44. Possible answer: The following table shows how much money you could earn with each plan.

Year	Salary Plan A	Salary Plan B
0	$0	$10,000
1	$20,000	$20,000
2	$40,000	$40,000
3	$60,000	$80,000

Choose plan B because plan A doesn't pay anything for the first year and because after 3 years, plan B pays more money.

45. C; the other graphs do not increase exponentially.

46. G; $f(4) = 15(1.4)^2 = 29.4$

47. D; $a_1 = 5$, $r = 5$, hence $a_n = 5(5)^{n-1} = 5^n$

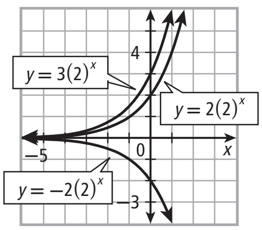
CHALLENGE AND EXTEND

48. $4^x = 64$
$4^x = 4^3$
$x = 3$

49. $\left(\frac{1}{3}\right)^x = \frac{1}{27}$
$3^{-x} = 3^{-3}$
$-x = -3$
$x = 3$

50. $2^x = \frac{1}{16}$
$2^x = \frac{1}{24}$
$2^x = 2^{-4}$
$x = -4$

51. The value of a is the y-intercept.



READY TO GO ON? Section A Quiz

1. $\frac{6}{3} = 2$; $\frac{12}{6} = 2$; $\frac{24}{12} = 2$; the common ratio is 2
next 3 terms: $24(2) = 48$, $48(2) = 96$, and $96(2) = 192$

2. $\frac{2}{-1} = -2$; $\frac{-4}{2} = -2$; $\frac{8}{-4} = -2$;
the common ratio is -2
next 3 terms: $8(-2) = -16$, $(-16)(-2) = 32$, and $32(-2) = -64$

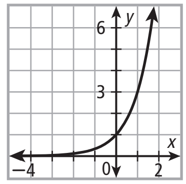
3. $\frac{-1200}{-2400} = \frac{1}{2}$; $\frac{-600}{-1200} = \frac{1}{2}$; $\frac{-300}{-600} = \frac{1}{2}$
next 3 terms: $-300\left(\frac{1}{2}\right) = -150$, $-150\left(\frac{1}{2}\right) = -75$,
and $-75\left(\frac{1}{2}\right) = -37.5$

4. $a_n = a_1 r^{n-1}$
$a_8 = (2)(3)^{8-1}$
$a_8 = 4374$

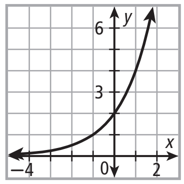
5. $a_1 = 1000$, $r = \frac{4}{5}$
$a_n = a_1 r^{n-1}$
$a_7 = 1000\left(\frac{4}{5}\right)^{7-1}$
$a_7 = 262.144$ cm

6. $f(x) = 3(1.1)^x$
$f(4) = 3(1.1)^4$
$f(4) = 4.39$ in

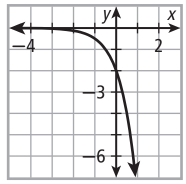
7. $y = 3^x$



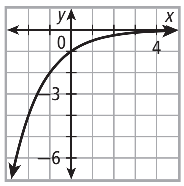
8. $y = 2(2)^x$



9. $y = -2(4)^x$



10. $y = -(0.5)^x$



11. $f(x) = 40(0.8)^x$
$2 = 40(0.8)^x$
$x \approx 14$;
after about 14 h

9-3 EXPONENTIAL GROWTH AND DECAY

CHECK IT OUT!

1. $y = a(1 + r)^t$
$= 1200(1.08)^t$;
In 2006, $y = 1200(1.08)^6 = \$1904.25$

2a. $A = P\left(1 + \frac{r}{n}\right)^{nt}$
$= 1200\left(1 + \frac{0.035}{4}\right)^{4t}$
$= 1200(1.00875)^{4t}$;
After 4 years, $A = 1200(1.00875)^{16} = \$1379.49$

b. $A = P\left(1 + \frac{r}{n}\right)^{nt}$
$= 4000\left(1 + \frac{0.03}{12}\right)^{12t}$
$= 4000(1.0025)^{12t}$
After 8 years, $A = 4000(1.0025)^{96} = \$5083.47$

3. $y = a(1 - r)^t$
$= 48{,}000(1 - 0.03)^t$
$= 48{,}000(0.97)^t$
After 7 years, $y = 48{,}000(0.97)^7 = 38{,}783$

