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A2.A.6: Solve an application which results in an exponential function

1. 060721b, P.I. A2.A.6
A population of wolves in a county is represented by the equation $P(t) = 80(0.98)^t$, where t is the number of years since 1998. Predict the number of wolves in the population in the year 2008.

2. 060607b, P.I. A2.A.6
The height, $f(x)$, of a bouncing ball after x bounces is represented by $f(x) = 80(0.5)^x$. How many times higher is the first bounce than the fourth bounce?
[A] 4 [B] 2 [C] 8 [D] 16

3. 080502b, P.I. A2.A.6
The growth of bacteria in a dish is modeled by the function $f(t) = 2^{\frac{t}{3}}$. For which value of t is $f(t) = 32$?
[A] 15 [B] 16 [C] 2 [D] 8

4. 060224b, P.I. A2.A.6
Growth of a certain strain of bacteria is modeled by the equation $G = A(2.7)^{0.584t}$, where: G = final number of bacteria, A = initial number of bacteria, t = time (in hours). In approximately how many hours will 4 bacteria first increase to 2,500 bacteria? Round your answer to the *nearest hour*.

5. 010923b, P.I. A2.A.6
Given a starting population of 100 bacteria, the formula $b = 100(2^t)$ can be used to find the number of bacteria, b , after t periods of time. If each period is 15 minutes long, how many minutes will it take for the population of bacteria to reach 51,200?

6. 010828b, P.I. A2.A.6
The number of houses in Central Village, New York, grows every year according to the function $H(t) = 540(1.039)^t$, where H represents the number of houses, and t represents the number of years since January 1995. A civil engineering firm has suggested that a new, larger well must be built by the village to supply its water when the number of houses exceeds 1,000. During which year will this first happen?

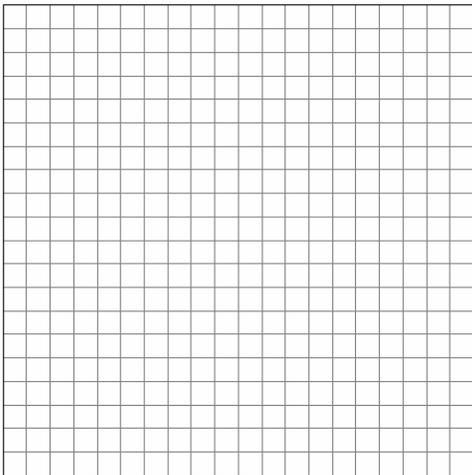
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7. fall9930b, P.I. A2.A.6

In the equation $y = 0.5(1.21)^x$, y represents the number of snowboarders in millions and x represents the number of years since 1988. Find the year in which the number of snowboarders will be 10 million for the first time. (Only an algebraic solution will be accepted.)

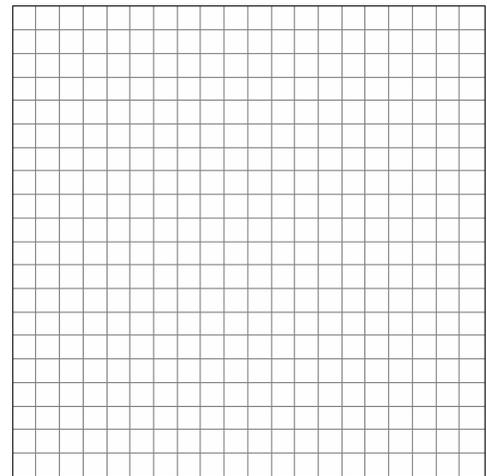
8. 010728b, P.I. A2.A.6

Since January 1980, the population of the city of Brownville has grown according to the mathematical model $y = 720,500(1.022)^x$, where x is the number of years since January 1980. Explain what the numbers 720,500 and 1.022 represent in this model. If this trend continues, use this model to predict the year during which the population of Brownville will reach 1,548,800. [The use of the grid is optional.]



9. 080632b, P.I. A2.A.6

After an oven is turned on, its temperature, T , is represented by the equation $T = 400 - 350(3.2)^{-0.1m}$ where m represents the number of minutes after the oven is turned on and T represents the temperature of the oven, in degrees Fahrenheit. How many minutes does it take for the oven's temperature to reach 300°F ? Round your answer to the nearest minute. [The use of the grid is optional.]



10. 080729b, P.I. A2.A.6

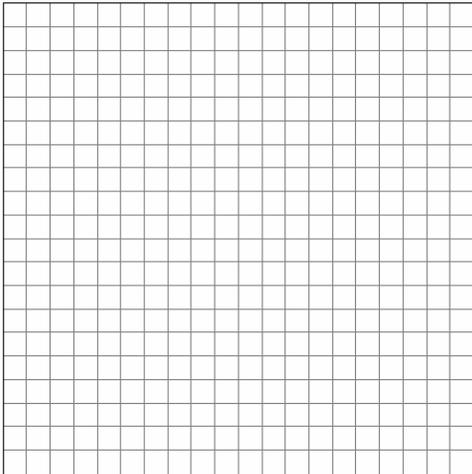
Drew's parents invested \$1,500 in an account such that the value of the investment doubles every seven years. The value of the investment, V , is determined by the equation $V = 1500(2)^{\frac{t}{7}}$, where t represents the number of years since the money was deposited. How many years, to the nearest tenth of a year, will it take the value of the investment to reach \$1,000,000?

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11. 080832b, P.I. A2.A.6

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?

(Use the formula $A = P(1 + \frac{r}{n})^{nt}$, where A is the amount accrued, P is the principal, r is the interest rate, $n = 12$, and t is the length of time, in years.) [The use of the grid is optional.]



12. 080428b, P.I. A2.A.6

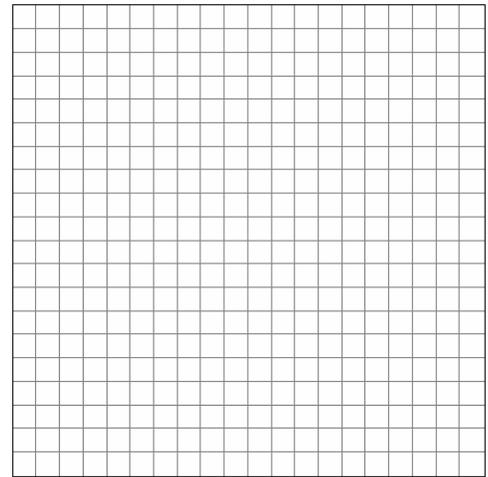
An amount of P dollars is deposited in an account paying an annual interest rate r (as a decimal) compounded n times per year. After t years, the amount of money in the account, in dollars, is given by the equation

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

Rachel deposited \$1,000 at

2.8% annual interest, compounded monthly. In how many years, to the *nearest tenth of a year*, will she have \$2,500 in the account?

[The use of the grid is optional.]



13. 060330b, P.I. A2.A.6

Sean invests \$10,000 at an annual rate of 5% compounded continuously, according to the formula $A = Pe^{rt}$, where A is the amount, P is the principal, $e = 2.718$, r is the rate of interest, and t is time, in years. Determine, to the *nearest dollar*, the amount of money he will have after 2 years. Determine how many years, to the *nearest year*, it will take for his initial investment to double.

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[2] 65, and appropriate work is shown, such as $P(10) = 80(0.98)^{10}$.

[1] Appropriate work is shown, but one computational or rounding error is made.

or [1] Appropriate work is shown, but one conceptual error is made.

or [1] 65, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[1] incorrect procedure.

[2] C

[3] A

[2] 12, and appropriate work is shown, such as solving $2,500 = 4(2.7)^{0.584t}$.

[1] Appropriate work is shown, but the answer is not rounded or is rounded to 11.

or [1] Appropriate work is shown, but one computational error is made.

or [1] 12, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[4] incorrect procedure.

[2] 135, and appropriate work is shown.

[1] Appropriate work is shown, but one computational error is made.

or [1] Appropriate work is shown, but one conceptual error is made.

or [1] Appropriate work is shown to find 9, the number of periods, but it is not converted to minutes.

or [1] 135, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[5] incorrect procedure.

[4] 2011, and appropriate work is shown, such as solving a logarithmic equation or trial and error with at least three trials and appropriate checks.

[3] Appropriate work is shown, but one computational or rounding error is made.

[3] Appropriate work is shown to find t but the year is not stated or is stated incorrectly.

[2] Appropriate work is shown, but two or more computational or rounding errors are made.

or [2] Appropriate work is shown, but one conceptual error is made.

or [2] The trial-and-error method is used to find the correct solution, but only two trials and appropriate checks are shown.

or [2] The trial-and-error method is attempted and at least six systematic trials and appropriate checks are shown, but no solution is found.

[1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.

[1] 2011, but no work or only one trial with an appropriate check is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[6] incorrect procedure.

