



### **DISTANCE = RATE TIMES TIME**

One of the most daunting tasks in mathematics is to translate a “word problem” into a mathematical equation. Honestly, there is no one way that works for everyone. Teachers, students, textbooks outline step after step that hopefully will help with the process. Usually, you just have to discover an approach that is best for YOU. However, it does seem that “*LOTS of PRACTICE*” helps one to improve ones’ skills in this area of mathematics.

Here is another “list” and “some practice” aimed at translating “word problems into mathematical equations”.

### **READ THE PROBLEM SLOWLY AND SEVERAL TIMES. OUTLINE THE PROBLEM.**

You aren’t suppose to read a word problem like a novel because you might miss some important clues. So begin by reading *carefully* and *slowly*. A problem might be so packed with information that it will require several readings. Make an “outline” of the information as you read.

Example from Allen R. Angel. Elementary Algebra for College Students. Pearson Education, Inc. (2004).

“Bullet trains in Japan have been known to average 240 kilometers per hour (Kph). Prior to using bullet trains, trains in Japan traveled at an average speed of 120 Kph. If a bullet train traveling from Shin-Osake to Hakata can complete its trip in 2.3 hours less time than an older train, determine the distance from Shin-Osake to Hakata.”

If you read this like a novel, your first reaction to the reading might be this: **@#A\$%, huh?**

But if you read it slowly and returned for another reading, you might notice the following:

#### **Second reading:**

“**Bullet trains** in Japan have been known to average 240 kilometers per hour (Kph). **Prior to using bullet trains, (other) trains in Japan** traveled at an average speed of 120 Kph. If a **bullet train** traveling from Shin-Osake to Hakata can complete its trip in 2.3 hours less time than an **older train**, determine the distance from Shin-Osake to Hakata.”

So your outline might begin:

**Bullet Trains**                      **and**                      **Other Trains.**

### Third reading:

“Bullet trains in Japan have been known to average 240 kilometers per hour (Kph). Prior to using bullet trains, (*other*) trains in Japan traveled at an average speed of 120 Kph. If a bullet train traveling from Shin-Osake to Hakata can complete its trip in 2.3 hours less time than an older train, determine the distance from Shin-Osake to Hakata.”

So your outline would expand as:

#### Bullet Trains

a). Average 240 Kph.

#### Other Trains

a). Average 120 Kph

### Fourth reading:

“Bullet trains in Japan have been known to average 240 kilometers per hour (Kph). Prior to using bullet trains, trains in Japan traveled at an average speed of 120 Kph. If a **bullet train traveling from Shin-Osake to Hakata** can complete its trip in 2.3 hours less time than an **older train**, determine the distance **from Shin-Osake to Hakata**.”

Outline:

#### Bullet Trains

a). Average 240 Kph.

b). Shin-Osake to Hakata

#### Other Trains

a). Average 120 Kph

b). Shin-Osake to Hakata

### Fifth Reading:

“Bullet trains in Japan have been known to average 240 kilometers per hour (Kph). Prior to using bullet trains, trains in Japan traveled at an average speed of 120 Kph. If a **bullet train** traveling from Shin-Osake to Hakata **can complete its trip in 2.3 hours less time than an older train**, determine the distance from Shin-Osake to Hakata.”

Outline:

#### Bullet Trains

a). Average 240 Kph.

b). Shin-Osake to Hakata

c). 2.3 hours less time than the older train.

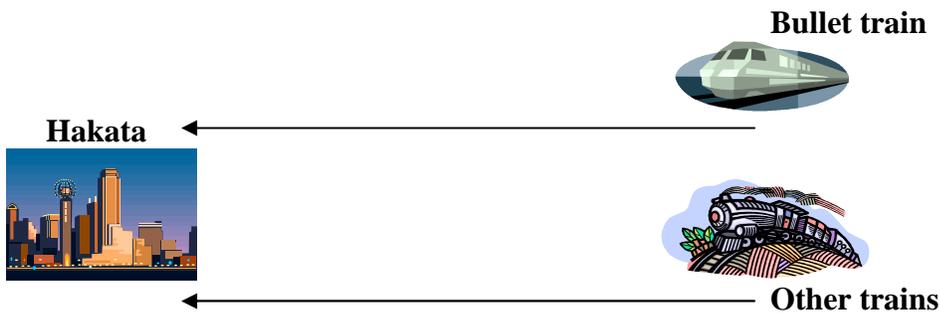
#### Other Trains

a). Average 120 Kph

b). Shin-Osake to Hakata

**TRANSLATE ENGLISH INTO MATH SYMBOLS.  
 USE OUTLINE ABOVE TO HELP.  
 DRAW A SKETCH TO ALSO HELP.  
 ORGANIZE INFORMATION.**

From the example above, we know that both the Bullet Trains and the Other Trains are traveling from Shin-Osake to Hakata (see the outlines). A sketch might help.



From the sketch, it is clear that the two trains are traveling the **same** distance. They both travel from Shin-Osake to Hakata along the same track.

So from this information, one can deduce that the Bullet Train distance is the same as (equal to) the Other Trains distance.

We write: **(Bullet Train Distance) = (Other Trains Distance).**

**Now let's start to get organized.**

Usually problems that deal with distance, rate, and time are organized in a 3 row by 4 column chart like the one below.

$$\text{Distance} = (\text{Rate})(\text{Time})$$

	<b>R</b>	<b>T</b>	<b>D</b>

We get the information for the chart from the outline made earlier.

