Chapter 3: Section 3.1

Solve the following problems:

1. The population of a community is known to increase at a rate proportional to the number of people present at time t. If an initial population P_0 has doubled in 5 years, how long will it take to triple? To quadruple?

2. Suppose it is known that the population of the community in Problem 1 is 10,000 after 3 years. What was the initial population P_0? What will be the population in 10 years? How fast is the population growing at $t = 10$?

3. The radioactive isotope of lead, Pb-209, decays at a rate proportional to the amount present at time t and has a half- life of 3.3 hours. If 1 gram of this isotope is present initially, how long will it take for 90% of the lead to decay?

4. Initially 100 milligrams of a radioactive substance was present. After 6 hours the mass had decreased by 3%. If the rate of decay is proportional to the amount of the substance present at time t, find the amount remaining after 24 hours.

5. Archaeologists used pieces of burned wood, or charcoal, found at the site to date prehistoric paintings and drawings on walls and ceilings of a cave in Lascaux, France. Use the information on page 84 (in our text book) to determine the approximate age of a piece of burned wood, if it was found that 85.5% of the C-14 found in living trees of the same type had decayed.

6. A small metal bar, whose initial temperature was 20°C, is dropped into a large container of boiling water. How long will it take the bar to reach 90°C if it is known that its temperature increases 2° in 1 second? How long will it take the bar to reach 98°C?

7. A dead body was found within a closed room of a house where the temperature was a constant 70°F. At the time of discovery the core temperature of the body was determined to be 85°F. One hour later a second measurement showed that the core temperature of the body was 80°F. Assume that the time of death corresponds to $t = 0$ and that the core

temperature at that time was 98.6°F. Determine how many hours elapsed before the body was found. [Hint: Let $t_1 > 0$ denote the time that the body was discovered.]