- [4] 2003 or 2004 (since the calculator yields 15.7 either year is acceptable) and correctly solves the log problem algebraically with work shown.
- [3] Algebraically solves, with work shown, for 15.7, but does not find the correct year.
- or [3] Makes a computational error in solving the log problem, but uses the answer to find a year.
- [2] Sketches a graph and gets 15.7, and finds the year.
- or [2] Uses trail and error method (with at least 3 trials) and finds the correct year.
- or [2] Tries to use logs and makes multiple mechanical errors, but finds a year.
- or [2] Sets up correct log equation.
- [1] Finds 15.7, or gives the year with no work shown.
- or [1] Sets equation equal to 10 or 10,000,000 but does not solve.
- [0] Response is completely incorrect, irrelevant, or incoherent; or is a correct response that was obtained by an obviously incorrect procedure.
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- [4] 720,500 is the population in 1980, 1.022 represents a growth rate of 2.2% added to the current population, and the population will reach the given number in 2015, and appropriate work is shown.
- [3] Appropriate work is shown, but one computational error is made.
- or [3] 720,500 and 1.022 are explained correctly, and 2015 is found as the year, but no work is shown to indicate how the year was obtained.
- or [3] Either 720,500 or 1.022 is explained correctly, and 2015 is found as the year, and appropriate work is shown.
- or [3] 720,500 and 1.022 are explained correctly, but 35.167 years is found as an answer, but appropriate work is shown.
- [2] Appropriate work is shown, but two or more computational errors are made.
- or [2] Appropriate work is shown, but one conceptual error is made.
- or [2] 720,500 and 1.022 are not explained or are explained incorrectly, but 2015 is found as the year, and appropriate work is shown.
- or [2] 720,500 and 1.022 are explained correctly, but no further correct work is shown.
- [1] Appropriate work is shown, but one conceptual error and one computational error are made.
- or [1] Either 720,500 or 1.022 is explained correctly, but no further correct work is shown.
- or [1] 35.167 or 35 years, and appropriate work is shown, but the year is not found, and no explanations or incorrect explanations are given.
- or [1] 2015, but no work is shown.
- [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
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- [4] 11, and appropriate work is shown, such as a logarithmic equation or a graph.
[3] Appropriate work is shown, but one computational, rounding, or graphing error is made.
[2] Appropriate work is shown, but two or more computational, rounding, or graphing errors are made.
or [2] Appropriate work is shown, but one conceptual error is made.
or [2] A correct logarithmic equation is written, but no further correct work is shown.
or [2] A correct graph is drawn, but the solution is not found or is found incorrectly.
[1] Appropriate work is shown, but one conceptual error and one computational, rounding, or graphing error are made.
or [1] 11, but no work is shown.
[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
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- [4] 65.7, and appropriate work is shown.
[3] Appropriate work is shown, but one computational or rounding error is made.
[2] Appropriate work is shown, but two or more computational or rounding errors are made.
or [2] Appropriate work is shown, but one conceptual error is made.
[1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.
or [1] 65.7, but no work is shown.
[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
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- [4] 11.6, and appropriate work is shown, such as the use of logarithms, graphing, or trial and error with at least three trials and appropriate checks.
[3] Appropriate work is shown, but one computational, rounding, or graphing error is made.
[2] Appropriate work is shown, but two or more computational, rounding, or graphing errors are made.
or [2] Appropriate work is shown, but one conceptual error is made.
or [2] The trial-and-error method is used to find the correct solution, but only two trials and appropriate checks are shown.
or [2] The trial-and-error method is attempted, and at least six systematic trials and appropriate checks are shown, but no solution is found.
or [2] A correct logarithmic equation is written, but no further correct work is shown.
[1] Appropriate work is shown, but one conceptual error and one computational, rounding, or graphing error are made.
or [1] A correct substitution is made into the compound interest formula, but no further correct work is shown.
or [1] A correct graph is drawn, but no further correct work is shown.
or [1] 11.6, but no work or only one trial with an appropriate check is shown.
[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
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[11]

- [4] 32.8, and appropriate work is shown.
[3] Appropriate work is shown, but one computational, rounding, or graphing error is made.
or [3] An incorrect substitution is made, but appropriate work is shown and an appropriate solution is found.
[2] Appropriate work is shown, but two or more computational, rounding, or graphing errors are made.
or [2] Appropriate work is shown, but one conceptual error is made, such as incorrect application of a logarithm rule.
[1] Correct substitutions are made, but no further correct work is shown.
or [1] 32.8, but no work is shown.
[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
- [12] incorrect procedure.

- [4] 11,052 and 14, and appropriate work is shown.
[3] Appropriate work is shown, but one computational or rounding error is made.
or [3] 14, and appropriate work is shown, but the amount of money he will have after 2 years is not found.
[2] Appropriate work is shown, but more than one computational or rounding error is made.
or [2] 11,052, and appropriate work is shown, and a correct log equation, such as $\log 2 = .05x \log 2.718$ is written, but it is not solved.
[1] 11,052, and appropriate work is shown, but the number of years to double his investment is not found or is found incorrectly.
or [1] Appropriate substitutions are made for both equations, but neither equation is solved.
or [1] 11,052 and 14, but no work is shown.
[0] 11,052 or 14, but no work is shown.
or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
- [13] obviously incorrect procedure.