When two of the **R-T-D** cells are filled, use  **$D = (R)(T)$**  to find the remaining entry for the chart.

Here's the earlier outline:

Bullet Trains	Other Trains
a). Average <b>240 Kph</b> .	a). Average <b>120 Kph</b>
b). Shin-Osake to Hakata	b). Shin-Osake to Hakata
c). <b>2.3 hours less time than the older train.</b>	

Fill the chart (note how the colors match from outline to chart)

$$\text{Distance} = (\text{Rate})(\text{Time})$$

	R	T	D
Bullet Trains	240 Kph		
Other Trains	120 Kph		

In the outline above, it is stated that the **Bullet Train** takes **2.3 hours less time than the older train**, but we *don't know* the time for the **older train**. Define the "time for the older train" as "x", and put "x" in the chart under T for **Other Trains**.

$$\text{Distance} = (\text{Rate})(\text{Time})$$

	R	T	D
Bullet Trains	240 Kph		
Other Trains	120 Kph	x	

The **Bullet Train** takes **2.3 hours less time than the older train**, so we can write the bullet train's time as "x - 2.3". Put this into the chart under T for the **Bullet Trains**.

$$\text{Distance} = (\text{Rate})(\text{Time})$$

	R	T	D
Bullet Trains	240 Kph	x - 2.3	
Other Trains	120 Kph	x	

For both the Bullet Trains and the Other Trains, two cells in the chart are filled.

Use Distance = ( Rate ) (Time) and the information from the cells to find the remaining cell.

**Bullet Trains: Distance = ( 240 Kph ) ( x - 2.3 )**

**Other Trains: Distance = ( 120 Kph ) ( x )**

Fill the distance cells with the information.

$$\text{Distance} = (\text{Rate})(\text{Time})$$

	R	T	D
Bullet Trains	240 Kph	x - 2.3	( 240 ) ( x - 2.3 )
Other Trains	120 Kph	x	( 120 ) ( x )

## DEFINE AN EQUATION

Looks for words and phrases that imply equality.

For example, “is” means “equal”. The phrase “the same as” also means “equal”.  
The word “total” means to add two quantities and make the sum “equal” to something.

From the sketch, we wrote: **(Bullet Trains Distance) = (Other Trains Distance)**.

Using information from the chart under “D” for distance,  
translate : **(Bullet Trains Distance) = (Other Trains Distance)**  
into:  $(240)(x - 2.3) = (120)(x)$   
simplify:  $240x - 240(2.3) = 120x$

## SOLVE THE EQUATION

$$\begin{aligned}240x - 552 &= 120x \\240x - 552 - 120x &= 120x - 120x \\120x - 552 &= 0 \\120x - 552 + 552 &= 0 + 552 \\120x &= 552 \\ \frac{120x}{120} &= \frac{552}{120} \\x &= 4.6\end{aligned}$$

From the chart,  $x$  is the “Other Trains Time” in hours.  
This means it takes “Other Trains” 4.6 hours to travel from Shin-Osake to Hakata.

**CHECK THE ANSWER. IS IT REASONABLE?  
DID YOU ANSWER THE QUESTION?**

**The question asked** “determine the distance from Shin-Osake to Hakata”.  
The answer obtained was the time it takes “Other Trains” to travel from Shin-Osake to Hakata.  
Using **Distance = (Rate)(Time)** for “Other Trains” we obtain the answer to the question.

$$\begin{aligned}\text{Distance} &= (\text{Rate})(\text{Time}) \\ \text{Distance} &= (120)(4.6) \\ &= 552 \text{ Km.}\end{aligned}$$

**Note: one cancels common units as one would cancel common factors.**

$$(Kph)(hr) = \left(\frac{Km}{hr}\right)(hr) = \left(\frac{Km}{\cancel{hr}}\right)(\cancel{hr}) = Km$$

**WORD PROBLEMS  
SUMMARY**

1. When it comes to translating word problems into math equations, you just have to discover an approach that is best for YOU.
2. *“LOTS of PRACTICE”* helps
3. **SOME SUGGESTED STEPS ARE:**
  - a). **READ THE PROBLEM SLOWLY AND SEVERAL TIMES.  
OUTLINE THE PROBLEM.**
  - b). **TRANSLATE ENGLISH INTO MATH SYMBOLS.  
USE OUTLINE ABOVE TO HELP.**  
  
**DRAW A SKETCH TO ALSO HELP.  
ORGANIZE INFORMATION.**
  - c). **DEFINE AN EQUATION.**
  - d). **SOLVE THE EQUATION.**
  - e). **CHECK THE ANSWER. IS IT REASONABLE?  
DID YOU ANSWER THE QUESTION?**
4. For distance equals rate times time organize information in a chart before trying to set up an equation.

$$\text{Distance} = (\text{Rate})(\text{Time})$$

	<b>R</b>	<b>T</b>	<b>D</b>

5. If there are two rates in a distance equals rate times time problem, when a vehicle is going against an opposing force such as wind or a river current, subtract the rate of the opposing force from the rate of the vehicle, e.g. Boat Speed – River Current, Plane Speed – Wind Speed.  
When going with it, add the two rates e.g. Boat Speed + River Current, Plane Speed + Wind Speed.

