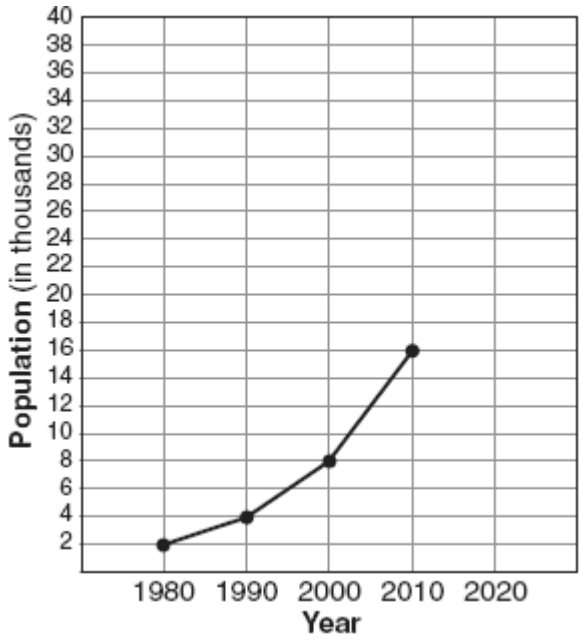
MATH TOOLBOX P. 311

REGRESSION

1. 080705a, P.I. A2.S.7
The population growth of Boomtown is shown in the accompanying graph.



If the same pattern of population growth continues, what will the population of Boomtown be in the year 2020?

[A] 20,000 [B] 40,000

[C] 64,000 [D] 32,000

2. 080429b, P.I. A2.S.7
A box containing 1,000 coins is shaken, and the coins are emptied onto a table. Only the coins that land heads up are returned to the box, and then the process is repeated. The accompanying table shows the number of trials and the number of coins returned to the box after each trial.

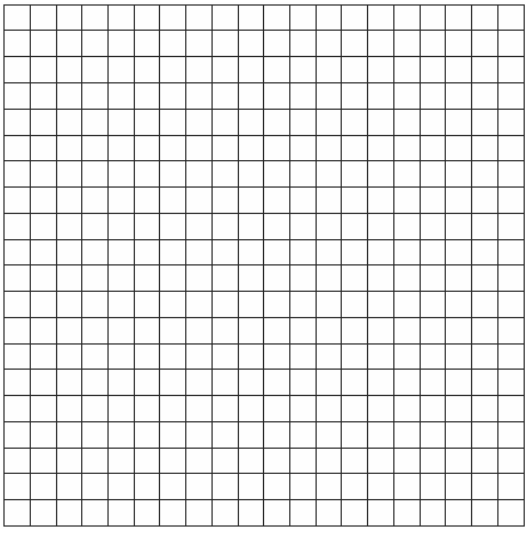
Trial	0	1	3	4	6
Coins Returned	1,000	610	220	132	45

Write an exponential regression equation, rounding the calculated values to the *nearest ten-thousandth.* Use the equation to predict how many coins would be returned to the box after the eighth trial.

3. 060234b, P.I. A2.S.7

The table below, created in 1996, shows a history of transit fares from 1955 to 1995. On the accompanying grid, construct a scatter plot where the independent variable is years. State the exponential regression equation with the coefficient and base rounded to the *nearest thousandth*. Using this equation, determine the prediction that should have been made for the year 1998, to the *nearest cent.*

Year	Fare ($)
55	0.10
60	0.15
65	0.20
70	0.30
75	0.40
80	0.60
85	0.80
90	1.15
95	1.50

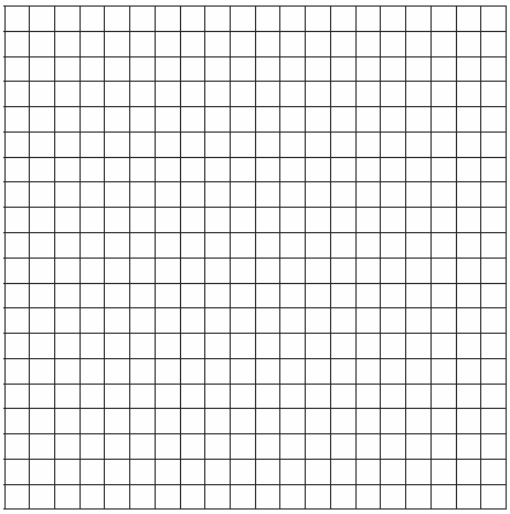


4. 080232b, P.I. A2.S.7

The breaking strength, *y*, in tons, of steel cable with diameter *d*, in inches, is given in the table below.

d (in)	*y* (tons)
0.50	9.85
0.75	21.80
1.00	38.30
1.25	59.20
1.50	84.40
1.75	114.00

