Honors Algebra II
WS-3: Application of Growth/Decay

Name ______________________

Real World Application (from Math 3 book and note-taking guide)

1. **From 1990 to 2006, the population P (in millions) of a large city can be modeled by $P = 1.1(1.05)^t$ where t is the number of years since 1990.**

   A. What is the population in 1990? 1.1 million people

   B. What is the percent of increase each year? 5%

   C. What is the expected population in 2002? $P = 1.1(1.05)^{12} = 1.98$ million people

2. **The number of applications to Georgia Tech was 35000 in 2015 and growing at a rate of 4.6% every 2 years. How many applications does Georgia Tech expect to receive in 2022?**

   $f(7) = 35000(1.046)^{7/2} = 40966.51 \approx 40967$ applications

3. **You buy a car for $12,500. You had to take out a loan for the full amount. The loan you got is a 72 month loan. The interest rate on the loan is 2.85% compounded monthly.**

   A. What is the amount you end up paying for the car once you are done paying the loan off? $y = 12500\left(1+\frac{.0285}{12}\right)^{72} = \$14828.13$

   B. How much money could you have saved if you paid off the loan in half the time?

   $y = 12500\left(1+\frac{.0285}{12}\right)^{36} = \$13614.39$ You could save $1213.74

4. **A population of 500 elk is released in a wildlife preserve. Every 3 years, the population grows by 16.4%.**

   A. Write an exponential equation that represents the number of elk x years after the release.
   $f(x) = 500(1.164)^{x/3}$

   B. After 5 years, how many elk are there?

   $f(5) = 500(1.164)^{5/3} = 644.01 \approx 644$ elk

5. **Suppose the population of a nation is growing by 9% per decade. If the population was 30,000,000 in 1975, what will the population be in 2019, to the nearest million?**

   $f(44) = 30{,}000{,}000(1.09)^{\frac{44}{10}} = 43832661.91 \approx 44{,}000{,}000$ people

6. **According to legend, in 1626 Manhattan Island was purchased for trinkets worth about $24. If the $24 had been invested at a rate of 6% interest per year, what would be its value in 2006? Compare this with a total of $802.4 billion in assessed values for Manhattan in 2006.**

   $f(380) = 24(1.06)^{380} \approx \$99.18$ billion   About $\frac{1}{10}$ as much as the actual value

7. **If the price of theater tickets increases by 2% 3 times per year, how much will a $100 ticket cost 5 years from now?**

   $f(5) = 100(1.02)^{3(5)} = \$134.59$

8. **You bought a new car for $28,000. The car depreciates (loses value) at a rate of 15% per year.**

   A. What is the exponential decay model giving the car's value V after t years? $V(t) = 28000(.85)^t$

   B. What is the value of the car after 3.5 years? $V(5) = 28000(.85)^{3.5} = \$15853.47$

   C. After about how many years will the car be worth $10? About 48.5 years

5	10	15	20	25	45	48	49
12423.75	5512.48	2445.92	1085.27	481.54	18.66	11.46	9.74

9. **You charged \$200 to your credit card. Your credit card charges you 8.9% per month. Assume the card doesn't charge you late fees.**
   A. If you don't make a payment, how much will you owe after 5 months? How much more than your original charge did you pay in interest?
   $y = 200(1.089)^5 = \$306.32$ \$106.32 in interest
   B. If you don't make a payment, how much will you owe after 2 years? How much more than your original charge did you pay in interest?
   $y = 200(1.089)^{24} = \$1547.74$ \$1347.74 in interest

Use the compound interest formulas for problems 10 and 11. $A = P\left(1 + \frac{r}{n}\right)^{nt}; A = Pe^{rt}$

10. **You are saving \$3000 at 5% compounded monthly.**
   A. How much do you have after 5 years? $A = 3000\left(1 + \frac{.05}{12}\right)^{12 \cdot 5} = \$3850.08$
   B. How much do you have after 20 years? $A = 3000\left(1 + \frac{.05}{12}\right)^{12 \cdot 20} = \$8137.92$
   C. If the interest were compounded continuously, how much would you have after 20 years?
   $A = 3000e^{(.05)(20)} = \$8154.85$ \$16.93 more

11. **You deposit \$1000 in an account that earns 3% annual interest.**
   A-D. Find the balance for the given number of years if the interest is compounded with the given frequency. (show your set up)

	A.	B.	C.	D.
# of years:	3	10	21	4
Compounded:	quarterly	Annually	monthly	continuously
	\$3091.02	\$1343.92	\$1876.14	\$1127.50

   E. How much more would you earn on your \$1000 compounding continuously for 20 years at a rate of 3% than you would compounding quarterly?
   $A = 1000e^{.03 \cdot 20} = \$1822.12$ $A = 1000\left(1 + \frac{.03}{4}\right)^{4 \cdot 20} = \$1818.04$ \$4.08 more

12. **The half-life of strontium-90 (Sr-90) is approximately 28 years. The amount A (in milligrams) of Sr-90 that remains in a sample after t years is given by**

$$A = 120\left(\frac{1}{2}\right)^{t/28}$$

   A. What is the initial amount? 120 mg
   B. In about how many years will 30 mg of the Sr-90 remain?
   $30 = 120\left(\frac{1}{2}\right)^{t/28}$
   $\frac{1}{4} = \frac{1}{2}^{t/28}$
   $\left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{t/28}$
   $2 = \frac{t}{28}$
   $t = 56$ years
   C. How much Sr-90 will be present after 7 years? $A = 120\left(\frac{1}{2}\right)^{7/28} = 100.91$ mg
   D. After how many years will you have ½ of your initial amount?
   28 years (coefficient)

13. **The table below represents the number of people using beepers. Consider 2000 as yr 0.**

Year	# of beepers
2000	100,000
2001	70,000
2002	49,000
2003	34,300

   A. Write an equation to represent the number of beepers being used according to the year 2000. $y = 100{,}000(.7)^x$
   B. Based on your equation, how many beepers will be used in 2020?
   $y = 100{,}000(.7)^{20} = 79.79 \approx 80$ beepers
   C. Based on your equation, when did the beeper usage decrease faster: between 2000 and 2005 or between 2005 and 2010?
   $ROC_{2000-2005} = \frac{16807 - 100000}{2005 - 2000} = -16638.6$ beepers/yr $ROC_{2005-2010} = \frac{2824.75 - 16807}{2010 - 2005} = -2796.45$ beepers/yr
   $\boxed{\text{B/t 2000 and 2005}}$

CHALLENGE: The cost of goods and services in an urban area increased by 1.5% last month. If this rate continues, what will be the annual rate of increase?
$(1 + .015)^{12} = 1.20$ 20% annually