

Question 1: Why are variables necessary, and how do I know when to introduce one?

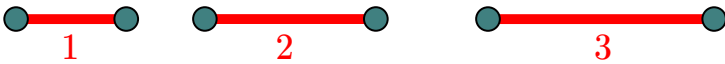
General Answer 1: Variables represent changing, or unknown quantities. In the physical world, virtually everything, changes all the time.

Example 1:

- Below is a line segment. This is the same line segment represented at three different points in time.



- Close your eyes, and now reproduce the segment in your imagination. This means picture it very vividly, as it changes its length. This step is absolutely crucial. Math is a mind game.
- Having pictured the segment in our imagination, we ask which feature of the segment can be represented with a number. A possible choice is the length.

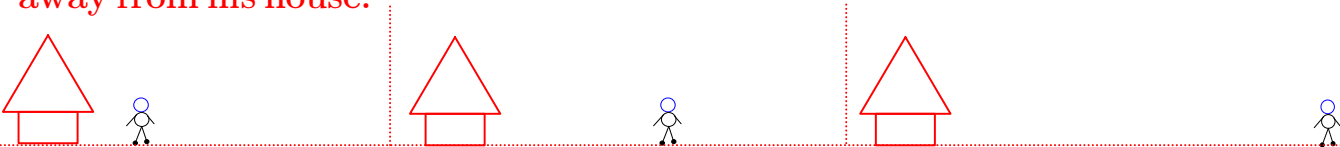


- Looking at the numbers from left to right, we observe that they change from 1 to 2 to 3. The fact that they change indicates we should introduce a letter like x , or y , or z to represent the changing length of the segment.
- So, now we draw a single segment, whose length is NOT a definite number like 5. It's length is an unknown quantity. We label this length as, say, x for length.

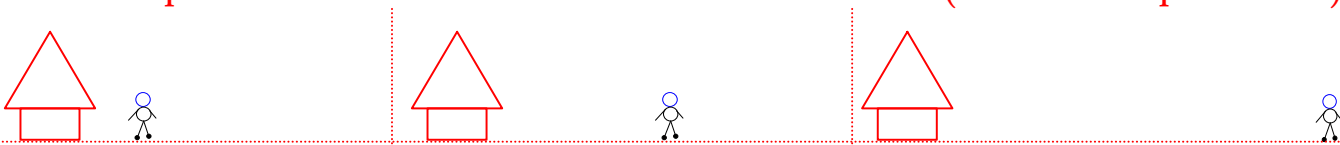


Check point 1:

- Below is a guy. It's the same person shown at three different points in time, as he walks away from his house.



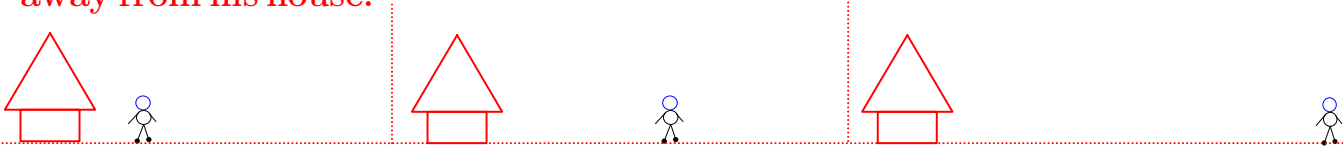
- Close your eyes. Imagine a house, and a guy walking away from it. What's happening to the distance that separates the guy from his house?
- Having pictured the scene in our minds with complete clarity, what's a feature of the scene we can represent with at least three different numbers? (Just like step 3. above)



- At a random point in time, the guy is an unknown distance from his house. Therefore, numbers can no longer be used. Draw a mental image of the house, guy, and a variable to represent the distance between the guy and house.

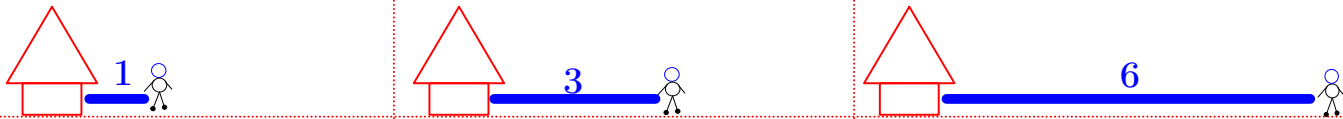
Check point 1 sample solution:

- Below is a guy. It's the same person shown at three different points in time, as he walks away from his house.

