

YOUR NAME: _____

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Read each problem **very carefully** before starting to solve it. Each problem is worth 10 points. It is necessary to show **all** your work. Correct answers without explanations are worth 0 points. GOOD LUCK!!

1. A roast is taken from the refrigerator (where it had been for several days) and placed immediately in a preheated oven to cook. The temperature $R = R(t)$ of the roast t minutes after being placed in the oven is given by $R = 325 - 280e^{-0.005t}$ degrees Fahrenheit.

- (a) What is the temperature of the refrigerator?

- (b) Express the temperature of the roast 30 minutes after being put in the oven in functional notation. Then calculate its value.

- (c) By how much did the temperature of the roast increase during the first 10 minutes of cooking?

- (d) By how much did the temperature of the roast increase from the first hour to 10 minutes after the first hour of cooking?

2. At 4:00 pm on a winter day, an arctic air mass moved from Kansas to Oklahoma, causing temperatures to plummet. The temperature $T = T(h)$ in degrees Fahrenheit h hours after 4 pm in Stillwater, Oklahoma, on that day is recorded in the following table:

$h = \text{Hours After 4 pm}$	$T = \text{Temperature}$
0	62
1	59
2	38
3	26
4	22

- (a) Use functional notation to express the temperature in Stillwater at 5:30 pm. Then estimate its value.
- (b) What was the average rate of change per minute in temperature between 5:00 pm and 6:00 pm? What was the average decrease per minute over that time interval?
- (c) Estimate the temperature at 5:12 pm.
- (d) At about what time did the temperature reach the freezing point? Explain your reasoning.

3. The amount of carbon dioxide in the air is influenced by several factors, including respiration of plants. The accompanying figure shows the concentration of carbon dioxide in parts per million (PPM) in a closed (unventilated) greenhouse on a cold, clear day during a 24-hour period beginning at 6 am.
- (a) At what time is carbon dioxide in the greenhouse at its lowest concentration?
 - (b) When is carbon dioxide in the greenhouse at its highest concentration?
 - (c) Photosynthesis results in a carbon dioxide exchange between plants and the surrounding air. During what times do the plants in the greenhouse show a net absorption of carbon dioxide?
 - (d) What is happening in terms of carbon dioxide exchange from 6 am to 9 am?
 - (e) Where is the graph concave up? Where is it concave down?
 - (f) At what time is there an inflection point? What is its significance?

4. The world record time for a certain swimming event was 63.2 seconds in 1950. Each year thereafter, the world record time decreased by 0.4 seconds.
- (a) Use a formula to express the world record time as a function of the time since 1950. Be sure to explain the meaning of the letters you choose and the units.
- (b) Express using functional notation the world record time in the year 1955. Then calculate its value.
- (c) Would you expect the formula to be valid indefinitely? Be sure to explain your answer.