1 Problem Solving

Exercise Set 1-1

1. Deductive reasoning makes conclusions from general rules; inductive reasoning arrives at general conclusions from specific examples.

2. A conjecture is a guess based on previous outcomes.

3. Answers may vary.

4. A counterexample is an example that contradicts a conjecture. It is used to disprove a conjecture.

5. In order for a conclusion to be "proven true," it needs to be shown to be true in every possible case. Inductive reasoning does not look at every possible case, but only at a few specific cases.

6. An arbitrary number is variable; a number selected at random is a specific value obtained by chance.

7. Deductive reasoning used in court should be more influential with the jury. For example, as a general rule, if your DNA is found on a crime victim, then generally speaking, it is safe to conclude that you had some kind of contact with the victim. Inductive reasoning is used in court as well, and while it shouldn't necessarily influence the jury, it often does. For example, if the defendant has previously been convicted for the same crime that he is now on trial for, the jurors may use that specific example to draw a conclusion about the defendant's guilt.

8. If you have tried a bunch of specific examples to test a conjecture, and you didn't find a counterexample, it is reasonable to become confident that a conjecture is true. However, confidence is not the same as certainty. You can only be certain that a conjecture is true by using deductive reasoning to show that the conjecture is true for every possible example.

9. 1 2 4 7 11 16 22 29

+1 +2 +3 +4 +5 +6 +7 +8

The next number is 37.

10. 6 10 22 58 166 490

+4 +12 +36 +108 +324 +972

×3 ×3 ×3 ×3 ×3

The next number is 1,462.

11. 10 20 11 18 12 16 13 14 14 12 15

+10 +(−9) +7 +(−6) +4 +(−3) +1 +0 +(−2) +3 +(−5)

The next number is 10.

12. 2 3 8 63 3,968

$\times 2-1$ $\times 3-1$ $\times 8-1$ $\times 63-1$ $\times 3968-1$

The next number is 15,745,023.

13. 100 99 97 94 90 85 79

-1 -2 -3 -4 -5 -6 -7

The next number is 72.

14. 9 12 11 14 13 16 15 18

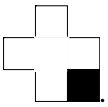
$+3$ -1 $+3$ -1 $+3$ -1 $+3$ -1

The next number is 17.

15. The line through the circle is horizontal, vertical, horizontal, vertical, and then horizontal. The first two circles have no shading, the third and fourth circles have dark shading on top and then on the left, and the fifth circle has light shading on top. We could reasonably expect the next figure to be  .

16. The outer shapes are square, triangle, square, triangle, square, triangle, and then square. The inner shapes are solid circle, solid circle, open square, open square, open circle, open circle, and then solid square. The triangles point up, then right, then down. We could reasonably expect the next figure to be  .

17. The eye shading and mouth shape is right-shaded smile, left-shaded frown, none shaded smile, both shaded smile, right-shaded frown. The eye pattern appears to be right-shaded, left-shaded, none shaded, both shaded. So, we can reasonably expect the next figure to have the left-shaded. The mouth pattern appears to be that the number of smiles between frowns increases by one each time. So, we could expect the next figure to be  .

18. The shading is middle, upper left, lower left, middle, upper right. We could reasonable expect the next figure to be  .

19. $5 + 13 + 17 = 35$, which is odd.

20. $7(15) + 4 = 109$, which is odd.

21. $5^2 \div 2 = 12.5$

22. $58(6) = 348$; $3 + 4 + 8 = 15$, which is not divisible by 6.

23. Approach: Induction

Original number:	10	50
Double the number:	$10(2) = 20$	$50(2) = 100$
Subtract 20:	$20 - 20 = 0$	$100 - 20 = 80$
Divide by 2:	$0 \div 2 = 0$	$80 \div 2 = 40$
Subtract the original number:	$0 - 10 = -10$	$40 - 50 = -10$
Result:	-10	-10

Conjecture: The final answer is -10.

Approach: Deduction

Pick a number:	x
Double the number:	$2x$
Subtract 20:	$2x-20$
Divide by 2:	$(2x-20)\div 2 = x-10$
Subtract the original number:	$x-10-x=-10$
Result:	-10

The final answer is always -10.

24. Approach: Induction

Original number:	1	11
Multiply by 9:	$1(9)=9$	$11(9)=99$
Add 21:	$9+21=30$	$99+21=120$
Divide by 3:	$30\div 3=10$	$120\div 3=40$
Subtract three times the original number:	$10-3(1)=7$	$40-3(11)=7$
Result:	7	7

Conjecture: The final answer is 7.

Approach: Deduction

Pick a number:	x
Multiply by 9:	$9x$
Add 21:	$9x+21$
Divide by 3:	$(9x+21)\div 3 = 3x+7$
Subtract three times the original number:	$3x+7-3x=7$
Result:	7

The final answer is always 7.

25. Approach: Induction

Original number:	4	13
Add 6:	$4+6=10$	$13+6=19$
Multiply by 9:	$10(9)=90$	$19(9)=171$
Divide by 3:	$90\div 3=30$	$171\div 3=57$
Subtract 3 times the original number:	$30-3(4)=18$	$57-3(13)=18$
Result:	18	18

Conjecture: The final answer is 18.

Approach: Deduction

Pick a number:	x
Add 6:	$x+6$
Multiply by 9:	$9(x+6)=9x+54$
Divide by 3:	$(9x+54)\div 3=3x+18$
Subtract three times the original number:	$3x+18-3x=18$
Result:	18

The final answer is always 18.

26. Approach: Induction

Original number:	4	10
Multiply by 4:	$4(4)=16$	$4(10)=40$
Add 8:	$16+8=24$	$40+8=48$
Divide by 2:	$24\div 2=12$	$48\div 2=24$
Subtract two times the original number:	$12-2(4)=4$	$24-2(10)=4$
Result:	4	4

Conjecture: The final answer is 4.

Approach: Deduction

Pick an even number:	x
Multiply by 4:	$4(x) = 4x$
Add 8:	$4x + 8$
Divide by 2:	$(4x + 8) \div 2 = 2x + 4$
Subtract 2 times the original number:	$2x + 4 - 2(x) = 4$
Result:	4

The final answer is always 4.