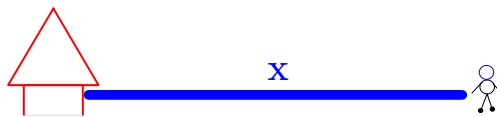


- Close your eyes. Imagine a house, and a guy walking away from it. What's happening to the distance that separates the guy from his house? **The distance increases.**

- Having pictured the scene in our minds with complete clarity, what's a feature of the scene we can represent with at least three different numbers? (Just like step 3. above)



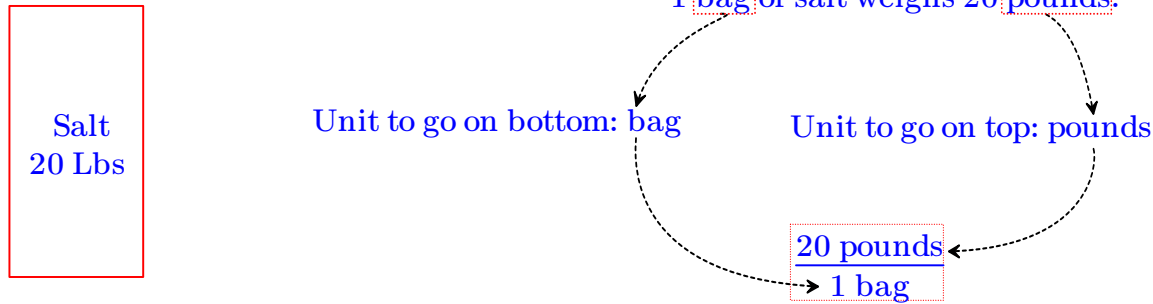
- At a random point in time, the guy is an unknown distance from his house. Therefore, numbers can no longer be used. Draw a mental image of the house, guy, and a variable to represent the distance between the guy and house.



Big Idea: $\text{rate} = \frac{\text{first number} \text{ first unit}}{\text{second number} \text{ second unit}}$

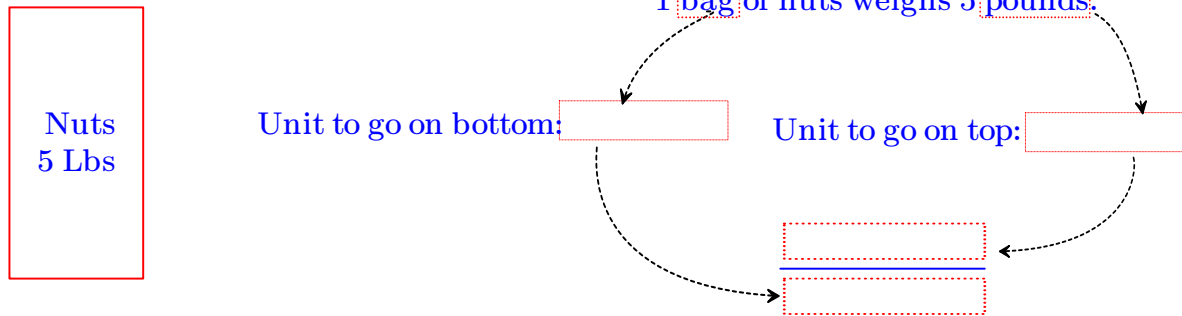
A rate uses division to compare two numbers with different units.

Example 1:



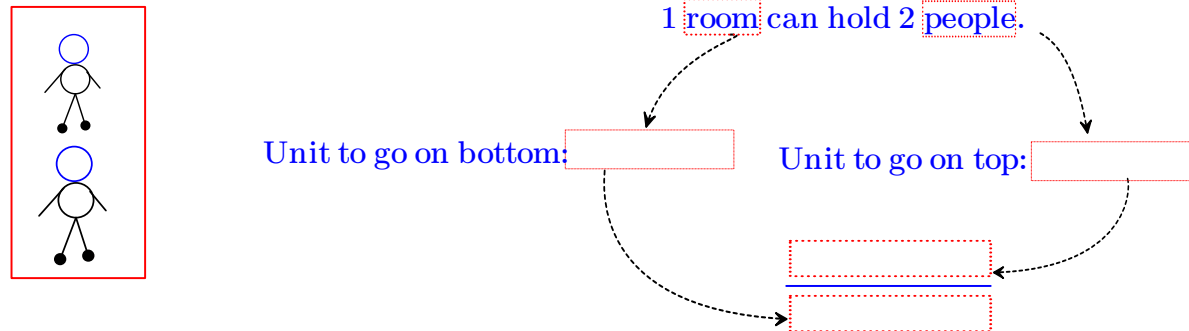
Express rate using different words: 20 pounds per bag.