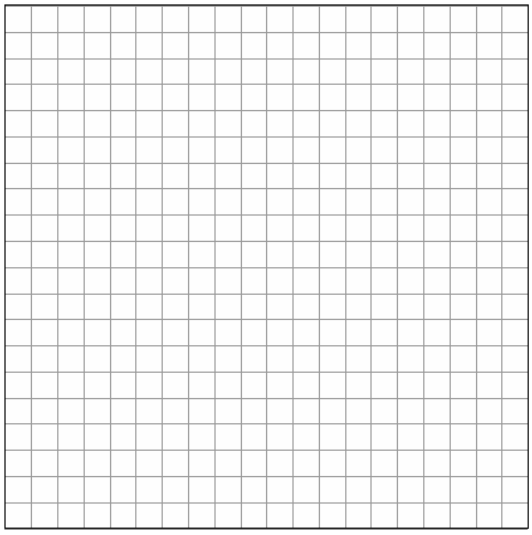
On the accompanying grid, make a scatter plot of these data. Write the exponential regression equation, expressing the regression coefficients to the *nearest tenth.*



5. 010433b, P.I. A2.S.7
The accompanying table shows the average salary of baseball players since 1984. Using the data in the table, create a scatter plot on the grid and state the exponential regression equation with the coefficient and base rounded to the *nearest hundredth.* Using your written regression equation, estimate the salary of a baseball player in the year 2005, to the *nearest thousand dollars.*

Baseball Players' Salaries

Numbers of Years Since 1984	Average Salary (thousands of dollars)
0	290
1	320
2	400
3	495
4	600
5	700
6	820
7	1,000
8	1,250
9	1,580



6. 080631b, P.I. A2.S.7
Jean invested $380 in stocks. Over the next 5 years, the value of her investment grew, as shown in the accompanying table.

Years Since Investment (x)	Value of Stock, in Dollars (y)
0	380
1	395
2	411
3	427
4	445
5	462

Write the exponential regression equation for this set of data, rounding all values to *two decimal places.* Using this equation, find the value of her stock, to the *nearest dollar*, 10 years after her initial purchase.

CHAPTER 7-2

EXPONENTIAL FUNCTIONS

7. 010813b
A radioactive substance has an initial mass of 100 grams and its mass halves every 4 years. Which expression shows the number of grams remaining after t years?

[A] $100(4)^{-2t}$ [B] $100(4)^{\frac{t}{4}}$

[C] $100(\frac{1}{2})^{4t}$ [D] $100(\frac{1}{2})^{\frac{t}{4}}$

8. 060721b, P.I. A.A.9
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.

9. 060607b, P.I. A.A.9
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] 8 [C] 2 [D] 16

10. 010525b, P.I. A.A.9
On January 1, 1999, the price of gasoline was $1.39 per gallon. If the price of gasoline increased by 0.5% per month, what was the cost of one gallon of gasoline, to the *nearest cent*, on January 1 one year later?

11. fall0719ia, P.I. A.A.9
Daniel's Print Shop purchased a new printer for $35,000. Each year it depreciates (loses value) at a rate of 5%. What will its approximate value be at the end of the fourth year?

[A] $33,250.00 [B] $27,082.33
[C] $28,507.72 [D] $30,008.13

12. 080221b, P.I. A.A.9
A used car was purchased in July 1999 for $11,900. If the car depreciates 13% of its value each year, what is the value of the car, to the *nearest hundred dollars*, in July 2002?

13. 080224b, P.I. A.A.9
The Franklins inherited $3,500, which they want to invest for their child's future college expenses. If they invest it at 8.25% with interest compounded monthly, determine the value of the account, in dollars, after 5 years.
Use the formula $A = P(1+\frac{r}{n})^{nt}$, where A = value of the investment after t years, P = principal invested, r = annual interest rate, and n = number of times compounded per year.

SOLVING NONLINEAR SYSTEMS

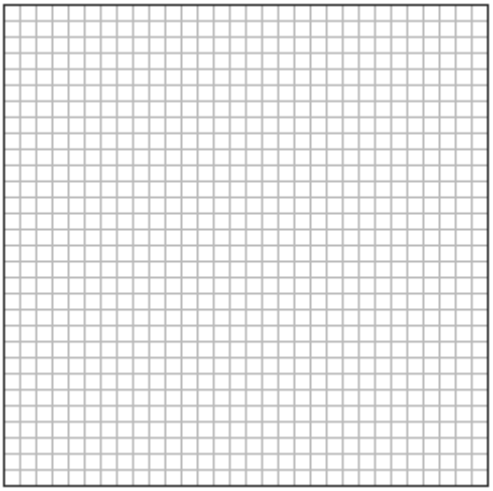
14. 060519b
The graphs of the equations $y = 2^x$ and $y = -2x + a$ intersect in Quadrant I for which values of a?

