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LESSON #2: QUESTIONS WITH CHALLENGING EXPONENTS

Do Now:

1. The value of an initial investment of $400 at 3% nominal interest compounded quarterly can be modeled using which of the following equations, where t is the number of years since the investment was made?

(1) $A=400(1.0075)^{4t}$　　(3) $A=400(1.03)^{4t}$

(2) $A=400(1.0075)^{t}$　　(4) $A=400(1.0303)^{4t}$

$A=P\left(1+\frac{r}{n}\right)^{nt}$

$A=400\left(1+\frac{.03}{4}\right)^{4t}$

$A=400(1.0075)^{4t}$

2. True or false?　$5^{\frac{x}{12}}=\left(5^{\frac{1}{12}}\right)^{x}$　True! multiply $\frac{1}{12}\cdot\frac{x}{1}=\frac{x}{12}$!

3. Rewrite $3^{\frac{x}{10}}$ as a number raised to the x power.

$$3^{\frac{x}{10}}=\left(3^{\frac{1}{10}}\right)^{x}$$

1) A study of the annual population of the red-winged blackbird in Ft. Mill, South Carolina, shows the population, $B(t)$, can be represented by the function $B(t)=750(1.16)^{t}$, where the t represents the number of years since the study began. In terms of the monthly rate of growth, the population of red-winged blackbirds can be best approximated by the function

a. $B(t)=750(1.012)^{t}$

b. $B(t)=750(1.012)^{12t}$

c. $B(t)=750(1.16)^{12t}$

d. $B(t)=750(1.16)^{\frac{t}{12}}$

$750(1.16)^{t}=750\left(1.16^{\frac{1}{12}}\right)^{12t}$

$750(1.0124)^{12t}$

why? $\frac{1}{12}\cdot\frac{12t}{1}=t$ equal!

2) A payday loan company makes loans between $100 and $1000 available to customers. Every 14 days, customers are charged 30% interest with compounding. In 2013, Remi took out a $300 payday loan. Which expression can be used to calculate the amount she would owe, in dollars, after one year if she did not make payments?

2 weeks ≈ 26 times per year

(1) $300(.30)^{\frac{14}{365}}$ Decay　　(3) $300(.30)^{\frac{365}{14}}$ Decay

(2) $300(1.30)^{\frac{14}{365}}$ → .038　　(4) $300(1.30)^{\frac{365}{14}}$ → 26.07 ✓

$A=300(1+.30)^{\frac{365}{14}}$

≈ 26 times a yea

3) One of the medical uses of Iodine–131 (I–131), a radioactive isotope of iodine, is to enhance x-ray images. The half-life of I–131 is approximately 8.02 days. Decay!

.5 ≥ 50%

a. Which equation represents this situation?

$A = P(1-r)^t$

$A = P(1-.5)$

(1) $A = P(1.5)^{\frac{t}{8.02}}$ (2) $A = P\left(\frac{1}{2}\right)^{\frac{t}{8.02}}$

(3) $A = P\left(\frac{1}{2}\right)^{\frac{8.02}{t}}$ (4) $A = P(2)^{\frac{t}{8.02}}$

.5

Think! what if it was every 10 days over a 50 day period How many times? 5! why? $\frac{50}{10} = 5$

initial

b. A patient is injected with 20 milligrams of I–131. Using the equation form part a, determine, to the *nearest day*, the amount of time needed before the amount of I–131 in the patient's body is approximately 7 milligrams.

A = 7

P = 20

t = ?

$A = P\left(\frac{1}{2}\right)^{\frac{t}{8.02}}$

$\frac{7}{20} = \frac{20\left(\frac{1}{2}\right)^{\frac{t}{8.02}}}{20}$

LOG IT! $.35 = \left(\frac{1}{2}\right)^{\frac{t}{8.02}}$

$\log_{\frac{1}{2}} .35 = \frac{t}{8.02}$

$1.5145 = \frac{t}{8.02}$

t = 12.1468

$\boxed{t = 13 \text{ days}}$

4) Last year, the total revenue for Home Style, a national restaurant chain, increased 5.25% over the previous year. If this trend were to continue, which expression could the company's chief financial officer use to approximate their monthly percent increase in revenue? [*Let m represent months.] →

GROWTH!

(1) $(1.0525)^m$ (3) $(1.00427)^m$

(2) $(1.0525)^{\frac{12}{m}}$ (4) $(1.00427)^{\frac{m}{12}}$

$\left((1+.0525)^{\frac{1}{12}}\right)^m$

$(1.0042)^m$

5) An equation to represent the value of a car after *t* months of ownership is $v = 32{,}000(0.81)^{\frac{t}{12}}$. Which statement is ***not*** correct?

1) The car lost approximately 19% of its value each month.

2) The car maintained approximately 98% of its value each month.

3) The value of the car when it was purchased was \$32,000. A = 32,000

4) The value of the car 1 year after it was purchased was \$25,920.

sub t = 12 and check in calc

$32000\left(.81^{\frac{1}{12}}\right)^t$

(.9825...)

1 − r = .9825

−1 −1

−r = −.0174

r = .0174

1.7 ≈ 2% decay

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LAB #2

1) Kristen invests $5,000 in a bank. The bank pays 6% interest compounded monthly. To the nearest tenth of a year, how long must she leave the money in the bank for it to double?

$$A = P\left(1+\frac{r}{n}\right)^{nt}$$

$$\frac{10{,}000}{5000} = \frac{5{,}000}{5000}\left(1+\frac{.06}{12}\right)^{12t}$$

$$2 = (1.005)^{12t}$$

$$\frac{\log_{1.005} 2}{12} = \frac{12t}{12}$$

$$t = 11.58$$

$$\boxed{t = 11.6 \text{ years}}$$

*2) Titanium-44 is a radioactive isotope such that every 63 years, its mass decreases by half. For a sample of titanium-44 with an initial mass of 100 grams, write a function that will give the mass of the sample remaining after any amount of time.

decay!

~~(1)~~ $A(t) = 100(1+.5)^{\frac{t}{63}}$ (3) $A(t) = 100(1-.5)^{\frac{t}{63}}$

~~(2)~~ $A(t) = 63(1-.5)^{\frac{t}{100}}$ ~~(4)~~ $A(t) = 100(1-.5)^{\frac{63}{t}}$

growth!

3) Last year, the total revenue for Outback Steakhouse, increased 7% over the previous year. If this trend were to continue, which expression could the company's CFO use to approximate their monthly percent increase in revenue? [*Let m represent months.]

(1) $(1.07)^m$ (3) $(1.00565)^m$

(2) $(1.07)^{\frac{12}{m}}$ (4) $(1.00565)^{\frac{m}{12}}$

$$(1+.07^{\frac{1}{12}})^m$$

$$(1.00565)^m$$