Instructions. Provide a solution, written to be understandable and illuminating to Algebra I students.

Cadillac and Toyota 1.1. A pink Cadillac leaves Oklahoma City at 6AM headed west on I-40 with the cruise control set at 70 mph. A federal agent in a green Toyota follows, leaving at 7 AM and traveling 85 mph. When and where does the Toyota catch up?

PROBLEM:

GIVEN: ① PINK CADILLAC leaves Oklahoma City at 6:00 A.M with a SPEED OF 70 mph
② GREEN TOYOTA leaves Oklahoma City at 7:00 AM with a SPEED of 85 mph

SOLUTION: Let x = to the number of minutes travelled by TOYOTA
$x+60$ = to the number of minutes travelled by the CADILLAC

SPEED IN MINUTES → (we use this in order to become more accurate)

CADILLAC → 70 miles per hour → $\frac{70 \text{ miles}}{60 \text{ minutes}}$ (1 hour = 60 minutes) $= \frac{7}{6}$ miles per minute

TOYOTA → 85 miles per hour → $\frac{85 \text{ miles}}{60 \text{ minutes}}$ (1 hour = 60 minutes) $= \frac{17}{12}$ miles per minute

EQUATION:

~~(SPEED OF CADILLAC in minutes)(x+60) =~~

(SPEED OF CADILLAC in minutes)(number of minutes travelled by CADILLAC) = (SPEED OF TOYOTA in mins.)(number of minutes travelled by toyota)

$$\left(\frac{7}{6}\right)(x+60) = \left(\frac{17}{12}\right)(x)$$

make this fraction become equivalent to the other fraction by multiplying both numerator and denominator by 2

$$\left(\frac{14}{12}\right)(x+60) = \left(\frac{17}{12}\right)(x)$$

$$\frac{14}{12}x + 70 = \frac{17}{12}x$$

$$-\frac{14}{12}x \qquad -\frac{14}{12}x$$

$$70 = \frac{3}{12}x$$

$$\frac{13}{12} \div \frac{3}{12}$$

$$280 = x$$

$$x = 280 \text{ minutes}$$

~~6:00 A.M.~~
~~+ 280 minutes~~

$$60 \overline{)280} \text{ minutes} = 4$$

$$\begin{array}{r} 280 \\ -240 \\ \hline 40 \text{ minutes} \end{array}$$

4 hour and 40 minutes

$$\begin{array}{r} 6:00 \text{ AM} \\ + 4:40 \\ \hline \end{array}$$

$\boxed{10:40 \text{ AM}}$

FINAL ANSWER: TOYOTA CATCHES UP AT 10:40 AM / ASSUMING ITS STILL ON I-40

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We want to find out if a car leaves OK city at 6:00 am and then a second car leaves one hour later than the first, when and where does the 2nd car catch up with the first.

1st Car - Pink Cadillac leaves @ 6.00 am rate 70 mph

2nd Car - Green Toyota leaves @ 7:00 am rate 85 mph

t = Time

Pink Cadillac

Green Toyota

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We want to find the time at which the Cadillac & Toyota are side by side, i.e. when their distances from Oklahoma City are equal.

← Cadillac 70 mph ———— 7AM (initial time = t_i)

← Toyota 85 mph ———— 8AM (one hour later = $t_i - 1$)

First, let's use the distance formula to represent the distance (d) of each car from OK city given a rate (r) and time (t).

$$d = rt$$

Cadillac: $d = 70t_i$ $\quad$ $r = \text{rate} = 70$, $t = \text{initial time}$

Toyota: $d = 85(t_i - 1)$ $\quad$ $r = 85$, $t = t_i - 1$ = initial time is subtracted by 1 b/c the Toyota left OK City an hour later

Since we want to find the time at which the distances are the same, we set the distance equations equal and solve for our variable t algebraically.

$$70t_i = 85(t_i - 1)$$
$$70t_i = 85t_i - 85$$
$$-15t_i = -85$$
$$t_i = 17/3 \approx 5.\bar{6}$$

∴ It takes 5 hours and 40 mins $(0.\bar{6} \times 60)$ for the Toyota to catch up. This is at 12:40 PM (7AM + 5hrs 40min) and $396.\bar{6}$ miles ($d = 70(17/3)$ or $d = 85(\frac{17}{3} - 1)$) west of OK City

plug in t_i

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Caddy departs @ 6AM @ 70 mph
Toyota departs @ 7AM @ 85 mph.

