Exponential Growth and Decay Problems | Lesson 4.5 Day 3

In Class Problem Solving Assignment

QUESTION 1 - ***<u>DUE DATE:</u>***

Mr Smith's wife has just learned that she is pregnant! Mr. Smith wants to know when his new baby will arrive and decides to do some research. On the Internet, he finds the following article:

Hormone Levels for Pregnant Women

When a woman becomes pregnant, the hormone HCG (human chlorionic gonadotropin) is produced in order to enable the baby to develop.

During the first few weeks of pregnancy, the level of HCG hormone grows exponentially, starting with the day the embryo is implanted in the womb. However, the rate of growth varies with each pregnancy. Therefore, doctors cannot use just a single test to determine how long a woman has been pregnant. Commonly, the HCG levels are measured two days apart to look for this rate of growth.

A woman who is not pregnant will often have an HCG level of between 0 and 5 mIU (milli-international units) per ml (milliliter).

Then Smith remembered that his wife was tested for HCG during her last two doctor visits.

1. On March 21, her HCG level was 200 mIU/ml, while two days later, her HCG level was 392 mIU/ml.. Assuming that the model for HCG levels is of the form $y = ab^x$, what equation models the growth of HCG for his wife's pregnancy?

2. Assume her HCG level was 5 mIU on the day of implantation. How many days after implantation was his wife's first doctor visit? March 21? What day did the baby most likely become implanted?

3. Smith also learned that a baby is born approximately 37 weeks after implantation. What day can Smith expect to become a father?

QUESTION 2: *Saving For College:*

Mr. S would like to have $40,000 to help pay for Ian's college fees in 8 years time and currently has $10,000. Let *y* represent the amount of money and let *x* represent the number of years after today, you will find equations that model his financial situation.

1. If we were to use a linear relation, determine the equation that models this situation. What yearly interest rate would help him reach his goal?

2. If we were to use a exponential relation, determine the equation that models this situation. What yearly interest rate would help him reach his goal?

3. Graph both models on your graphing calculator, using xmin = 0 and xmax = 20. Show me your graphs.

4. Which model is better for Mr. S in the short term (0-5 years)

5. Which model is better for Mr. S in the long term (>10 years assuming Ian takes some time off before going to college)

6. Suppose he starts with $7800 and wants to have $18,400 twenty years from now. What annual interest rate does he need (compounded yearly) in this scenario

QUESTION #3: *Doses of Medicine*

Medicine in the body decays in an exponential way. Mr. Smith is taking some medication. On Monday Mr. Smith took the pills. On Tuesday he had 15 mg of medicine left in his body. On Friday he had 6.328125 mg left in his body.

1. Create an exponential equation modeling this situation. (Remember… starting should be on Monday)

2. When the amount of medicine in Mr. Smith's body drops below 4 mg, he needs to take another pill. When does Mr. Smith need to take more medicine?

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Answer the following questions that deal with the doubling concept. Recall that the formula $y = Ca^x$ which can now be rewritten as $y = C(2)^{\frac{t}{D}}$. In these two formulas, recall what the variables really mean:

$y = Ca^x$	$y = C(2)^{\frac{t}{D}}$
y ➔	y ➔
C ➔	C ➔
a ➔	t ➔
x ➔	D ➔

1. A dish has 212 bacteria in it. The population of bacteria will double every 2 days. How many bacteria will be present in . . .

   a) 8 days b) 11 days c) 4 hours d) 2 months

2. An experiment starts off with *X* bacteria. This population of bacteria will double every 7 days and grows to 11,888 in 32 days. How many bacteria where present at the start of the experiment?

3. A bacteria culture grows according to the formula: $y = 12000(2)^{\frac{t}{4}}$ where t is in hours. How many bacteria are present:
   (a) at the beginning of the experiment?
   (b) after 12 hours?
   (c) after 19 days?
   (d) What is the doubling time of the bacteria?

4. A bacteria culture starts with 3000 bacteria. After 3 hours there are 48 000 bacteria present. What is the length of the doubling period?

5. Mr S. makes an initial investment of $15,000. This initial investment will double every 9 years. What is the value of this investment in . . .

   a) 20 years b) 6 years c) What is the yearly rate of increase of this investment?

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Answer the following questions that deal with the doubling concept. Recall that the formula $y = Ca^x$ which can now be rewritten as $y = C\left(\frac{1}{2}\right)^{\frac{t}{H}}$. In these two formulas, recall what the variables really mean:

$y = Ca^x$	$y = C\left(\frac{1}{2}\right)^{\frac{t}{H}}$
y ➔ C ➔ a ➔ x ➔	y ➔ C ➔ t ➔ H ➔

6. Iodine-131 is a radioactive isotope of iodine that has a half-life of 8 days. A science lab initially has 200 grams of iodine-131. How much iodine-131 will be present in . . .

   a) 8 days b) 20 days c) 1 year d) 2 months

7. A medical experiment starts off with *X* grams of a radioactive chemical called Mathematus. This chemical will decay in half every 15 seconds and in the course of the experiment, will decay to 9.765 g in 2 minutes. How much Mathematus was present at the start of the experiment?

8. A chemical decays according to the formula: $y = 12000\left(\frac{1}{2}\right)^{\frac{t}{25}}$ where t is in time in hours and y is amount of chemical left, measured in grams. What amount of chemical is present:

   (e) at the beginning of the experiment?
   (f) after 100 hours?
   (g) after 19 days?
   (h) What is the half-life of the chemical?

9. A block of dry ice is losing its mass at a rate of 12.5% per hour. At 1 PM it weighed 50 pounds. What was its weight at 5 PM? What was the approximate half-life of the block of dry ice under these conditions?