4a. $t = \frac{180 \text{ years}}{30 \text{ years}}$
$= 6$
$A = P(0.5)^t$
$= 100(0.5)^6$
$= 1.5625$ mg

b. $t = \dfrac{5 \text{ weeks}}{5 \text{ days}}$
$= 7$
$A = P(0.5)^t$
$= 100(0.5)^7$
$= 0.78125$ g

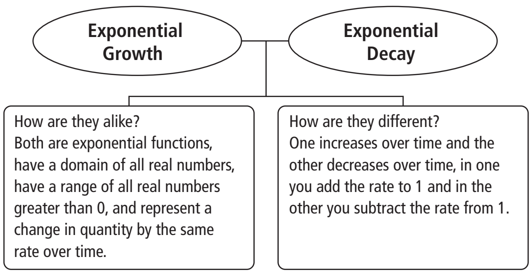
THINK AND DISCUSS

1. Possible answers: interest earned on an investment, population growth or decline, radioactive decay

2. increasing; by 2% per year

3. An exponential growth function has the form $y = a(1 + r)^t$. The base $(1 + r)$ corresponds to the base b. The exponent t corresponds to the exponent x. An exponential decay function has the form $y = a(1 - r)^t$. The base $(1- r)$ corresponds to the base b. The exponent t corresponds to the exponent x.

4.



EXERCISES

GUIDED PRACTICE

1. exponential growth, since 2 > 1.

2. $y = a(1 + r)^t$
$= 12{,}000(1 + 0.06)^t$
$= 12{,}000(1.06)^t$
After 4 years, $y = 12{,}000(1.06)^4 = \$15{,}149.72$

3. $y = a(1 + r)^t$
$= 300(1 + 0.08)^t$
$= 300(1.08)^t$
After 5 years, $y = 300(1.08)^5 = 441$

4. $A = P\left(1 + \dfrac{r}{n}\right)^{nt}$
$= 1500\left(1 + \dfrac{0.035}{1}\right)^t$
$= 1500(1.035)^t$
After 4 years, $A = 1500(1.035)^4 = \$1721.28$

5. $A = P\left(1 + \dfrac{r}{n}\right)^{nt}$
$= 4200\left(1 + \dfrac{0.028}{4}\right)^{4t}$
$= 4200(1.007)^{4t}$
Ater 6 years, $A = 4200(1.007)^{24} = \$4965.43$

6. $y = a(1 - r)^t$
$= 18{,}000(1 - 0.12)^t$
$= 18{,}000(0.88)^t$
After 10 years, $y = 18{,}000(0.88)^{10} = \$5013.02$

7. $y = a(1 - r)^t$
$= 10(1 - 0.16)^t$
$= 10(0.84)^t$
After 4 hours, $y = 10(0.84)^4 = 4.98$ mg

8. $t = \dfrac{1 \text{ hr}}{20 \text{ min}}$
$= 3$
$A = P(0.5)^t$
$= 30(0.5)^3$
$= 3.75$ g

9. $t = \dfrac{156 \text{ days}}{52 \text{ days}}$
$= 3$
$A = P(0.5)^t$
$= 44(0.5)^3$
$= 5.5$ g

PRACTICE AND PROBLEM SOLVING

10. $y = a(1 + r)^t$
$= 149{,}000(1.06)^t$
After 7 years, $y = 149{,}000(1.06)^7 = \$224{,}040.91$

11. $y = a(1 + r)^t$
$= 1600(1 + 0.03)^t$
$= 1600(1.03)^t$
After 10 years, $y = 1600(1.03)^{10} = 2150$

12. $A = P(1 + r)^t$
$= 700(1 + 0.012)^t$
$= 700(1.012)^t$
After 8 years, $A = 700(1.012)^8 = \$770.09$

13. $y = P(1 + r)^t$
$= 30(1 + 0.078)^t$
$= 30(1.079)^t$
After 6 years, $y = 30(1.078)^6 = 47$ members

14. $A = P\left(1 + \dfrac{r}{n}\right)^{nt}$
$= 28{,}000(1 + 0.04)^t$
$= 28{,}000(1.04)^t$
After 5 years, $A = 28{,}000(1.04)^5 = \$34{,}066.28$

15. $A = P\left(1 + \dfrac{r}{n}\right)^{nt}$
$= 7000\left(1 + \dfrac{0.03}{4}\right)^{4t}$
$= 7000(1.0075)^{4t}$
After 10 years, $A = 7000(1.0075)^{40} = \$9438.44$

16. $A = P\left(1 + \dfrac{r}{n}\right)^{nt}$
$= 3500\left(1 + \dfrac{0.018}{12}\right)^{12t}$
$= 3500(1.0015)^{12t}$
After 4 years, $A = 3500(1.0015)^{48} = \$3761.09$

17. $A = P\left(1 + \dfrac{r}{n}\right)^{nt}$
$= 12{,}000(1 + 0.026)^t$
$= 12{,}000(1.026)^t$
After 15 years, $A = 12{,}000(1.026)^{15} = \$17{,}635.66$

18. $y = a(1 - r)^t$
$= 18{,}000(1 - 0.02)^t$
$= 18{,}000(0.98)^t$
After 6 years, $y = 18{,}000(0.98)^6 = 15{,}945$

19. $y = a(1 - r)^t$
$= 58(1 - 0.1)^t$
$= 58(0.9)^t$
After 8 years, $y = 58(0.9)^8 = \$24.97$

20. $t = \dfrac{6 \text{ days}}{36 \text{ hours}}$
$= \dfrac{144 \text{ hours}}{36 \text{ hours}}$
$= 4$
$A = P(0.5)^t$
$= 80(0.5)^4$
$= 5$ g

21. growth; 61%, since $1 + r = 1.61$

22. decay; 90.2%, since $1 - r = 0.098$

23. decay; $33\frac{1}{3}$%, since $1 - r = \frac{2}{3}$

24. growth; 50%, since $1 + r = \frac{3}{2}$

25. growth; 10%, since $1 + r = 1.1$

26. decay; 20%, since $1 - r = 0.8$

27. growth; 25%, since $1 + r = \frac{5}{4}$

28. decay; 50%, since $1 - r = \frac{1}{2}$

29. $y = a(1 + r)^t$
$= 58{,}000{,}000(1.001)^t$
After 3 years, $y = 58{,}000{,}000(1.001)^3$
$= 58{,}174{,}174$

30. $y = a(1 + r)^t$
$= 32{,}000(1.07)^t$
After 5 years, $y = 32{,}000(1.07)^5 = \$44{,}881.66$

31. $y = a(1 - r)^t$
$= 8200(1 - 0.02)^t$
$= 8200(0.98)^t$
After 7 years, $y = 8200(0.98)^7 = \$7118.63$

32. $y = a(1 - r)^t$
$= 25{,}000(1 - 0.15)^t$
$= 25{,}000(0.85)^t$
After 6 years, $y = 25{,}000(0.85)^6 = \$9428.74$

33. $y = a(1 + r)^t$
$= 970(1 + 0.012)^t$
$= 970(1.012)^t$
After 5 years, $y = 970(1.012)^5 = 1030$

34. $t = \dfrac{3500 \text{ years}}{5700 \text{ years}}$
$= \dfrac{35}{57}$
$A = P(0.5)^t$
$= 15(0.5)^{\frac{35}{57}}$
≈ 9.80 g

35. B; possible answer: student B did not subtract the rate from 1.

36. No; possible answer; there is no value for t that would make $(0.84)^t$ equal 0.

37. $y = a(1 + r)^t$
$600 = 300(1 + 0.04)^t$
$2 = 1.04^t$
$t \approx 18$ years

38a. $y = a(1 + r)^r$
$= 20{,}000(1.09)^t$

b. In 2008, $t = 6$, hence
$y = 20{,}000(1.09)^6 = \$33{,}542$

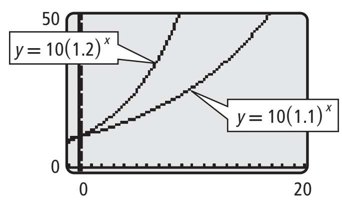
c. 2011

Year	Tuition ($)
2002	20,000
2003	21,800
2004	23,762
2005	25,900.58
2006	28,231.63
2007	30,772.48
2008	33,542.00
2009	36,560.78
2010	39,851.25
2011	43,437.87

39. In 10 years:
A: $600(1.05)^{10} = \$977.34$
B: $500(1 + \frac{0.06}{4})^{40} = 500(1.015)^{40}$
$= \$907.01$
A will have a larger balance.
In 20 years:
A: $600(1.05)^{20} = \$1591.98$
B: $500(1.015)^{80} = \$1645.33$
B will have a larger balance.

40. 50 h; 15h

41. The graph when r is 20% rises faster than when r is 10%. The greater the value of r, the faster the graph will rise.



42. Possible answer: $400 is invested at a rate of 8% compounded annually.

43. Possible answer: The population is 800 and decreasing at a rate of 4% per year.

44. No; possible answer: the sample doubles every minute, so the container is half full 1 minute before it is full. This would be after 5 min.

