

**A.REI.D.11: Other Systems 2**

1 Selected values for the functions  $f$  and  $g$  are shown in the tables below.

$x$	$f(x)$		$x$	$g(x)$
-3.12	-4.88		-2.01	-1.01
0	-6		0	0.58
1.23	-4.77		8.52	2.53
8.52	2.53		13.11	3.01
9.01	3.01		16.52	3.29

A solution to the equation  $f(x) = g(x)$  is

- 1) 0
  - 2) 2.53
  - 3) 3.01
  - 4) 8.52
- 2 Which value, to the *nearest tenth*, is *not* a solution of  $p(x) = q(x)$  if  $p(x) = x^3 + 3x^2 - 3x - 1$  and  $q(x) = 3x + 8$ ?
- 1) -3.9
  - 2) -1.1
  - 3) 2.1
  - 4) 4.7
- 3 If  $f(x) = (x^2 + 3x + 2)(x^2 - 4x + 3)$  and  $g(x) = x^2 - 9$ , then how many real solutions are there to the equation  $f(x) = g(x)$ ?
- 1) 1
  - 2) 2
  - 3) 6
  - 4) 4
- 4 If  $f(x) = 3|x| - 1$  and  $g(x) = 0.03x^3 - x + 1$ , an approximate solution for the equation  $f(x) = g(x)$  is
- 1) 1.96
  - 2) 11.29
  - 3) (-0.99, 1.96)
  - 4) (11.29, 32.87)
- 5 To the *nearest tenth*, the value of  $x$  that satisfies  $2^x = -2x + 11$  is
- 1) 2.5
  - 2) 2.6
  - 3) 5.8
  - 4) 5.9
- 6 The equations  $y = 3t + 6$  and  $y = (1.82)^t$  approximately model the growth of two separate populations where  $t > 0$ . What is the best approximation of the time,  $t$ , at which the populations are the same?
- 1) -1.9
  - 2) 0.3
  - 3) 5.1
  - 4) 21.3
- 7 Pedro and Bobby each own an ant farm. Pedro starts with 100 ants and says his farm is growing exponentially at a rate of 15% per month. Bobby starts with 350 ants and says his farm is steadily decreasing by 5 ants per month. Assuming both boys are accurate in describing the population of their ant farms, after how many months will they both have approximately the same number of ants?
- 1) 7
  - 2) 8
  - 3) 13
  - 4) 36

- 8 The populations of two small towns at the beginning of 2018 and their annual population growth rate are shown in the table below.

Town	Population	Annual Population Growth Rate
Jonesville	1240	6% increase
Williamstown	890	11% increase

Assuming the trend continues, approximately how many years after the beginning of 2018 will it take for the populations to be equal?

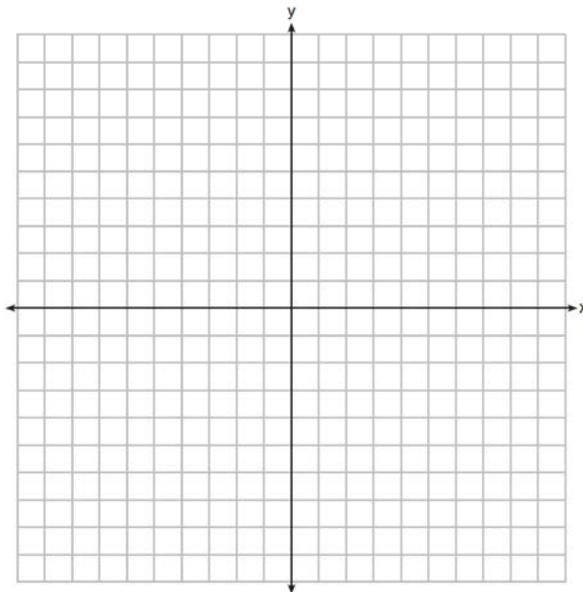
- 1) 7  
2) 20  
3) 68  
4) 125
- 9 After examining the functions  $f(x) = \ln(x + 2)$  and  $g(x) = e^{x-1}$  over the interval  $(-2, 3]$ , Lexi determined that the correct number of solutions to the equation  $f(x) = g(x)$  is
- 1) 1  
2) 2  
3) 3  
4) 0
- 10 How many solutions exist for  $\frac{1}{1-x^2} = -|3x-2| + 5$ ?
- 1) 1  
2) 2  
3) 3  
4) 4
- 11 When  $g(x) = \frac{2}{x+2}$  and  $h(x) = \log(x+1) + 3$  are graphed on the same set of axes, which coordinates best approximate their point of intersection?
- 1)  $(-0.9, 1.8)$   
2)  $(-0.9, 1.9)$   
3)  $(1.4, 3.3)$   
4)  $(1.4, 3.4)$
- 12 For which approximate value(s) of  $x$  will  $\log(x+5) = |x-1| - 3$ ?
- 1) 5, 1  
2)  $-2.41, 0.41$   
3)  $-2.41, 5$   
4) 5, only
- 13 For which values of  $x$ , rounded to the *nearest hundredth*, will  $|x^2 - 9| - 3 = \log_3 x$ ?
- 1) 2.29 and 3.63  
2) 2.37 and 3.54  
3) 2.84 and 3.17  
4) 2.92 and 3.06
- 14 If  $p(x) = 2 \ln(x) - 1$  and  $m(x) = \ln(x+6)$ , then what is the solution for  $p(x) = m(x)$ ?
- 1) 1.65  
2) 3.14  
3) 5.62  
4) no solution



