LESSON 12-1 Ready to Go On? Skills Intervention
Introduction to Probability

Probability is the measure of how likely an event is to occur.

Vocabulary
probability

Estimating the Likelihood of an Event
Write *impossible, unlikely, as likely as not, likely,* or *certain* to describe each event.

A. you roll an even number on a standard number cube

as likely as not

B. the month of April has only 28 days

impossible

Writing Probabilities

A. The chance of rolling an odd number on a standard number cube is 50%. Write this probability as a decimal and as a fraction.

50% = 0.50 Write 50% as a decimal.

50% = $\frac{50}{100} = \frac{1}{2}$ Write 50% as a fraction in simplest form.

B. The chance of red being chosen as the theme color for the dance is 0.4. Write this probability as a fraction and a percent.

0.4 = $\frac{4}{10} = \frac{2}{5}$ Write 0.4 as a fraction in simplest form.

0.4 = 40% Write 0.4 as a percent.

Comparing Probabilities
If you draw a marble out of a bag, there is a 30% chance of drawing a red marble, a 10% chance of drawing a blue marble, a 40% chance of drawing a green marble, and a 20% chance of drawing a yellow marble. Is it less likely that you will choose a yellow marble or a green marble from the bag?

Compare: 20% < 40%

It is less likely that you will choose a yellow marble than a green marble.

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LESSON 12-1 Ready to Go On? Problem Solving Intervention
Introduction to Probability

You can organize what you know about events to help find and compare probabilities.

Ten cards numbered 1–10 are placed in a bag and mixed up. Without peeking, someone picks a card. Look at the events A–D listed below and order them from most likely to least likely.

A. The number is odd.

B. The number has no curved lines.

C. The number is a factor of 240.

D. The number is a common multiple of 3 and 5.

Understand the Problem

1. If you pick a card, what are the possible numbers you could pick?

1, 2, 3, 4, 5, 6, 7, 8, 9, 10

2. If an event is certain, would you list it first, last, or neither? Explain.

first; *Certain* is the most likely an event can be.

Make a Plan

3. Which of the possible numbers are odd? How does that help you decide how likely event A is?

1, 3, 5, 7, and 9; Sample response: I can compare how many odd numbers there are with how many numbers there are.

4. How might a table like the one below help you solve the problem?

Sample answer: It can help me keep track of the numbers that fit each description and the probabilities.

Solve

5. Make a table of the 4 events. In the last row, write *impossible, likely, as likely as not, unlikely,* or *certain.*

Event	A	B	C	D
Numbers that fit description	1, 3, 5, 7, 9	1, 4, 7	1, 2, 3, 4, 5, 6, 8, 10	none of them
Probability	as likely as not	unlikely	likely	impossible

Check

6. Answer the question in the problem. C, A, B, D

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LESSON 12-2 Ready to Go On? Skills Intervention
Experimental Probability

An **experiment** is an activity involving chance that can have different results. The different results that can occur are called **outcomes** of the experiment.

Vocabulary
experiment
outcome
experimental probability

Identifying Outcomes
For the experiment of spinning a spinner, identify the outcome shown.

outcome shown: solid



The **experimental probability** of an event is the ratio of the number of times the event occurs to the total number of times the experiment is performed.

Finding and Comparing Experimental Probabilities
For one month, Mona recorded the number of students in her class who brought their lunch to school.

A. Find the experimental probability of 6 to 11 students bringing their own lunch to school.

Number of Students	0–5	6–11	12–17
Frequency	6	9	5

$P(6 \text{ to } 11) \approx \frac{\text{number of times the event occurs}}{\text{total number of trials}} = \frac{9}{20}$

B. Based on Mona's experiment, which number of students is most likely to bring their own lunch to school?

Find the experimental probability of each outcome.

$P(0 \text{ to } 5) \approx \frac{\text{number of times the event occurs}}{\text{total number of trials}} = \frac{6}{20}$

$P(6 \text{ to } 11) \approx \frac{\text{number of times the event occurs}}{\text{total number of trials}} = \frac{9}{20}$

$P(12 \text{ to } 17) \approx \frac{\text{number of times the event occurs}}{\text{total number of trials}} = \frac{5}{20}$

$\frac{9}{20} > \frac{6}{20} > \frac{5}{20}$ Compare the probabilities.

It is most likely that between 6 and 11 students will bring their own lunch to school.

