Motion Problems

1. Two cars leave the same place at the same time and travel in opposite directions, one of the cars traveling 10 mph faster than the other. After 3 hours they are 240 miles apart. What is the rate of each car in miles per hour?

	D	**S**	**T**
Car 1	D	S	3
Car 2	240-D	S+10	3

Case 2: **3S + 3(S+10) = D + 240 – D = 240**
S = 35, S+10 = 45

2. Two planes which are 1060 miles apart, leave at the same time and fly toward each other, meeting in 4 hours. If their rates differ by 15 miles per hour, what is the rate of each plane?

	D	**S**	**T**
Plane 1	1060-D	S	4
Plane 2	D	S+15	4

Case 2: **4S + 4(S+15) = 1060**
S = 125, 145

3. One car traveling at the rate of 60 mph is 4 miles behind another car traveling at 50 mph. How many minutes will it take faster car to overtake the slower car?

	D	**S**	**T**
Car 1	D+4	60	T
Car 2	D	50	T

Case 3: **60T = 50T + 4**

T = .4 hours = 24 minutes

4. A man travels from one city to another at the rate of 40 mph. He returns at the rate of 60 mph. If the trip takes 8 hours, how far apart are the cities?

	D	**S**	**T**
Man G 1	D	40	8-T
Man R 2	D	60	T

Case 1: **40(8-T) = 60T**
T = 3.2 hours

5. Two men travel toward each other from points 540 miles apart. If their rates are 48 and 60 mph, respectively, when will they meet if they started at the same time?

	D	S	T
Man 1	D	48	T
Man 2	540-D	60	T

Case 2: **48T + 60T = 540**
T = 5

6. A boy starts to walk to a town 15 miles away at the rate of 4 mph. After walking for a time, he is taken to the town by a friend traveling by car at the rate of 40 mph. If the boy's total time reaching the town is 1 ½ hours, how far does he ride?

	D	S	T
Walk	15-D	4	1.5-T
Ride	D	40	T

Case 2: **4(1.5-T) + 40T = 15**
T = .25

7. A plane has a cruising speed of 280 mph and wind velocity is 40 mph. How far can the plane fly against the wind and return in 7 hours?

	D	S	T
With	D/2	320	T
Against	D/2	240	7-T

Case 1: **320T = 240(7-T)**
T = 3

8. A plane can fly a certain distance in 6 hours with the wind, but can return only ¾ the distance in the same time. If the speed of the plane in still air is 200 mph, find the speed of the wind.

	D	S	T
With	D	200+W	6
Against	¾ D	200-W	6

Case 4: **(200-W)6 = ¾(200-W)6**
W = 200/7

9. A man drove at the rate of 50 mph while outside a city and 30 mph while inside the city. If a trip of 30 miles took him 40 minutes, how much of the trip was outside the city?

	D	S	T
Outside	30-D	50	T
Inside	D	30	2/3-T

Case 2: **50T + 30(2/3-T) = 30**
T = ½ = .50

10. A train leaves a station and travels at 45 mph. Three hours later a second train leaves the station and travels at 75 mph. How long will it take the second train to overtake the first train?

	D	S	T
Train 1	D	45	T
Train 2	D	75	T-3

Case 1: **45T = 75(T-3)**
T = 7.5

Four Cases

There will always be two unknowns to be solved with two equations; however, the solutions can most easily be solved by eliminating the distance right from the start and then solving for either S or T. You can always set the $S_1 \times T_1$ and $S_2 \times T_2$ terms equal to something based upon the relationship between the distances. There are four cases to consider:

Case	D_1	D_2	Action
1	D	D	When the two distances are equal, the "speed X time" terms can be set equal.
2	D	C - D	When the combined distance is a constant, the two "speed X time" terms can be added and set equal to that constant. This is because D + (C – D) = C. This saves a little algebra over substituting for D.
3	D	D + C	When the two distances are different by constant, the "speed X time" terms are set equal, except one of the terms has that constant added to it. Or you could subtract the two terms and set them equal to the constant.
4	D	C × D	When the two distances differ by a constant multiple, the "speed X time" terms are set equal, with of the terms is multiplied by that constant.