21 On the set of axes below, graph  $y = f(x)$  and  $y = g(x)$  for the given functions.

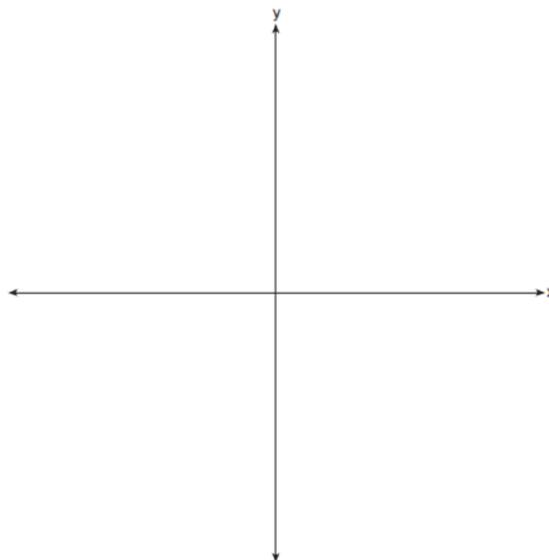
$$f(x) = x^3 - 3x^2$$

$$g(x) = 2x - 5$$

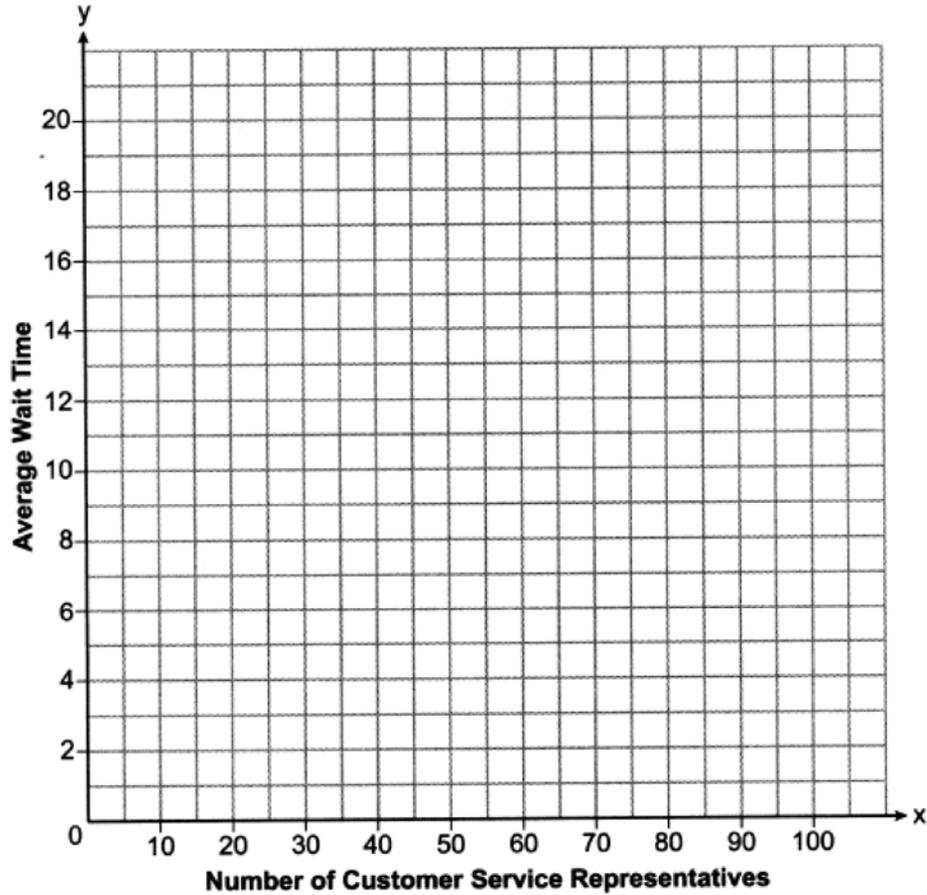


State the number of solutions to the equation  $f(x) = g(x)$ .

22 Sketch the graphs of  $r(x) = \frac{1}{x}$  and  $a(x) = |x| - 3$  on the set of axes below. Determine, to the *nearest tenth*, the positive solution of  $r(x) = a(x)$ .

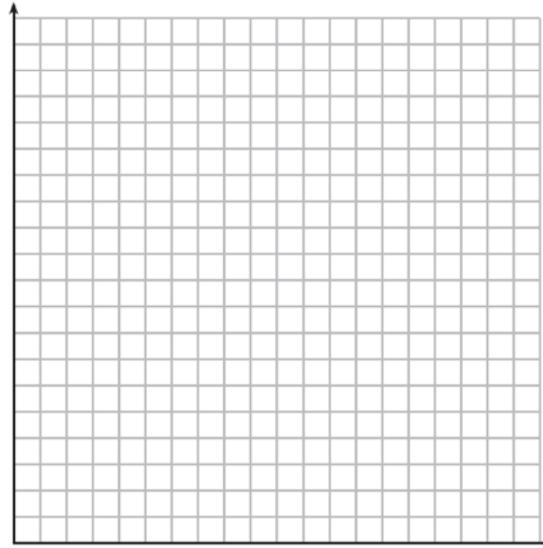


- 23 A technology company is comparing two plans for speeding up its technical support time. Plan  $A$  can be modeled by the function  $A(x) = 15.7(0.98)^x$  and plan  $B$  can be modeled by the function  $B(x) = 11(0.99)^x$  where  $x$  is the number of customer service representatives employed by the company and  $A(x)$  and  $B(x)$  represent the average wait