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LESSON 12-2 Ready to Go On? Problem Solving Intervention
Experimental Probability

Sometimes you can find probabilities from information displayed in a table.

The table shows the results of quizzes in a math class so far this year. Based on these results, what is the probability that the next quiz score of a randomly chosen student will be greater than 5? Round your answer to a close common fraction.

Score	Number of Students with that Score
0–2	3
3–5	16
6–8	32
9–10	27

Understand the Problem

1. How many of the quiz scores were 6, 7, or 8? 32

Make a Plan

2. Complete with words to show how you will calculate the probability.

$P(\text{greater than } 5) = \frac{\text{number of scores greater than 5}}{\text{total number}}$

Solve

3. How many quiz scores were greater than 5? Explain.

59; 32 in 6–8 range + 27 in 9–10 range

4. How many scores are there in all? 78

5. Use the word equation you wrote in Exercise 2 to find the probability that a randomly chosen student will get a score greater than 5.

$P(\text{greater than } 5) = \frac{59}{78}$

6. Round your answer to a close common fraction.

$\frac{59}{78}$ = about $\frac{60}{80}$, or $\frac{3}{4}$

Check

7. Round the numbers in the table and estimate the probability.

$P = \frac{32 + 27}{3 + 16 + 32 + 27} = \text{about } \frac{30 + 30}{20 + 30 + 30}$

$= \frac{60}{80}$, or $\frac{3}{4}$; It checks.

Solve

8. How do you know the probability of a score of 0 is less than $\frac{1}{25}$?

There were no more than three 0's out of 78 scores.

$\frac{3}{78} < \frac{3}{75}$ which is $\frac{1}{25}$.

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LESSON 12-3

Ready to Go On? Skills Intervention

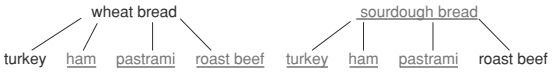
Counting Methods and Sample Spaces

Vocabulary
sample space

Problem Solving Application

A. The school cafeteria is serving sandwiches. Students have two choices of bread, wheat or sourdough. They have four choices for meat, turkey, ham, pastrami, or roast beef. The **sample space** is all the possible outcomes. How many different sandwiches can they choose from?

Fill in the missing information on the tree diagram.



Follow each branch of the tree diagram to find all of the possible outcomes. How many different sandwiches are there in the sample space?

8 sandwiches

B. Patrick can choose from a small, medium, or large pizza. He can also choose pepperoni, sausage, or mushrooms as a topping. How many different pizzas can he choose from?

Fill in the missing information on the tree diagram.



How many different pizza choices are there? 9 pizzas

Making an Organized List

Denny cannot decide in which order to complete his homework. He has homework for math, science, and social studies. How many choices does he have?

Make an organized list to keep track of the choices.

math, science, then social studies

math, social studies, then science

science, math, then social studies

science, social studies, then math

social studies, math, then science

social studies, science, then math

How many choices did you list? 6 choices

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LESSON 12-3

Ready to Go On? Problem Solving Intervention

Counting Methods and Sample Spaces

A code uses rows of 2 or 3 figures. If only 3 shapes are used, will there be enough arrangements to represent 26 letters and 10 digits?

Examples

Understand the Problem

1. Why would square-square-circle count as a different arrangement than circle-square-square?

A different order can be a different letter because it looks different.

Make a Plan

2. Suppose you knew how many 3-figure arrangements start with a square. How could you use that to find how many start with a circle?

It is the same number.

Solve

3. Complete the lists and use them to find how many 2-figure arrangements are possible and how many 3-digit arrangements are possible. Fill in the table.

Arrangements that start with s	
2-figures	3-figures
s–s	s–s–s s–t–s **s–c–s**
s–t	s–s–t s–t–t **s–c–t**
s–c	s–s–c s–t–c **s–c–c**

Arrangements with	Square first	Triangle first	Circle first	Total
2 figures	3	3	3	9
3 figures	9	9	9	27
			Total	36

4. Are there enough arrangements for 26 letters and 10 digits?

Yes, there are 36, which is just enough.

Check

5. Use logical reasoning to check the number of 3-figure arrangements.

3 choices for 1st figure • 3 choices for 2nd figure • 3 choices for 3rd figure = 27 arrangements

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LESSON 12-4

Ready to Go On? Skills Intervention

Theoretical Probability

Vocabulary
theoretical probability
equally likely
fair
complement

Theoretical probability is a way to describe the probability of an event. When all outcomes have the same chance of occurring, the outcomes are **equally likely.** An experiment with equally likely outcomes is called **fair.**

Finding Theoretical Probability

A. What is the probability of rolling a number that is a multiple of 2 on a fair number cube?

There are 6 possible outcomes when rolling a number cube.