[A] $a > 1$ [B] $a \geq 1$
[C] $a < 1$ [D] $0 < a < 1$

15. 080705b
The flight paths of two Thunderbird jets are plotted on a Cartesian coordinate plane, and the equations of the jets' flight paths are represented by $y = 2^x + 3$ and $y = 0.5^x$. The best approximation of the intersection of the flight paths is

[A] (-1.50, 2.82) [B] (0, 1)
[C] (-1.72, 3.3) [D] (-2, -1)

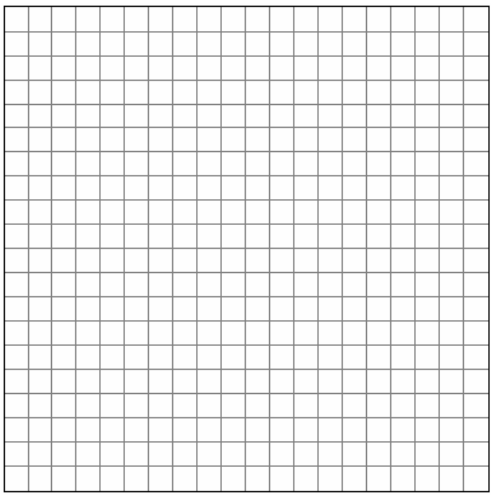
16. 010628b
On the accompanying grid, sketch the graphs of $y = 2^x$ and $3y = 7x + 3$ over the interval $-3 \leq x \leq 4$. Identify and state the coordinates of all points of intersection.



17. 010527b
On the accompanying grid, solve the following system of equations graphically:

$$y = -x^2 + 2x + 1$$

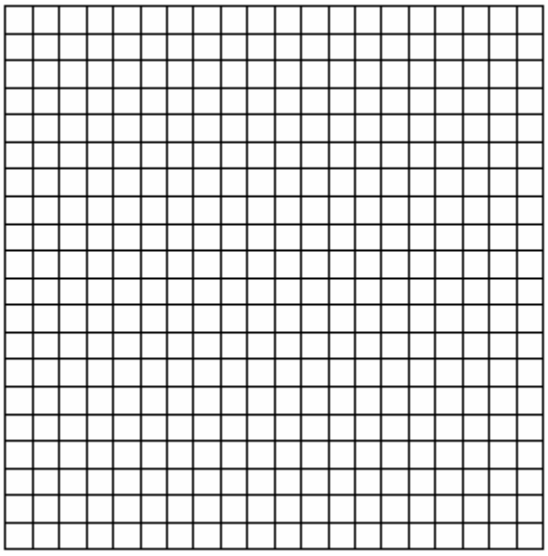
$$y = 2^x$$



CHAPTER 7-3

GRAPHING LOGARITHMIC FUNCTIONS

18. 080530b, P.I. A2.A.28
A hotel finds that its total annual revenue and the number of rooms occupied daily by guests can best be modeled by the function $R = 3\log(n^2 + 10n),\ n > 0,$ where R is the total annual revenue, in millions of dollars, and n is the number of rooms occupied daily by guests. The hotel needs an annual revenue of \$12 million to be profitable. Graph the function on the accompanying grid over the interval $0 < n \le 100.$ Calculate the minimum number of rooms that must be occupied daily to be profitable.



PROPERTIES OF LOGARITHMS

19. 060409b, P.I. A2.A.19
If $\log_b x = y,$ then x equals

[A] $y \cdot b$ [B] b^y [C] y^b [D] $\frac{y}{b}$

20. 080607b, P.I. A2.A.19
The function $y = 2^x$ is equivalent to

[A] $y = x\log 2$ [B] $x = \log_2 y$

[C] $y = \log_2 x$ [D] $x = y\log 2$

21. 060301b
For which value of x is $y = \log x$ undefined?

[A] 1.483 [B] 0 [C] $\frac{1}{10}$ [D] π

22. 010412b
The expression $\log_3(8-x)$ is defined for all values of x such that

[A] $x \le 8$ [B] $x \ge 8$

[C] $x > 8$ [D] $x < 8$

23. 080110b, P.I. A2.A.19
If log 5 = a, then log 250 can be expressed as

[A] 50a [B] 2a + 1

[C] 25a [D] 10 + 2a

24. 010208b, P.I. A2.A.19
Which expression is *not* equivalent to $\log_b 36$?

[A] $\log_b 72 - \log_b 2$ [B] $\log_b 9 + \log_b 4$

[C] $6\log_b 2$ [D] $2\log_b 6$

25. 060316b, P.I. A2.A.19
If log a = 2 and log b = 3, what is the numerical value of $\log\frac{\sqrt{a}}{b^3}$?

