Lesson 12

Solving Problems about Percent Increase or Decrease

Goals

Solve word problems leading to equations of the form $px + q = r$ or $p(x + q) = r$.

Learning Targets

I can solve story problems about percent increase or decrease by drawing and reasoning about a tape diagram or by writing and solving an equation.

Lesson Narrative

This lesson is an opportunity for students to revisit percentages of and percentage change to solve word problems. Minimal scaffolding is provided, so students will need to make sense of the problems and perhaps attempt different solution pathways. Now, they can choose to use their deeper understanding of tape diagrams and writing and solving equations.

Student Learning Goal

Let's use tape diagrams, equations, and reasoning to solve problems with negatives and percents.

Access for Students with Diverse Abilities

- Action and Expression (Activity 1)
- Representation (Activity 2)

Access for Multilingual Learners

- MLR8 (Activity 1)
- Three Reads (Activity 2)

Instructional Routines

- MLR6: Three Reads
- MLR8: Discussion Supports

Required Materials

Materials to Gather

- Sticky notes: Activity 2
- Tools for creating a visual display: Activity 2

Required Preparation

Lesson:

- Decide if students will conduct group presentations or a Gallery Walk for the last activity. If so, prepare tools for creating a visual display and about 3 sticky notes per student. If not, these materials are not necessary.

Lesson Timeline

Warm-up	Activity 1	Activity 2	Lesson Synthesis	Assessment: Cool-down
10 min	10 min	15 min	10 min	5 min

Warm-up

20% Off

10 min

Activity Narrative

In this *Warm-up*, students identify expressions that are equivalent to applying a 20% discount on an x-dollar purchase. Analyzing the structure of equivalent expressions for the same situation helps students see how the quantities in it are related.

Launch

Arrange students in groups of 2.

Give students 1 minute of quiet work time followed by 2 minutes to compare their responses with their partner.

During the partner discussion, tell students to discuss the expressions they have in common and ones they don't, and then try to come to an agreement on the correct expressions that represent the price of the item after the discount. Follow with a whole-class discussion.

Student Task Statement

An item costs x dollars and then a 20% discount is applied. Select **all** the expressions that could represent the price of the item after the discount.

A. $\frac{20}{100}x$

B. $x - \frac{20}{100}x$

C. $(1 - 0.20)x$

D. $\frac{100 - 20}{100}x$

E. $0.80x$

F. $(100 - 20)x$

Expressions 2, 3, 4, and 5 represent the price of the item after the discount is applied.

Activity Synthesis

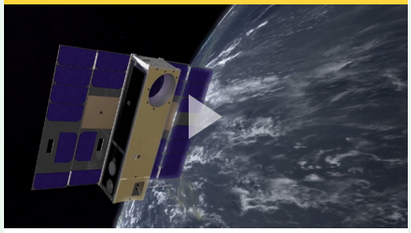
The purpose of this discussion is to review how to solve for percentage change and represent these situations with expressions.

Possible discussion questions:

- *"For each expression, does it represent the price after the discount? How do you know?"*
- *"What connections do you see between the equivalent expressions?"*
- *"Which expression feels like the most natural way to represent the price of an item discounted by 20%?"*
- *"Which expression feels easiest to work with?"*

Inspire Math

CubeSats video



Go Online
Before the lesson, show this video to reinforce the real-world connection.

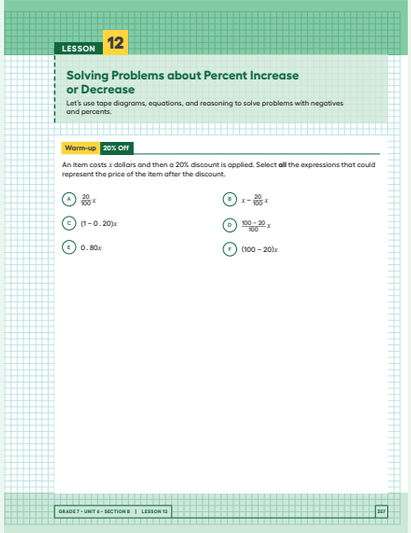
ilclass.com/l/614215

Please log in to the site before using the QR code or URL.