Given information

When & where will the Toyota catch up to Caddy?

Think: When will there distances be equal to each other?

Distance = Rate × time ← formula for distance.

Define the variables

Let D_C represent distance travelled by Caddy and D_T represent distance travelled by Toyota
Respectively, R_C = Rate, T_C = time for Caddy and R_T = Rate, T_T = time for Toyota

Set up the formula

(1) $D_C = D_T$ — (1) (Toyota will catch up to caddy when their distances are equal)

(2) $R_C T_C = R_T T_T$ — (2) (substitute distance formula)

(3) $70\,T_C = 85\,T_T$ — (3) (Substitute given rates for cars)

(4) $70(T_T+1) = 85\,T_T$ — (4) (Substitute $T_C = T_T + 1$ b/c Caddy drove for 1 hour longer than Toyota)

(5) $70T_T + 70 = 85T_T$ — (5) (distribute)

(6) $70 = 15T_T$

(7) $\boxed{4.7 = T_T}$

Toyota travelled for 4.7 hours to catch up to Caddy. ∴ $T_C = 4.7 + 1 = 5.7$ hours

Determine distance travelled by Both cars:

Determine Distance

$D_T = R_T \times T_T$
$D_T = 85 \times 4.7$
$D_T = 399.5$ miles

$D_C = R_C \times T_C$
$D_C = 70 \times 5.7$
$D_C = 399$ miles

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Cadillac and Toyota 1.1. A pink Cadillac leaves Oklahoma City at 6AM headed west on I-40 with the cruise control set at 70 mph. A federal agent in a green Toyota follows, leaving at 7 AM and traveling 85 mph. When and where does the Toyota catch up?

Let x = the time travelled by pink Cadillac in mph

x + 1 = the time travelled by Toyota in mph

$D = vt$

For Pink Cadillac

$D = 70 \text{ mph } (x)$

For Toyota

$D = 85 \text{ mph } (x-1)$

$70x = 85(x-1)$

$70x = 85x - 85$

$-85x \quad -85x$

$\frac{-15x}{-15} = \frac{-85}{-15}$

$X = 5.6\overline{6}$

6:00	70 mph
6:15	73.75
6:30	77.5
6:45	81.25
7:00	85 mph

	d	s	t
Cadillac		70	x
Toyota		85	x + 1

We have to relate their distance to find the time

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Cadillac and Toyota 1.1. A pink Cadillac leaves Oklahoma City at 6AM headed west on I-40 with the cruise control set at 70 mph. A federal agent in a green Toyota follows, leaving at 7 AM and traveling 85 mph. When and where does the Toyota catch up?

In this problem we have two different veichles traveling different speeds for different amounts of time. Since they are traveling the same direction on the same road and the faster car is behind the slower, we know the cars <u>must</u> converge. The question then is when and where do they converge. ~~[illegible]~~ Since the cars left from the same location and will meet up at the same location they must have the same distance traveled. This info will allow us to easily solve the problem. First we must know the relationships between speed (s), distance (d), and time traveled (t) in hours at the speed: which I will call X.

$$d = s \cdot t$$

For the Cadillac, $d_1 = (70\,\text{mph})(X)$.

For the Toyota, $d_2 = (85)(X-1)$ $\Rightarrow$ since the Toyota traveled for exactly 1 hr. Less than the Cadillac

Knowing that the two veichles <u>must</u> have traveled the same distance allows us to set the equations equal to each other.

$(70)(X) = (85)(X-1)$ $\Rightarrow$ distribute

$70x = 85x - 85$ $\Rightarrow$ subtract $85x$ from both sides.

$-15x = -85$ $\Rightarrow$ divide both sides by -15

$x = 17/3$. Plugging X into both equations yields

$$d_1 = (70)\left(17/3\right) = d_2 = (85)\left(\tfrac{17}{3} - 1\right) = 396.\overline{6} \text{ miles.}$$

time the Cadillac traveled after 6 AM, 3 hr. 40 min = 9:40 AM

Time the toyota traveled after 7AM, 2 HR 40 min = 9:40 AM.

Thus both cars traveled $396.\overline{6}$ miles and met up at 9:40 AM.