time, in minutes, of each customer. Graph  $A(x)$  and  $B(x)$  in the interval  $0 \leq x \leq 100$  on the set of axes below.



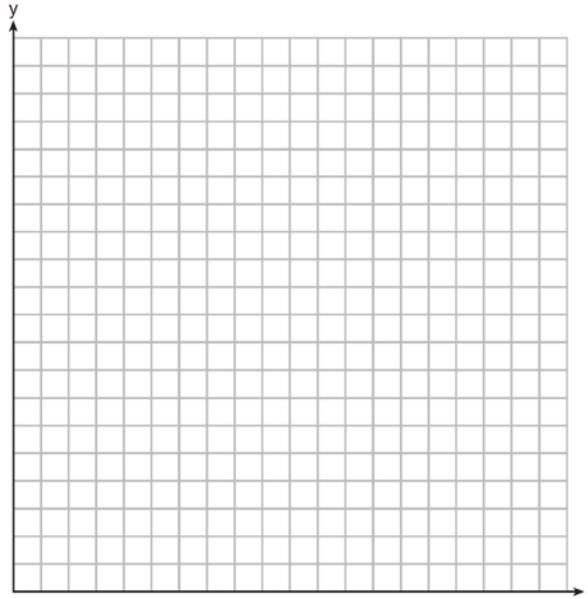
To the *nearest integer*, solve the equation  $A(x) = B(x)$ . Determine, to the *nearest minute*,  $B(100) - A(100)$ . Explain what this value represents in the given context.

- 24 The value of a certain small passenger car based on its use in years is modeled by  $V(t) = 28482.698(0.684)^t$ , where  $V(t)$  is the value in dollars and  $t$  is the time in years. Zach had to take out a loan to purchase the small passenger car. The function  $Z(t) = 22151.327(0.778)^t$ , where  $Z(t)$  is measured in dollars, and  $t$  is the time in years, models the unpaid amount of Zach's loan over time. Graph  $V(t)$  and  $Z(t)$  over the interval  $0 \leq t \leq 5$ , on the set of axes below.



