YELLOW LIGHT PROBLEM SOLUTION:

BRAKING distance to be farther away to safely brake

$$D_a \geq \left( V_i \ T_R + -\left( \frac{(V_i)^2}{2A_B} \right) \right)$$

$$D_R + D_B$$

---

ACCELERATING the distance to be safely away or closer is

1)for $Vi \leq (V_{SL} - A(T_Y - T_R))$ never reach speed limit) (ACADEMIC)

$$D_a \leq \left( V_i \ T_R + (Vi(T_Y - T_R) + \frac{1}{2} A(T_Y - T_R)^2) - D_I - D_{CL} \right)$$

$$D_R + \quad D_{ACC} \quad - D_I - D_{CL}$$

----------(HONORS ONLY)----------

2)for $(V_{SL} - A(T_Y - T_R)) \leq Vi \leq V_{SL}$ (reacting, accelerating up to speed limit, at speed limit)

$$D_a \leq \left( (V_i \ T_R) + \left( \frac{(V_{SL}^2 - V_i^2)}{2A} \right) + \left( V_{SL} \left( T_Y - T_R - \left( \frac{(V_{SL} - V_i)}{A} \right) \right) \right) - D_I - D_{CL} \right)$$

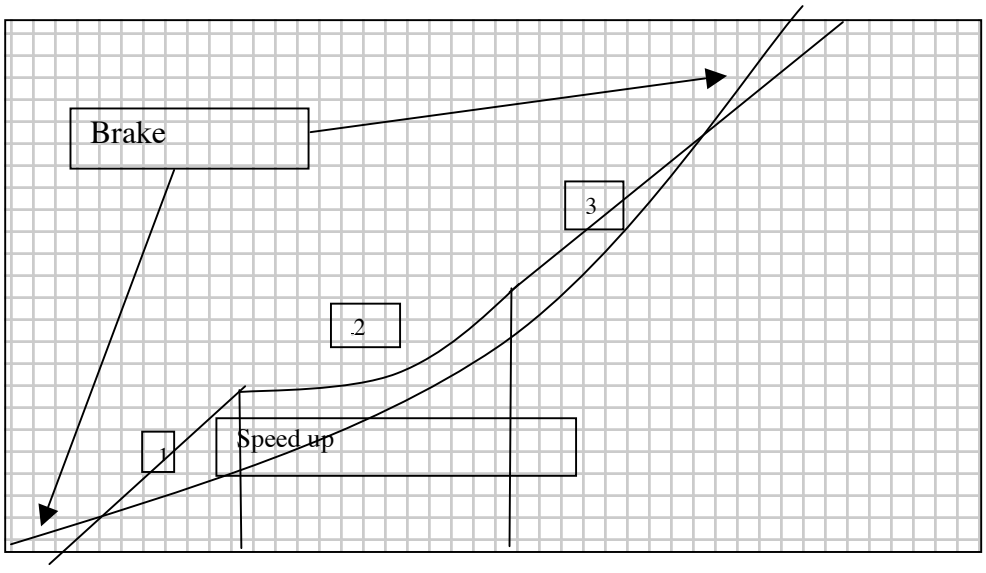
$$D_R + \quad D_{ACC} \quad + D_{SL} \quad - D_I - D_{CL}$$

----------(HONORS ONLY)----------

3)for $Vi \geq V_{SL}$ $D_a \leq (V_i \ T_R + (Vi(T_Y - T_R) - D_I - D_{CL})$ ( already over speed limit)

$$D_R + \quad + D_{SL} \quad - D_I - D_{CL}$$

---




Distance Away Da

Velocity $Vi$ $(V_{SL} - A(T_Y - T_R))$ $V_{SL}$

$$D = ViT + \frac{1}{2}AT^2 \qquad V_f = V_i + AT \qquad A = \frac{V_f - V_i}{T}$$

$$V_f^2 = V_i^2 + 2AD \qquad D = \frac{(V_i + V_f)}{2}T$$

YELLOW LIGHT BRAKING CASE:

$D_B$ = distance traveled while braking
$T_R$ = Reaction time in sec (measured)
$D_R$ = distance traveled in reaction time in m
$V_i$ = Initial velocity in m/s, $D_a$ = distance away in m << - - - your two variables
$D_a \geq D_B$

$A_B$ is your braking acceleration (a negative number) of car in m/s$^2$ gotten by using $V_f^2 = V_i^2 + 2AD$. Braking is usually given as 60mph-0 or 40mph-0 in distance to stop in feet.