Building on Student Thinking

Some students may choose expressions that represent the discount itself instead of the price of the item after the discount is applied. Ask those students to refer back to the situation to identify which part of the problem the expression they chose represents. If students are still unclear, it may be helpful to give students a price for x such as $10 and ask them if 20% of $10 makes sense as the new price of the item after the discount and then what part of the problem they found.

Student Workbook


LESSON 12

Solving Problems about Percent Increase or Decrease

Let's use tape diagrams, equations, and reasoning to solve problems with negatives and percents.

Warm-up 20% Off

An item costs x dollars and then a 20% discount is applied. Select **all** the expressions that could represent the price of the item after the discount.

A $\frac{20}{100}x$

B $x - \frac{20}{100}x$

C $(1 - 0.20)x$

D $\frac{100 - 20}{100}x$

E $0.80x$

F $(100 - 20)x$

Instructional Routines

MLR8: Discussion Supports

ilclass.com/r/10695617

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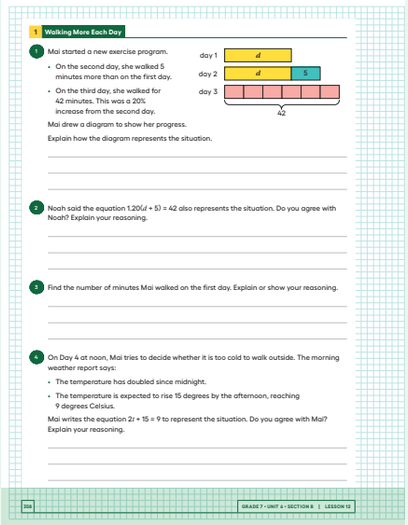
Access for Students with Diverse Abilities (Activity 1, Task Statement)

Action and Expression: Internalize Executive Functions.
To support development of organizational skills in problem-solving, chunk this task into more manageable parts. For example, break the first question into three parts and ask how the tape diagram represents the situation and how it relates to the previous tape diagram.
Supports accessibility for: Organization, Attention

Building on Student Thinking

If students bring up that the diagram represents 120% or $\frac{6}{5}$, or if they refer to each equal part as 20% or $\frac{1}{5}$, ask what whole the fraction or percent refers to. They should understand that the whole is the amount from Day 2, $d + 5$.

Student Workbook


1 Walking More Each Day

1. Mai started a new exercise program.
   - On the second day, she walked 5 minutes more than on the first day.
   - On the third day, she walked for 42 minutes. This was a 20% increase from the second day.

   Mai drew a diagram to show her progress.

   day 1 d
   day 2 d 5
   day 3
   42

   Explain how the diagram represents the situation.

2. Noah said the equation $1.20(d + 5) = 42$ also represents the situation. Do you agree with Noah? Explain your reasoning.

3. Find the number of minutes Mai walked on the first day. Explain or show your reasoning.

4. On Day 4 at noon, Mai tries to decide whether it is too cold to walk outside. The morning weather report says:
   - The temperature has doubled since midnight.
   - The temperature is expected to rise 15 degrees by the afternoon, reaching 9 degrees Celsius.

   Mai writes the equation $2t + 15 = 9$ to represent the situation. Do you agree with Mai? Explain your reasoning.

Activity 1

Walking More Each Day

10 min

Activity Narrative

In this activity, students interpret a sequence of tape diagrams and an equation that represents a percentage increase situation.

The last question is review of previous work in this unit. This fourth question can be used for additional practice, but it can be safely skipped if time is short.

The focus of this task is critiquing the work presented and explaining their reasoning, so students are critiquing the reasoning of others.

Launch

Keep students in the same groups. Tell students to work on the first three questions and pause for discussion.

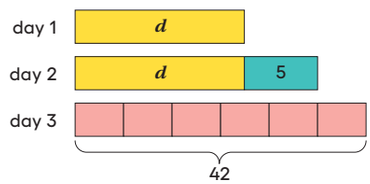
Give 5 minutes of quiet work time and time to share their responses with a partner, followed by a whole-class discussion. If time permits, the last question can be used as more practice on work from earlier in the unit.