Are the outcomes equally likely? Explain.

Yes, because each number on the cube has an equal chance of occurring.

How many ways are there to roll a multiple of 2 on the number cube? 3 ways

$P(\text{multiple of 2}) = \frac{3 \text{ ways event can occur}}{6 \text{ equally likely outcomes}} = \frac{3}{6} = \frac{1}{2}$

B. What is the probability of choosing a pink marble from a bag that contains 3 blue marbles, 1 yellow marble, and 5 pink marbles?

There are 9 possible outcomes when choosing a marble.

Are the outcomes equally likely? yes

How many pink marbles are in the bag? 5

$P(\text{pink}) = \frac{5 \text{ ways event can occur}}{9 \text{ possible outcomes}} = \frac{5}{9}$

The **complement** of an event is the total of the ways the event will not occur.

Finding the Complement of an Event

There is a 15% chance of hail. What is the probability that it will NOT hail?

What are the two possible outcomes?

It will hail or it will not hail.

$P(\text{hail}) + P(\text{not hail}) = 100\%$

$15\% + P(\text{not hail}) = 100\%$ Substitute known values.

$-15\% \quad -15\%$ Solve for $P(\text{not hail})$.

$P(\text{not hail}) = 85\%$

The probability that it will not hail is 85%.

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LESSON 12-4

Ready to Go On? Problem Solving Intervention

Theoretical Probability

To win games, you often think about chance.

Suppose you are Player A in a game of Target-19. You have a sum of 17 so far. Will you have a better chance of winning if you stop or if you roll again? Explain.

Rules for Target-19

1. Player A rolls a 1–6 number cube as many times as she likes and adds the numbers rolled.
2. Player B does the same.
3. The player whose sum is closer to 19 wins.

Understand the Problem

1. If one player ends up with a sum of 17 and the other player has 20, why would the player with 20 win?

20 is closer to 19 than 17.

Make a Plan

2. If you roll again, how is it possible for your sum not to get better and not to get worse?

Sample answer: With a 4, I will have 21, so I will still be 2 away from 19.

3. Why might a table be helpful?

Sample answer: To keep track of all the things that can happen.

Solve

4. Complete the table to organize the possibilities.

Event	Ways It Can Happen
Sum gets closer to 19	1, 2, 3
Sum does not get closer to or further from 19	4
Sum gets further from 19	5, 6

5. Should you stop or roll again? Explain.

Roll again; Sample explanation: Of the 6 possible numbers, 3 of them will improve my score and only 2 will make my score worse.

Check

6. Make sure you looked at each possible roll.

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SECTION 12A

Ready to Go On? Quiz

12-1 Introduction to Probability

Write *impossible, unlikely, as likely as not, likely,* or *certain* to describe the event.

1. You have 1 green, 4 red, and 5 yellow marbles. Without looking, you pick a green marble. — unlikely
2. You roll two fair number cubes. The sum of the the numbers you roll is 1. — impossible
3. Each of the letters needed to spell "mathematics" is written on a tile that is placed in a bag. Eleven tiles are drawn from the bag. The letters on the tiles could be arranged to spell "mathematics." — certain
4. You roll a number greater than 3 on a fair number cube. — as likely as not
5. The scores for Jerry's first four tests are 70, 87, 79, and 91. The score on his next test will be greater than 75. — likely
6. The weather report says that there is a 30% chance of snow between 9 A.M. and noon, a 45% chance of snow between noon and 3 P.M., and a 40% chance of snow between 3 P.M. and 6 P.M. During which three hours is it most likely to snow?

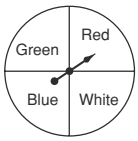
   between noon and 3 P.M.
7. The probability that the traffic signal is green when Mark arrives at the intersection is 0.35. Write this probability as a fraction and as a percent. — $\frac{35}{100} = \frac{7}{20}$, 35%

12-2 Experimental Probability

For each experiment identify the outcome shown.

8. 

heads

9. 

red

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SECTION 12A

Ready to Go On? Quiz continued

10. Carmen recorded the number of times cars made a left turn, went straight, and made a right turn at an intersection between 8 A.M. and 9 A.M. Based on Carmen's data, which direction is the next car arriving at the intersection most likely to go?

Outcome	left	straight	right
Frequency	𝍸 IIII	𝍸 II	𝍸 𝍸 I

right

12-3 Counting Methods and Sample Spaces

11. Serena has three sweaters and three skirts. The sweaters are red (R), orange (O), and yellow (Y). The skirts are black (B), gray (G), and white (W). What are the possible combinations?

    RB, RG, RW, OB, OG, OW, YB, YG, YW
12. The code for a lock consists of three digits. The digits are 0, 1, and 3. A digit may be repeated. How many different codes are possible? — 27

12-4 Theoretical Probability

13. Mrs. Swanson's class has 17 boys and 19 girls. She randomly selects one student to answer a question. What is the probability that she selects a boy? — $\frac{17}{36}$
14. What is the probability of rolling a number greater than 5 on a fair number cube? — $\frac{1}{6}$
15. The probability of a baseball game being postponed because of rain is 0.45. What is the probability of the game not being postponed because of rain? — 0.55

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SECTION 12A

Ready to Go On? Enrichment

Which Is More Likely to Occur?

Jonathan has three red marbles and two blue marbles in a bag. Without looking, he selects a marble and, without replacing the first marble, he selects a second marble. He wants to know if he is more likely to draw a red followed by a blue or a blue followed by a red marble. What do you think? Explain.

Answers will vary. Response should include explanation of prediction.

He decides to conduct an experiment drawing two marbles 50 times.

Red-Blue	Blue-Red
𝍸 𝍸 𝍸 𝍸 𝍸 II	𝍸 𝍸 𝍸 𝍸 III

Conduct the same experiment and record your results.

Red-Blue	Blue-Red

How do the results of your experiment compare to Jonathan's? Answers will vary.

Jonathan's experimental results suggest that red-blue and blue-red may be equally likely. He decides to make a tree diagram to find the theoretical probability of each event occurring. Complete Jonathan's table.



How many times does red-blue occur? — 6 times

How many times does blue-red occur? — 6 times

Which event is more likely to occur? — They are equally likely.

What is the theoretical probability of choosing blue-red? — $\frac{6}{20}$ or $\frac{3}{10}$

Theoretically, if Jonathan performs this experiment 100 times, how many times will he choose a red marble and then a blue one? — 30 times

What is the theoretical probability of choosing two marbles of the same color? — $\frac{8}{20}$ or $\frac{2}{5}$

Is this more or less likely than choosing two different-colored marbles? Why?

less likely; the probability of two different-colored marbles is $\frac{12}{20}$ or $\frac{3}{5}$, which is greater than $\frac{2}{5}$

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LESSON 12-5

Ready to Go On? Skills Intervention

Compound Events

A **compound event** consists of two or more single events.

Vocabulary
compound event

Finding Probabilities of Compound Events

A. Alison flips a fair coin and then spins the spinner. Find the probability of the spinner showing black and the coin showing heads.

First find all of the possible outcomes. Complete the table.



		Spinner		
		W	B	G
Coin	H	W, H	B, H	G, H
	T	W, T	B, T	G, T

How many possible outcomes are there? 6 possible outcomes

Are they all equally likely? yes

How many outcomes have black and heads? 1 outcome

$P(\text{B, H}) = \frac{1 \text{ way event can occur}}{6 \text{ possible outcomes}} = \frac{1}{6}$

B. Brad rolls a fair number cube and then chooses a marble out of a bag that contains one white marble and one black marble. Find the probability of the number cube showing an even number and a white marble being chosen.

First find all of the possible outcomes. Complete the table.

		Number cube					
		1	2	3	4	5	6
Marble	W	1, W	2, W	3, W	4, W	5, W	6, W
	B	1, B	2, B	3, B	4, B	5, B	6, B

How many possible outcomes are there? 12 possible outcomes

Are they all equally likely? yes

How many outcomes have an even number and a white marble? 3 outcomes

$P(\text{even, white}) = \frac{3 \text{ ways event can occur}}{12 \text{ possible outcomes}}$

$= \frac{3}{12} = \frac{1}{4}$ Write your answer in simplest form.

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LESSON 12-5 Ready to Go On? Problem Solving Intervention
Compound Events

Sometimes it is difficult to know which event is more likely without calculating the probabilities.

Suppose a family has 4 children. Which event is more likely?

Event A: having 2 boys and 2 girls

Event B: having 3 of one gender and 1 of the other

Assume that having a boy and having a girl are equally likely events.

Understand the Problem

1. Suppose the children's births were in the order girl-girl-boy-girl. Would that count as Event A or Event B? Event B

Make a Plan

2. Suppose you knew which event could occur in more ways. How would that help you solve the problem?

   Whichever event could occur in more ways would be the more likely event.

3. How can you find out which event can occur in more ways?

   Sample answers: Make a list. Make a tree diagram.

Solve

4. Complete the organized list of ways of having 4 children.

g-g-g-g	g-g-g-b	g-g-b-g	g-g-b-b
g-b-g-g	g-b-g-b	g-b-b-g	g-b-b-b
b-g-g-g	b-g-g-b	b-g-b-g	b-g-b-b
b-b-g-g	b-b-g-b	b-b-b-g	b-b-b-b

Students may complete the list in other ways but should have 16 different arrangements.

5. On your list, circle the arrangements that make Event A occur. Underline the ones that make Event B occur.

6. Which is more likely, Event A or Event B? Explain.

   Event B; There are 8 ways that Event B can occur and only 6 ways that Event A can occur.

Check

7. Check the pattern in your list. Make sure you counted all the ways.

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LESSON 12-6 Ready to Go On? Skills Intervention
Making Predictions

A **prediction** is a guess about something in the future. When you take a survey, the **population** is the whole group being surveyed. You can use a **sample,** or part of the group, to make a prediction.

Vocabulary
prediction
population
sample

Using Sample Surveys to Make Predictions

A sweater store estimates that 60% of the sweaters they sell are large. Out of 650 sweaters sold, how many would you predict are large?

You can write a proportion. Remember that *percent* means "per hundred."

$\frac{60}{100} = \frac{x}{650}$ — *Think:* 60 out of 100 is how many out of 650?

$100 \cdot x = 60 \cdot 650$ — Set the cross products equal.

$100x = 39{,}000$ — Multiply.

$\frac{100x}{100} = \frac{39{,}000}{100}$ — What will you divide both sides by to undo the multiplication?

$x = 390$

You can predict that 390 of 650 sweaters sold will be large.

Using Theoretical Probability to Make Predictions

A box contains 3 red beads, 7 yellow beads, and 4 green beads. You pick a bead from the box, record its color, and put the bead back in the box. If you repeat this process 77 times, how many times do you expect to pick a green bead from the box?

$P(\text{picking a green bead}) = \frac{4}{14} = \frac{2}{7}$

$\frac{2}{7} = \frac{x}{77}$ — *Think:* 2 out of 7 is how many out of 77?

$7 \cdot x = 2 \cdot 77$ — Set the cross products equal.

$7x = 154$ — Multiply.

$\frac{7x}{7} = \frac{154}{7}$ — Divide both sides by 7 to undo the multiplication.

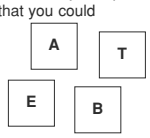
$x = 22$ — Solve for x.

You can expect to pick a green bead from the box about 22 times.

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LESSON 12-6 Ready to Go On? Problem Solving Intervention
Making Predictions

You put these 4 letter tiles in a bag. Without peeking, you take out 3 tiles. If you repeat this 200 times, how many times would you expect to get 3 letters that you could arrange to form a word that is not a person's name?



Understand the Problem

1. Suppose you pick A, E, and T? Would that count as 3 letters that you can form a word with? Explain.

   yes; You could form ATE, EAT, or TEA.

Make a Plan

2. If you knew the probability of picking 3 letters that can form a word, how would you solve the problem?

   Sample responses: Set up and solve a proportion. Multiply probability • 200.

3. How can you find the probability of picking 3 letters that can form a word?

   Sample response: Find the number of 3-letter combinations that can form a word. Divide that by the total number of possible combinations.

Solve

4. List the possible 3-letter combinations. How many are there?

   ABT, BEA, EBT, AET; 4

5. Which 3-letter combinations can be arranged to form a word that is not a person's name?

   ABT can form BAT or TAB, EBT can form BET, and AET can form ATE, EAT, or TEA.

6. What is the probability of picking 3 letters that can form a word? $\frac{3}{4}$

7. If you picked 3 letters 200 times, how many times would you expect to get letters that can form a word? Show your work.

   150 times; $\frac{3}{4} = \frac{x}{200}$, $4x = 600$, $x = 150$

Check

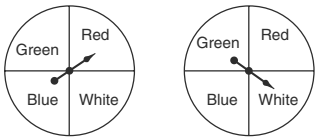
8. Can more than $\frac{1}{2}$ of the combinations form a word? Is your answer more than $\frac{1}{2}$ of 200? yes; yes

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SECTION 12B Ready to Go On? Quiz

12-5 Compound Events

Use the spinners to answer the questions.



1. Rhonda spins the spinner twice. What is the probability that the first spin lands on red and the second spin lands on white? $\frac{1}{16}$

2. Meher spins the spinner twice. What is the probability that the first spin lands on red and the second spin lands on red? $\frac{1}{16}$

3. Eulanda spins the spinner twice. What is the probability that one spin lands on red and the other spin lands on white? $\frac{1}{8}$

4. Roberto spins the spinner twice. What is the probability that one spin lands on red and the other spin lands on a different color? $\frac{7}{16}$

An experiment involves flipping three fair coins.

5. What is the probability that all three coins show heads? $\frac{1}{8}$

6. What is the probability that at least one coin shows heads? $\frac{7}{8}$

7. List the possibilities for flipping three fair coins.

   HHH, TTT, HHT, HTT, HTH, THT, TTH, THH

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SECTION 12B Ready to Go On? Quiz continued

12-6 Making Predictions

8. A sample survey shows 32% of the 6th grade students at Roosevelt Middle School spend at least one hour each evening doing their homework. There are 214 students in the 6th grade. About how many of the 6th grade students spend at least one hour each evening doing their homework?

about 68 students

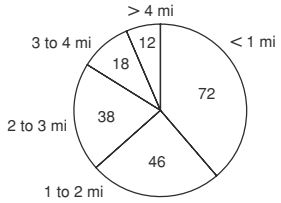
9. A fair number cube is rolled 72 times. How many times can you expect the number rolled to be odd?

36 times

10. An airline ticket agent has established the probability of a ticketed passenger showing up to take his or her seat on a flight is 92%. The airplane has 140 seats. How many seats should the ticket agent sell to be fairly certain that the plane will be filled to capacity for the flight?

152 seats

The graph shows the results of a survey of 186 6th grade students at Madison Middle School when asked how many miles they lived from school.



Miles from School

11. A random group of the 6th grade students includes 22 students who live less than one mile from school. How many 6th grade students would you predict are in the group?

about 57 students

12. In a group of 124 of these 6th grade students, about how many would you expect to live between 2 and 3 miles from school?

about 25 students

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SECTION 12B Ready to Go On? Enrichment

How Many Fish Are in the Pond?

You can determine the approximate number of fish in a pond by using a method known as capture-recapture. A certain number of fish are caught, tagged, and returned to the pond. A few days later, a sample population of fish is caught and the number of tagged fish is counted. The following proportion is used to calculate the approximate number of fish in the pond.

$$\frac{\text{tagged fish in sample}}{\text{number of fish in sample}} = \frac{\text{number of tagged fish}}{\text{number of fish in pond}}$$

Suppose you catch and tag 100 fish and return the fish to the pond. A few days later, you catch 100 fish and 38 of them are tagged. Use the proportion to calculate the approximate number of fish in the pond.

$\frac{38}{100} = \frac{100}{f}$ Set up the proportion.

$100 \times 100 = 38 \times f$ Use cross products.

$\frac{100 \times 100}{38} = f$ Isolate the variable.

$\frac{10{,}000}{38} = f$ Simplify the fraction.

$263.16 \approx f$

There are about 263 fish in the pond.

Use the capture-recapture proportion to determine the approximate number of fish in each of the ponds.

1. You catch and tag 40 fish and release them back into the pond. A few days later, 22 of the 50 fish caught have a tag. About how many fish are in the pond?

There are about 91 fish in the pond.

2. You catch and tag 70 fish and release them back into the pond. A few days later, 43 of the 95 fish caught have a tag. About how many fish are in the pond?

There are about 155 fish in the pond.

3. Simulate this technique by placing an unknown number of dried beans in a jar. Remove a known number of beans and mark them. Shake the jar of beans to disperse the tagged population throughout the jar. Remove a known number of beans and count how many are tagged. Approximate the number of beans in the jar. Count the beans and compare your results.

Answers will vary.

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