[A] -8 [B] -25 [C] 25 [D] 8

26. 010409b, P.I. A2.A.19
If log x = a, log y = b, and log z = c, then $\log\frac{x^2y}{\sqrt{z}}$ is equivalent to

[A] $2ab - \frac{1}{2}c$ [B] $2a + b - \frac{1}{2}c$

[C] $a^2 + b - \frac{1}{2}c$ [D] $42a + b + \frac{1}{2}c$

27. 010316b, P.I. A2.A.19
The expression $\log 10^{x+2} - \log 10^x$ is equivalent to

[A] $\frac{1}{100}$ [B] -2 [C] 2 [D] 100

28. 060510b, P.I. A2.A.19
If $\log a = x$ and $\log b = y$, what is $\log a\sqrt{b}$?

[A] $x + \frac{y}{2}$ [B] $x + 2y$

[C] $\frac{x+y}{2}$ [D] $2x + 2y$

29. 010611b, P.I. A2.A.19
The speed of sound, v, at temperature T, in degrees Kelvin, is represented by the equation $v = 1087\sqrt{\frac{T}{273}}$. Which expression is equivalent to log v?

[A] $1087 + \frac{1}{2}\log T - \log 273$

[B] $1087(\frac{1}{2}\log T - \frac{1}{2}\log 273)$

[C] $\log 1087 + \frac{1}{2}\log T - \frac{1}{2}\log 273$

[D] $\log 1087 + 2\log(T + 273)$

30. 080709b, P.I. A2.A.19
The equation used to determine the time it takes a swinging pendulum to return to its starting point is $T = 2\pi\sqrt{\frac{\ell}{g}}$, where T represents time, in seconds, ℓ represents the length of the pendulum, in feet, and g equals 32 ft/sec^2. How is this equation expressed in logarithmic form?

[A] $\log T = \log 2 + \log \pi + \frac{1}{2}\log \ell - \frac{1}{2}\log 32$

[B] $\log T = 2 + \log \pi + \frac{1}{2}\log \ell - 16$

[C] $\log T = \log 2 + \log \pi + \frac{1}{2}\log \ell - \log 16$

[D] $\log T = \log 2 + \log \pi + \log \sqrt{\ell - 32}$

31. 010717b, P.I. A2.A.19
A black hole is a region in space where objects seem to disappear. A formula used in the study of black holes is the Schwarzschild formula, $R = \frac{2GM}{c^2}$. Based on the laws of logarithms, $\log R$ can be represented by

[A] $2\log G + \log M - \log 2c$

[B] $\log 2G + \log M - \log 2c$

[C] $2\log GM - 2\log c$

[D] $\log 2 + \log G + \log M - 2\log c$

CHAPTER 7-4

LOGARITHMIC EQUATIONS

32. 010519b, P.I. A2.A.28
If $\log_5 x = 2$, what is the value of $\sqrt{x}$?

[A] 5 [B] $2^{\frac{2}{5}}$ [C] 25 [D] $\sqrt{5}$

33. 060623b, P.I. A2.A.28
Solve for x: $\log_2(x+1) = 3$

34. 010819b, P.I. A2.A.28
If $\log_x 9 = -2$, what is the value of x?

[A] 81 [B] $\frac{1}{81}$ [C] $\frac{1}{3}$ [D] 3

35. 080212b, P.I. A2.A.19
If $\log k = c\log v + \log p$, k equals

[A] $v^c p$ [B] $cv + p$

[C] $(vp)^c$ [D] $v^c + p$

36. 080209b, P.I. A2.A.28
In the equation $\log_x 4 + \log_x 9 = 2$, x is equal to

[A] $\sqrt{13}$ [B] 6 [C] 18 [D] 6.5

37. 080624b, P.I. A2.A.28
Solve for x: $\log_b 36 - \log_b 2 = \log_b x$

38. 060230b, P.I. A2.A.28
Solve for x: $\log_4(x^2 + 3x) - \log_4(x+5) = 1$

39. 080720b, P.I. A2.A.28
If $\log_2 a = \log_3 a$, what is the value of a?

[A] 3 [B] 4 [C] 1 [D] 2

40. 010324b, P.I. A2.A.28
The relationship between the relative size of an earthquake, *S*, and the measure of the earthquake on the Richter scale, *R*, is given by the equation $\log S = R$. If an earthquake measured 3.2 on the Richter scale, what was its relative size to the *nearest hundredth*?

41. 060102b, P.I. A2.A.28
The magnitude (R) of an earthquake is related to its intensity (I) by $R = \log(\frac{I}{T})$, where T is the threshold below which the earthquake is not noticed. If the intensity is doubled, its magnitude can be represented by

[A] $2(\log I - \log T)$ [B] $2\log I - \log T$

[C] $\log I - \log T$ [D] $\log 2 + \log I - \log T$

42. 060125b, P.I. A2.A.18
The scientists in a laboratory company raise amebas to sell to schools for use in biology classes. They know that one ameba divides into two amebas every hour and that the formula $t = \log_2 N$ can be used to determine how long in hours, *t*, it takes to produce a certain number of amebas, *N*. Determine, to the *nearest tenth of an hour*, how long it takes to produce 10,000 amebas if they start with one ameba.