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Cadillac and Toyota 1.1. A pink Cadillac leaves Oklahoma City at 6AM headed west on I-40 with the cruise control set at 70 mph. A federal agent in a green Toyota follows, leaving at 7 AM and traveling 85 mph. When and where does the Toyota catch up?

Problem. A cadillac leaves Oklahoma City at 6 AM w/ a speed of 70mph and a Toyota follows, leaving at 7 AM w/ a speed at 85mph. When and where does the Toyota catch up?

For cadillac:

speed = 70mph

For Toyota:

Speed = 85 mph

Use the Distance-Rate-Time ~~Formula~~ formula to know the time of both cars to be ~~together~~

$D = rt$

$D = rt$

where D = distance

r = rate/speed

t = time in hours

Since cadillac leaves at 6 AM and Toyota leaves at 7 AM which is a difference of one hour, Thus equating the two distances of both car: (Time of cadillac is t+1 in reference to Toyota's time)

Cadillac = Toyota

$D = rt \longrightarrow D = rt$

$rt = rt$

$70(t+1) = 85t$

$70t + 70 = 85t$

$15t = 70$

$t = \frac{70}{15}$

$t = 4.67$ hrs

or $t = 4$ hrs and 40 minutes

Since $t = 4$ hrs and 40 minutes, Add this to Toyota's time of leaving at 7 AM. Thus

at 7 AM

+ 4 hrs and 40 minutes

11:40 AM time that Toyota will catchup w/ the cadillac.

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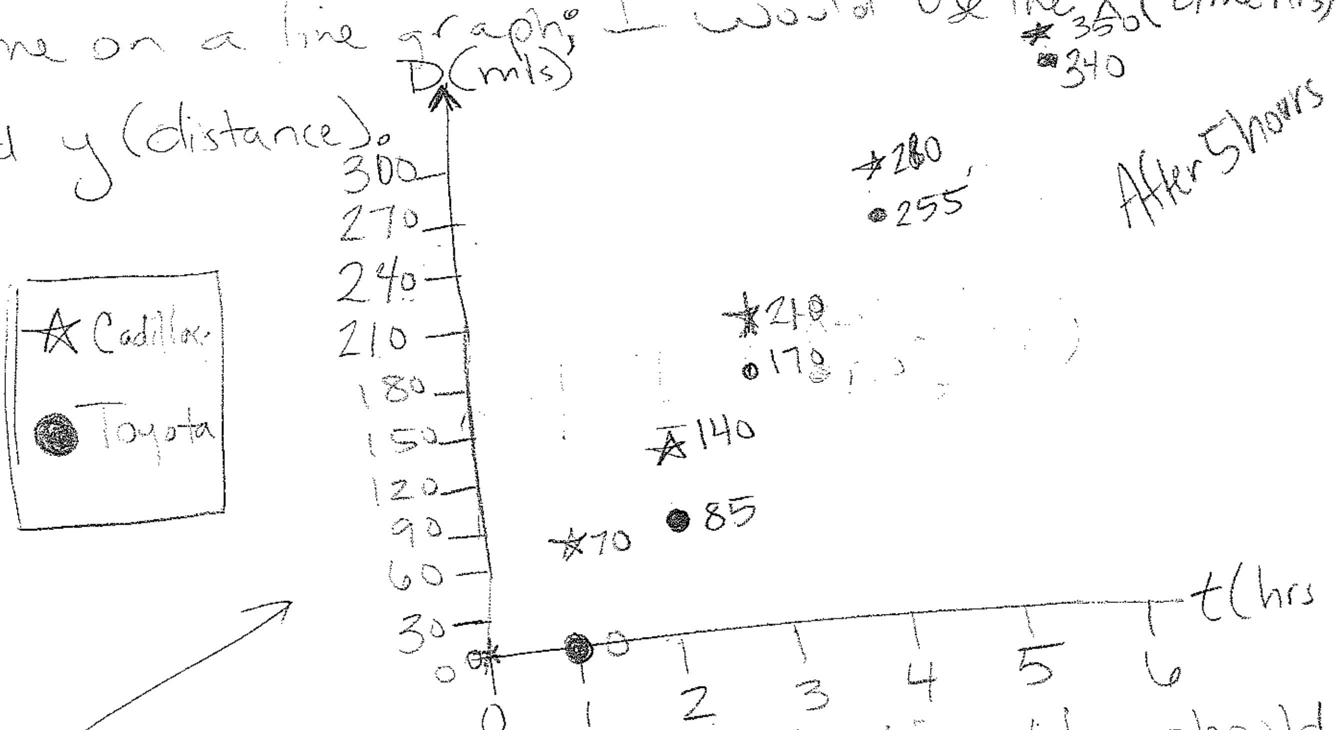
Cadillac and Toyota 1.1. A pink Cadillac leaves Oklahoma City at 6AM headed west on I-40 with the cruise control set at 70 mph. A federal agent in a green Toyota follows, leaving at 7 AM and traveling 85 mph. When and where does the Toyota catch up?