$$\text{So } A_B = -\left(\frac{(V_B * .44704)^2}{2(D_S * .3048)}\right)$$

If there is no reaction time then the distance to brake to a stop uses $V_f^2 = V_i^2 + 2AD$,

$$D_B = -\left(\frac{(V_i)^2}{2A_B}\right) \text{ so distance to be farther away to safely brake}$$

$$\text{is } D_a \geq D_B \text{ so } D_a \geq -\left(\frac{(V_i)^2}{2A_B}\right)$$

If you figure in reaction time, then the distance traveled is the distance you go in that reaction time (at a constant speed) plus the distance you go while braking to a stop.

$$D_R = V_i \ T_R \qquad \text{so } D_a \geq D_R + D_B \text{ so } D_a \geq \left(V_i \ T_R + -\left(\frac{(V_i)^2}{2A_B}\right)\right)$$

distance to be farther away to safely brake

$$D = ViT + \frac{1}{2}AT^2 \qquad V_f = V_i + AT \qquad A = \frac{V_f - V_i}{T}$$

$$D = \frac{(V_i + V_f)}{2}T \qquad V_f^2 = V_i^2 + 2AD$$

YELLOW LIGHT ACCELERATING CASE

$T_Y$ = Time of yellow light (measured)

$D_y$ = distance traveled in time of yellow light in m

$T_R$ = Reaction time in sec (measured)

$D_R$ = distance traveled in reaction time in m

$V_i$ = Initial velocity

$T_{Acc}$ = time while accelerating to speed limit

$D_{Acc}$ = distance travelled while accelerating to speed limit

$T_{SL}$ = Time spent at speed limit

$D_{SL}$ = distance traveled while at speed limit

$V_{SL}$ = Speed limit in m/s (measured)

$T_L$ = time left over in sec

$V_i$ = Initial velocity in m, $D_a$ = distance away in m << - - - your two variables

$D_a \le D_Y - D_I - D_{CL}$

$D_I$ = distance across intersection in m (measured)

$D_{CL}$ = car length in m (measured)

A = acceleration of car in m/s$^2$ gotten by $A = \frac{60mph * .44704}{T_{0-60mph}}$ where $T_{0-60mph}$ is known in sec.

YELLOW LIGHT ACCELERATING CASE

If no reaction time or no speed limit, then the distance traveled in the time of the yellow light is simply:

$D_Y = ViT_Y + \frac{1}{2}AT_Y^2$ so then the distance to be safely away or closer is

$D_Y \ge D_a + D_I + D_{CL}$ so $D_a \le (D_Y - D_I - D_{CL})$ or

$$D_a \le ViT_Y + \frac{1}{2}AT_Y^2 - D_I - D_{CL}$$

YELLOW LIGHT ACCELERATING CASE

If you figure in reaction time, then the distance traveled in the time of the yellow light is the distance you go in that reaction time (at a constant speed) plus the distance you go while accelerating in the time left. $T_{ACC} = T_L$ = time left over in sec = $T_Y - T_R$

$D_R = V_i \ T_R$

$$D_{ACC} = ViT_L + \frac{1}{2} AT_L{}^2$$

$$D_{ACC} = Vi(T_Y - T_R) + \frac{1}{2} A(T_Y - T_R)^2$$

so $D_Y = D_R + D_{ACC}$

$$D_Y = V_i \ T_R + Vi(T_Y - T_R) + \frac{1}{2} A(T_Y - T_R)^2 \quad = ViT_Y + \frac{1}{2} A(T_Y - T_R)^2$$

$D_a \le (D_Y - D_I - D_{CL})$ so then the distance to be safely away or closer is

$$D_a \le \left( ViT_Y + \frac{1}{2} A(T_Y - T_R)^2 - D_I - D_{CL} \right)$$

(ACADEMIC---→)

This is also true if you figure in the speed limit if your car is traveling too slow or doesn't have enough acceleration to accelerate up to the speed limit in the time leftover from the yellow light.

---

If your car is going faster than that, then it goes up to the speed limit and then have to stay at that speed.

That critical velocity of $Vi$ is (using $V_f = V_i + AT$ with $V_{SL}$ and $T_Y$) is $Vi \le (V_{SL} - A(T_Y - T_R))$

---

---

When the car's initial speed is at or above the speed limit, ($Vi \ge V_{SL}$)it simply stays the same speed for the entire time of the yellow light so that the distance is

$$D_Y = V_i \ T_Y$$

and $D_a \le (D_Y - D_I - D_{CL})$

so then the distance to be safely away or closer is $D_a \le (V_i \ T_Y - D_I - D_{CL})$

Technically, the car is already illegal anyway (over the speed limit), so it wouldn't make sense to have it drop down to the speed limit as it goes through the yellow light.