CHAPTER 7-5

EXPONENTIAL EQUATIONS

43. 060612b, P.I. A2.A.27
The solution set of $2^{x^2+2x} = 2^{-1}$ is
[A] {1} [B] { } [C] {-1} [D] {-1, 1}

44. 010709b, P.I. A2.A.27
What is the value of *b* in the equation $4^{2b-3} = 8^{1-b}$?
[A] $\frac{10}{7}$ [B] $\frac{-3}{7}$ [C] $\frac{7}{9}$ [D] $\frac{9}{7}$

45. 010626b, P.I. A2.A.27
Solve algebraically for *x*: $8^{2x} = 4^6$

46. 060303b, P.I. A2.A.27
What is the value of *x* in the equation $81^{x+2} = 27^{5x+4}$?
[A] $\frac{4}{11}$ [B] $-\frac{3}{2}$ [C] $-\frac{4}{11}$ [D] $-\frac{2}{11}$

47. 060422b, P.I. A2.A.27
Solve algebraically for *x*: $27^{2x+1} = 9^{4x}$

48. 060522b, P.I. A2.A.27
Solve for *m*: $3^{m+1} - 5 = 22$

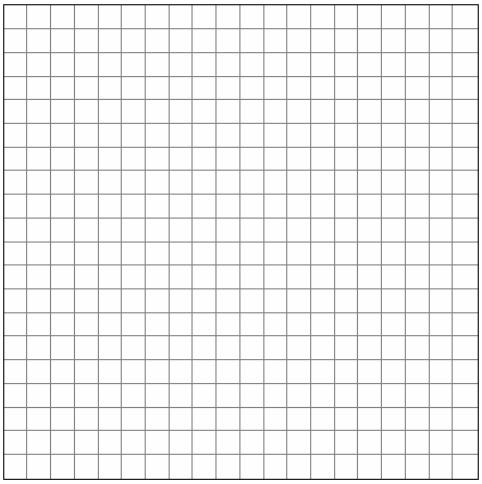
49. 080118b, P.I. A2.A.27
Determine the value of *x* and *y* if $2^y = 8^x$ and $3^y = 3^{x+4}$.
[A] $x = 2, y = 6$ [B] $x = 6, y = 2$
[C] $x = y$ [D] $x = -2, y = -6$

50. 080502b, P.I. A2.A.27
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] 8 [D] 2

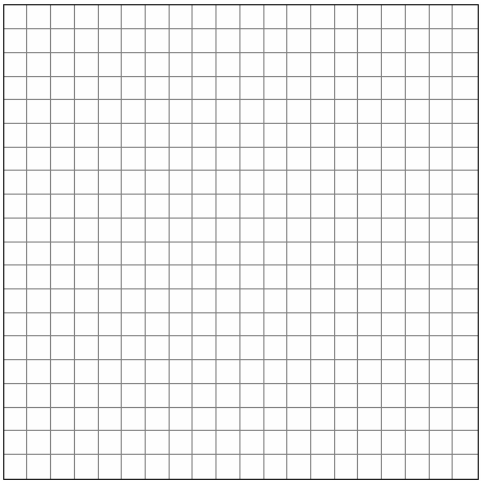
51. 060224b, P.I. A2.A.27
Growth of a certain strain of bacteria is modeled by the equation $G = A(2.7)^{0.584t}$, where: *G* = final number of bacteria, *A* = initial number of bacteria, *t* = time (in hours). In approximately how many hours will 4 bacteria first increase to 2,500 bacteria? Round your answer to the *nearest hour*.

52. 010828b, P.I. A2.A.27
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?

53. 010728b, P.I. A2.A.27
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.]



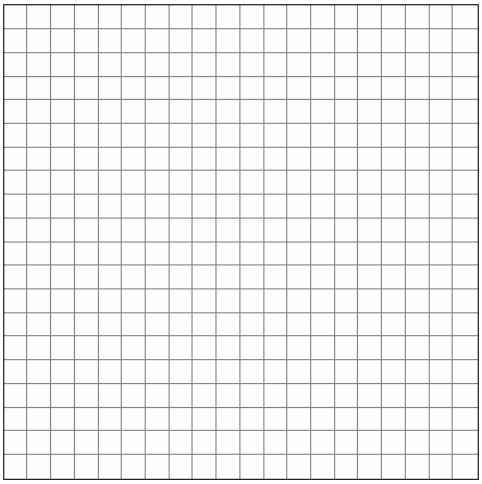
54. 080632b, P.I. A2.A.27
After an oven is turned on, its temperature, T, is represented by the equation $T = 400 - 350(3.2)^{-0.1m}$ where m represents the number of minutes after the oven is turned on and T represents the temperature of the oven, in degrees Fahrenheit. How many minutes does it take for the oven's temperature to reach 300°F? Round your answer to the *nearest minute*. [The use of the grid is optional.]



55. 080729b, P.I. A2.A.27
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?

56. 080428b, P.I. A2.A.27

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.]



57. 010429b, P.I. A2.A.27

The equation for radioactive decay is $p = (0.5)^{\frac{t}{H}}$, where *p* is the part of a substance with half-life *H* remaining radioactive after a period of time, *t*. A given substance has a half-life of 6,000 years. After *t* years, one-fifth of the original sample remains radioactive. Find *t*, to the *nearest thousand years*.

58. 060431b, P.I. A2.A.27

An archaeologist can determine the approximate age of certain ancient specimens by measuring the amount of carbon-14, a radioactive substance, contained in the specimen. The formula used to determine the age of a specimen is $A = A_0 2^{\frac{-t}{5760}}$, where *A* is the amount of carbon-14 that a specimen contains, A_0 is the original amount of carbon-14, *t* is time, in years, and 5760 is the half-life of carbon-14. A specimen that originally contained 120 milligrams of carbon-14 now contains 100 milligrams of this substance. What is the age of the specimen, to the *nearest hundred years*?

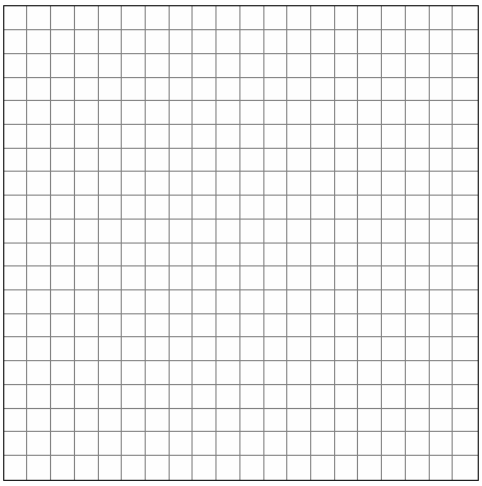
59. 010230b, P.I. A2.A.27

Depreciation (the decline in cash value) on a car can be determined by the formula $V = C(1-r)^t$, where *V* is the value of the car after *t* years, *C* is the original cost, and *r* is the rate of depreciation. If a car's cost, when new, is $15,000, the rate of depreciation is 30%, and the value of the car now is $3,000, how old is the car to the *nearest tenth of a year*?

60. 080132b, P.I. A2.A.27

The amount *A*, in milligrams, of a 10-milligram dose of a drug remaining in the body after *t* hours is given by the formula $A = 10(0.8)^t$. Find, to the *nearest tenth of an hour*, how long it takes for half of the drug dose to be left in the body.

61. 010632b, P.I. A2.A.27
The current population of Little Pond, New York, is 20,000. The population is *decreasing*, as represented by the formula $P = A(1.3)^{-0.234t}$, where P = final population, t = time, in years, and A = initial population. What will the population be 3 years from now? Round your answer to the *nearest hundred people*. To the *nearest tenth of a year*, how many years will it take for the population to reach half the present population? [The use of the grid is optional.]



CHAPTER 7-6

62. 060330b, P.I. A2.A.27
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.

[1] D

[4] $y = 1{,}018.2839(0.5969)^x$ and 16, and appropriate work is shown.
[3] Appropriate work is shown, but one computational or rounding error is made.
or [3] $y = 1{,}018.2839(0.5969)^x$ and 16, but the substitution is not shown.
[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] An appropriate regression equation is written, but the number of coins returned after the eighth trial is not found.
[1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.
or [1] An incorrect regression equation is written, but the number of coins returned after the eighth trial is found appropriately.
or [1] $y = 1{,}018.2839(0.5969)^x$ and 16, but no work is shown.
[0] $y = 1{,}018.2839(0.5969)^x$ or 16, 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
[2] obviously incorrect procedure.

[6] A correct scatter plot, $y = (0.002)(1.070)^x$, and \$1.52 or an equivalent answer, and appropriate work is shown.
[5] Appropriate work is shown, but one computational or rounding error is made.
[4] A correct scatter plot is shown, but an incorrect equation of equal difficulty is used, but an appropriate fare for 1998 is determined, based on the incorrect equation.
or [4] A correct scatter plot with a function other than exponential is used, but an appropriate equation and fare derived from that equation are shown.
[3] A correct scatter plot is shown, and an appropriate fare based on the scatter plot is found, but no equation or work is shown.
[2] Only a correct scatter plot is shown.
[1] \$1.52, 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
[3] incorrect procedure.

[4] The scatter plot is completed correctly, and the correct regression equation is given, such as $y = (4.8)(6.8)^x$.
[3] Appropriate work is shown, but one graphing or rounding error is made.
[2] The scatter plot is completed correctly, but the coefficients of the regression equation are transposed.
or [2] The scatter plot is inaccurate, but the correct regression equation is given.
[1] No scatter plot is drawn, but the correct regression equation is given.
or [1] The scatter plot is completed correctly, but no regression equation is given.
[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously
[4] incorrect procedure.