27. $12{,}345{,}679 \times 9 = 12{,}345{,}679 \times 9(1) =$ $111{,}111{,}111$

$12{,}345{,}679 \times 18 = 12{,}345{,}679 \times 9(2) =$ $222{,}222{,}222$

$12{,}345{,}679 \times 27 = 12{,}345{,}679 \times 9(3) =$ $333{,}333{,}333$

Therefore the last multiplication should be:

$12{,}345{,}679 \times 72 = 12{,}345{,}679 \times 9(8) =$ $888{,}888{,}888$

28. By inductive reasoning $5^2 + 11 = 6^2$.

29. By inductive reasoning $999{,}999 \times 9 = 8{,}999{,}991$.

30. By inductive reasoning $1 + 2 + 3 + 4 + 5 + 6 + 7 + 6 + 5 + 4 + 3 + 2 + 1 = 7^2$.

31. By inductive reasoning $99{,}999 \times 99{,}999 = 9{,}999{,}800{,}001$.

32. By inductive reasoning $12{,}345 \times 8 + 5 = 98{,}765$.

33. By inductive reasoning $11{,}111 \cdot 11{,}111 = 123{,}454{,}321$

34. By inductive reasoning $5 \cdot 91 = 455$.

35. $142{,}857 \times 2 = 285{,}714$

$142{,}857 \times 3 = 428{,}571$

$142{,}857 \times 4 = 571{,}428$

$142{,}857 \times 5 = 714{,}285$

$142{,}857 \times 6 = 857{,}142$

$142{,}857 \times 7 = 999{,}999$

$142{,}857 \times 8 = 1{,}142{,}856$

When multiplied by the numbers 1-6 the digits in the answer are a permutation (that's a fancy word for a scrambled version) of the original number. It might seem like this will always be true, but 7 and 8 are counterexamples of that conjecture.

36. $1 = 1 = 1^2$

$1 + 3 = 4 = 2^2$

$1 + 3 + 5 = 9 = 3^2$

$1 + 3 + 5 + 7 = 16 = 4^2$

So, using inductive reasoning,

$1 + 3 + 5 + 7 + 9 = 25$,

$1 + 3 + 5 + 7 + 9 + 11 = 36$, and

$1 + 3 + 5 + 7 + 9 + 11 + 13 = 49$.

37. By inductive reasoning you can conjecture that the next three sums are $\frac{9}{5}, \frac{11}{6}$, and $\frac{13}{7}$.

38. By inductive reasoning the sum should be $7(8) = 56$. Add: $2 + 4 + 6 + 8 + 10 + 12 + 14 = 56$, so the result is verified.

39. By inductive reasoning you can conjecture that the next three letters are: g e h .

40. By inductive reasoning you can conjecture that the next letters are: j k u .

41. By inductive reasoning you can conjecture that the next letters are: M J J .

42. By inductive reasoning you can conjecture that the next letters are: J J M .

43. Inductive
44. Inductive
45. Deductive
46. Deductive
47. Inductive
48. Inductive
49. Deductive
50. Inductive
51. Deductive
52. Inductive
53. Deductive
54. Inductive
55. Deductive
56. Deductive
57. Deductive
58. Inductive

59. (a) If you use inductive reasoning, you'd be more likely to text while driving. (b) If you use deductive reasoning, you'd be less likely to text while driving.

60. You are using inductive reasoning and your parents are using deductive reasoning. Your parents win on this one, even if you would never actually admit it!

61. (a) The simplest answers are 16 and 32, since each new term is double the previous term. (b) The formula 2^n will give you those numbers if you plug the term number in for *n*. (c) You can get the answers 14 and 22 by checking the differences between the terms. You add 2 from the first term to the second term and 4 from the second term to the third term. If you add 6, you get a fourth term of 14 and then by adding 8 you get a fifth term of 22. (d) Since finding the formula is difficult, it helps to fill out a table. The formula $n^2 - n + 2$ works for each entry in the table.

n	1	2	3	4	5
$n^2 - n + 2$	2	4	8	14	22

If you only have the first few terms of a string of numbers, there may be more than one pattern and formula.

62. (a) The answers could be 81 and 243, since each new term is three times the previous term. (b) The formula 3^n will give you those numbers if you plug the term number in for *n*. (c) You can get the answers 57 and 99 by checking the differences between the terms. You add 6 to get from the first term to the second term and you add 18 to get from the second term to the third term. The difference of the differences is 12, so the next difference should be 18 + 12 = 30. The fourth term is 27 + 30 = 57. The difference from the fourth term to the fifth term is 30 + 12 = 42. The fifth term is 57 + 42 = 99. (d) Since finding the formula is difficult, it helps to fill out a table. The formula $6n^2 - 12n + 9$ works for each entry in the table.

n	1	2	3	4	5
$6n^2 - 12n + 9$	3	9	27	57	99

If you only have the first few terms of a string of numbers, there may be more than one pattern and formula.

63. Answers vary for parts (a) – (c).
64. Answers vary for parts (a) – (c).

65. (a) Answers will vary. One example is a distance of 120 miles. It will take 120 ÷ 20 = 6 hours to travel the distance at 20mph and it will take 120 ÷ 60 = 2 hours to travel back. In total, that is 8 hours of driving for 240 miles, so the average speed is 240 ÷ 8 = 30 mph. After doing a few more numeric examples, you can use inductive reasoning

and conjecture that the average speed is always 30 mph. (b) If the distance is x miles, then the hours to travel at 20 mph is $\frac{x}{20}$. On return, the hours to travel will be $\frac{x}{60}$. The total hours driven is $\frac{x}{20}+\frac{x}{60}$

$$\frac{x}{20}+\frac{x}{60}=\frac{3\cdot x}{3\cdot 20}+\frac{x}{60}$$
$$\frac{3x}{60}+\frac{x}{60}=\frac{4x}{60}$$
$$\frac{4x}{60}=\frac{4\cdot x}{15\cdot 4}$$
$$\frac{\cancel{4}\cdot x}{15\cdot\cancel{4}}=\frac{x}{15}$$

The average speed is the total distance driven divided by the total time.

$$2x\div\frac{x}{15}=\frac{2x}{1}\cdot\frac{15}{x}.$$

$\frac{2\cancel{x}}{1}\bullet\frac{15}{\cancel{x}}=30$, so the average speed is always 30 mph.

66. (a) Answers will vary. One example is a distance of 120 miles. It will take $120\div 40=3$ hours to travel the distance at 40mph and it will take $240\div 20=12$ hours to travel twice the distance after turning around. In total, that is 15 hours of driving for 360 miles, so the average speed is $360\div 15=24$ mph. After doing a few more examples, you can use inductive reasoning and conjecture that the average speed seems to always be 24 mph. (b) If the distance is x miles, then the hours to travel at 40 mph is $\frac{x}{40}$. On return, the hours to travel will be $\frac{2x}{20}$ or $\frac{x}{10}$. The total hours driven is $\frac{x}{40}+\frac{x}{10}$.

$$\frac{x}{40}+\frac{x}{10}=\frac{x}{40}+\frac{4\cdot x}{4\cdot 10}.$$
$$\frac{4x}{40}+\frac{x}{40}=\frac{5x}{40}$$
$$\frac{5x}{40}=\frac{5\cdot x}{5\cdot 8}$$
$$\frac{\cancel{5}\cdot x}{\cancel{5}\cdot 8}=\frac{x}{8}.$$

The average speed is the total distance driven divided by the total time.

$$3x\div\frac{x}{8}=\frac{3x}{1}\cdot\frac{8}{x}.$$

$\frac{3\cancel{x}}{1}\cdot\frac{8}{\cancel{x}}=24$, so the average speed is always 24 mph.

