Supplement #11

1. How long does it take for a $5,000 investment to double if it is invested at an annual rate of 5% and interest is compounded continuously?

2. How long does it take for an $8,000 investment to double if it is invested at an annual rate of 4% and interest is compounded continuously?

3. How long does it take for a $5,000 investment to triple if it is invested at an annual rate of 5% and interest is compounded continuously?

4. How long does it take for a $10,000 investment to triple if it is invested at an annual rate of 4% and interest is compounded continuously?

5. How long does it take for any investment to double if it is invested at an annual rate of 5% and interest is compounded continuously?

6. How long does it take for any investment to triple if it is invested at an annual rate of 4% and interest is compounded continuously?

7. The growth of a population *p* of cicadas follows the exponential model

$$A(t) = 1000e^{0.01t}$$

   (a) If time is measured in weeks, how long until there are 3,500 cicadas?

   (b) What is the doubling time for this population of cicadas?

8. The number *N* of bacteria present in a petri dish follows the exponential model

$$A(t) = 50e^{0.02t}$$

   (a) If time is measured in hours, how long until there are 10,000 bacteria?

   (b) What is the doubling time for this population of bacteria?

9. If the population of the United States was about 250 million in 1990 and about 290 million in 2003

   (a) Find an exponential function that fits these data points.

   (b) When will there be half a billion people in the U.S. according to this exponential model?

10. Assume the world population was 6 billion in 1999, and that it will be 8 billion in 2040.

   (a) Find an exponential function that fits these data points.

   (b) What is the doubling time according to this exponential model?

11. The amount of radioactive iodine (iodine-131) decays according to the rule

$$A(t) = Pe^{-0.087t}$$

   (a) If time is measured in days, how long until 10% of a 50-gram sample remains?

   (b) What is the half-life of iodine 131?

12. The amount *A* of plutonium-239 decays according to the rule

$$A(t) = Pe^{-0.000029t}$$

(a) If time is measured in years, how long until one-fifth of a 100-gram sample remains?

(b) What is the half-life of plutonium-239?

13. The half-life of radium is 1690 years. How long until only 2 grams of a 20 gram sample are left?

14. The half-life of radium is 1690 years. How long until only 20% of a sample is left?

15. Carbon-14 has a half-life of about 5600 years. How old is a piece of charcoal that has only 25% of its original carbon-14?

16. Carbon-14 has a half-life of about 5600 years. How old is a piece of charcoal that only has one third of its original carbon-14?

17. According to legend, in the fifth century King Arthur and his knights sat at a huge round table. A round table alleged to have belonged to King Arthur was found at Winchester Castle in England. In 1976 carbon dating revealed the amount of radiocarbon in the table to be 91% of the radiocarbon present in living wood. Could the table possibly have belonged to King Arthur?

18. You are trying to decide whether to invest in an oil company or a pharmaceutical concern. You estimate that if you invest $100,000 in the oil company, your investment will grow exponentially at 4.3%. Conversely, the pharmaceutical company takes longer to get going, but the return will yield exponential growth at 16.2%. Because of the greater risk, you are only willing to invest $37,000 in the drug company.

(a) When will these two investments strategies break even?

(b) Which is the better investment if you need the money for retirement in 7 years?

(c) In 10 years?

(d) At what rate is the money growing when there is $109,000 in each account?

1. 13.9 yrs.
2. 17.3 yrs.
3. 22 yrs.
4. 27.5 yrs.
5. 13.9 yrs.
6. 27.5 yrs.
7. (a) 125.3 weeks (b) 69.3 weeks
8. (a) 265 hrs. (b) 34.7 hrs.
9. $(a)\ A(t) = 250e^{0.0114t}$ (b) *The year* 2051
10. $(a)\ A(t) = 6e^{0.007t}$ (b) *The year* 2098.
11. (a) 26.5 days (b) 7.967 days
12. (a) 55,498 yrs. (b) 23,902 yrs.
13. 5614 yrs.
14. 3924 yrs.
15. 11,552 yrs.
16. 8875 yrs.
17. 786 yrs. old or 1190 A.D., NOT the 5th century
18. (a) 8.3 yrs. (b) Oil: $135,121 Drugs: $115,000 (c) Oil: $153,726 Drugs: $186,964 (d) Oil: $4687/yr. Drugs: $17,658/yr.