I want to know when & where the Toyota will catch up with the Cadillac. I know that the Cadillac leaves Oklahoma City at 6AM headed west on I-40 going 70 mph & the Toyota follows an hour later going 85 mph. I can graph their distance and time on a line graph. I would use the X (time hrs) and y (distance).



This would just be a good visualization. You should then look at point intercept form ($y = mx + b$), where y is distance $D_C = 70t$ and $D_T = 85t - 60$

time

left 1 hour later
60 (minutes)

Set equations equal (same place, same time)

$70t = 85t - 60$ or $\frac{60}{15} = \frac{15t}{15}$ $t = 4$? NO!

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Cadillac and Toyota 1.1. A pink Cadillac leaves Oklahoma City at 6AM headed west on I-40 with the cruise control set at 70 mph. A federal agent in a green Toyota follows, leaving at 7 AM and traveling 85 mph. When and where does the Toyota catch up?

Our task requires us to determine how long it takes for the two vehicles to travel the same distance, then how far they have traveled.

Let h = the # of hours traveled by both cars, beginning at 7:00 a.m. At this time, the Cadillac has already traveled 70 miles, since $70\ \text{mi/hr} \cdot 1\ \text{hr} = 70\ \text{mi}$. The expression $70h + 70$ then represents the total distance traveled by the Cadillac.

If we set this expression equal to the distance traveled by the Toyota ($85h$), we can find the number of hours it takes for the two cars to travel the same total distance (and meet).

$$70h + 70 = 85h$$
$$15h = 70$$
$$h = 4\tfrac{2}{3}\ \text{hrs}\ (4\ \text{hrs}\ 40\ \text{min})$$

$\therefore$ The cars meet 4 hrs 40 min after 7:00 a.m., or at 11:40 a.m. Each car has traveled a total of $396\frac{2}{3}$ mi west of Okla. City ($70 \cdot 4\frac{2}{3} + 70 = 396\frac{2}{3}$ and $85 \cdot 4\frac{2}{3} = 396\frac{2}{3}$).

Cadillac 6:00 am – 11:40 am $5\frac{2}{3}$ hr $\cdot$ 70 mph

Toyota 7:00 am – 11:40 am $4\frac{2}{3}$ hr $\cdot$ 85 mph

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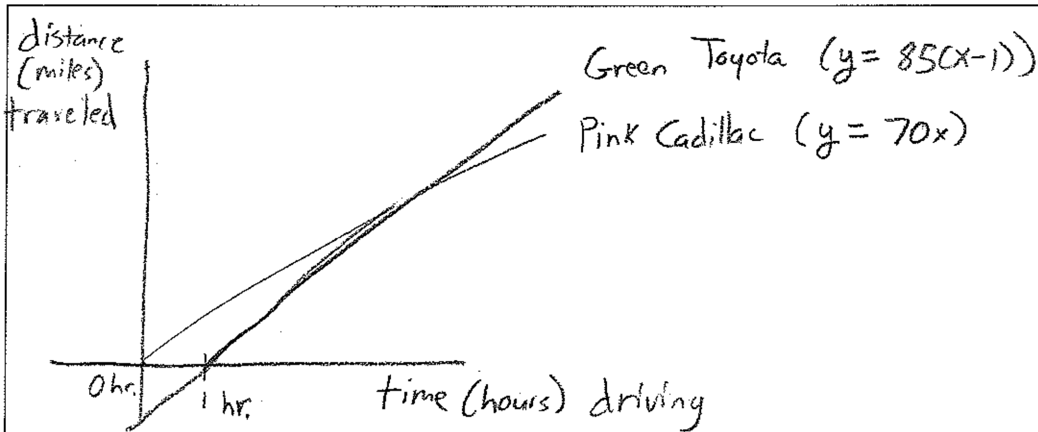