67. This induction is weak because six games is really only a handful of observations.

68. This induction is weak because compared to the total number of air travelers, observing 52 travelers is not going to tell you too much.

69. This induction is strong both because the poll was likely taken scientifically by CNN and because the conclusion uses the phrase "majority of Americans" rather than specifically saying "75% of Americans."

70. This induction is weak because the number of observations is relatively small.

71. This induction is strong, because we all know that there is no such thing as a person who lives in Michigan and cheers for OSU.

72. This induction is weak since it is based on only three observations. Besides, math teachers are not nerdy; we are merely "cool challenged."

73. a) The triangular numbers are 1, 3 = 1+2, 6 = 3 + 3, 10 = 6 + 4, 15 = 10+5, so the next triangular number should be 15 + 6 = 21, then 28 and 36.
b) The square numbers are 1, 4 = 1+ 3, 9 = 4 + 5, 16 = 9 + 7, 25 = 16 + 9, so the next square number should be 25 + 11 = 36, then 49 and 64.
c) The pentagonal numbers are 1, 5 = 1 + 4, 12 = 5 + 7, 22 = 12 + 10, so the next pentagonal number should be 22 + 13 = 35, then 51 and 70.

d) All the types of numbers started at 1. The triangular numbers were formed by adding 2, 3, 4, 5, etc. to the previous number; the square numbers were formed by adding 3, 5, 7, 9, etc to the previous number; the pentagonal numbers were formed by adding 4, 7, 10, 13, etc to the previous number. So by inductive reasoning, the hexagonal numbers should be formed by adding 5, 9, 13, 17, etc. to the previous number. Therefore, the first four hexagonal numbers should be 1, 6, 15, and 28.

74. By inductive reasoning the formula for finding hexagonal numbers should be

$$\frac{n(4n-2)}{2} = n(2n-1).$$

Exercise Set 1-2

1. Answers may vary.

2. Answers may vary.

3. You can use estimation to see if the answer "makes sense."

4. If the next digit is 4 or less then leave the number as it is. If the next digit is 5 or more, then round the digit up.

5. There is no single correct answer because the answer depends on how the numbers were rounded.

6. Trace the top of the bar on a graph to either the horizontal or vertical axis to determine the quantity. The length of a bar on a bar graph may not fall even with an exact tick mark on the axis, so you will need to eyeball the length using the nearest tick mark on the axis and the scale used on the axis.

7. A pie chart shows all of the different categories that an entire quantity can be divided into. The size of a slice in the pie shows how much a category is worth compared to the entire quantity. Pie charts work well when a quantity can be broken into distinct categories, and comparing parts to a whole is helpful.

8. You can tell that a quantity is getting larger over time in a time series graph if the points and lines that connect the points are rising as you read the graph from left to right.

9. If I'm grocery shopping and the only way that I have to pay is a $20 bill, then I'd want to overestimate as I shop to make sure that I'm not left red faced when I check out. If I'm calculating how much my wife just spent on a shopping spree, it is much better to underestimate!

10. A picture paints a thousand words . . . or so they say. If you are looking at a graph, you can spot trends and patterns that are not obvious when you are looking at data in table form.

11. In the number 2,861, the 8 is the digit being rounded. Since the digit to the right is 6, 1 is added to the 8 and the digits 6 and 1 are replaced by zeros. The rounded number is 2,900.

12. In the number 732.6498, the 9 is the digit being rounded. Since the digit to the right is 8, 1 is added to the 9, which means the digit to the left is increased by 1 and the digit 9 is replaced by a zero and the digit 8 is dropped. The rounded number is 732.650.

13. In the number 3,261,437, the 6 is the digit being rounded. Since the digit to the right is 1, the digit 6 remains the same and the digits to the right are replaced by zeros. The rounded number is 3,260,000.

14. In the number 9,347, the 4 is the digit being rounded. Since the digit to the right is 7, 1 is added to the 4 and the 7 is replaced by zero. The rounded number is 9,350.

15. In the number 62.67, the 2 is the digit being rounded. Since the digit to the right is 6, 1 is added to the 2 and the digits to the right are dropped. The rounded number is 63.

16. In the number 45,371,999, the 5 is the digit being rounded. Since the digit to the right is 3, the digit 5 remains the same and the digits to the right are replaced by zeros. The rounded number is 45,000,000.

17. In the number 218,763, the 2 is the digit being rounded. Since the digit to the right is 1, the digit 2 remains the same and the digits to the right are replaced by zeros. The rounded number is 200,000.

18. In the number 923, the 9 is the digit being rounded. Since the digit to the right is 2, the digit 9 remains the same and the digits to the right are replaced by zeros. The rounded number is 900.

19. In the number 3.671, the 7 is the digit being rounded. Since the digit to the right is 1, the digit 7 remains the same and the digit 1 is dropped. The rounded number is 3.67.

20. In the number 56.3, the 6 is the digit being rounded. Since the digit to the right is 3, the digit 6 remains the same and the digit 3 is dropped. The rounded number is 56.

21. In the number 327.146, the 1 is the digit being rounded. Since the digit to the right is 4, the digit 1 remains the same and the digits 4 and 6 are dropped. The rounded number is 327.1.

22. In the number 83,261,000, the 3 is the digit being rounded. Since the digit to the right is 2, the digit 3 remains the same and the digits to the right are replaced by zeros. The rounded number is 83,000,000.

23. In the number 5,462,371, the 6 is the digit being rounded. Since the digit to the right is 2, the digit 6 remains the same and the digits to the right are replaced by zeros. The rounded number is 5,460,000.

24. In the number 7.8662, the second 6 from the left is the digit being rounded. Since the digit to the right is 2, the digit 6 remains the same and the digit 2 is dropped. The rounded number is 7.866.

25. In the number 272,341, the first 2 from the left is the digit being rounded. Since the digit to the right is 7, 1 is added to the 2 and the digits to the right are replaced by zeros. The rounded number is 300,000.

26. In the number 63.715, the 7 is the digit being rounded. Since the digit to the right is 1, the digit 7 remains the same and the digits to the right are dropped. The rounded number is 63.7.