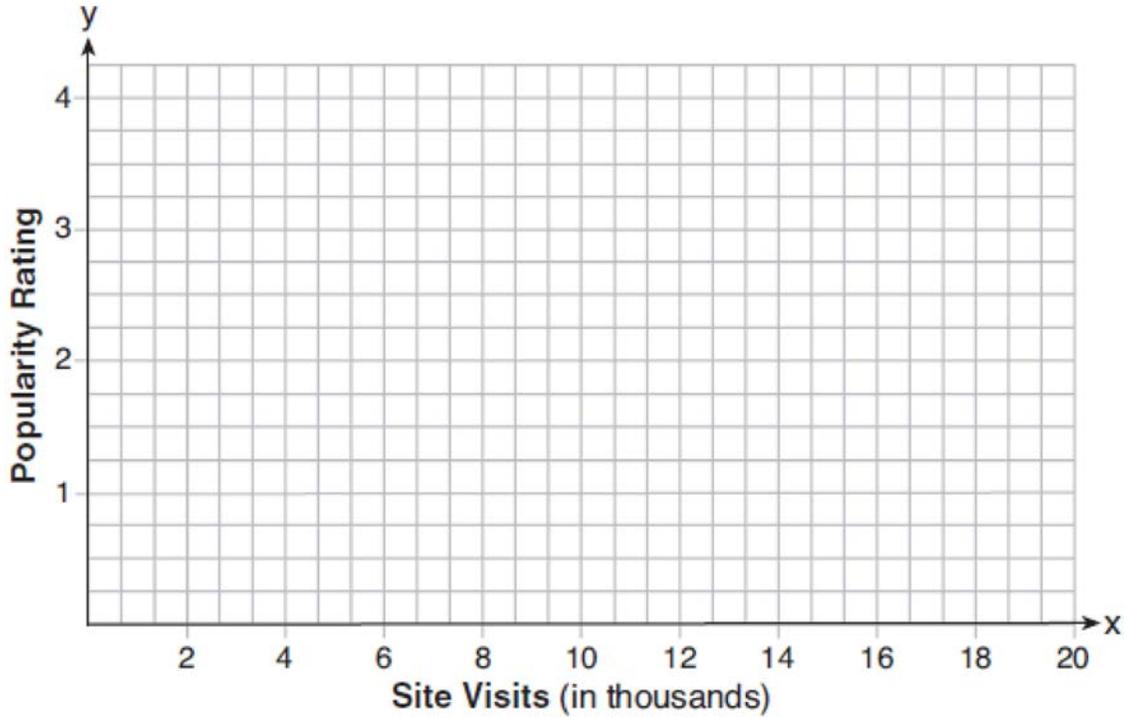
State when  $V(t) = Z(t)$ , to the *nearest hundredth*, and interpret its meaning in the context of the problem. Zach takes out an insurance policy that requires him to pay a \$3000 deductible in case of a collision. Zach will cancel the collision policy when the value of his car equals his deductible. To the *nearest year*, how long will it take Zach to cancel this policy? Justify your answer.

- 25 Drugs break down in the human body at different rates and therefore must be prescribed by doctors carefully to prevent complications, such as overdosing. The breakdown of a drug is represented by the function  $N(t) = N_0(e)^{-rt}$ , where  $N(t)$  is the amount left in the body,  $N_0$  is the initial dosage,  $r$  is the decay rate, and  $t$  is time in hours. Patient  $A$ ,  $A(t)$ , is given 800 milligrams of a drug with a decay rate of 0.347. Patient  $B$ ,  $B(t)$ , is given 400 milligrams of another drug with a decay rate of 0.231. Write two functions,  $A(t)$  and  $B(t)$ , to represent the breakdown of the respective drug given to each patient. Graph each function on the set of axes below.



To the *nearest hour*,  $t$ , when does the amount of the given drug remaining in patient  $B$  begin to exceed the amount of the given drug remaining in patient  $A$ ? The doctor will allow patient  $A$  to take another 800 milligram dose of the drug once only 15% of the original dose is left in the body. Determine, to the *nearest tenth of an hour*, how long patient  $A$  will have to wait to take another 800 milligram dose of the drug.