To find when and where the Toyota catches up, we must solve a system of linear equations. First, we find an equation to describe the distance the pink Cadillac traveled with respect to the amount of time driving. The rate of change in miles per hour of the pink Cadillac is 70, thus the equation describing the distance traveled is $y_1 = 70x_1 + b_1$ where x_1 is the amount of driving time and y_1 is the distance traveled. b_1 represents the amount of time that has elapsed before the driver starts to drive. In the case of the pink Cadillac, $b_1 = 0$ and so his equation is $y_1 = 70x_1$. Similarly, the green Toyota travels 85 mph and so his equation is $y_2 = 85x_2 + b_2$. Since he waits an hour before he leaves, we must solve for b_2. We know that waiting one hour before leaving results in a loss of 1 hour worth of traveling, so $0 = 85(1) + b_2 \iff b_2 = -85$. Thus $y_2 = 85x - 85$. Now to find where they meet (where the distance is the same) we solve $y_1 = y_2 \iff 70x = 85x - 85 \iff x = 5.67$. So they both drive for 5.67 hours (5 hrs, 40 min). Thus, they meet up at 6:00 + 5:40 = 11:40 AM at $y = 70(5.67) \iff y \approx 396.7$ miles west of Oklahoma City.

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Cadillac and Toyota 1.1. A pink Cadillac leaves Oklahoma City at 6AM headed west on I-40 with the cruise control set at 70 mph. A federal agent in a green Toyota follows, leaving at 7 AM and traveling 85 mph. When and where does the Toyota catch up?

When working with distance (d), time (t), and rate (r), you want to remember that $d = rt$. A problem like this can be visualized better by beginning with a chart as shown:

Time	Cad. miles	Toy. miles
6am	0	0
7am	70	0
8am	140	85
9am	210	170
10am	280	255
11am	350	340
12pm	420	425

You can see that the vehicles crossed paths between 11am and noon.

Using the formula for each vehicle, the cadillac distance can be found with $d = 70t$, and the Toyota distance with $d = 85(t-1)$. The Toyota started one hour after the cadillac, so its time is $(t-1)$. Setting them equal to each other will allow you to calculate when they will cross paths.

$$70t = 85(t-1)$$
$$70t = 85t - 85$$
$$\frac{85}{15} = \frac{15t}{15}$$
$$5\tfrac{2}{3} = t$$

After $5\frac{2}{3}$ hours, or 5 hours and 40 minutes, from the beginning they will meet. This will be at 11:40 am since t starts at 6am.

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(1) I would like to compare the distances and times:

at 70 mph

Cadillac

time	miles travelled
6: am	0
7	70
8	140
9	210
10	280
11	350
12	420

at 85 mph

Toyota

time	miles travelled
7. am	0
8	85
9	170
10	255
11	340
12	425

(2) We can see they are close at 11: am

(3) at 12:00 the toyota has passed the Cadillac. So we know that at some point:

$350 + 70 \text{ mph} = 340 + 85 \text{ mph}$

(4)

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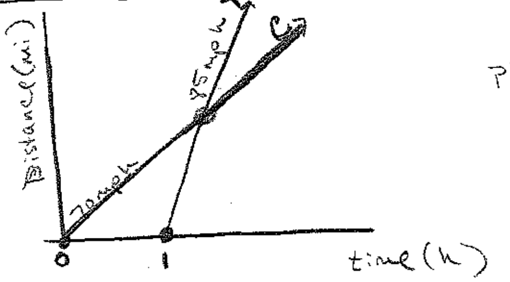
Looking for when and where the cars will meet.



pink Cadillac leaves at 6 AM traveling @ 70 mph
if 6AM is start point, can assume time starts a zero,

Toyota leaves at 7 AM traveling @ 85 mph
If 6AM starts at zero, then 7AM will start at one

Know $y = mx + b$, create an equation for both lines:

$D_C = 70t + 0$

$D_T = 85t - 1$

when will the two meet? Same as systems of equations:

$D_C = D_T$

$70t = 85t - 1$
$-85t \quad -85t$

$\frac{-15t}{-15} = \frac{-1}{-15}$

$t = 1/15$

time is measured in hours,
so

$\frac{1}{15}\text{hr} \times \frac{60\text{ min}}{1\text{ hr}} = 4\text{ min}$

$D_C = 70\left(\frac{1}{15}\right) = \frac{14}{3}$ miles

$D_T = 85\left(\frac{1}{15}\right) - 1 = \frac{14}{3}$ miles

Answer:

When? 4 minutes after the Toyota leaves: 7:04AM

Where? $\frac{14}{3}$ miles from OKC

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Distance = Rate X Time

PC T_1 = (60 min)(70 mph) = 4200

GT T_2 = (45 min)(85 mph) = 3825

need to find an amt. of minutes where these #'s are =

$85T_1 = 70t_2$

$\frac{85 \text{ mph}}{60 \text{ min}}$ = 1.42 m per min.

travels 1.42 miles per minute

travels 1.17 miles per minute

$\frac{70 \text{ mph}}{60 \text{ min}}$ = 1.17 m per min

$70(1.42) \approx 85(1.17)$

$99.4 \approx 99.4$

PK → (85 mph)(70 min) = 5950

GT → (70 mph)(85 min) = 5950

They catch up — same distance.

Now, 6 am + 85 min = $\boxed{\text{7:25 am they meet 99.4 miles west of OKC.}}$

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Let D_C = the distance travelled by pink Cadillac
D_T = the distance travelled by green toyota

* In solving for the distance of pink Cadillac use the formula $d=rt$ where d is distance, r is rate & t is time.

* Since time and distance is unknown then, $D_C = 70t$ and $D_T = 85(t-1)$ which is equal to $85t - 85$.

* I want to know when and where does the Toyota catch up so set up an equation in which both of the cars will be equal.

Solution:

$D_C = D_T$

Substitute the equation

$70t = 85t - \cancel{85}$
$-70t \quad -70t + 85$
$+85$

by elimination we get

$\frac{85}{15} = \frac{15t}{15}$

$5\frac{2}{3} = t$

Check the work

$D_C = 70t$
$396\frac{2}{3} = 70\left(\frac{17}{3}\right)$
$396\frac{2}{3} = 396\frac{2}{3}$

$D_T = 85t - 85$
$396\frac{2}{3} = 85\left(\frac{17}{3}\right) - 85$
$396\frac{2}{3} = 396\frac{2}{3}$

Solve for t with respect to D.

$\frac{D_C}{70} = \frac{70t}{70}$

$T_C = \frac{D}{70}$

$D_T = 85t - 85$
$+85 \quad +85$

$\frac{D+85}{85} = \frac{85t}{85}$

$T = \frac{D}{85} + 1$

5 hours and 40 minutes the Toyota can catch up with the Cadillac

Solve for distance

$T_C = T_T$

$70(85)\frac{D}{70} = \left(\frac{D}{85} + 1\right) 70(85)$

$85D = 70D + 5950$
$-70D \quad -70D$
$15D = 5950$

$\frac{15D}{15} = \frac{5950}{15}$

$D = 396\frac{2}{3}$ miles

the distance that both cars will meet in $396\frac{2}{3}$ mi

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Where and when will the pink cadillac and green toyota meet.

The pink cadillac travels at 70mph west on I-40, with the cruise contro set. The pink cadillac leaves at 6am.

The green toyota is traveling at 85 mph in the same direction of the pink cadillac but leaves at 7am.

PC = pink cadillac

PC = 70 mph

PC leaves at 6 am

GT = green toyota

GT = 85 mph

GT leaves at 7am

Time

	6am	7am	8am	9am	10am	11am	12pm
PC		70	140	210	280	350	420
GT		0	85	170	255	340	425