Student Task Statement

1. Mai started a new exercise program.

- On the second day, she walked 5 minutes more than on the first day.
- On the third day, she walked for 42 minutes. This was a 20% increase from the second day.

Mai drew a diagram to show her progress.



Explain how the diagram represents the situation.

Sample response: The minutes she walked on Day 1 is unknown, d. Day 2 is 5 more minutes than Day 1. Day 3 is Day 2 plus $\frac{1}{5}$ (20%) of Day 2.

2. Noah said the equation $1.20(d + 5) = 42$ also represents the situation. Do you agree with Noah? Explain your reasoning.

Sample responses: Yes, Mai walked 42 minutes on Day 3, which is the same as (equal to) 20% more than (1.20 times) 5 more than Day 1 ($d + 5$). No, I wrote the equation $\frac{6}{5}(d + 5) = 42$ because the diagram shows that 42 is $\frac{1}{5}$ more than $d + 5$.

3. Find the number of minutes Mai walked on the first day. Explain or show your reasoning.

30 minutes Sample responses:

- From the diagram, $42 \div 6 = 7$, $7 \cdot 5 = 35$, $35 - 5 = 30$
- From the equation, $1.2(d + 5) = 42$, $d + 5 = 42 \div 1.2$, $d + 5 = 35$, $d = 30$
- From another version of the equation: $\frac{6}{5}(d + 5) = 42$, $d + 5 = \frac{5}{6} \cdot 42$, $d + 5 = 35$, $d = 30$

4. On Day 4 at noon, Mai tries to decide whether it is too cold to walk outside. The morning weather report says:

- The temperature has doubled since midnight.
- The temperature is expected to rise 15 degrees by the afternoon, reaching 9 degrees Celsius.

Mai writes the equation $2t + 15 = 9$ to represent the situation. Do you agree with Mai? Explain your reasoning.

Sample response: No, the equation would be $2t + 15 = 9$ (or equivalent).

5. Find what the temperature was at midnight. Explain or show your reasoning.

-3 degrees Celsius

Sample reasoning: Subtract 15 from 9 to get -6 and divide by 2 to get -3.

Activity Synthesis

The purpose of this discussion is to ensure students understand strategies for representing a percentage increase situation. Select groups with different approaches to share their responses to the first three questions.

Possible discussion questions:

- *"How can you tell the Day 3 diagram is 20% longer than the Day 2 diagram?"*
- *"What are some different equations that represent the same relationship?"*
- *"To find the minutes walked on the first day, do you prefer reasoning about the diagram, the equation, or another method?"*

Activity 2

A Sale on Shoes

15 min

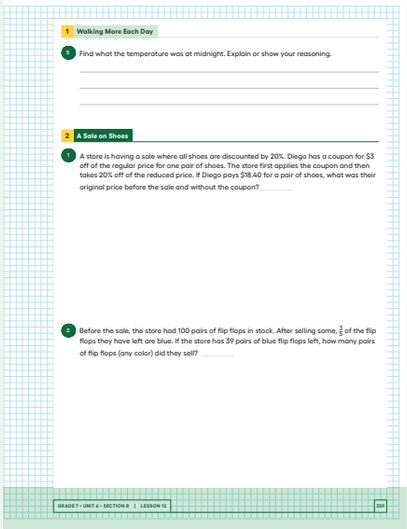
Activity Narrative

In this activity, students solve one or more word problems, using strategies of their choice. Depending on time constraints, you may have all students complete all four problems or assign a different problem to each group. The problems increase in difficulty. It is suggested that students create a visual display of one of the problems and do a Gallery Walk or presentation, but if time is short, you may choose to just have students work in their workbooks or devices.

Since these problems are unscaffolded, students make sense of the problems and persevere in problem solving.

This activity uses the *Three Reads* math language routine to advance reading and representing as students make sense of what is happening in the text.

Student Workbook


1 Walking More Each Day

3 Find what the temperature was at midnight. Explain or show your reasoning.

2 A Sale on Shoes

1 A store is having a sale where all shoes are discounted by 20%. Diego has a coupon for $3 off of the regular price for one pair of shoes. The store first applies the coupon and then takes 20% off of the reduced price. If Diego pays $18.40 for a pair of shoes, what was their original price before the sale and without the coupon?

2 Before the sale, the store had 100 pairs of flip flops in stock. After selling some, $\frac{2}{5}$ of the flip flops they have left are blue. If the store has 39 pairs of blue flip flops left, how many pairs of flip flops (any color) did they sell?

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Access for Multilingual Learners (Activity 2, Synthesis)

MLR8: Discussion Supports. Provide students with the opportunity to rehearse what they will say with a partner before they share with the whole class.

Advances: Speaking.

Instructional Routines

MLR6: Three Reads

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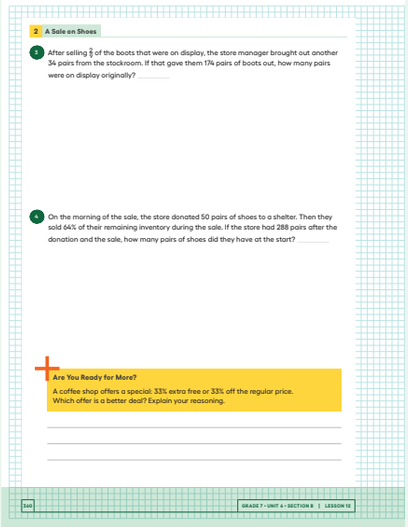
Access for Students with Diverse Abilities (Activity 2, Task Statement)

Representation: Internalize Comprehension.
Represent the same information through different modalities by using diagrams, equations, or other drawings to depict the situation. If students are unsure where to begin, suggest that they draw a diagram to help organize the information provided.

Supports accessibility for: Conceptual Processing, Visual-Spatial Processing

Student Workbook


2 A Sale on Shoes

3 After selling $\frac{2}{9}$ of the boots that were on display, the store manager brought out another 34 pairs from the stockroom. If that gave them 174 pairs of boots out, how many pairs were on display originally?

4 On the morning of the sale, the store donated 50 pairs of shoes to a shelter. Then they sold 64% of their remaining inventory during the sale. If the store had 288 pairs after the donation and the sale, how many pairs of shoes did they have at the start?

Are You Ready for More?
A coffee shop offers a special: 33% extra free or 33% off the regular price. Which offer is a better deal? Explain your reasoning.

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Launch

Keep students in the same groups. Either instruct students to complete all four problems or assign one problem to each group. If opting to have students do presentations or a Gallery Walk, distribute tools for making a visual display.

Use *Three Reads* to support reading comprehension and sense-making about this problem. Display only the first problem, and only the first three sentences, without revealing the question.

For the first read, read the problem aloud then ask,

"What is this situation about?"

Buying shoes with a discount and a coupon.

Listen for and clarify any questions about the context.

After the second read, ask students to list any quantities that can be counted or measured.

(The amount of the discount, the amount of the coupon.)

After the third read, reveal the question:

"If Diego pays $18.40 for a pair of shoes, what was their original price before the sale and without the coupon?"

and ask,

"What are some ways we might get started on this?"

Invite students to name some possible starting points, referencing quantities from the second read.

(We could draw a tape diagram, we could assign a variable to the original price.)

Student Task Statement

1. A store is having a sale where all shoes are discounted by 20%. Diego has a coupon for $3 off of the regular price for one pair of shoes. The store first applies the coupon and then takes 20% off of the reduced price. If Diego pays $18.40 for a pair of shoes, what was their original price before the sale and without the coupon?

   $26 Sample response: The equation $0.8(x - 3) = 18.40$ shows that Diego paid 80% (0.8) of the original price x less the $3 coupon $(x - 3)$, which came to a discounted price of $18.40.

2. Before the sale, the store had 100 pairs of flip flops in stock. After selling some, $\frac{3}{5}$ of the flip flops they have left are blue. If the store has 39 pairs of blue flip flops left, how many pairs of flip flops (any color) did they sell?

   35 pairs of flip flops Sample reasoning: $\frac{3}{5}(100 - x) = 39$, $x = 35$.

3. After selling $\frac{2}{9}$ of the boots that were on display, the store manager brought out another 34 pairs from the stockroom. If that gave them 174 pairs of boots out, how many pairs were on display originally?