27. In the number 264.97348, the 4 is the digit being rounded. Since the digit to the right is 8, 1 is added to the 4 and the digit 8 is dropped. The rounded number is 264.9735.

28. In the number 1,655,432, the second 5from the left is the digit being rounded. Since the digit to the right is 4, the digit 5 remains the same and the digits to the right are replaced by zeros. The rounded number is 1,655,000.

29. In the number 482.6002, the first 0 is the digit being rounded. Since the digit to the right is 0, the digit 0 remains the same and the digits 0 and 2 are dropped. The rounded number is 563.60.

30. In the number 426.861356, the 5 is the digit being rounded. Since the digit to the right is 6, 1 is added to the 5 and the digit 6 is dropped. The rounded number is 426.86136.

31. Round –4.21 to –4. Round 7.38 to 7 and round 3.51 to 4. The expression using rounding is $-4(7 + 4) = -44$. The exact calculation is –45.8469. The error is 1.8469 and the percent error is 1.8469/45.8469 ≈ 4%.

32. Round 10.24 to 10. Round –8.93 to –9 and 2.77 to 3. The expression using rounding is $10(-9 + 3) = -60$. The exact calculation is –63.0784. The error is 3.0784 and the percent error is 3.0784/63.0784 ≈ 4.9%.

33. Round 9.36 to 9. Round 7.423 to 7 and 9.1 to 9. The expression using rounding is equal to $\frac{\sqrt{9}}{7-9} = -1.5$. The exact calculation is –1.8243. The error is 0.3243 and the percent error is 0.3243/1.8243 ≈ 17.8%.

34. Round 47.256 to 47. Round 9.9 to 10 and 24.501 to 25. The expression using rounding is $\frac{47-10}{\sqrt{25}} = 7.4$. The exact calculation is –7.5469. The error is 0.1469 and the percent error is 0.1469/7.5469 ≈ 1.9%.

35. Round \$16.99 to \$17, so $8 \times 17 =$ \$136 is the estimated cost; overestimate

36. Round \$39.95 to \$40, so $40 \times 5 =$ \$200 is the estimated cost; overestimate

37. Round the distance to 240 miles and the speed to 40 miles per hour. Then $240 \div 40 = 6$, so the estimated time is 6 hours; overestimate

38. Round the time to 3 hours and the speed to 40 miles per hour. Then $3 \times 40 = 120$, so the estimated distance is 120 miles; underestimate

39. Round the cost of the futon to 180. You will pay 40% so multiply $180 \times 0.4 =$ \$72 is the estimated cost of the futon; overestimate

40. Round the cost of the Blu-ray player to \$43. Fifteen percent of 43 is $43 \times 0.15 =$ \$6.45. So the cost of the Blu-ray player is about \$43 – 6.5 = \$36.50; overestimate

41. Round the Quarter Pounder with cheese to \$3, the fries to \$2 and the shake to \$1. The estimated cost of the meal is \$6; overestimate

42. Round the loft bed to \$160, the beanbag chair to \$50, the storage cubes to \$30 and the lava lamp to \$20. The estimated cost of the items is \$260; overestimate

43. Round the prize money to \$1000. Each student will receive about \$1000 / 5 = \$200; overestimate.

44. Round the number of rats to 50 and round the pounds of food to 100. Each rat eats about 100 / 50 = 2 pounds of food per week; overestimate

45. Round \$48,300.00 to \$50,000.00. The person works 40 hours per week times 50 weeks per year or $40 \times 50 = 2000$ hours per year. Thus the person earns about $\$50{,}000 \div 2000 =$ \$25 per hour; overestimate.

46. Round \$8.75 to \$9.00. The person works 40 hours per week times 50 weeks per year or $40 \times 50 = 2000$ hours per year. Then the person earns about $\$9.00 \times 2000 = \$18{,}000$ per year; underestimate

47. Round 24 ft to 25 ft and 18 ft to 20 ft. Round \$5.95 to \$6. There are approximately $25 + 25 + 20 + 20 = 90$ feet at approximately \$6 per 10 feet. The estimated cost is 9×6 or \$54; overestimate.

48. Round the dimensions of the float to 10 feet by 20 feet. The area to be painted is approximately 200 square feet. Round the amount a quart of paint covers to 50 square feet, and the cost of a quart of paint to \$12. Then it will take about four quarts of paint and will cost approximately \$48; underestimate.

49. Five posters on a wall will take up 10 feet and will have 4 gaps in between. That's a total of $10 + (4 \times 5) = 30$ feet. With 2 walls, they will need 10 posters. The approximate total cost for the posters is $5 \times 10 = \$50$.

50. Round \$365.00 to \$360 and \$62.00 to \$60. Then monthly expenses are $\$360 + \$60 = \$420$, so yearly expenses are about $\$420 \times 12 = \$5{,}040$.

51. The number of native English speakers in the world is approximately 350 million.

52. The number of native Chinese speakers in the world is approximately 1.2 billion.

53. The first most common language is Chinese. The fifth most common language is Arabic. The estimated difference is 1.2 billion – 0.2 billion or 1 billion.

54. The number of Native speakers of Chines is 1.2 billion. An estimate for the next four languages is $400 + 300 + 200 + 200 = 1.1$ billion. So, they are very close to being equal.

55. There are 1,385 office workers in the survey. The ones who are most productive outside of normal office hours are the "after office hours" and the "before office hours" people, which is approximately 34%. Multiply $1{,}385 \times 0.34 = 470.9$. Round up to an estimated 471 people who feel they are most productive outside of normal office hours.

56. There are 1,385 office workers in the survey. The percentage that feel most productive "before late morning" are those who are in the "before office hours" and the "first few working hours" categories, which is approximately 56%. So multiply $1{,}385 \times 0.56 = 775.6$. So an estimated 776 workers feel they are more productive before late morning.

57. There are 1,385 office workers in the survey. The percentage that feels most productive "in the first few working hours" is 31%. So, multiply $1{,}385 \times 0.31 = 429.35$, approximately 429. The percentage that feels most productive "in the last few office hours" is 13%. So multiply $1{,}385 \times 0.13 = 180.05$, approximately 180. Since $429 - 180 = 249$, an estimated 249 workers feel more productive in the first few working hours than in the last few working hours.

58. There are 1,385 office workers in the survey. The percentage that feels most productive "before office hours" is 25%. So, multiply $1{,}385 \times 0.25 = 346.25$, approximately 346. The percentage that feels most productive "after office hours" is 9%. So multiply $1{,}385 \times 0.09 = 124.65$, approximately 125. Since $346/125 = 2.768$, approximately 2.8 times more people are most productive before office hours than after office hours.

7. $5(7)(11) = 385$, which is odd.

