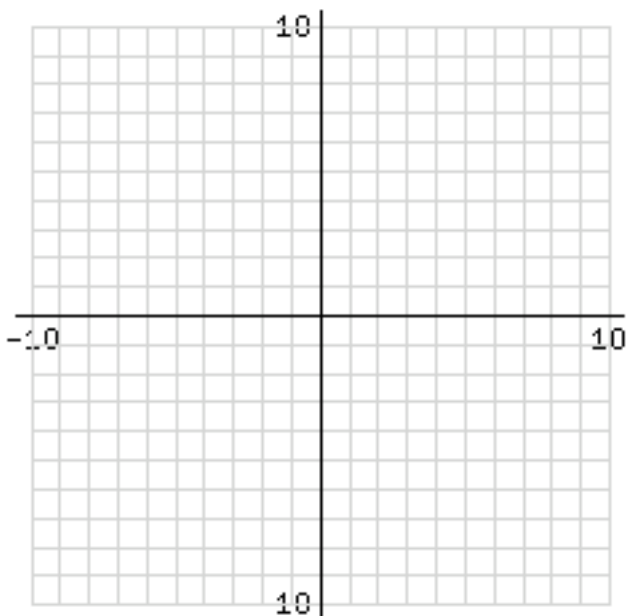


4a. Sketch the graph of $y = \frac{1}{3}x^2 - 2x - 3$.

b) What is the vertex ? Give both x and y coordinates

c) What is the y-intercept ?

d) What are the x-intercepts if any. If there are none, state so.



5. International Acme Coffee Bean, Inc has done a market study and discovered that the relation between the price p and the quantity x sold of sacks of beans may be modeled by the demand function

$$p = -x/12 + 480, \quad 0 \leq x \leq 5,760.$$

a) What is the revenue R if 600 sacks of beans are sold? (Recall that revenue is price times quantity sold.)

b) Express the revenue R as a function of x .

c) What quantity x maximizes the revenue? And what is the maximum revenue?

d) What price should the company charge in order to maximize the revenue?

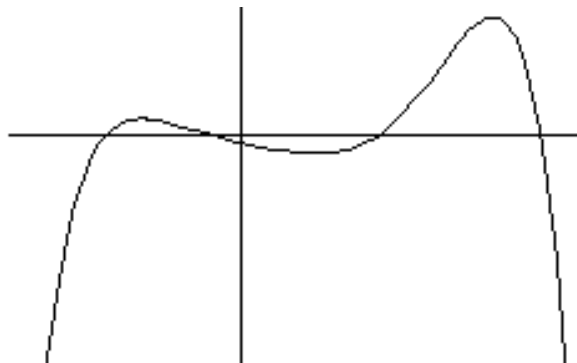
6a Factor the polynomial into linear and quadratic terms with real coefficients. Then find all the real roots of the polynomial (list any multiplicities greater than 1).

$$f_1(x) = (x^2 - 10x - 11)(625 - x^4)$$

b. Factor the polynomial into linear and quadratic terms with real coefficients. Then find all the roots of the polynomial (list any multiplicities greater than 1).

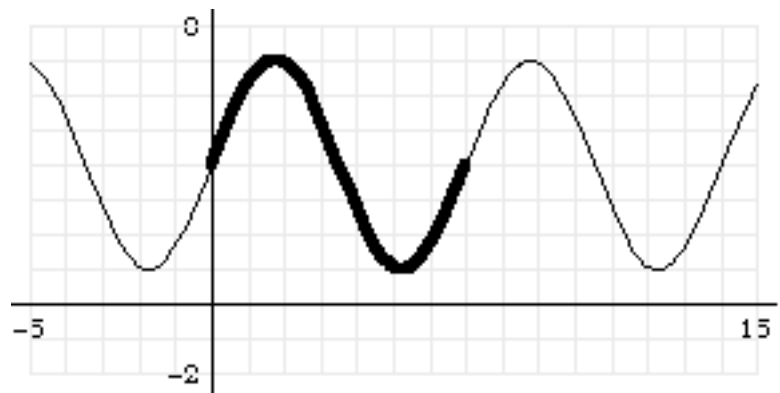
$$f_2(x) = (1 - x^2)^2(121x - x^3)$$

c. The graph of one of the above functions is given. Indicate which one it is and label the roots on the graph.



7. A newly discovered colony of bacteria is observed to grow from 1800 to 2500 in three hours. Assume the bacteria grows exponential according to $A(t) = A_0 e^{kt}$.
- Find the value of the growth constant k .
 - How much bacteria will there be in five hours (starting from when there was 1800 bacteria)?
 - How long will it take the bacteria to grow from the initial population of 1800 to 3000?
- 8a. Assuming the Earth is a sphere of radius 6378 kilometers, what is the difference in latitudes of two cities if one is 1,063 kilometers due north of the other? Give your answer in radians and then convert to degrees, minutes and seconds

- b) Find an equation for the function given by the graph.



9a. Solve for x : $(1+x)^3 = 3.375$

b) Solve for x : $5 \cdot (3^{2x}) = 8$

- 10 Solve the system of linear equations for x, y and z . (You may use your calculator to check your answer - but you still must show the computational work to solve the problem.)

$$\begin{array}{rclcrcl} x & + & y & + & z & = & 3 \\ 6x & - & 4y & - & z & = & -1 \\ 3x & - & 2y & + & 3z & = & 10 \end{array}$$