   180 pairs of boots Sample reasoning: $\frac{7}{9}x + 34 = 174$, $x = 180$.

4. On the morning of the sale, the store donated 50 pairs of shoes to a shelter. Then they sold 64% of their remaining inventory during the sale. If the store had 288 pairs after the donation and the sale, how many pairs of shoes did they have at the start?

   850 pairs of shoes Sample reasoning: $0.36(x - 50) = 288$, $x = 850$.

Are You Ready for More?

A coffee shop offers a special: 33% extra free or 33% off the regular price. Which offer is a better deal? Explain your reasoning.

Answers vary.

Sample response: 33% off the price is a better deal. Suppose you buy 1 cup of coffee at price p. 33% off means you pay $0.67p$ for 1 cup. 33% extra free means you pay p for 1.33 cups of coffee, or $\frac{p}{1.33}$ for 1 cup, which is about $0.75p$. The unit price for 1 cup of coffee is less with 33% off the price than with 33% extra free.

Activity Synthesis

The purpose of this discussion is to compare and contrast different solution methods.

If students created a visual display and you opt to conduct a Gallery Walk, ask students to post their solutions. Distribute sticky notes and ask students to read others' solutions, using the sticky notes to leave questions or comments. Give students a moment to review any questions or comments left on their displays.

Invite any students who chose to draw a diagram to share. Ask the class if they agree or disagree with each diagram and encourage them to suggest any revisions. Next, invite students who did not try to draw a diagram to share strategies. Ask students about any difficulties they had creating the expressions or equations. Highlight equivalent expressions that represent the same quantity and different strategies for solving equations.

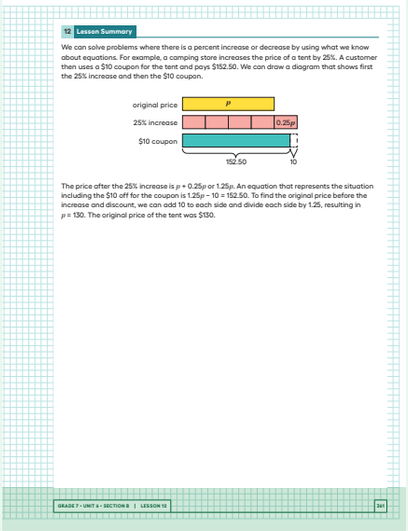
Lesson Synthesis

Ask students to reflect on the work done in this unit so far. Ask:

- *"What strategies have you learned?"*
- *"What kinds of problems can you solve that you weren't able to, previously?"*

Ask students to record or share with a partner one new thing they have learned and one thing they still have questions or confusion about.

Student Workbook


12 Lesson Summary

We can solve problems where there is a percent increase or decrease by using what we know about equations. For example, a camping store increases the price of a tent by 25%. A customer then uses a $10 coupon for the tent and pays $152.50. We can draw a diagram that shows first the 25% increase and then the $10 coupon.

The price after the 25% increase is $p + 0.25p$ or $1.25p$. An equation that represents the situation including the $10 off for the coupon is $1.25p - 10 = 152.50$. To find the original price before the increase and discount, we can add 10 to each side and divide each side by 1.25, resulting in $p = 130$. The original price of the tent was $130.

Responding To Student Thinking

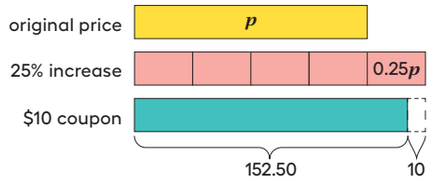
Press Pause

By this point in the unit, students should have some mastery of interpreting problems and solving equations involving variables and fractional amounts. If most students struggle, make time to revisit related work in the lessons referred to here. See the Course Guide for ideas to help students re-engage with earlier work.

Grade 7, Unit 6, Lesson 11 Using Equations to Solve Problems Grade 7, Unit 6, Lesson 12 Solving Problems about Percent Increase or Decrease

Lesson Summary

We can solve problems where there is a percent increase or decrease by using what we know about equations. For example, a camping store increases the price of a tent by 25%. A customer then uses a $10 coupon for the tent and pays $152.50. We can draw a diagram that shows first the 25% increase and then the $10 coupon.