[6] An appropriate scatter plot is drawn, and either $y = 276.67(1.21)^x$ and \$15,151,000 or $y = 276673.91(1.21)^x$ and \$15,152,000.
[5] Appropriate work is shown, but one computational error is made.
or [5] Appropriate work is shown, but one error is made in rounding the coefficients or by substituting an incorrect value of x for the year 2005.
or [5] Appropriate work is shown, but an incorrect nonlinear function for the regression equation is written, but an appropriate salary is found.
or [5] No scatter plot or an incorrect scatter plot is drawn, but the correct regression equation is written, and the correct salary is found.
[4] Appropriate work is shown, but two or more computational errors are made.
or [4] No scatter plot or an incorrect scatter plot is drawn, and one rounding error is made, but the correct regression equation is written, and an appropriate salary is found.
[3] Appropriate work is shown, but a linear function for the regression equation is written, but an appropriate salary is found.
or [3] An appropriate scatter plot is drawn, and the correct regression equation is written, but no further correct work is shown.
[2] An appropriate scatter plot is drawn, and the correct salary is found, but no work or regression equation is shown.
or [2] An appropriate scatter plot is drawn, but an incorrect regression equation is written, but an appropriate salary is found.
[1] No scatter plot or an incorrect scatter plot is drawn, and an incorrect regression equation is written, but an appropriate salary is found.
[1] An appropriate scatter plot is drawn, but no further correct 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.

[5]

[4] $y = 379.92(1.04)^x$ and 562, and appropriate work is shown.
[3] Appropriate work is shown, but one computational or rounding error is made.
or [3] $y = 379.92(1.04)^x$ and 562, but the substitution is not shown to find the value of the stock.
or [3] The expression $379.92(1.04)^x$ is written and 562, and appropriate work is shown, but the equation is not written.
[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 expression $379.92(1.04)^x$ is written and 562, but no work is shown.
or [2] A correct regression equation is written, but no further correct work is shown.
or [2] An incorrect exponential regression equation of equal difficulty is written, but an appropriate substitution is made, and an appropriate value of the stock is found.
[1] Appropriate work is shown, but one conceptual error and one computational or rounding error are made.
or [1] An incorrect regression equation of a lesser degree of difficulty is written, but an appropriate substitution is made, and an appropriate value of the stock is found.
or [1] The expression $379.92(1.04)^x$ is written, but no further correct work is shown.
or [1] 562, 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.

[6]

[7] D

[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 incorrect procedure.

[8]

[9] B

[2] \$1.48, and appropriate work is shown, such as providing a correctly labeled table or solving the equation $(1.39)(1.005)^{12} = C$.
[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, such as using 1.05 or 1.5 or using an incorrect exponent.
or [1] A correct equation is written, but no further correct work is shown.
or [1] An incorrect equation of equal difficulty is solved appropriately.
or [1] \$1.48, 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.

[10]

[11] C

[2] 7,800, and appropriate work is shown.
[1] Appropriate work is shown, but one computational or rounding error is made.
or [1] 7,800, 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]

[2] 5,279.61, and appropriate work is shown, such as $3{,}500(1+\frac{0.0825}{12})^{(12\times5)}$.
[1] Appropriate work is shown, but one computational or substitution error is made.
or [1] 5,279.61, 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.

[13]

[14] A

[15] C

[4] (0,1) and (3,8), and both graphs are sketched correctly.
[3] Appropriate work is shown, but one graphing error is made, but all appropriate points of intersection are identified.
[2] Appropriate work is shown, but two or more graphing errors are made, but all appropriate points of intersection are identified.
or [2] Appropriate work is shown, but one conceptual error is made, such as failing to draw the graph over the specified interval, resulting in only one point of intersection.
or [2] Both graphs are sketched correctly, and the two points of intersection are indicated, but the coordinates are not stated or are stated incorrectly.
[1] Only the graph of the exponential function is sketched correctly, and no further correct work is shown.
or [1] (0,1) and (3,8), but no graph is sketched.
[0] (0,1) or (3,8), but no graph is sketched.
or [0] Only the line is graphed correctly.
or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.

[16]

[4] (0,1) and (1,2), and a correct graph is drawn with at least one function labeled.
[3] Appropriate work is shown, but one graphing error is made, such as plotting one point incorrectly or not labeling either function.
or [3] The graphs are drawn correctly, but only one correct solution is found or only the x- or the y-values are found correctly.
[2] Appropriate work is shown, but two or more graphing errors are made.
or [2] (0,1) and (1,2), but the solution is found by a nongraphic method.
or [2] The graphs are drawn correctly, but no correct solutions are found.
[1] The graph of only one equation is drawn correctly, and no further correct work is shown.
or [1] (0,1) and (1,2), but no work is shown.
[0] (0,1) or (1,2), 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

[17] obviously incorrect procedure.

