Section 10

Mixture

In Mixture Problems, there are two substances that are the same item but with different strengths. Varying amounts of these two substances are mixed together to form a final mixture of the same substance with still another strength.

For example, if you mixed 1cup of chocolate milk that was 23% Hershey's syrup with 2 cups of chocolate milk that was 8% Hershey's syrup, you would have a final mixture in the amount of 3 cups of chocolate milk that was 13% Hershey's syrup.

10.1 Explaining Mixture Problems

In mixture problems, the strength of the substances are given as percentages. All three percentages of the substances are always given--the percents of the two substances mixed together and the percent of the final mixture.

What you will be solving for in the problem is one or more amounts of the substances you mix together in order to obtain the desired percentage of the final mixture.

One of the three substance amounts is always given. It may be the amount of one of the substances that will be mixed together, or it may be the total amount of the final mixture.

HELPFUL HINT

- When the percent for a substance is not given, it will state in the problem that the substances is pure. That means that it is 100% of that substance and not diluted in any way. In that event, you use 100% as the percentage for that substance.

10.2 Determining Correct Substance

- It is EXTREMELY important to match the percent of each substance with its corresponding amount. The key word to look for is "of". The amount stated *before* the word "of" connects to the percent given *after* the word "of".

- For example, in the statement "A pharmacist has **2 liters** ***of*** a solution containing **30%** alcohol", the word "of" connects the amount "2 liters" with "30%". Therefore, you know that information belongs to the same substance. In this particular case, you have been given both the percent and the amount of the substance.

- Another example is the statement "**How many** cubic centimeters ***of*** a **25%** antibiotic solution", the phrase "how many" (which has to do with amount) connects the word "of" with 25%. Therefore, you know this information belongs to the same substance. In this example, you have the percent, but the amount is unknown and will need an expression.

- To determine which of the substances is the Final Mixture, you need to look for information that follows such phrases as "**to get, to obtain, to have, to make**" and others phrases that have the same type of meaning.

  The information that is stated after such a phrase is the information that you will be given about the final mixture. You will always be given a percent for the final mixture. The *amount* of the final mixture may or may not be given.

10.3 How To Express The Amounts

Before you can begin to solve the problem, you need to determine the amount of each substance that is mixed together. In the problem, you may be given the amount of one of these substances. In that event, use the variable x for the amount of the other substance.

In order to get the expression to represent the total amount of the final mixture, **add together the amounts of the two substances**. For example, if the amount of the 1st substance is given as 3 quarts, the variable x would be used for the 2nd unknown amount of substance, and the total amount of the final mixture would be expressed as "**$3 + x$**", as in the table below.

1^{st} Substance Amount	+ 2^{nd} Substance Amount	= Final Mixture Total Amount
3	x	$3 + x$

Sometimes, instead of being given the amount of one of the substances that is mixed together, the only amount you are given is the Total Amount of the final mixture. In that event, use the alternate Total Amount method to find expressions for the two amounts of substances that are mixed together: Use the variable x for one of the substances and then use the Total Amount of the Final Mixture minus x for the other substance.

For example, if you are given 14 gallons as the amount of the Final Mixture, name the amount of the 1^{st} substance with the variable $\mathbf{x}$, and name the amount of the 2^{nd} substance "**$14 - x$**".

1^{st} Substance Amount	+ 2^{nd} Substance Amount	= Final Mixture Total Amount
x	$14 - x$	14

10.4 Solving The Problem

**** <u>NOTE</u> The substance type and unit of measurement are not used in solving the problem.**

Step 1
Read The Problem And Match The Substances

Take note of the percentages given and to which amount they belong. Find the information that belongs to the final mixture substance. See if the given amount is for a substance you mix or for the total amount of the final mixture so you know how to name the amounts as explained in 10.3.

Step 2
Set Up And Fill In A Chart

Set up a pre-equation chart like the one below. This is how you determine the three Substance Terms that you need in the next step in order to set up your equation.

Substance	***Percent*** •	***Amount*** =	***Substance Term***
1st Substance			
2nd Substance			
Final Mixture			

The rows in the chart represent the two substances that are mixed together and the substance that will be the final mixture. Enter the percentage for each as given in the problem in the Percent Column.

For the Amounts Column, enter the names of the expression for the two substances and for the final mixture **as explained in 10.3**. To get the expression to fill in the column for the Substance Terms portion of the chart, multiply the Percent times the Amount.

HELPFUL HINT

- If your instructor has no objection, there is a shortcut you can use. Instead of changing the percents to decimal, just drop the percent symbol and use the whole number. **This shortcut can only be used in Mixture problems** (because every term in the equation has a percent).

- Double Check at this time to verify that you have the percent paired up with its corresponding amount as explained in 10.2. It is important to determine that the percentage belongs with its corresponding substance amount.

