9-2 Experimental Probability

CONTENT STANDARDS
7.SP.6, 7.SP.7, 7.SP.7.b

What You'll Learn

To find experimental probability and to use simulations

New Vocabulary experimental probability

Check Skills You'll Need

1. **Vocabulary Review** Explain the difference between an *event* and an *outcome*.

You roll a number cube once. Find each probability.

2. $P(4)$
3. $P(\text{multiple of } 2)$
4. $P(8)$

Why Learn This?

Manufacturers collect data on the quality of their products. They use experimental probability to determine how many defective items they can expect to produce.

Probability based on experimental data or observations is called **experimental probability.**

KEY CONCEPTS Experimental Probability

$$P(\text{event}) = \frac{\text{number of times an event occurs}}{\text{total number of trials}}$$

EXAMPLE 1 Finding Experimental Probability

You attempt 16 free throws in a basketball game. Your results are shown. What is the experimental probability of making a free throw?

Results of Free Throw Attempts

0 = miss				1 = make			
0	0	1	1	1	0	1	0
0	1	0	1	1	0	0	1

$$P(\text{free throw}) = \frac{8}{16} \leftarrow \text{number of throws made} \leftarrow \text{total number of attempted free throws}$$
$$= \frac{1}{2} \leftarrow \text{Simplify.}$$

The experimental probability of making a free throw is $\frac{1}{2}$.

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1 EXAMPLE A player makes 7 free throws out of 12 attempts. Based on this, what is the experimental probability of this player making a free throw?

$$P(\text{free throw}) = \frac{7}{12} \leftarrow \text{number of throws made} \leftarrow \text{total number of attempted free throws}$$

The experimental probability of making a free throw is $\frac{7}{12}$.

EXAMPLE 2 Application: Manufacturing

Multiple Choice A bicycle company checks a random sample of bikes. The results are shown. If the trend continues, which is the best prediction of the number of defective bikes in a batch of 1,300?

Ⓐ 430 bikes Ⓑ 390 bikes Ⓒ 43 bikes Ⓓ 39 bikes

Quality Control Results

Defective Bikes	Bikes Checked
12	400

The experimental probability that a bike is defective is $\frac{12}{400}$, or $\frac{3}{100}$.

Let x represent the predicted number of defective bikes.

$$\frac{\text{defective bikes} \rightarrow 3}{\text{bikes checked} \rightarrow 100} = \frac{x}{1{,}300} \begin{array}{l}\leftarrow \text{defective bikes} \\ \leftarrow \text{bikes checked}\end{array} \quad \leftarrow \text{Write a proportion.}$$

$$3(1{,}300) = 100x \quad \leftarrow \text{Write the cross products.}$$

$$3{,}900 = 100x \quad \leftarrow \text{Simplify.}$$

$$\frac{3{,}900}{100} = \frac{100x}{100} \quad \leftarrow \text{Divide each side by 100.}$$

$$39 = x \quad \leftarrow \text{Simplify.}$$

You can predict that 39 bikes are defective. The correct answer is D.

Test Prep Tip

You can write and solve a proportion using a probability ratio to make a prediction.

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2 EXAMPLE A manufacturer of computer parts checks 100 parts each day. On Monday, two of the checked parts are defective.

a. What is the experimental probability that a part is defective?

$$P(\text{defective part}) = \frac{2}{100} \quad \begin{array}{l}\leftarrow \text{number of defective parts} \\ \leftarrow \text{total number of parts checked}\end{array}$$

$$= \frac{1}{50} \quad \leftarrow \text{Simplify.}$$

The experimental probability is $\frac{1}{50}$.

2 EXAMPLE A manufacturer of computer parts checks 100 parts each day. On Monday, two of the checked parts are defective.

b. Predict the probable number of defective parts in Monday's total production of 1,250 parts.