- 26 Website popularity ratings are often determined using models that incorporate the number of visits per week a website receives. One model for ranking websites is  $P(x) = \log(x - 4)$ , where  $x$  is the number of visits per week in thousands and  $P(x)$  is the website's popularity rating. According to this model, if a website is visited 16,000 times in one week, what is its popularity rating, rounded to the *nearest tenth*? Graph  $y = P(x)$  on the axes below.



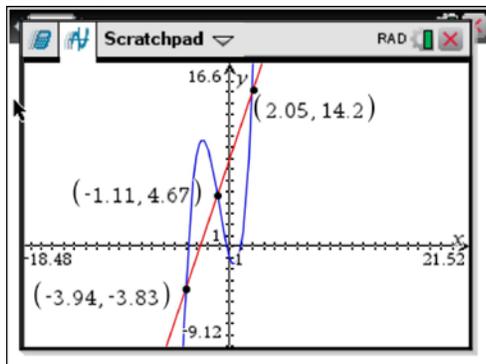
An alternative rating model is represented by  $R(x) = \frac{1}{2}x - 6$ , where  $x$  is the number of visits per week in thousands. Graph  $R(x)$  on the same set of axes. For what number of weekly visits will the two models provide the same rating?

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### Answer Section

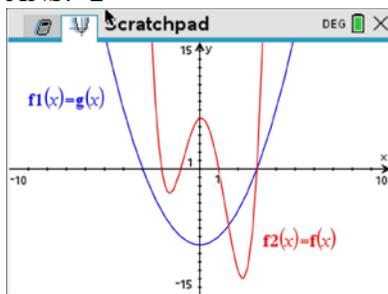
1 ANS: 4 REF: 061914aai

2 ANS: 4



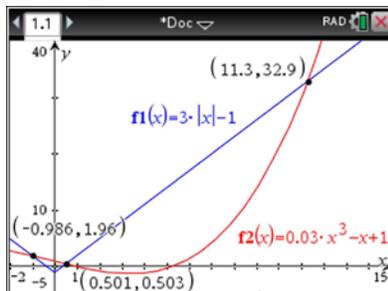
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3 ANS: 2



REF: 082319aai

4 ANS: 2



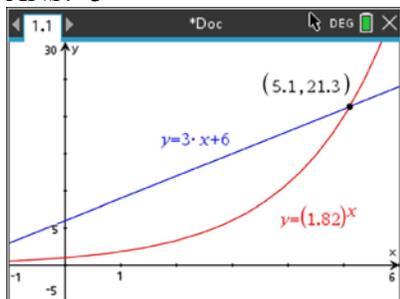
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5 ANS: 2



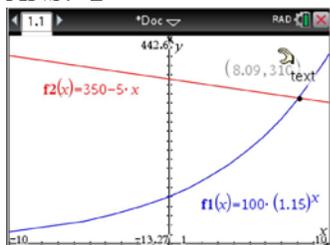
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6 ANS: 3



REF: 012406aai

7 ANS: 2



REF: 011716aai

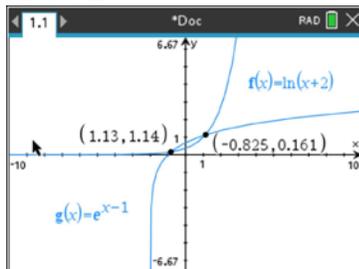
8 ANS: 1

$$1240(1.06)^x = 890(1.11)^x$$

$$x \approx 7$$

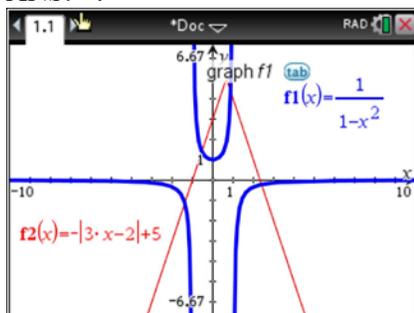
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9 ANS: 2



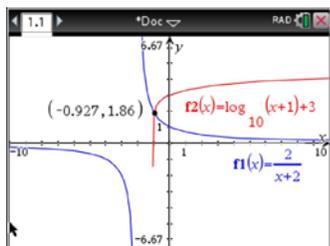
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10 ANS: 4