8. $2(5) + 4(5) + 6(5) = 10 + 20 + 30 = 60$, which does not end in a 5.

9. Approach: Induction

Original number:	2	12
Add 6:	$2+6=8$	$12+6=18$
Divide by 2:	$8\div 2=4$	$18\div 2=9$
Add 10:	$4+10=14$	$9+10=19$
Result:	$14=\frac{1}{2}(2)+13$	$19=\frac{1}{2}(12)+13$

Conjecture: The final answer is 13 more than $\frac{1}{2}$ of the original even number.

Approach: Deduction

Pick a number:	x
Add 6:	$x+6$
Divide by 2:	$\frac{1}{2}(x+6)=\frac{1}{2}x+3$
Add 10:	$\frac{1}{2}x+3+10=\frac{1}{2}x+13$
Result:	$\frac{1}{2}x+13$

The final answer is always 13 more than $\frac{1}{2}$ of the original even number.

10. Approach: Induction

Original number:	5	9
Multiply by 9:	$9(5)=45$	$9(9)=81$
Add 18:	$45+18=63$	$81+18=99$
Divide by 3:	$63\div 3=21$	$99\div 3=33$
Subtract 6:	$21-6=15$	$33-6=27$
Result:	$15=3(5)$	$27=3(9)$

Conjecture: The final answer equals 3 times the original number.

Approach: Deduction

Pick a number:	x
Multiply by 9:	$9x$
Add 18:	$9x+18$
Divide by 3:	$(9x+18)\div 3=3x+6$
Subtract 6:	$3x+6-6=3x$
Result:	$3x$

The final answer is always 3 times the original number.

11. Inductive reasoning suggests the next two equations are:

$337\times 3(4)=337\times 12=4{,}044$

$337\times 3(5)=337\times 15=5{,}055$

12. Inductive reasoning suggests the next two equations are:

$33{,}333\cdot 33{,}333=1{,}111{,}088{,}889$

$333{,}333\cdot 333{,}333=111{,}110{,}888{,}889$

13. Inductive reasoning suggests that $\sqrt{1+3+5+7+9+11+13+15+17}=9$

14. I'll try some numbers for conjecture (a): I pick a few numbers that are divisible by 3: 15, 27 and 81. The squares of these numbers are 225, 729 and 6,561. Since 225, 729, and 6,561 are all divisible by 3, it appears as if conjecture (a) seems to be true. Even though 3 examples doesn't really prove anything for certain, I could stop now since the problem said that one conjecture is true and the other is false. But I'm pretty sure the guy who wrote this problem wants me to find a counter-example to (b) so that I can "prove" that (b) is false and that will prove that (a) is definitely true. $10^2 = 100$, $11^2 = 100$, $12^2 =$. . . wait a minute, I should probably start with the biggest two digit number. $99^2 = 9{,}801$. Since the square of 99 has four digits, conjecture (b) is false and I now know for certain that conjecture (a) is true.

15. Inductive

16. Deductive

17. Deductive

18. Inductive

19. In the number 132,356, the 2 is the digit being rounded. Since the digit to the right is 3, the digit 2 remains the same and the digits to the right are replaced by zeros. The rounded number is 132,000.

20. In the number 186.75, the 6 is the digit being rounded. Since the digit to the right is 7, 1 is added to the 6 and the digits to the right are dropped. The rounded number is 187.

21. In the number 14.63157, the 5 is the digit being rounded. Since the digit to the right is 7, 1 is added to the 5 and the 7 is dropped. The rounded number is 14.6316.

22. In the number 0.6314, the 6 is the digit being rounded. Since i to the right is 3, the digit 6 remains and the digits to the right are dropped. The rounded number is 0.6.

23. In the number 3,725.63, the 2 is the digit being rounded. Since the digit to the right is 5, 1 is added to the 2, the digit 5 to the right is replaced by zero and the digits 3 and 6 are dropped. The rounded number is 3,730.

24. Round the cost of each lawnmower to \$330.00. Then $4 \times \$330.00 = \$1{,}320.00$. The estimated cost of the lawnmowers is \$1,320.

25. Round the costs for the books as follows (for convenience in adding):

\$115.60	→	\$115
\$89.95	→	\$90
\$29.95	→	\$30
\$62.50	→	\$60
\$43.10	→	\$45
		\$340

The books cost an estimated \$340.

26. Round 19.7 miles per gallon to 20 and round 364 gallons of gas to 360. Then the tank will hold approximately $360/20 = 18$ gallons of gas.

27. Round the cost of the tickets for those older than 12 to \$60 and round the cost of the tickets for those 12 and under to \$50. Then the cost for the family will be approximately $4(60) + 2(50) = \$340$.

28. (a) Round the number of credits to 10, then the student's cost will be approximately 689(10) or \$6,890.

(b) Round the student's pay to \$10 per hour, so the student makes about \$300 dollars per week. Round the cost of attending the university for the semester to \$6,900 then divide 6,900 by 300. It will take her approximately 23 weeks to afford one semester.

29. Round the cost of the T-shirts to \$20 and round the cost of the sweatpants to \$17. Since my brain got fried during finals week, I better make an organized list to keep track of all of the possibilities spending as close to \$130 as possible.

T-shirt	6	5	4	3	2	1	0
Pants	0	1	2	4	5	6	7

30. The percentage of people who plan to re-gift is 32% and the percentage of people who plan to sell is 14%. So, a total of 46% are going to use one of these options. 46% of 1000 people are $1000 \times 0.46 = 460$ people.

31. The percentage of people who plan to return the gift is 31%. The percentage of people who plan to donate is 23%. So 8% more people plan to return than donate. 8% of 1000 people is $1000 \times 0.08 = 80$ people.

32. The only people who will keep the gift are the 14% with a conscience who hide it until the gift-giver visits. If only 14% are going to keep it, then 86% are going to get rid of it. 86% of 1000 people ares $1000 \times 0.86 = 860$ people.

33. The total of all of the percentages on the graph is 114%. So, the number of responses given is greater than the number of people who took the survey, meaning that some people gave more than one response.

34. Locate the year 1988 between 1985 and 1990 on the horizontal axis and move up to the line on the graph. At this point, move horizontally to the vertical axis. We estimate that the average weekly salary in 1988 was about $350.

35. Locate $400 on the vertical axis and move left to the point of intersection on the graph. At this point, move vertically down to the horizontal axis. Estimate that the weekly salary went over $400 in 1995.

36. Locate 1970 on the horizontal axis and estimate that the weekly salary was $125. Locate 2010 on the horizontal axis and estimate that the weekly salary was $650. The change in salary is 650 – 110 = $540, and the change in years is 2010 – 1970 = 40 years. So the average rate of change in salary is 540/40 = $13.50 a week per year.

