Name: _____ Date: _____

MATH

4.1

4.1 Percent Error

When you do scientific experiments that involve measurements, your results may fit the trend that is expected. However, it is unlikely that the numbers will turn out exactly as expected.

In an experiment, you often make a prediction about an event's outcome, but find that your actual measured outcome is slightly different. The percent error (% Error) gives you a means to evaluate how far apart your prediction and measured values are.

Percent error is calculated as the absolute value of the difference between the predicted and measured values divided by the true value multiplied by 100, or:

$$\% \text{ Error } = \frac{|\text{measured value} - \text{predicted value}|}{\text{true value}} \times 100$$

Which value is the true value? That depends on your experiment design. If you want to evaluate how well a graph is able to predict an actual event (like how far a marble will travel or how long a car will take to travel down a ramp) then you use the measured value as the true value.

On the other hand, if you have carefully calculated how much product you should get in a chemical reaction, and you want to evaluate how carefully you made your measurements and followed the procedure, then you would use the predicted value as the true value.

Remember that with percent error, smaller is better. A perfect outcome would have zero percent error.

EXAMPLE

Some students are conducting an experiment using a toy car with a track, timer, and photogates.

Their task is to determine how quickly the car will travel a given distance, and then to predict and test the last trip that the car takes. The table below shows the distances and times traveled by the car so far.

Distance from A to B (cm)	Time from A to B (sec)
10.	0.3305
20.	0.3380
40.	0.3535
50.	0.3610
60.	?

Based on an estimation made by extending their graph, the students predict that it will take the car 0.3685 seconds to travel 60 centimeters. When the experiment was conducted three times, it took the car 0.3669, 0.3680, and 0.3694 seconds to make the trip. Calculate the percent of error based on the predicted and actual outcomes.

Solution:

The process:

1. Average the times recorded in the three 60-centimeter trials to use as the measured value in the formula.
2. Calculate percent error using the formula given above, using the average from (1) as the measured value.

The work:

1. Find the average:

$$\frac{0.3669 + 0.368 + 0.3694}{3} = \frac{1.1043}{3} = 0.3681$$

2. Calculate:

$$\%\ \text{Error} = \frac{\text{measured value} - \text{predicted value}}{\text{true value}} \times 100$$

$$\%\ \text{Error} = \frac{0.3681 - 0.3685}{0.3681} \times 100 = \frac{0.0004}{0.3981} \times 100 \approx 0.11\%$$

The Answer: The percent error in this particular experiment is 0.11%. This means that the student's predicted time was 0.11% off the actual, measured time.

PRACTICE

Use the method shown in the example to calculate the percent error in each of the following problems.

Part I: This table was constructed by a group of students conducting an experiment similar to the one in the example above, but using a different incline. Complete the table using the average time calculated at each distance from the information provided in the problems below.

Distance from A to B (cm)	Time from A to B (sec)
10.	1.0050
20.	1.8877
30.	2.8000
40.	3.7850
50.	?
60.	?
70.	?
80.	?
90.	?

MATH
4.1

1. The lab group conducting this experiment decided to call themselves "the Science Sleuths." They graphed the data shown in the table and based on their graph, predicted that it would take the car 4.7500 seconds to travel 50 centimeters. The three trials they conducted resulted in 4.8020, 4.8100, and 4.7000 seconds. What is the percent error? Remember to update the table.

2. The Sleuths predict that the car will travel 60 centimeters in 5.7950 seconds. Their trials gave times of 5.7702, 5.8000, and 5.2600 seconds. What is the percent error here?

3. For 70 centimeters, the trial runs resulted in 6.9150, 6.8080, and 7.0003 seconds. The Sleuths had predicted that it would take the car 6.8150 seconds to cover the distance. Calculate the percent error.

4. The Sleuths' car took 7.9903, 7.9995, and 7.9047 seconds to travel 80 centimeters. They had predicted a time of 7.9520 seconds. What is the percent error?

5. This time, the Sleuths predicted that it would take the car 9.0000 seconds flat to cover the 90 centimeters it needed to travel. It actually took the car 8.9907, 9.0006, and 9.0507 seconds in each of three trials. Find the percent error.

6. Lisa was trying out for the track team at her middle school. The coach asked her to make predictions about how fast she could run each of the sprint events, then timed her in each event on three different days. All the information is shown in the table below. Calculate Lisa's percent error for her prediction in each event.

Event	Predicted time (s)	Actual times (s)
100 m	18.05	17.55
		18.94
		15.06
200 m	34.70	41.05
		38.22
		35.90
400 m	67.45	72.75
		65.10
		65.88

Calculate the percent error for each event:

a. 100 m

b. 200 m

c. 400 m