

Shepley L. Ross *Introduction to Ordinary Differential Equations*

Chapter 3. Applications of First-Order Equations

3.3. Rate Problems

- 3.3.1.** Assume that the rate at which radioactive nuclei decay is proportional to the number of such nuclei that are present in a given sample. In a certain sample 10% of the original number of radioactive nuclei have undergone disintegration in a period of 100 years.
- (a) What percentage of the original radioactive nuclei will remain after 1000 years?
 - (b) In how many years will only one-fourth of the original number remain?
- 3.3.5.** In a certain bacteria culture the rate of increase in the number of bacteria is proportional to the number present.
- (a) If the number triples in 5 hours, how many will be present in 10 hours?
 - (b) When will the number present be 10 times the number initially present?
- 3.3.9.** A hot pie is taken directly from an oven and placed outdoors on a porch table to cool on a day when the surrounding outdoor temperature is a constant 80° F. The temperature of the pie was 350° F at the instant $t = 0$ when it is placed on the table, and it was 300° F 5 minutes later.
- (a) What was the temperature 10 minutes after it was placed on the table?
 - (b) When was the temperature 100° F?
- 3.3.11.** Assume that the population of a certain city increases at a rate proportional to the number of inhabitants at any time. If the population doubles in 40 years, in how many years will it triple?
- 3.3.21.** A tank initially contains 100 gal of brine in which there is dissolved 20 lb of salt. Starting at time $t = 0$, brine containing 3 lb of dissolved salt per gallon flows into the tank at the rate of 4 gal/min. The mixture is kept uniform by stirring and the well-stirred mixture simultaneously flows out of the tank at the same rate.
- (a) How much salt is in the tank at the end of 10 min?
 - (b) When is there 160 lb of salt in the tank?

3.3.27(a). The air in a room whose volume is $10,000 \text{ ft}^3$ tests 0.15% carbon dioxide. Starting at $t = 0$, outside air testing 0.05% carbon dioxide is admitted at the rate of $5000 \text{ ft}^3/\text{min}$. Assume this forces out well-mixed air from the room at the same rate. What is the percentage of carbon dioxide in the air in the room after 3 minutes?