distance per hour

Distance is speed ~~plus~~ times time

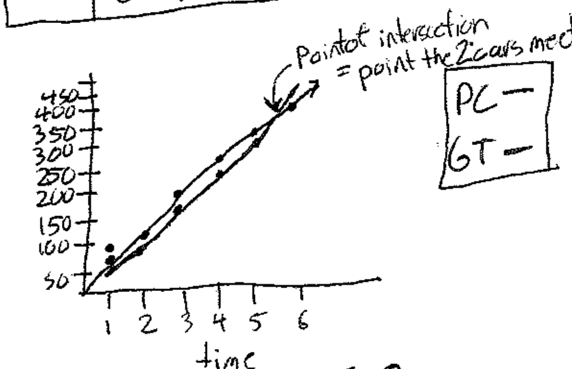
$D = st$

Distance for PC

$D_{PC} = 70t$

Distance for GT

$D_{GT} = 85t$



$D_{PC} = D_{GT} \Rightarrow 70(t+1) = 85t =$

$70t + 70 = 85t \Rightarrow 70 = 15t \Rightarrow t = 4.\bar{6}$ $\frac{2}{3}$. $4\frac{2}{3}$

$\Downarrow$

4 hours and 40 mins

$D_{PC} = 70(4\frac{2}{3}+1) \Rightarrow 70(5\frac{2}{3}) = 396.\bar{6}$

$D_{GT} = 85(4\frac{2}{3}) = 396.\bar{6}$

It takes GT $4\frac{2}{3}$ hours or 4 hours and 40 minutes to catch up to the PC, which has been driving for $5\frac{2}{3}$ hours or 5 hours + 40 min.

The two cars meet at 11:40 am and both cars are ~~350~~ $396.\bar{6}$ miles west of Oklahoma City.

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We are going to use the relationship between time, speed & distance to form an equation in terms of the time after 6 AM. We will use this equation to discover the time the cars met & ultimately the distance the cars traveled.

Variables

C = distance in miles the caddy traveled W on I-40 from OK city

F = distance in miles the feds traveled W on I-40 from OK city.

t = time in hours the cars traveled after 6 AM.

We know that distance = speed · time.

So the distance the Caddy traveled can be represented:

(1.) $C = 70t$, i.e., 70 mph for t # of hours.

Similarly, the distance the Feds traveled can be represented:

(2.) $F = 85(t-1)$; i.e., 85 mph for one hour less than the caddy.

In order for the 2 cars to meet, they would have to travel the same distance, so we can write:

$C = F$ - equal distances

$70t = 85(t-1)$ - from (1) & (2)

$70t = 85t - 85$ - distributive property

$5\frac{2}{3} = \frac{17}{3} = t$

Since t is the # of hours after 6 AM, we can find the time adding 6:00 + $5\frac{2}{3}$. $\frac{2}{3}$ of an hour is $\frac{2}{3}$ (60 minutes) = 40 minutes, so add 6:00 + 5:40 = 11:40 AM.

Using t again in (1.) will give $C = 70\left(\frac{17}{3}\right) = \frac{1190}{3} = 396\frac{2}{3}$ miles.

Since the distances are equal we can conclude the cars met $396\frac{2}{3}$ miles W of OK city @ 11:40 AM.

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Cadillac and Toyota 1.1. A pink Cadillac leaves Oklahoma City at 6AM headed west on I-40 with the cruise control set at 70 mph. A federal agent in a green Toyota follows, leaving at 7 AM and traveling 85 mph. When and where does the Toyota catch up?

Pink Cadillac leaves Oklahoma at 6AM going 70 mph.
Green Toyota leaves from same place at 7AM, traveling at 85mph.
When will the Toyota catch up to the Cadillac?

① We know the formula for Distance; $D = r \cdot t$ where r = rate and t = time.

So for the cadillac $D_C = 70 \cdot t$ and for the Toyota; $D_T = 85t$.
We want to know when they met, but we have to factor in that the Cadillac left an hour before the Toyota.
If we want them to meet at the same time, we can simply adjust the time for the Cadillac OR Toyota.
So $D_T = 85t$ and $D_C = 70(t+1)$
Now we have 2 equations, we need to find the point where the distance is the same. (where they meet).
So, $85t = 70(t+1) \Leftrightarrow 85t = 70t + 70 \Leftrightarrow t = \frac{14}{3}$
$\frac{14}{3} = 4.\overline{6}$. Now we know it was 4 hours and some $\frac{2}{3}$ minutes so we have to convert to minutes
$\frac{2}{3}$ min $\cdot\ 60 = 36$ min. So in 4h 40 min they will meet → OUR time is in terms of the Toyota (since we adjusted the cadillac's time) Thus they meet at 11:40 AM.