YELLOW LIGHT ACCELERATING CASE

If the car's initial speed is over the critical velocity ($Vi \geq (V_{SL} - A(T_Y - T_R))$),but less than the speed limit ($Vi \leq V_{SLY}$)it will be three parts, the distance you go in your reaction time at a constant speed, plus the distance while accelerating up to the speed limit, plus the distance you go while at the speed limit in the time you have left. $D_Y = D_R + D_{ACC} + D_{SL}$

-The distance in reaction time: $D_R = V_i \ T_R$

-The distance while accelerating from $Vi$ to $V_{SL}$ using $V_f^2 = V_i^2 + 2AD$

$$D_{ACC} = \frac{(V_{SL}^2 - V_i^2)}{2A}$$

or solving for the time it takes to accelerate to the speed limit. Using $V_f = V_i + AT$,

$$T_{ACC} = \frac{(V_{SL} - V_i)}{A}$$

using $D = ViT + \frac{1}{2}AT^2$, and substituting for $T_{ACC}$,

$D_{ACC} = Vi\left(\frac{(V_{SL} - V_i)}{A}\right) + \frac{1}{2}A\left(\frac{(V_{SL} - V_i)}{A}\right)^2$ which simplifies to:

$$D_{ACC} = \frac{(V_{SL}^2 - V_i^2)}{2A}$$

-The distance the car goes at the speed limit is the velocity at the speed limit times the time left.

$$D_{SL} = V_{SL} \ T_{SL}$$

The time left is the time of the yellow light minus the reaction time minus the time spent accelerating up to the speed limit. $T_{SL} = T_L = T_Y - T_R - T_{ACC} =$

$$T_L = T_Y - T_R - \left(\frac{(V_{SL} - V_i)}{A}\right)$$

So $$D_{SL} = V_{SL} \ T_{SL} = V_{SL}\left(T_Y - T_R - \left(\frac{(V_{SL} - V_i)}{A}\right)\right)$$

To get the total distance in this case: when the car's initial speed is over that amount ($Vi \geq (V_{SL} - A(T_Y - T_R))$),but less than the speed limit ($Vi \leq V_{SL}$)

$$D_Y = D_R + D_{ACC} + D_{SL},$$

$$D_Y = (V_i \ T_R) + \left(\frac{(V_{SL}^2 - V_i^2)}{2A}\right) + \left(V_{SL}\left(T_Y - T_R - \left(\frac{(V_{SL} - V_i)}{A}\right)\right)\right)$$

$D_a \leq (D_Y - D_I - D_{CL})$ so then the distance to be safely away or closer is

$$D_a \leq (V_i \ T_R) + \left(\frac{(V_{SL}^2 - V_i^2)}{2A}\right) + \left(V_{SL}\left(T_Y - T_R - \left(\frac{(V_{SL} - V_i)}{A}\right)\right)\right) - D_I - D_{CL}$$

simplified a bit:

$$D_a \leq \left(\left(\frac{-V_i^2}{2A}\right) + V_i\left(\frac{(V_{SL} + AT_R)}{2A}\right) - \left(\frac{V_{SL}^2}{2A}\right) + V_{SL}(T_Y - T_R) - D_I - D_{CL}\right)$$