The price after the 25% increase is $p + 0.25p$ or $1.25p$. An equation that represents the situation including the $10 off for the coupon is $1.25p - 10 = 152.50$. To find the original price before the increase and discount, we can add 10 to each side and divide each side by 1.25, resulting in $p = 130$. The original price of the tent was $130.

Cool-down

Timing the Relay Race

5 min

Student Task Statement

The track team is trying to reduce their time for a relay race. First, they reduce their time by 2.1 minutes. Then they are able to reduce that time by $\frac{1}{10}$. If their final time is 3.96 minutes, what was their beginning time? Show or explain your reasoning.

6.5 minutes

Sample reasoning:

- With equation: $0.9(x - 2.1) = 3.96$, $x - 2.1 = 4.4$, $x = 6.5$
- Reasoning with or without a diagram: 9 out of 10 parts represent 3.96 minutes, so the $\frac{1}{10}$ reduction was $3.96 \div 9$ or 0.44 minutes. That makes the time before the 2.1 minute reduction $3.96 + 0.44$ or 4.4 minutes. The original time was $4.4 + 2.1$, or 6.5 minutes.

Lesson 12

Practice Problems

6 Problems

Problem 1

from Unit 4, Lesson 12

A backpack normally costs $25 but it is on sale for $21. What percentage is the discount?

16%

Problem 2

from Unit 5, Lesson 9

Find each product.

a. $\frac{2}{5} \cdot (-10)$

-4

b. $-8 \cdot \left(\frac{-3}{2}\right)$

12

c. $\frac{10}{6} \cdot 0.6$

1

d. $\left(\frac{-100}{37}\right) \cdot (-0.37)$

1

Problem 3

Select **all** expressions that show x increased by 35%.

A. $1.35x$

B. $\frac{35}{100}x$

C. $x + \frac{35}{100}x$

D. $(1 + 0.35)x$

E. $\frac{100 + 35}{100}x$

F. $(100 + 35)x$

Problem 4

from Unit 4, Lesson 11

Complete each sentence with the word *discount*, *deposit*, or *withdrawal*.

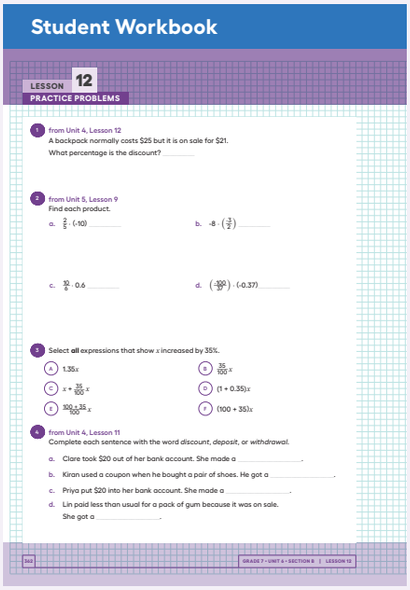
a. Clare took $20 out of her bank account. She made a withdrawal.

b. Kiran used a coupon when he bought a pair of shoes. He got a discount.

c. Priya put $20 into her bank account. She made a deposit.

d. Lin paid less than usual for a pack of gum because it was on sale. She got a discount.

Student Workbook


LESSON 12
PRACTICE PROBLEMS

1 from Unit 4, Lesson 12
A backpack normally costs $25 but it is on sale for $21.
What percentage is the discount? _____

2 from Unit 5, Lesson 9
Find each product.
a. $\frac{2}{5} \cdot (-10)$ _____
b. $-8 \cdot \left(\frac{-3}{2}\right)$ _____
c. $\frac{10}{6} \cdot 0.6$ _____
d. $\left(\frac{-100}{37}\right) \cdot (-0.37)$ _____

3 Select **all** expressions that show x increased by 35%.
A $1.35x$
B $\frac{35}{100}x$
C $x + \frac{35}{100}x$
D $(1 + 0.35)x$
E $\frac{100 + 35}{100}x$
F $(100 + 35)x$

4 from Unit 4, Lesson 11
Complete each sentence with the word *discount*, *deposit*, or *withdrawal*.
a. Clare took $20 out of her bank account. She made a _____.
b. Kiran used a coupon when he bought a pair of shoes. He got a _____.
c. Priya put $20 into her bank account. She made a _____.
d. Lin paid less than usual for a pack of gum because it was on sale. She got a _____.