Let x represent the predicted number of defective parts.

$$\begin{matrix}\text{defective} \longrightarrow \\ \text{total} \longrightarrow\end{matrix} \frac{1}{50} = \frac{x}{1{,}250} \begin{matrix}\longleftarrow \text{defective} \\ \longleftarrow \text{total}\end{matrix} \quad \longleftarrow \text{Write a proportion.}$$

$$1(1{,}250) = 50x \quad \longleftarrow \text{Write the cross products.}$$

$$1{,}250 = 50x \quad \longleftarrow \text{Simplify.}$$

$$\frac{1{,}250}{50} = \frac{50x}{50} \quad \longleftarrow \text{Divide each side by 50.}$$

$$25 = x \quad \longleftarrow \text{Simplify.}$$

You can predict 25 parts out of 1,250 to be defective.

You can simulate, or model, events to find experimental probabilities.

EXAMPLE Simulating an Event

3 Find the experimental probability that 2 of 3 children in a family are girls. Assume that girls and boys are equally likely.

Simulate the problem by tossing three coins. Let "heads" represent a girl and "tails" represent a boy. A sample of 20 coin tosses is shown.

T T H	T T T	H T H	H T T	H T H
T T H	H H T	H T T	T H T	H H H
H H T	T T H	T H H	H T H	T H T
T H T	T H T	T H T	H H H	H H H

$P(\text{two girls}) = \frac{6}{20}$, or $\frac{3}{10}$ ← number of times *two heads* occur / ← total number of tosses

The experimental probability that 2 of 3 children are girls is $\frac{3}{10}$.

3 EXAMPLE It is equally likely that a puppy will be born male or female. Use a simulation to find the experimental probability that, in a litter of four puppies, all four will be male.

Simulate the problem by tossing four coins at the same time. Assume that male and female puppies are equally likely. Let "heads" represent a female and "tails" represent a male.

A sample of 16 tosses is shown

Trial	Male	Female
1	2	2
2	1	3
3	4	0
4	2	2
5	3	1
6	2	2
7	1	3
8	2	2
9	2	2
10	3	1
11	2	2
12	1	3
13	2	2
14	0	4
15	2	2
16	3	1

$P(\text{exactly four males}) = \frac{1}{16}$ ← number of times four tails occur / ← total number of trials

Results will vary, but, according to this simulation, the experimental probability that in a litter of four puppies all four will be male is $\frac{1}{16}$.

Check Your Understanding

1. **Vocabulary** What is the difference between theoretical probability and experimental probability? Explain.

You toss a coin 40 times and get 18 tails. Find each experimental probability.

2. $P(\text{heads}) = \frac{22}{\blacksquare}$

3. $P(\text{tails}) = \frac{\blacksquare}{40}$

4. **Mental Math** In a bird sanctuary, the experimental probability that any bird you see is a robin is about $\frac{1}{8}$. Suppose this trend continues. There are 48 birds. Predict the number of robins you see.

5. You want to find the probability that three out of five babies are boys. You decide to toss coins to simulate the problem. How many coins would you use? Explain.

Name _____ Class _____ Date _____

Practice 9-2

Experimental Probability

Suppose you observe the color of socks worn by students in your class: 12 have white, 4 have black, 3 have blue, and 1 has red. Find each experimental probability as a fraction in simplest form.

1. P(white) _____
2. P(red) _____
3. P(black) _____
4. P(black or red) _____

Use the data in the table at the right for Exercises 5–8. Find each experimental probability as a percent.

5. P(fruit) _____
6. P(granola) _____
7. P(not fruit) _____
8. P(granola or chips) _____

Favorite Snack Survey Results

Snack	Number of Students
Fruit	8
Granola	2
Pretzels	3
Chips	7
Carrots	5

9. Suppose the following is the result of tossing a coin 5 times:
   heads, tails, heads, tails, heads
   What is the experimental probability for heads?
   _____

Solve.

10. The probability that a twelve-year-old has a brother or sister is 25%. Suppose you survey 300 twelve-year-olds. About how many do you think will have a brother or sister? _____

11. **a.** A quality control inspector found flaws in 13 out of 150 sweaters. Find the probability that a sweater has a flaw. Round to the nearest tenth of a percent. _____
    b. Suppose the company produces 500 sweaters a day. How many will not have flaws? _____