37. The graph looks steeper from the years 2000 to 2010 than it does from the years 1985 to 1995, so I would guess that the average rate of change is greater from 2000 to 2010. From 2000 to 2010, the salary went from about $475 to about $650, so the actual rate of change is about (650 – 475) / 10 = 17.5 or 18 dollars per year. From 1985 to 1995, the salary went from about $300 to about $400, so the actual rate of change is about (400 – 300)/10 = 10 dollars per year.

38. When I did problem 36, I found that the average rate of change per year was $13.50 per week. So, if the weekly salary in 2015 is 809, I would estimate that the weekly salary in 2017 is 809 + 2(13.50) = $836. Answers will vary on internet research.

39. Reread this one to see if it was a trick question. Nope. If she gave away all but nine, she has 9 left.

40. **Step 1** *Understand the problem.* The team played 40 matches, winning some and losing some. The team won 20 more matches than they lost. Find how many matches were lost.

Step 2 *Devise a plan to solve the problem.* The number of matches won plus the number of matches lost equals the total number of matches played. Let x represent the number of matches lost. Use subtraction to solve for x.

Step 3 *Carry out the plan to solve the problem.* If x represents the number of matches lost, then $x + 20$ is the number of matches won and

$$\begin{aligned} x + x + 20 &= 40 \\ 2x + 20 &= 40 \\ 2x &= 20 \\ x &= 10 \end{aligned}$$

The team lost 10 matches.

Step 4 *Check the answer.* The team lost 10 matches and won 10 + 20 = 30 matches. Then the number of matches lost plus the number of matches won equals the total number of matches played: 10 + 30 = 40.

41. Iesha's weight while standing on one foot is not supported by anything else, her weight on the scale does not change when the person steps on the scale with both feet. So the person still weighs 110 pounds.

42. **Step 1** *Understand the problem.* The total cost for the two items is $3.40 and the mocha latte cost $0.40 more than the biscotti. We need to find the cost of each item.

Step 2 *Devise a plan to solve the problem.* We'll let the cost of the biscotti be x, then the cost of the mocha latte is $x + 0.40$. Set the sum of the two equal to $3.40 and solve for x.

Step 3 *Carry out the plan to solve the problem.*

$$x + x + 0.40 = 3.40$$
$$2x + 0.40 = 3.40$$
$$3x = 3.00$$
$$x = 1.50$$

The cost of the biscotti is \$1.50 and the cost of the mocha latte is \$1.90.

Step 4 *Check the answer.* \$1.50 + \$1.90 = \$3.40.

43. If the boards are laid across the width of the deck, you are going to maximize the number of gaps that you leave and that will also minimize the amount of wood used. Each board is going to take up 6 inches, including the gap. With 40 feet of length to span, that is going to require $0.5 \times 40 = 80$ boards. Each board is going to be 10 feet long, so that means the total length of board needed is $80 \times 10 = 800$ feet. Since each board purchased is 12 feet long, the number of boards is 800/12 = 66.67 or 67 boards will be needed to complete the job.

44. **Step 1** *Understand the problem.* Mary has \$80 and spent \$8. She then spent $\frac{1}{3}$ of the remainder on tickets for the dance and we want to know what she had left.

Step 2 *Devise a plan to solve the problem.* Subtract the \$8 she spent on songs, then take $\frac{1}{3}$ of the remainder and subtract that value from the remainder to see what she had left.

Step 3 *Carry out the plan to solve the problem.* $(80 - 8) = 72$, $\frac{1}{3}(72) = 24$, $72 - 24 = 48$. So she had \$48 left.

Step 4 *Check the answer.* $48 + \frac{1}{3}(72) + 8 = 48 + 24 + 8 = 80$.

45. **Step 1** *Understand the problem.* The total for your text and lab packet was \$120. The text cost twice as much as the lab packet. Find how much the lab packet cost.

Step 2 *Devise a plan to solve the problem.* Let x represent the cost of the lab packet, then $2x$ is the cost of the text. Add these values and set them equal to \$120, then solve for x.

Step 3 *Carry out the plan to solve the problem.*

$$x + 2x = 120$$
$$3x = 120$$
$$x = 40$$

The lab packet cost \$40.

Step 4 *Check the answer.* $40 + 2(40) = 40 + 80 = 120$

46. A few possible answers are: $1{,}024 \times 38 = 38{,}912$; $2{,}024 \times 34 = 68{,}816$; $2{,}024 \times 39 = 78{,}936$.

47. **Step 1** *Understand the problem.* We want to find my house's age now, given that 10 years from now it will be five times as old as it was 10 years ago.

Step 2 *Devise a plan to solve the problem.* Make a list of possible combinations of ages for the house and see if a pair satisfies the conditions in the problem.

House's Age Now	House's Age 10 Years Ago	House's Age 10 Years from Now
10	0	20
11	1	21
12	2	22
13	3	23
14	4	24
15	5	25
		↑ correct

Step 3 *Carry out the plan to solve the problem* My house is 15 years old now.

Step 4 *Check the answer.* 10 years ago my house was 15 – 10 = 5 years old. 10 years from now my house will be 15 + 10 = 25 years old, which is five times 5, my house's age 10 years ago.

48. **Step 1** *Understand the problem.* If there are 18 more hours of daylight than hours of darkness, find how many hours of daylight and hours of darkness there are in a 24-hour period.

Step 2 *Devise a plan to solve the problem.* Make a list of possible hours of daylight and darkness where the hours of daylight are 18 more than the hours of darkness. Find the combination that gives a total of 24 hours.

Step 3 *Carry out the plan to solve the problem.*

Hours of Darkness	Hours of Daylight	Total Hours
1	19	20
2	20	22
3	21	24 ← correct

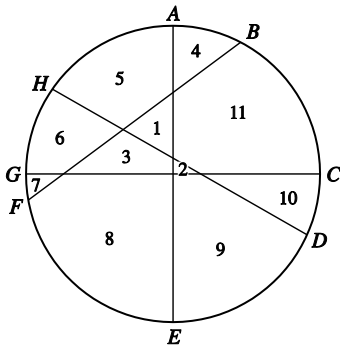
Answer: At times during the summer, Alaska has a 3-hour night and a 21-hour day.

Step 4 *Check the answer.* 3 + 18 = 21; 3 + 21 = 24

49. 2 × 9 + 6 – 7 = 17

50. Joe has done 2 problems and Tina has done 3. Since 2 + 1 = 3 if Joe does one more he'll have done the same numbers Tina; also if Tina does one more she will have done 3 + 1 = 4 which is twice the number Joe has done.

51.



The cuts are *AE*, *BF*, *CG*, and *DH*.

52. There are three sizes of triangles in the figure. There are 9 of the smallest triangles, 3 triangles each made up of 4 of the smallest triangles, and 1 triangle made up of all of the smallest triangles. Thus, there are 9 + 3 + 1 = 13 triangles in the figure.

53. I really doubt that a fly can fly faster than a train, but we will go with it. Since the trains are heading towards each other, they are covering 40 miles of the distance in between them each hour. So, it will take 200/40 = 5 hours before they collide. In that 5 hours, the fly can fly 60 × 5 = 300 miles.

54. **Step 1** *Understand the problem.* Find two numbers that when added equal 120 and when subtracted equal 15.

Step 2 *Devise a plan to solve the problem.* Make a list of number pairs that have a difference of 15. Find the pair with sum 120.

Step 3 *Carry out the plan to solve the problem.*

First Number	Second Number	
40	55	
45	60	
50	65	
51	66	
52.5	67.5	← correct

The numbers are 52.5 and 67.5.

Step 4 *Check the answer.* 52.5 + 67.5 = 120; 67.5 − 52.5 = 15

55. Step 1 *Understand the problem.* The store charges $2.00 a pound for high-protein nature mix, and $2.75 a pound for low-carb soy medley. There are ten pounds total and the cost was $24.50. Find the amount of each type of mix.

Step 2 *Devise a plan to solve the problem.* Make a list of possible amounts of each type of mixture so that the total is 10 pounds then calculate the total cost.

Step 3 *Carry out the plan to solve the problem.*

Nature mix	Soy medley	Total cost	
6	4	$23.00	
5	5	$23.75	
4	6	$24.50	←correct

There are 4 pounds of the nature mix and 6 pounds of the soy medley in the mixture.

Step 4 *Check the answer.* 4(2) + 6(2.75) = 8 + 16.5 = $24.50.

56. Step 1 *Understand the problem.* Taylor invested part of $1,000 in something that earned 8% simple interest and the rest of the $1,000 in something that earned 6% simple interest. After 1 year, he had earned $76.00 in interest. Find the amount invested at each rate.

Step 2 *Devise a plan to solve the problem.* Make a list of possible combinations of investments that add up to $1,000. Find the combination that gives $76.00 in simple interest. Use the fact that simple interest equals the principal times the rate times the length of time.

Step 3 *Carry out the plan to solve the problem*

Amount Invested at 8%	Amount Invested at 6%	Interest Earned on 8% Investment	Interest Earned on 6% Investment
$200	$800	$16	$48
$400	$600	$32	$36
$600	$400	$48	$24
$700	$300	$56	$18
$800	$200	$64	$12← correct

Taylor invested $800 at 8% and $200 at 6%.

Step 4 *Check the answer.*
$800 + $200 = $1,000; ($800)(0.08)(1) + ($200)(0.06)(1) = $64 + $12 = $76.

Chapter Test

* When using estimation, other correct answers are possible.

1. 2 5 4 8 6 11 8

$+3 \quad -1 \quad +4 \quad -2 \quad +5 \quad -3 \quad +6 \quad -4 \quad +7$

The next three numbers are 14, 10, and 17.

2. The states begin with the letters: K, L, M, N, O. When there is more than one state that begins with the letter, it is the one that comes first alphabetically that is listed. The next letter is P; the only state that begins with P is Pennsylvania.

3. Following the pattern started:

$9{,}876 \cdot 9 + 4 = 88{,}888$

$98{,}765 \cdot 9 + 3 = 888{,}888$

$987{,}654 \cdot 9 + 2 = 8{,}888{,}888$

So by inductive reasoning, $9{,}876{,}543 \cdot 9 + 1 = 88{,}888{,}888$

4. By inductive reasoning $6{,}666 \times 6{,}667 = 44{,}442{,}222$

5. Approach: Induction

Original number:	2	7
Add 10:	$2+10=12$	$7+10=17$
Multiply by 5:	$12\times5=60$	$17\times5=85$
Add 15:	$60+15=75$	$85+15=100$
Divide by 5:	$75\div5=15$	$100\div5=20$
Result:	$15=2+13$	$20=7+13$

Conjecture: The final answer equals the original number plus 13.

Approach: Deduction

Pick a number:	x
Add 10:	$x+10$
Multiply by 5:	$5(x+10)=5x+50$
Add 15:	$5x+50+15=5x+65$
Divide by 5:	$(5x+65)\div5=x+13$
Result:	$x+13$

The final answer is equal to the original number plus 13.

6. If all but two changed their minds there were two left in line.

7. **Step 1** *Understand the problem.* The worker earns twice as much as the previous day for a total of 12 days of work. The last day the person earned $204.80. Find which day the workers received $25.00, how much they received on the first day, and the total amount of the bonuses.

Step 2 *Devise a plan to solve the problem.* Since the amount earned on a given day is 2 times the amount earned the previous day, the amount earned the previous day is half the amount earned the given day. Starting with $204.80 for the tenth day, work back in time dividing the day's earnings by 2, until you reach the first day. Use the table to answer all questions.

Step 3 *Carry out the plan to solve the problem.*

Day of Work	Amount Earned
12^{th}	$204.80
11^{th}	$102.40
10^{th}	$51.20
9^{th}	$25.60
8^{th}	$12.80
7^{th}	$6.40
6^{th}	$3.20
5^{th}	$1.60
4^{th}	$0.80
3^{rd}	$0.40
2^{nd}	$0.20
1^{st}	$0.10

Answers: (a) On the ninth day the workers earned about \$25.00. (b) on the 1st day, the workers earned a measly dime – is this guy's name Ebeneezer Scrooge? and (c) by adding up all of the numbers in the second column of the table, the workers earned a total of \$409.50.

Step 4 *Check the answer.* Check the table as well as calculations for accuracy.

8. The letters T, T, F, F, S, S, ... are the first letters of the words Two, Three, Four, Five, Six, Seven, ... so the next two letters are E (for eight) and N (for nine).

9. Move the coin second from the left to the right of the rightmost coin as illustrated. You can also more the upper left coin under the bottom left coin.

10. Since the boat is floating on the water, then length of the ladder above the waterline doesn't change – nine feet of the ladder are above the waterline.

11. Let x represent the age of the man when he died. Then

Boyhood lasted $\frac{1}{6}x$ years

Beard grew at age $\frac{1}{12}x+\frac{1}{6}x$

Married at age $\frac{1}{7}x+\frac{1}{12}x+\frac{1}{6}x$

Son born at man's age $5+\frac{1}{7}x+\frac{1}{12}x+\frac{1}{6}x$

Son died at man's age $\frac{1}{2}x+5+\frac{1}{7}x+\frac{1}{12}x+\frac{1}{6}x$

Man died at age

$$x=4+\frac{1}{2}x+5+\frac{1}{7}x+\frac{1}{12}x+\frac{1}{6}x$$
$$x=\frac{25}{28}x+9$$
$$\frac{3}{28}x=9$$
$$x=84$$

The man was 84 when he died.