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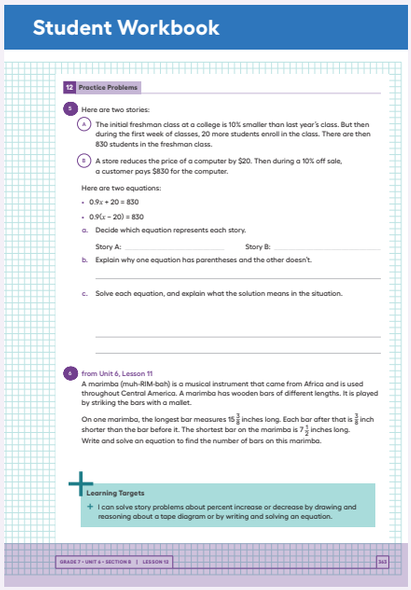
Student Workbook

12 Practice Problems

5 Here are two stories:

A The initial freshman class at a college is 10% smaller than last year's class. But then during the first week of classes, 20 more students enroll in the class. There are then 830 students in the freshman class.

B A store reduces the price of a computer by $20. Then during a 10% off sale, a customer pays $830 for the computer.

Here are two equations:

- $0.9x + 20 = 830$
- $0.9(x - 20) = 830$

a. Decide which equation represents each story.

Story A: _____ Story B: _____

b. Explain why one equation has parentheses and the other doesn't.

c. Solve each equation, and explain what the solution means in the situation.

6 from Unit 6, Lesson 11

A marimba (muh-RIM-bah) is a musical instrument that came from Africa and is used throughout Central America. A marimba has wooden bars of different lengths. It is played by striking the bars with a mallet.

On one marimba, the longest bar measures $15\frac{3}{8}$ inches long. Each bar after that is $\frac{3}{8}$ inch shorter than the bar before it. The shortest bar on the marimba is $7\frac{1}{2}$ inches long. Write and solve an equation to find the number of bars on this marimba.

Learning Targets

+ I can solve story problems about percent increase or decrease by drawing and reasoning about a tape diagram or by writing and solving an equation.

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Problem 5

Here are two stories:

A. The initial freshman class at a college is 10% smaller than last year's class. But then during the first week of classes, 20 more students enroll in the class. There are then 830 students in the freshman class.

B. A store reduces the price of a computer by $20. Then during a 10% off sale, a customer pays $830 for the computer.

Here are two equations:

$0.9x + 20 = 830$

$0.9(x - 20) = 830$

a. Decide which equation represents each story.

Story A: college class: $0.9x + 20 = 830$, Story B:computer: $0.9(x - 20) = 830$

b. Explain why one equation has parentheses and the other doesn't.

Sample response: It depends on the order of events in the story. In the college story, the 20 is added after the percent decrease, so no parentheses are needed—the percent does not apply to the 20. In the computer story, the 20 is subtracted before the percent decrease, so parentheses are needed to show the percent applies to that 20.

c. Solve each equation, and explain what the solution means in the situation.

college class: $x = 900$, which is the size of last year's freshman class, computer: $x = 942.22$ (rounding to the nearest cent), which is the original price of the computer

Problem 6

from Unit 6, Lesson 11

A marimba (muh-RIM-bah) is a musical instrument that came from Africa and is used throughout Central America. A marimba has wooden bars of different lengths. It is played by striking the bars with a mallet.

On one marimba, the longest bar measures $15\frac{3}{8}$ inches long. Each bar after that is $\frac{3}{8}$ inch shorter than the bar before it. The shortest bar on the marimba is $7\frac{1}{2}$ inches long. Write and solve an equation to find the number of bars on this marimba.

$15\frac{3}{8} - \frac{3}{8}x = 7\frac{1}{2}$ (or equivalent); $x = 21$, so including the first bar, there are 22 bars on this marimba.