[4] The function is graphed over the specified interval, and 96, and appropriate work is shown, such as calculating the revenue at 95 and 96 to show that 96 will make the hotel profitable or writing an explanation.
[3] Appropriate work is shown, but one computational, graphing, or rounding error is made.
[2] Appropriate work is shown, but two or more computational, graphing, or rounding errors are made.
or [2] Appropriate work is shown, but one conceptual error is made.
or [2] 96, and appropriate work is shown, but no graph is drawn.
or [2] The function is graphed correctly, but no further correct work is shown.
[1] Appropriate work is shown, but one conceptual error and one computational, graphing, or rounding error are made.
or [1] 96, but no work is shown and no graph is drawn.
[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[18] incorrect procedure.

[19] B

[20] B

[21] B

[22] D

[23] B

[24] C

[25] A

[26] B

[27] C

[28] A

[29] C

[30] A

[31] D

[32] A

[2] 7, and appropriate work is shown, such as $2^3 = x + 1$.
[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] $2^3 = x + 1$ is written, but no further correct work is shown.
or [1] 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.

[33]

[34] C

[35] A

[36] B

[2] 18, 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] The equation $\log_b \frac{36}{2} = \log_b x$ is written, but the value of x is not found.
or [1] 18, 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.

[37]

[4] 5 and -4, and appropriate work is shown.
[3] Appropriate work is shown, but one computational error is made.
[2] The correct log equation, $\log_4 \frac{x^2 + 3x}{x + 5} = \log_4 4$, is shown, but no further work or incorrect work is shown.
[1] One correct logarithmic step is shown, such as $\log_4 \frac{x^2 + 3x}{x + 5}$.
or [1] 5 and -4, 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.

[38]

[39] C

[2] 1,584.89, and appropriate work is shown.
[1] Appropriate work is shown, but one computational or rounding error is made.
or [1] 1,584.89, 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.

[40]

[41] D

[2] 13.3, and appropriate work is shown.
[1] Appropriate work is shown, but one computational or rounding error is made.
or [1] The correct value is substituted for n, and the equation is converted to exponential form, but it is not solved.
or [1] 13.3, 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.

[42]

[43] C

[44] D

[2] 2, 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] 2, but a method other than an algebraic solution is used.
or [1] 2, 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.

[45]

[46] C

[2] $\frac{3}{2}$, and appropriate work is shown.
[1] Appropriate work is shown, but one conceptual error or one computational error is made.
or [1] $\frac{3}{2}$, but a graphic solution is provided.
or [1] $\frac{3}{2}$, 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.

[47]

[2] 2, 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] 2, 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.

[48]

[49] A

[50] 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 incorrect procedure.

[51]

[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-arid-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 incorrect procedure.

[52]

[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.

[53]

[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.

[54]

[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.

[55]

[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.

[56]

[4] 14,000, 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.
or [2] A correct equation such as $\log\frac{1}{5} = (\frac{t}{6{,}000})\log 0.5$ is written, but no further correct work is shown.
[1] The correct substitutions are made, but no further correct work is shown.
or [1] 14,000, 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.

[57]

[4] 1,500, 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] A correct equation is written, but no further correct work is shown.
or [1] 1,500, 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.

[58]

[4] 4.5, and appropriate work is shown, such as using logs to solve the equation $0.2 = 0.7^t$.
[3] Appropriate work is shown, but one computational or rounding error is made.
[2] Substitution with $r = 30$ is shown and the log of both sides is determined, but the domain error is not recognized, such as $\log 0.2 = t\log(-29)$.
or [2] The order of operations is used incorrectly and an exponential function is maintained, but t is solved for appropriately, using logs.
[1] Substitution with $r = 0.3$ is shown, resulting in $0.2 = 0.7^t$, but no further work is shown.
or [1] 4.5, 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.

[59]

[4] 3.1, and appropriate work is shown, such as $5 = 10(0.8)^t$.
[3] Appropriate work is shown, but one computational or rounding error is made.
or [3] An incorrect value for *A* is used, but the equation is solved appropriately.
[2] An incorrect value for *A* is used, but the equation is solved appropriately, but one computational or rounding error is made.
[1] 3.1, 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.
[60]

[4] 16,600 and 11.3, and appropriate work is shown.
[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] Either 16,600 or 11.3 is found, and appropriate work is shown, but the other answer is not found.
[1] Appropriate work is shown, but one conceptual error and one computational, rounding, or graphing error are made.
or [1] Correct substitutions are made into both formulas, but no further correct work is shown.
or [1] 16,600 and 11.3, but no work is shown.
[0] 16,600 or 11.3, 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.
[61]

[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.
[62]