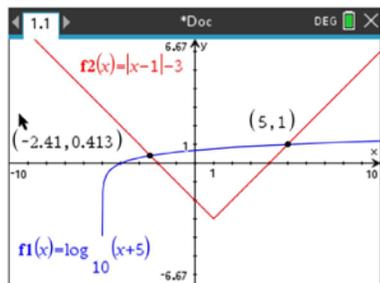
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11 ANS: 2



REF: 011712aaii

12 ANS: 3



REF: 012317aaii

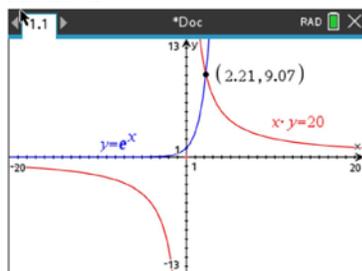
13 ANS: 1

REF: 011814aaii

14 ANS: 3

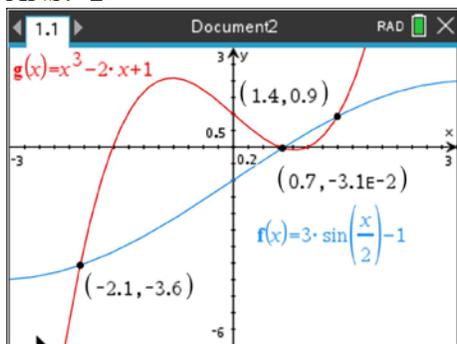
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15 ANS: 1



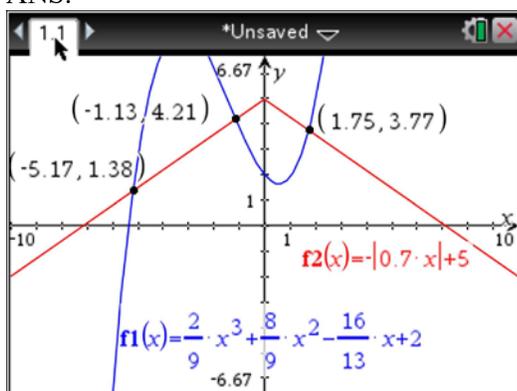
REF: 082210aaii

16 ANS: 2



REF: 012021aii

17 ANS:



REF: fall1510aii

18 ANS:

$$20e^{.05t} = 30e^{.03t}$$

$$\frac{\frac{2}{3}e^{.05t}}{e^{.05t}} = \frac{e^{.03t}}{e^{.05t}}$$

$$\ln \frac{2}{3} = \ln e^{-.02t}$$

$$\ln \frac{2}{3} = -.02t \ln e$$

$$\frac{\ln \frac{2}{3}}{-.02} = t$$

$$20.3 \approx t$$

REF: 011829aii

19 ANS:

$P(x) = 500(0.97)^x$ ; 18; The number of palm trees and flamingos will be equal in 18 years.

$$F(x) = 200e^{0.02x}$$

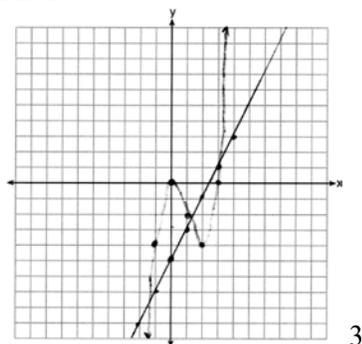
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20 ANS:

$$A(t) = 4000\left(1 + \frac{2.4\%}{12}\right)^{12t} \quad B(t) = 3500\left(1 + \frac{4\%}{4}\right)^{4t} \quad 8.4, \text{ the value of } t \text{ for which } A(t) = B(t)$$

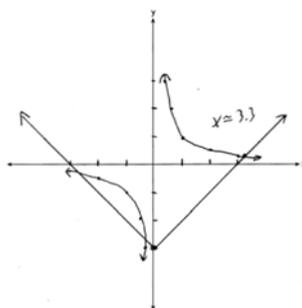
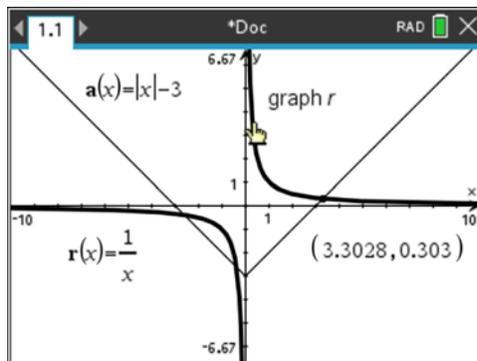
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21 ANS:



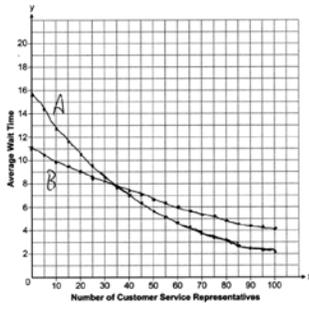
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22 ANS:



REF: 081932aii

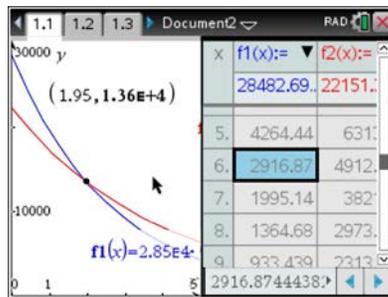
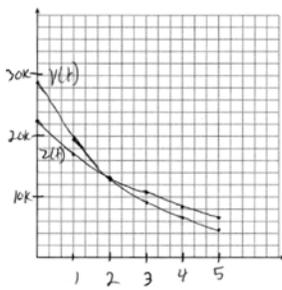
23 ANS:



35;  $B(100) - A(100) \approx 2$ , which represents the difference of the average wait time when there are 100 CSRs between the plans.

REF: 082237aii

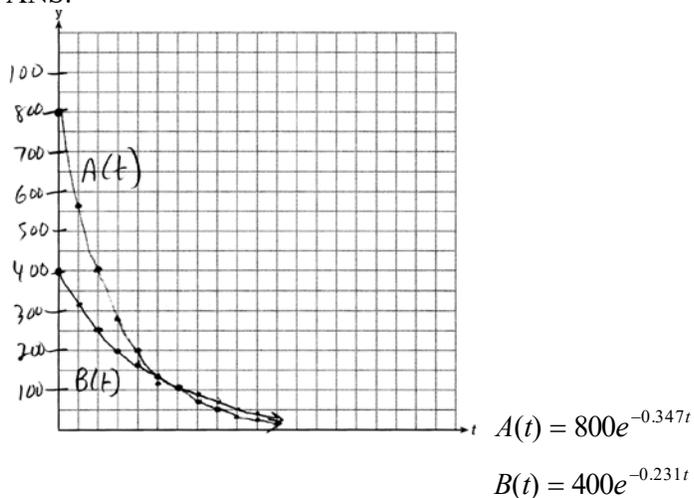
24 ANS:



At 1.95 years, the value of the car equals the loan balance. Zach can cancel the policy after 6 years.

REF: 081737aii

25 ANS:



$$800e^{-0.347t} = 400e^{-0.231t} \quad 0.15 = e^{-0.347t}$$

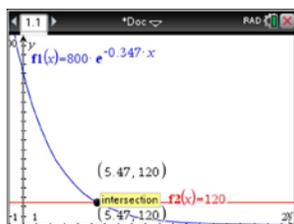
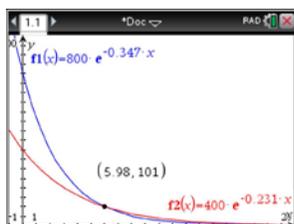
$$\ln 2e^{-0.347t} = \ln e^{-0.231t} \quad \ln 0.15 = \ln e^{-0.347t}$$

$$\ln 2 + \ln e^{-0.347t} = \ln e^{-0.231t} \quad \ln 0.15 = -0.347t \cdot \ln e$$

$$\ln 2 - 0.347t = -0.231t \quad 5.5 \approx t$$

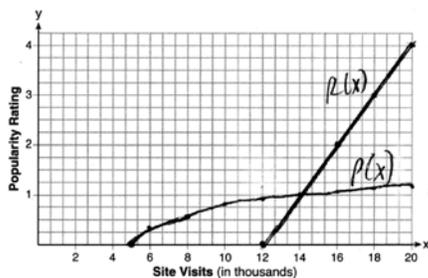
$$\ln 2 = 0.116t$$

$$6 \approx t$$



REF: 061637aii

26 ANS:



$P(16) = \log(16 - 4) \approx 1.1$ , 14000

REF: 061837aii