Exponential Growth & Decay Practice Problems

1) *Radioactive Decay* Radioactive radium has a half–life of approximately1620 years. What percentage of a given amount remains after 100 years?

2) *Population Growth* Dhaka, Bangladesh had a population of 4.22 million in 1990, and its projected population for the year 2000 is 6.49 million (source: U.S. Bureau of the Census) Find the exponential growth model $y = Ce^{kt}$ for the population growth of Dhaka by letting $t = 0$ correspond to 1990. Use the model to predict the population of the city in 2010.

3) *Newton's Law of Cooling* When an object is removed from a furnace and placed in an environment with a constant temperature of $90°F$, its core temperature is $1500°F$. One hour after it is removed, the core temperature is $1120°F$. Find the core temperature 5 hours after the unit is removed from the furnace.

4) *Population Growth* Houston, Texas had a population of 2.30 million in 1990, and its projected population for the year 2000 is 2.65 million. (source: U.S. Bureau of the Census) Find the exponential growth model $y = Ce^{kt}$ for the population growth of Houston by letting $t = 0$ correspond to 1990. Use the model to predict the population of the city in 2010.

5) *Population Growth* The number of a certain type of bacteria increases continuously at a rate proportional to the number present. If there are 100 present at a certain time and 300 present 5 hours later, how many will there be 10 hours after the initial time? How long does it take the number of bacteria to double?

6) *Newton's Law of Cooling* A thermometer is taken from a room at $72°F$ to the outdoors where the temperature is $20°F$. Determine what the reading of the thermometer will be after 5 minutes, if the reading drops to $48°F$ after 1 minute.

7) The polonium isotope ^{210}Po has a half-life of approximately 140 days. If a sample weighs 20mg initially, how much remains after t days? Approximately how much will be left after two weeks.

8) Suppose that a certain bacterial culture grows at a rate *proportional* to the population itself. If there are 5000 bacteria initially, and there are 7500 bacteria after 1 hour, how many bacteria will there be after 5 hours?

<u>Answers</u>

1. 95.812%
2. 9.981 million people
3. 383.298°
4. 3.053 million people
5. $P_{10} = 900$ / $t = 3.15$ hrs.
6. 22.34°
7. $y = 20e^{-\frac{\ln\left(\frac{1}{2}\right)}{140}t}$ mg / $y = 18.661$ mg
8. 37,968.8 bacteria

Extra practice problems

9) Suppose the world's human population fits the exponential growth model, and is observed to increase 4% in one year. At that rate, in how many years will the world's human population double?

10) An amount of money is deposited in a saving account and earns interest at the rate r, compounded continuousley. If a bank advertises that an account will double in ten years, what is the interest rate?

11) Suppose the population of a certain state grows at a rate *proportional* to the population. If the 1960 population was 650,000 and the 1970 population was 720,000 when will the state reach 1,000,000 in population?

12) Suppose the rabbit population of Tulare County grows exponentially. If the number of rabbits was estimated at 30,000 in 1975 and at 45,000 on 1978, about what was the rabbit population in 1981?

13) If 1,000 dollars is deposited in an account and earns interest at the rate of 6 %, compounded continuously, how much will be in the account after ten years?

14) If $100 is deposited in an account and earns interest at the rate of 12 %, compounded continuously, how much will be in the account after 5 years?

15) If the half-life of a radioactive substance is 8 days, how much of a 10 gram sample will be left after 6 days?

16) Of 3 mg of a certain radioactive element, 2 mg remained after 6 hours. What is its half-life?

17) A certain kind of mothball evaporates at a rate proportional to the volume of the mothball, and loses half its volume in six weeks. If the mothball must have at least 10% of its initial volume to be effective, how long is this kind of mothball effective?