for $(V_{SL} - A(T_Y - T_R)) \leq Vi \leq V_{SL}$

```
YELLOW LIGHT PROGRAM
FOR TI-82/83/84

ClrHome
ClrTable
Clear Entries
ClrTable
ClrDraw
Disp ""
Disp "YELLOW LIGHT"
Disp "PROBLEM!!!"
Pause
ClrHome
Disp "CAR LENGTH IN M?"
Disp ""
Disp "(TYPICAL VALUE"
Disp "       IS 3 M) "
Input L
ClrHome
Disp ""
Disp "CAR BRAKING"
Disp "DISTANCE"
Disp "60MPH TO 0"
Disp " IN FEET?"
Disp ""
Disp "(TYPICAL VALUE"
Disp "  IS 140 FT) "
Input B
"COMMENTBraKInG DeacceLeratIOn In M/s
² Is"

(60*.4470⁴)²/(2*(B*.305))→C

ClrHome
Disp "CAR ACCELERATION"
Disp " 0 TO 60 MPH"
Disp " IN SECONDS?"
Disp ""
Disp "(TYPICAL VALUE"
Disp " IS 7-15 SEC "
Input A
"COMMENTAcceLeratIOn OF Car In M/s ²
Is"

(60*.4470⁴)/A→F

ClrHome
Disp "REACTION TIME "
Disp "IN SECONDS?"
Disp ""
Disp "(TYPICAL VALUE"
Disp "IS .2 TO 1 S) "
Input R
ClrHome
Disp "TIME OF YELLOW"
Disp "LIGHT IN SECONDS?"
Disp ""
Disp "(TYPICAL VALUE"
Disp "  IS 2-8) "
Input T


ClrHome
Disp "INTERSECTION "
Disp "LENGTH IN METERS?"
Disp ""
Disp "(TYPICAL VALUE"
Disp "  IS 8-20 M) "
Input I
ClrHome
Disp "SPEED LIMIT(MPH)"
Disp ""
Disp "(TYPICAL VALUE"
Disp " 25-50 MPH) "
Input S

"COMMENTMAX InItaL speed In MpH tHe
car can GO MaX tO speed up tO tHe
speed LIMIt In tHIs tIMe Is"
(S-60*(T-R)/A)→Z



"COMMENTTime In sec It taKes tHe car
tO GO FrOM Its InItIaL speed tO tHe
speed LIMIt Is"
"(A*(S-X)/60)"→Y6

ClrHome
Disp "VELOCITY(MPH)"
Disp "OF CAR"
Disp "ON X AXIS"
Disp ""
Disp "DISTANCE(M)"
Disp "FROM LIGHT"
Disp "ON Y AXIS"
Pause
-9→Xmin
85→Xmax
5→Xscl
1→Xres
-50→Ymin
Y1(85)→Ymax
5→Yscl
Disp "Y1 IS BRAKING"
Disp " CASE >"
Disp "Y2 IS SPEED UP"
Disp "  CASE <"
Pause
"COMMENTX Is InItIaL veLOcItY
varIabLe OF car In MpH"
"COMMENTDIstance In M TraveLed In
reactIOn tIMe Is"
".4470⁴*X*R"→Y7
```

```
"COMMENTBraKInG Case, DIstance In M
traveLed In braKInG deacceLeratIOn
Is"
"(.447Ø4*X)²/(2*C)"→Y8

"COMMENTBraKInG Case, DIstance
traveLed In reactIOn tIMe pLus
deacceLeratIOn Is"
"Y7+Y8"→Y1

"COMMENTAcceLeratInG case IF nO speed
LIMIt, reactIOn tIMe dIstance In M
pLus dIstance In M traveLed as
acceLeratInG MInus IntersectIOn MInus
car LenGtH Is"
"Y7+(.447Ø4*X)*(T-R)+.5*F*(T-R)²-I-
L"→Y3

"COMMENTReactIOn tIMe dIstance pLus
dIstance traveLed In M wHILe
acceLeratInG up tO speed LIMIt pLus
tHe dIstance traveLed aFter tHat
wHILe at tHe speed LIMIt MInus
IntersectIOn MInus car LenGtH Is"
"Y7+(.447Ø4*X)*Y6+.5*F*Y6²+.447Ø4*S*(
T-R-Y6)-I-L"→Y4

"COMMENTDIstance traveLed IF at or
abOve speed LIMIt MInus IntersectIOn
MInus car LenGtH (reactIOn tIMe
dOesn't Matter, assuMe a cOnstant
speed above tHe speed LIMIt) Is"

"(.447Ø4*X)*T-I-L"→Y5


"COMMENTTHree part FunctIOn FOr
acceLeratIOn case. LIne FOr InItIaL
speed Less tHan MaX InItIaL speed,
pLus LIne FOr tHe InItIaL speed Is In
between MaX InItIaL speed and speed
LIMIt, and LIne FOr car's InItIaL
speed Is at or abOve speed LIMIt Is"

"(Y3)*(X<Z)+(Y4)*(X≥Z)*(X<S)+Y5*(X≥S)
"→Y2


PlotsOff
LabelOn
RectGC
AxesOn
CoordOn
GridOff
FnOff
FnOn 1,2,3
GraphStyle(1,3)
"COMMENTGrapH's BRaKInG Case as a
Greater tHan"

GraphStyle(2,4)
"COMMENTGrapHs AcceLeratIOn Case as a
Less tHan"

GraphStyle(3,5)
"COMMENTGrapHs nO speed LIMIt case"
Vertical X

Trace
ClrHome
Fix 1
Disp "ENTER SPEED OF"
Disp "CAR IN MPH"
Input V
Disp "BRAKE IF"
Disp "FARTHER THAN"
Disp Y1(V)
Disp "METERS. SPEED UP"
Disp "IF CLOSER THAN"
Disp Y2(V)," METERS AWAY"
Pause

ClrHome
Disp "THINKING"
Ø→X
If Y2(Ø)<Y1(Ø)
Then
Disp "NO SOLUTION!"
Else
solve((Y1-Y2),X,55,{-1ØØØ,1ØØØ})→X
End
Disp X," MPH,"
Disp
Disp Y1(X)," METERS AWAY"
Disp "IS THE DECISION"
DIsp" POINT"
Pause
```