45. D; $y = a(1 - r)^t$
$a = 500$, $1 - r = 1 - 0.01 = 0.99$

46. G; $a = -5$, so as the absolute value of y decreases, y is actually increasing.

47. D; $865(1.05)^3 = \$1001.35$

48a. $y = a(1 + r)^t$
$= 1000(1 + 0.05)^t$
$= 1000(1.05)^t$

b. $1300 = 1000(1.05)^t$
$t \approx 5$; about 2005

CHALLENGE AND EXTEND

49. about 20 years

50. $y = a(1 + r)^t$
$1000 = 500(1.04)^t$
$t \approx 18$ yr
for $r = 0.08$
$1000 = 500(1.08)^t$
$t \approx 9$ yr

51. $A = P(0.5)^t$
$10 = 80(0.5)^t$
$t = 3$
So, half-life $= \dfrac{300}{t} = 100$ min or 1 h 40 min

52. $A = P(0.5)^t$
$15 = P(0.5)^{\frac{6}{2}}$
$P = 120$ g

53. $A = P\left(1 + \dfrac{r}{n}\right)^{nt}$
$250{,}000 = P(1 + 0.013)^{(4 \cdot 8)}$
$P = \$225{,}344$

54.

Month	Balance ($)	Monthly Payment ($)	Remaining Balance ($)	1.5% Finance Charge ($)	New Balance ($)
1	200	30	170	2.55	172.55
2	172.55	30	142.55	2.14	144.69
3	144.69	30	114.69	1.72	116.41
4	116.41	30	86.41	1.30	87.71
5	87.71	30	57.71	0.87	58.58
6	58.58	30	28.58	0.43	29.01
7	29.01	29.01	0	0	0

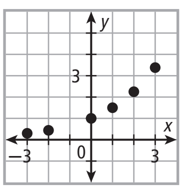
b. Table shows balance is paid off in 7 months.

c. $\big(6(30) + 29.01\big) - 200 = 9.01$

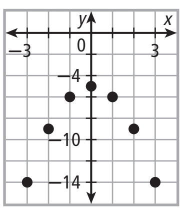
9-4 LINEAR, QUADRATIC AND EXPONENTIAL MODELS

CHECK IT OUT!

1a. exponential



b. quadratic



2. Quadratic; for every constant change in the x-values of $+1$, there is a constant second difference of -6 in the y-values.

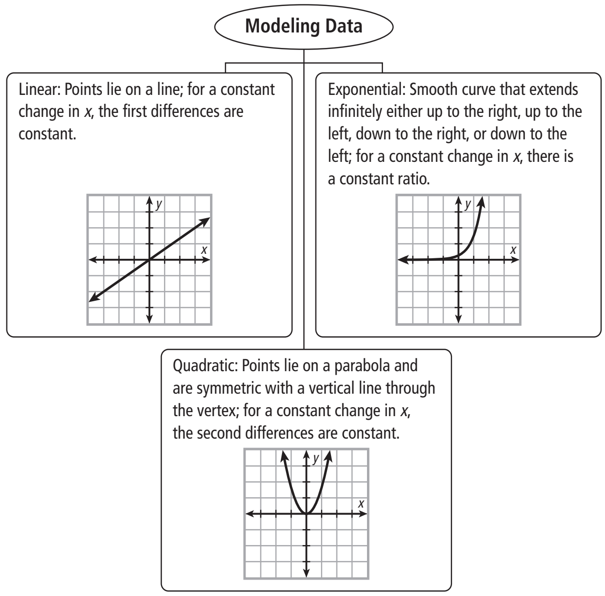
3. The oven temperature decreases by 50°F every 10 minutes; $y = -5x + 375$; 75°F

THINK AND DISCUSS

1. No; most real-world data probably will not fit exactly into one of these patterns.

2. No; this is just a prediction based on the assumption that the observed trends will continue, which they may or may not do.

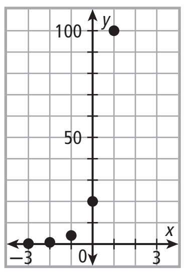
3.



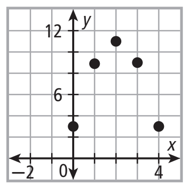
EXERCISES

GUIDED PRACTICE

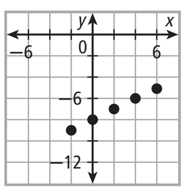
1. exponential



2. quadratic



3. linear



4. Quadratic; for every constant change of $+1$ in the x-values, there is a constant second difference of -1 in the y-values.

5. Exponential; for every constant change of $+1$ in the x-values, there is a constant ratio of 2.

6. Linear; for every constant change of $+1$ in the x-values, there is a constant change of $+2$ in the y-values.

7. Grapes cost \$1.79/lb; $y = 1.79x$; \$10.74