Step 3
Set Up An Equation

Once you have correctly set up and filled in your chart, it is very easy to set up your equation. All you need to do is set up the three Substance Terms from the chart as follows: Set up the Substance Term that represents the 1st substance and add to it the Substance Term that represents the 2nd substance. Set these two terms equal to the Substance Term that represents the Final Mixture.

1st Substance Term + 2nd Substance Term = Final Mixture Substance Term

Step 4
Solve the Equation

Using the method taught by your instructor, solve the equation for the variable.

Step 5
Make Sure to Answer the Question Being Asked

In Simple Interest Problems, as in other word problems, you need to make sure exactly what question is being asked. It is possible that the value for the variable x may be your answer. But it may *not* be.

For example, the value for x may be the amount of one of the substances you mix together, and the question wants to know the amount of the final mixture substance. To get the correct answer, look at your pre-equation chart and find the expression for the amount that will answer the question. Substitute the solution for x into that expression to get the correct answer.

EXAMPLES

EXAMPLE 1 How many quarts of a 25% antibiotic solution should be added to 10 quarts of a 60% antibiotic solution in order to get a 30% antibiotic solution?

SOLUTION

Step 1 *Read The Problem*

- 25% goes with an unknown amount of a substance that is mixed.
- 60% goes with 10 quarts of a substance that is mixed.
- The final mixture substance is 30%.
- The amount given, 10 quarts, is for a substance that is mixed.

Step 2 *Set Up And Fill In A Chart*

- Fill in 25, 60, and 30 in the percent column next to their corresponding substances.
- As per 10.3, name the expressions for all the amounts and fill in the amounts column.
- The 1st substance (25%) was unknown, so the amount is x.
- The amount of the 2nd substance (60%) was given in the problem. It is 10.
- The amount of the Final Mixture (30%) is the total of the other two substances, $x + 10$.
- Multiply the Percent times the Amount to get each Substance Term.

Substance	***Percent*** •	***Amount*** =	***Substance Term***
1st Substance	25	x	$25(x)$
2nd Substance	60	10	$60(10)$
Final Mixture	30	$x + 10$	$30(x + 10)$

Step 3 *Set Up The Equation*

- Use the three Substance Terms from your chart. They are $25(x)$, $60(10)$, and $30(x + 10)$.
- Set up your equation as 1st Substance Term + 2nd Substance Term = Final Mixture Term.

$$25(x) + 60(10) = 30(x + 10)$$

Step 4 *Solve The Equation*

- The solution to the equation is $x = 60$

Step 5 *Answer The Question Asked*

- The question asks for the amount of the 25% solution substance.
- x is the amount of the 25% solution. You are done. You have the correct answer.

Answer: Add 60 quarts of the 25% solution.

EXAMPLE 2 How much pure alcohol must be added to 2 liters of a solution containing 30% alcohol to obtain a solution containing 44% alcohol?

SOLUTION

Step 1 *Read The Problem*

- "Pure" means 100%, so 100% goes with an unknown amount of a mixing substance.
- 30% goes with 2 liters of a mixing substance.
- The final mixture substance is 44%.
- The amount given, 2 liters, is for a substance that is mixed.

Step 2 *Set Up And Fill In A Chart*

- Fill in 100, 30, and 44 in the percent column next to their corresponding substances.
- As per 10.3, name the expressions for all the amounts and fill in the amounts column.
- The 1st substance (100%) was unknown, so the amount is x.
- The amount of the 2nd substance (30%) was given in the problem. It is 2.
- The amount of the Final Mixture (44%) is the total of the two mixing substances, $x + 2$.
- Multiply the Percent times the Amount to get each Substance Term.

Substance	***Percent* •**	***Amount* =**	***Substance Term***
1st Substance	100	x	$100(x)$
2nd Substance	30	2	$30(2)$
Final Mixture	44	$x + 2$	$44(x + 2)$

Step 3 *Set Up The Equation*

- Use the three Substance Terms from your chart. They are $100(x)$, $30(2)$, and $44(x + 2)$.
- Set up your equation as 1st Substance Term + 2nd Substance Term = Final Mixture Term.

$$100(x) + 30(2) = 44(x + 2)$$

Step 4 *Solve The Equation*

•The solution to the equation is $x = 0.5$

Step 5 *Answer The Question Asked*

- The question asks for the amount of the pure (100%) solution substance.
- x is the amount of the 100% solution. You are done. You have the correct answer.

Answer: Add .5 liter (one-half of a liter) of the pure solution.

EXAMPLE 3 A chef wants to mix a 60% sugar solution with a 30% sugar solution to obtain 10 pints of a 51% sugar solution. How much of the 30% solution will the chef use?

SOLUTION

Step 1 *Read The Problem*

- 60% goes with an unknown amount of a substance that is mixed.
- 30% goes with an unknown amount of a substance that is mixed.
- The final mixture substance is 51%.
- The amount given, 10 pints, is for the total amount of the final mixture.

Step 2 *Set Up And Fill In A Chart*

- Fill in 60, 30, and 51 in the percent column next to their corresponding substances.
- As per 10.3, name the expressions for all the amounts and fill in the amounts column.
- The amount of the Final Mixture (51%) is the only amount given in the problem. It is 10.
- The 1st substance (60%) is unknown, so the amount is x.
- The 2nd substance (30%) is determined by the alternate Total Amount Method. It is $10 - x$.
- Multiply the Percent times the Amount to get each Substance Term.

Substance	***Percent*** •	***Amount*** =	***Substance Term***
1st Substance	60	x	$60(x)$
2nd Substance	30	$10 - x$	$30(10 - x)$
Final Mixture	51	10	$51(10)$

Step 3 *Set Up The Equation*

- Use the three Substance Terms from your chart. They are $60(x)$, $30(10 - x)$, and $51(10)$.
- Set up your equation as 1st Substance Term + 2nd Substance Term = Final Mixture Term.

$$60(x) + 30(10 - x) = 51(10)$$

Step 4 *Solve The Equation*

- The solution to the equation is $x = 7$

Step 5 *Answer The Question Asked*

- You have the solution to the equation, but it is NOT the answer to the question.
- The value of x is the 60% substance; the problem asks for the 30% substance.
- You need to use the expression for the 30% substance that you named in Step 2.
- Get the answer by substituting the solution for x (which is 7) into the expression.

30% Substance = $10 - x$
30% Substance = $10 - 7$
30% Substance = 3

Answer: The chef needs to use 3 pints of the 30% solution.

Mixture: Exercise Set

1. How many liters of a 25% salt solution must be added to 20 liters of a 12% solution to get a solution that is 20% salt?

2. How much of an alloy that is 20% copper should be mixed with 200 ounces of an alloy that is 50% copper in order to get an alloy that is 30% copper?

3. How many pounds of a metal containing 35% nickel would be needed to melt and mix with another metal containing 65% nickel to get 50 pounds of a metal containing 50% nickel?

4. How many gallons of an 18% pesticide solution must be added to 92 gallons of a 51% pesticide solution to obtain a 41% pesticide solution?

5. How many liters of pure salt must be added to 15 liters of a 40% salt solution to obtain a 60% salt solution?

6. How many gallons of pure anti-freeze must be mixed with 30 gallons of 15% anti-freeze to get a mixture that is 40% anti-freeze?

7. A pharmacist mixes a 24% iodine solution with a 64% iodine solution to get 160 milliliters of a 43% iodine solution. How much of the 24% iodine solution did she use?

8. A hairdresser mixes a 30% peroxide solution with a 10% peroxide solution to get 4 cups of 20% peroxide solution. How much of the 10% peroxide solution did she use?

9. A jeweler melted a 50% gold metal with a 20% gold metal to get 6 ounces of a 40% gold metal. How much of the 50% gold metal did he use?

10. A lab technician needs to mix a 45% phosphorus solution with an 18% phosphorus solution to obtain 12 milliliters of a 36% phosphorus solution. How many milliliters of the 18% phosphorus solution will the lab technician need?

11. How many pints of a 10% lemon juice marinade must be mixed with 20 pints of a 60% lemon juice marinade to get a 30% lemon juice marinade?

12. How much of a 60% salt solution must be mixed with 108 liters of an 80% salt solution to get a 75 % salt solution?

13. How many cubic inches of a candy bar that is 45% dark chocolate must be melted and mixed with 18 cubic inches of a candy bar that is 20% dark chocolate to obtain a candy bar that is 30% dark chocolate?

14. How much of a 20% alcohol solution must be mixed with 20 liters of a 5% alcohol solution in order to get a 10% alcohol solution?

15. How many tablespoons of pure butter would need to be mixed with 60 tablespoons of a 50% butter spread to get a 70% butter spread?

16. How many pints of pure orange juice must be added to 6 pints of a 25% orange juice drink to get a 55% orange juice drink?

17. How many cups of pure sour cream must be mixed with 12 cups of a 40% sour cream dip to get a 60% sour cream dip?

18. How much pure sodium must be mixed with 50 quarts of a 65% sodium solution to get a 75% sodium solution?

19. How many ounces of a 20% talcum powder should be mixed with 50 ounces of a 60% talcum powder to obtain a 30% talcum powder.

20. A chemistry student must mix a 5% iodine solution with a 12% iodine solution. How much of each must he use to obtain 70 liters of an 8% iodine solution.