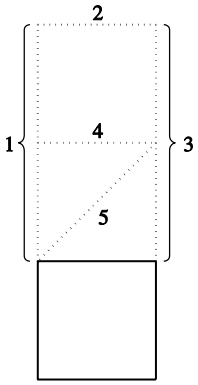
12. Let x represent the number. Then $x\div(x-3)=\frac{8}{5}$. Solve for x: $\frac{x}{x-3}=\frac{8}{5}$

$$x=8$$

13. Let x represent the number. Then $\frac{1}{2}x+\frac{1}{3}x=10$. Solve for x: $\frac{1}{2}x+\frac{1}{3}x=10$

$$\frac{5}{6}x=10$$
$$x=12$$

14. Add five lines where the dotted lines are shown.



15. **Step 1** *Understand the problem.* Two people work for 3 hours and 2 hours, respectively. The total amount earned is \$60.00. Find how much each person earned for the work.

Step 2 *Devise a plan to solve the problem.* The total time spent was 2 + 3 = 5 hours, and the total amount earned was \$60.00. Find the hourly rate by dividing, then find the amount earned by each person by multiplying by the number of hours worked by each person.

Step 3 *Carry out the plan to solve the problem.*

$$\begin{aligned}\text{Hourly rate} &= \$60.00 \div 5 \text{ hours} \\ &= \$12 \text{ per hour}\end{aligned}$$

First person earns $3 \times \$12 = \$36$.

Second person earns $2 \times \$12 = \$24$.

Step 4 *Check the answer.* $\$36 + \$24 = \$60$

16. Let x and y be the two numbers. Then $\frac{1}{x}+\frac{1}{y}=\frac{5}{6}$ and $\frac{1}{x}-\frac{1}{y}=\frac{1}{6}$. Solve for x and y. Use trial-and-error, substituting different numbers for x and y until a solution is found. Let $x = 2$ and $y = 3$. Then $\frac{1}{2}+\frac{1}{3}=\frac{3}{6}+\frac{2}{6}=\frac{5}{6}$ and $\frac{1}{2}-\frac{1}{3}=\frac{3}{6}-\frac{2}{6}=\frac{1}{6}$.

17. **Step 1** *Understand the problem.* Sam has taken 2 exams and scored 72% and 78%. Find the score Sam needs on her third exam to have an average exam score of 80%. If she has an 80% average going into the last exam, what would she need to score to have a final average of between 90% and 92%?

Step 2 *Devise a plan.* Make a list of possible third exam scores. Find the average exam score by adding the three exam scores and dividing by three. Find the third exam score that gives an average of 80%. Repeat the problem with possible fourth exam scores. Find the average exam score by adding the fourth exam scores and dividing by four. Find the fourth exam score that gives at least a 90% average.

Step 3 *Carry out the plan.*

Third Exam	**Average**	
84%	78%	
86%	78.7%	
88%	79.3%	
90%	80%	← correct

Answer: Sam needs a 90% on the third exam.

Fourth Exam	Average	
90%	82.5%	
95%	83.75%	
100%	85%	
120%	90%	← correct

Step 4 *Check the answer.* $72 + 78 + 90 = 340$; $342/3 = 80$. Unless there is some serious extra credit on that exam, there is no way possible for Sam to get an A–.

18. Think of heights and depths above and below sea level as positive distances from a horizontal line. Add the positive distances to find the total distance. 20,300 feet + 280 feet = 20,580 feet. The adventurer would have an average rate of change of 20,580/3 = 6,860 feet per day.

19. Let x be Mark's age. Then Mark's mother is $x + 32$ years old and $x + x + 32 = 66$. Solve for x and find $x + 32$:

$$\begin{aligned}x + x + 32 &= 66 \\ 2x &= 34 \\ x &= 17 \\ x + 32 &= 49\end{aligned}$$

Mark is 17 years old and his mother is 49.

20. In the number 1,674,253, the 6 is the digit being rounded. Since the digit to the right is 7, 1 is added to the 6 and the digits to the right are replaced by zeros. The rounded number is 1,700,000.

21. In the number 1.3752, the 7 is the digit being rounded. Since the digit to the right is 5, 1 is added to the 7 and the digits to the right are dropped. The rounded number is 1.38.

22. Round the blazer to \$70, the tie to \$33 and the pants to \$43. The cost is approximately $70 + 33 + 43 = \$146$.

23. (a) Locate the year 1960 on the horizontal axis and move up to the corresponding point on the graph, then move horizontally to the vertical axis. Estimate is 18%. Locate the year 2000 on the horizontal axis and move up to the corresponding point on the graph, then move horizontally to the vertical axis. Estimate is 42%.

(b) Locate 50% on the vertical axis and move right to the corresponding point on the graph, then move vertically down to the horizontal axis. Estimate the year to be 2003.

(c) Estimate the percentage for 1970 as 16%. Estimate the percentage for 2010 as 64%. The number of years between 1970 and 2010 is 40. The rate of change is $(64 - 16)/40 = 1.2\%$ per year.

24. Since 48.8% live in a residence hall, 51.2% of the students do not live in a residence hall: 51.2% of 3,646 is $3{,}646 \times 0.152 = 1{,}866.752$, so about 1,867 do not live in a residence hall. Since 8.5% live with their parents and 1.3% live in a frat or sorority house, there are 7.2% more students who live with their parents than in a frat or sorority house: $3{,}646 \times .072 = 262.5$, so about 263 students.

25. Baltimore's population is the highest of the three cities. Since the rates are almost the same, this means that Baltimore had the most homicides.

26. Calculate the total number of homicides for each city by using the rate provided on the bar graph and the population provided in the table. For example, Baltimore has 621,849 people which is $621{,}849/100{,}000 = 6.2$ hundred thousand people. If the number of homicides is 34 per 100,000 people, then the total number of homicides is $6.2 \times 34 = 210.8$ or 211.

City	Total Homicides
Baltimore	211
Detroit	232
New Orleans	152
Newark	106
St. Louis	160

Using the table, Detroit had the most homicides and Newark had the least homicides.

27. Since Chicago has 2,833,649 people, they have $2{,}720{,}548/100{,}000 = 27.2$ hundred thousand people. So, to find the number of homicides per hundred thousand people, divide the 509 homicides by 27.2: $509/27.2 = 18.7$. Create a bar on the graph for Chicago which has a bar height close to the 20 on the vertical axis.