Exercise 1:



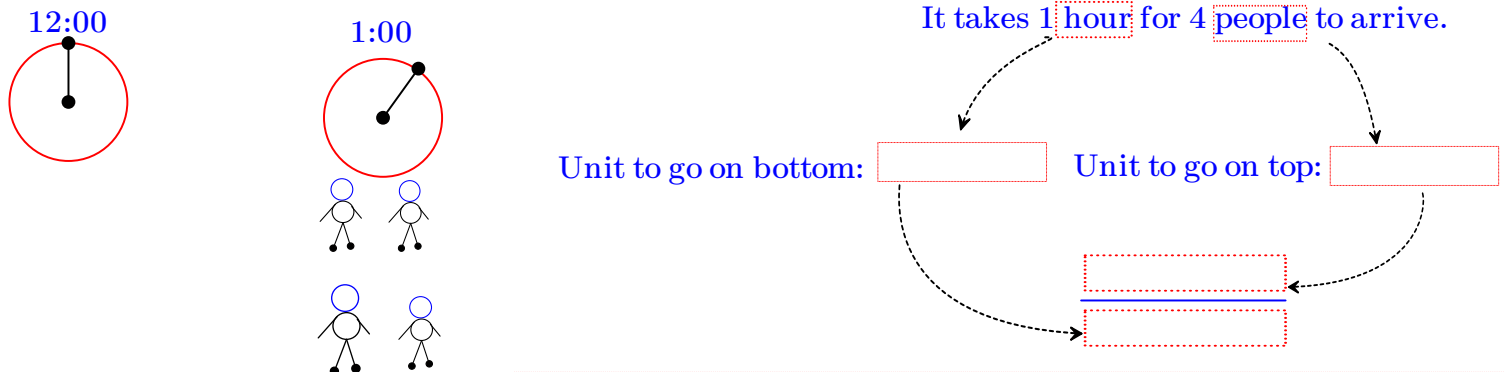
Express rate using different words:

Exercise 2:



Express rate using different words:

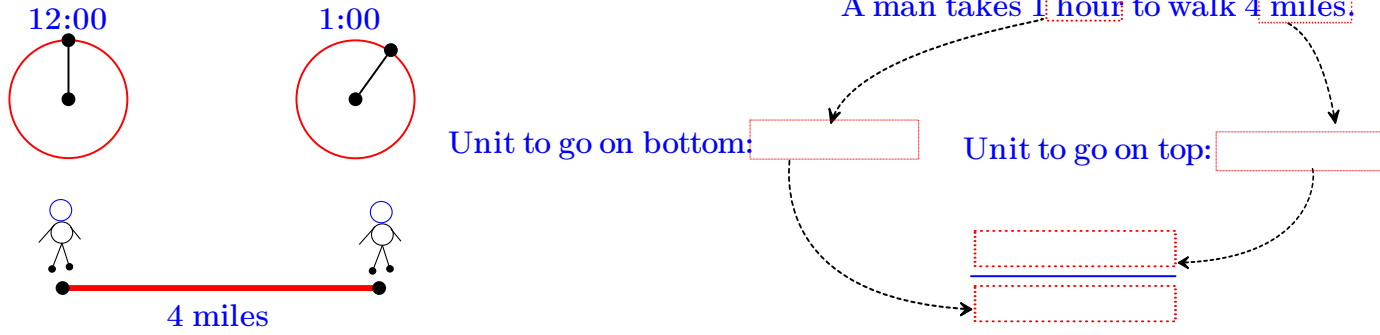
Exercise 3:



Express rate using different words:

Big Idea: $\text{rate} = \frac{\text{first number} \text{ first unit}}{\text{second number} \text{ second unit}}$

Exercise 4:



Express rate using different words: