



# Louisiana Department of Transportation and Development

## Yellow Time

Louisiana Traffic Engineers Meeting

Presented by

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State Traffic Engineer

June 26, 2012

# Yellow Time Quiz

1. True or False: In Louisiana as in most states is it legal to be in the intersection when the light turns red as long a you entered on a green or yellow?
2. True or False: Perception Reaction Time is the same for warning signs, traffic signals, and intersections?
3. Yellow Time is?
  - a. The time needed to come to a stop.
  - b. The time needed to go thru the intersection.
  - b. The time to travel the distance needed to stop.
  - c. None of the above.

# Yellow Time

## Legal

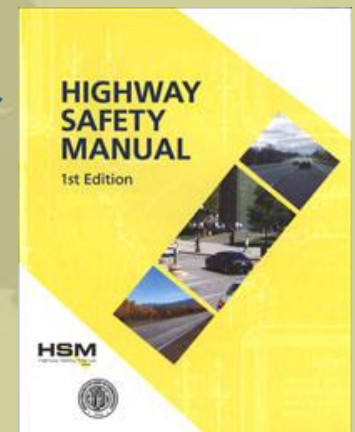
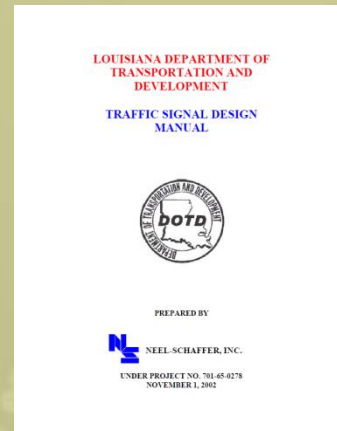
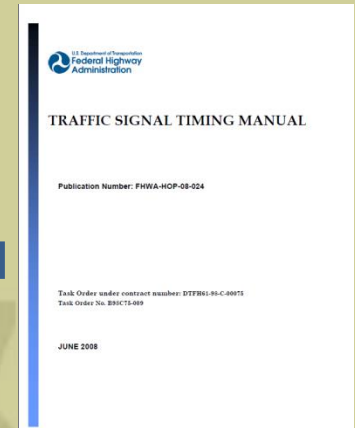
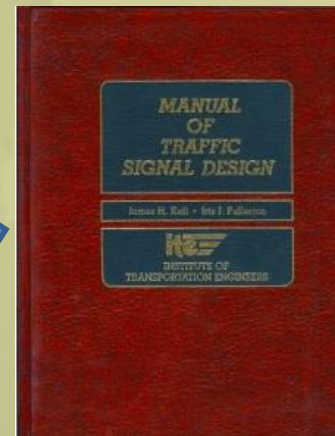
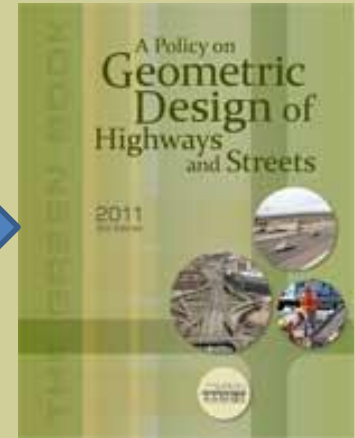
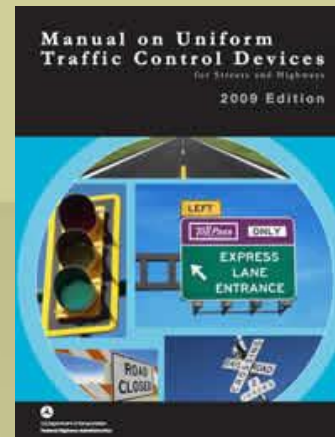
- Permissive Yellow Law: A driver can enter the intersection during the entire yellow interval and be in the intersection during the red indication as long as the vehicle entered the intersection during the yellow interval.
- Restrictive Yellow Law: A vehicle may not enter an intersection when the indication is yellow unless the vehicle can clear the intersection by the end of yellow.

## Louisiana Revised Statute 32:232. Traffic-control signals

(2)(a) Vehicular traffic facing a steady yellow signal alone is thereby warned that the related green signal is being terminated or that a red signal will be exhibited immediately thereafter and such vehicular traffic shall not enter or be crossing the intersection when the red signal is exhibited.

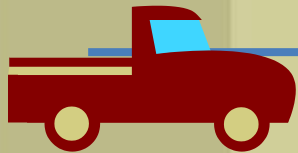
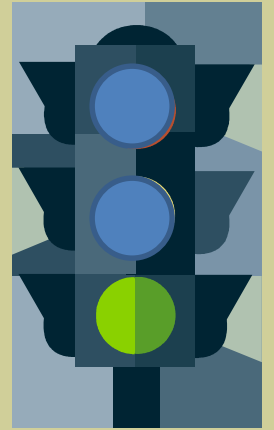
# References

- 2009 MUTCD
- 2011 Green Book
- 2008 FHWA Signal Timing Manual
- 2002 DOTD Traffic Signal Design Manual
- 2006 Manual of Traffic Signal Design
- 2010 Highway Safety Manual



# Yellow Time Physics

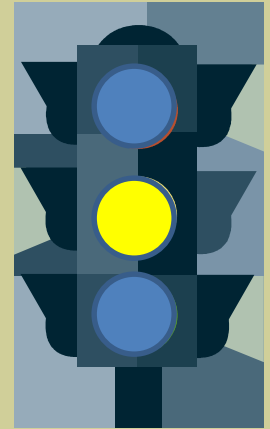
Vehicle approaching a Traffic Signal on a Green.



# Yellow Time Physics

The Traffic Signal turns Yellow.

Step 1: Consider Vehicle Stops



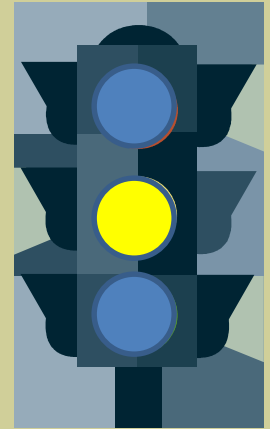
Stop or  
go?



# Yellow Time Physics

The Traffic Signal turns Yellow.

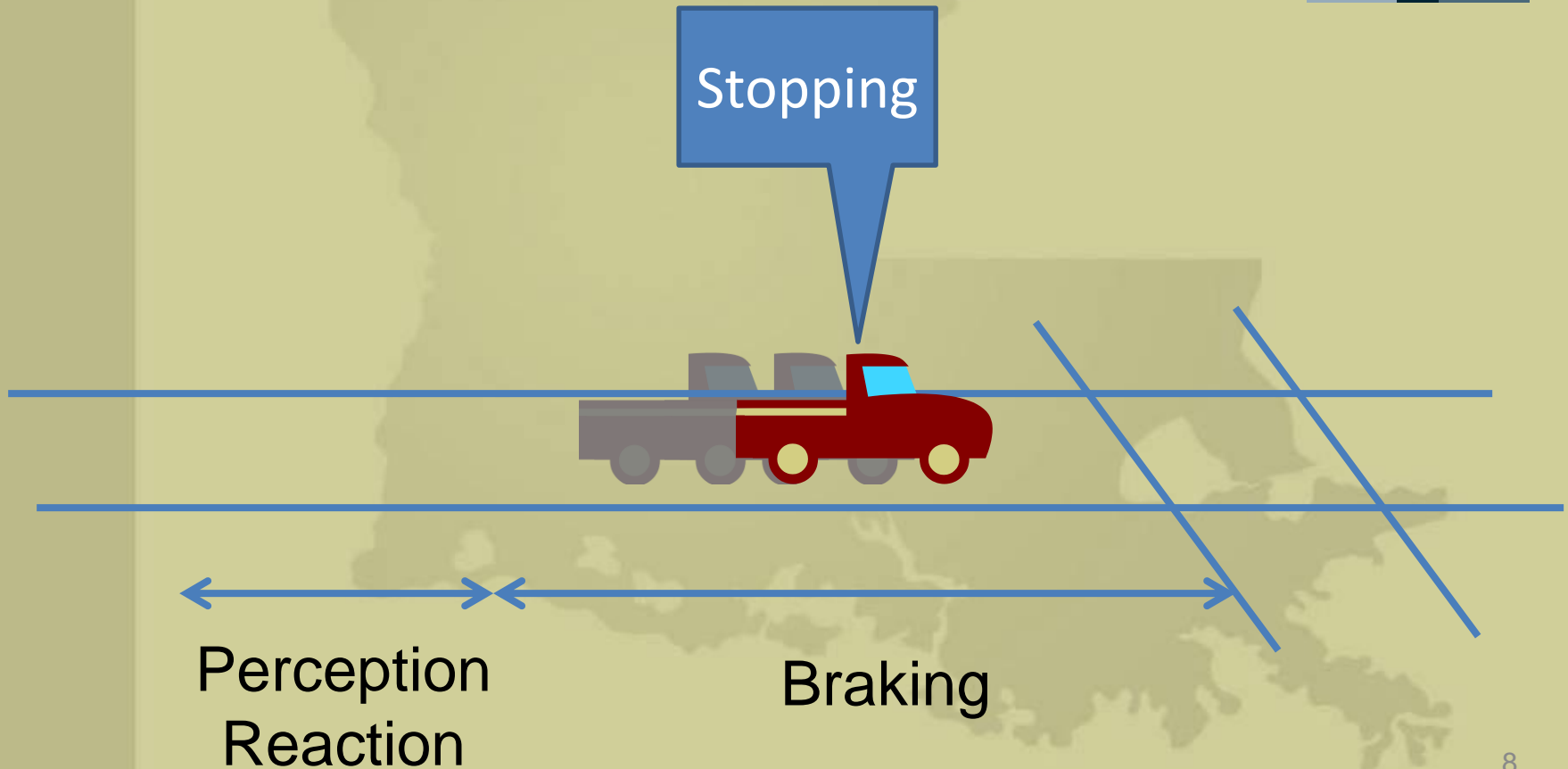
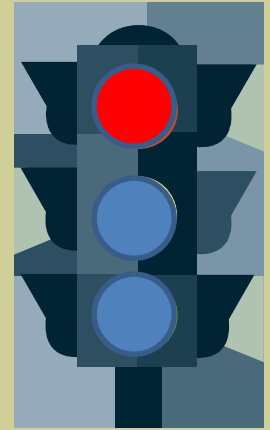
Step 1: Consider Vehicle Stops



# Yellow Time Physics

The Traffic Signal turns Red.

Step 1: Consider Vehicle Stops

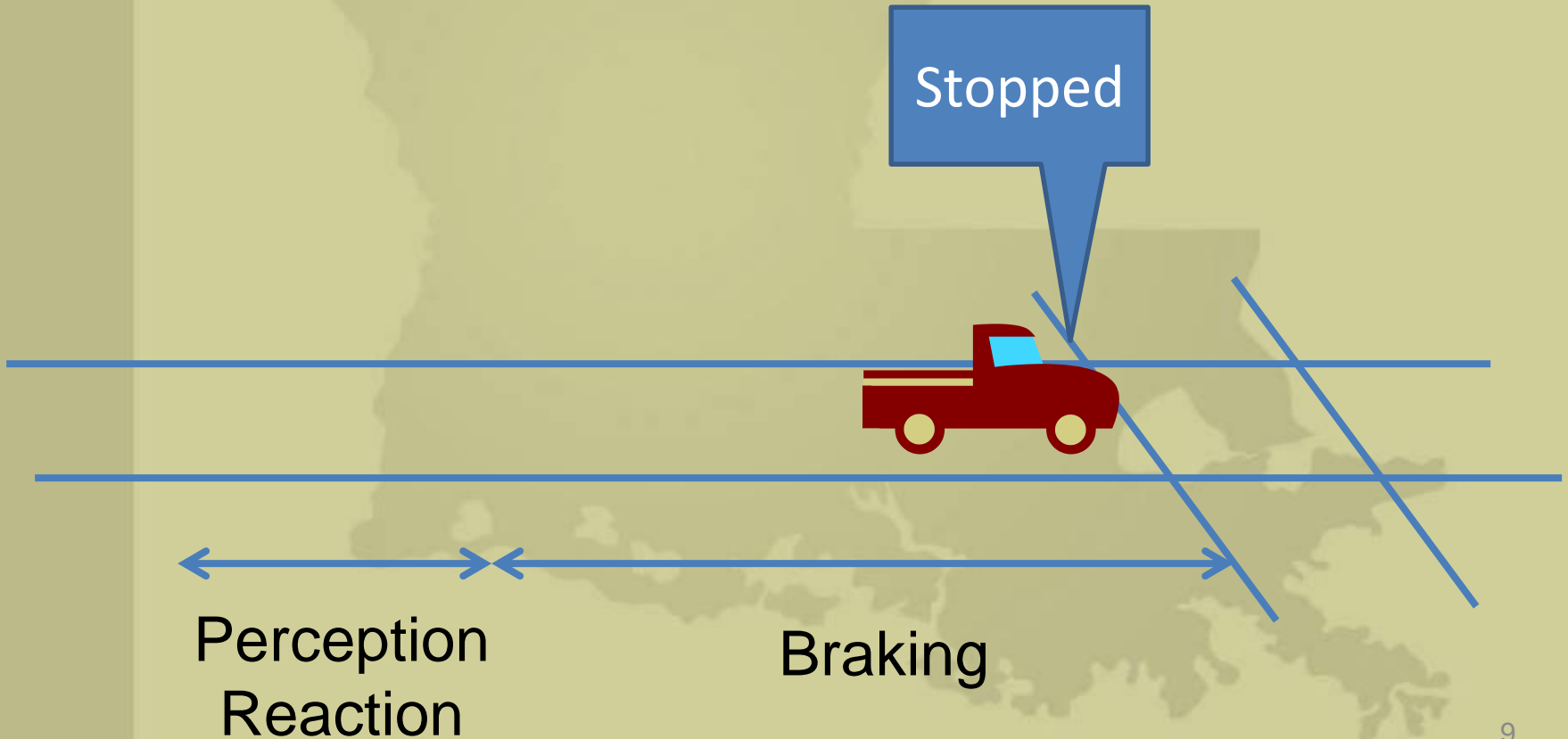
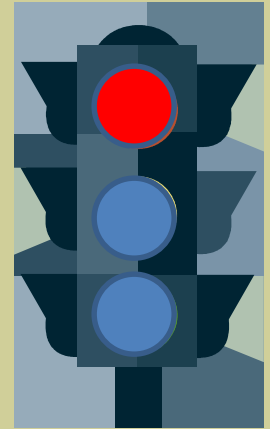




# Yellow Time Physics

The Traffic Signal turns Red.

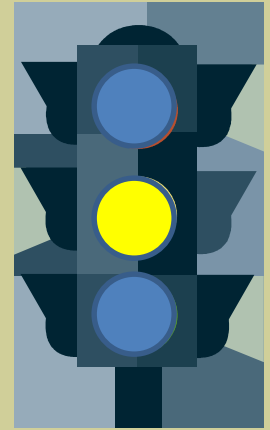
Step 1: Consider Vehicle Stops



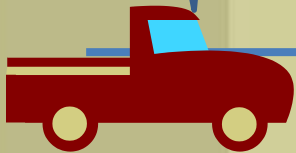
# Yellow Time Physics

The Traffic Signal turns Yellow.

Step 2: Consider Vehicle Does Not Stop



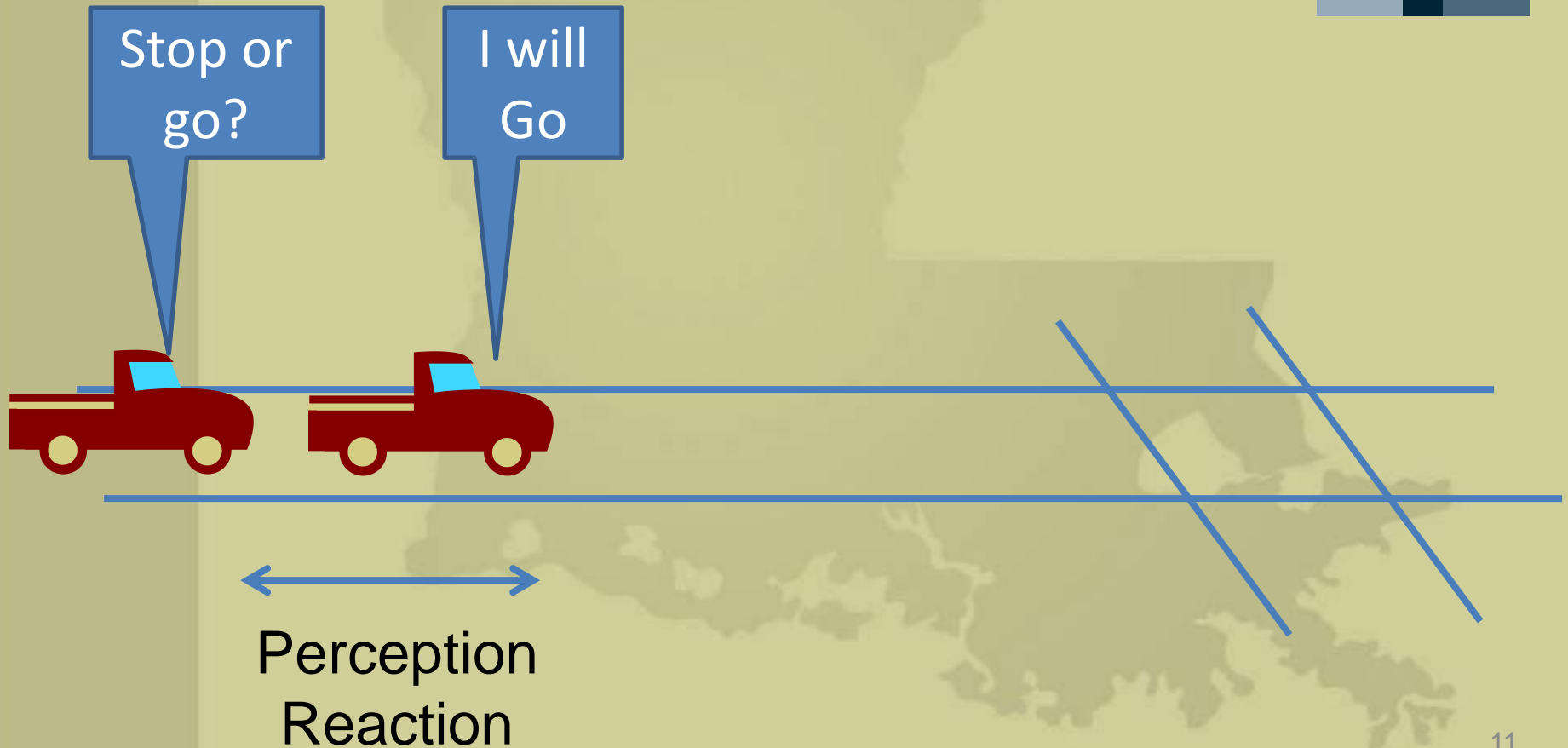
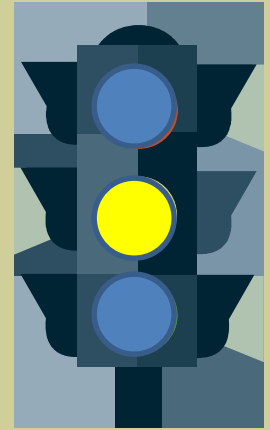
Stop or  
go?



# Yellow Time Physics

The Traffic Signal turns Yellow.

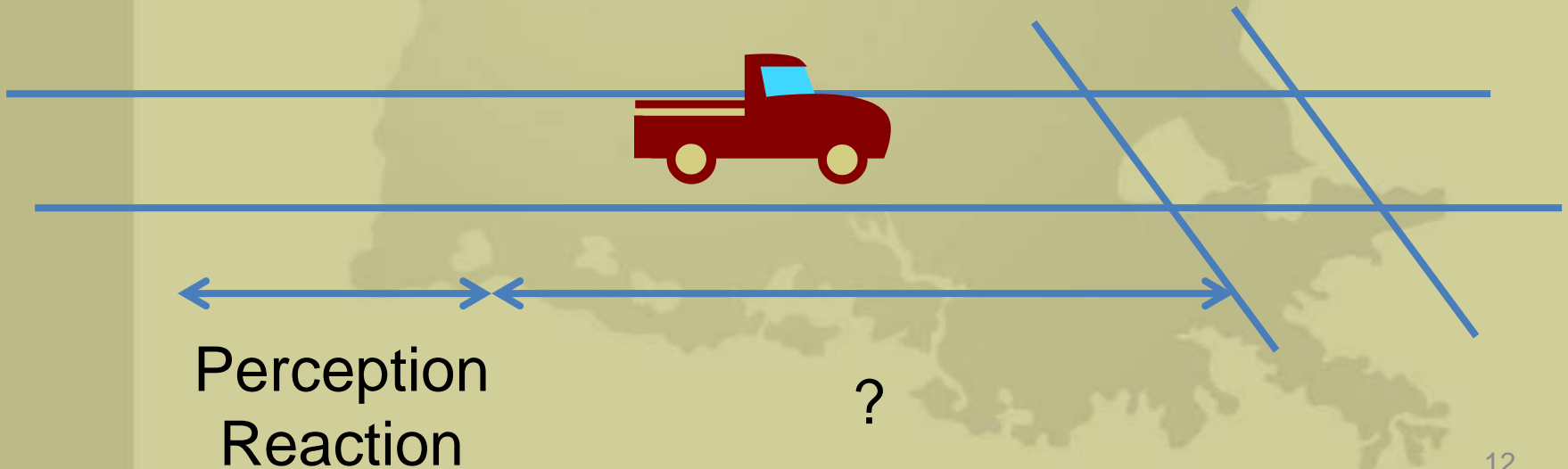
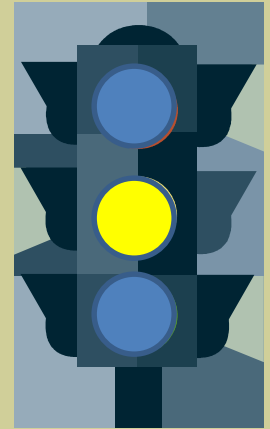
Step 2: Consider Vehicle Does Not Stop



# Yellow Time Physics

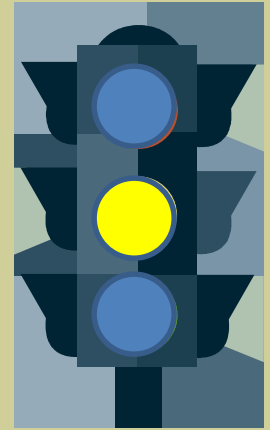
The Traffic Signal turns Yellow.

Step 2: Consider Vehicle Does Not Stop



# Yellow Time Physics

Step 2: Consider Vehicle Does Not Stop

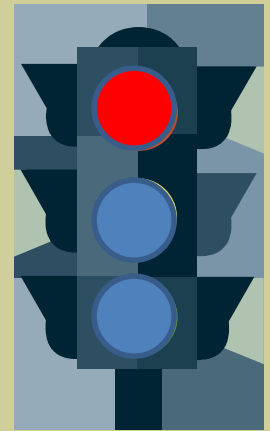


I hope  
I make it!

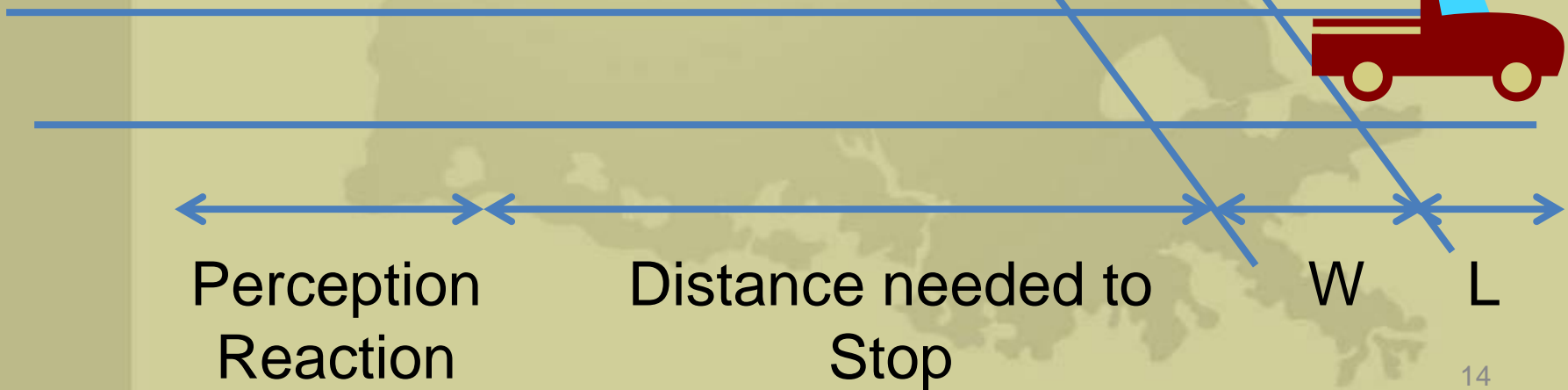
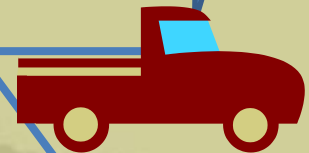


# Yellow Time Physics

Step 2: Consider Vehicle Does Not Stop

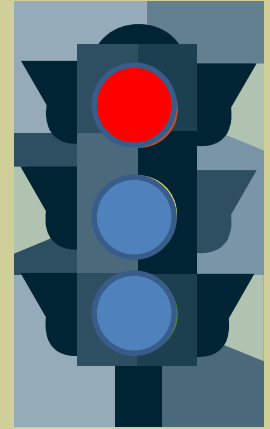


I made it!



# Yellow Time Physics

## Step 1: Consider Vehicle Stops



Distance traveled during perception reaction,

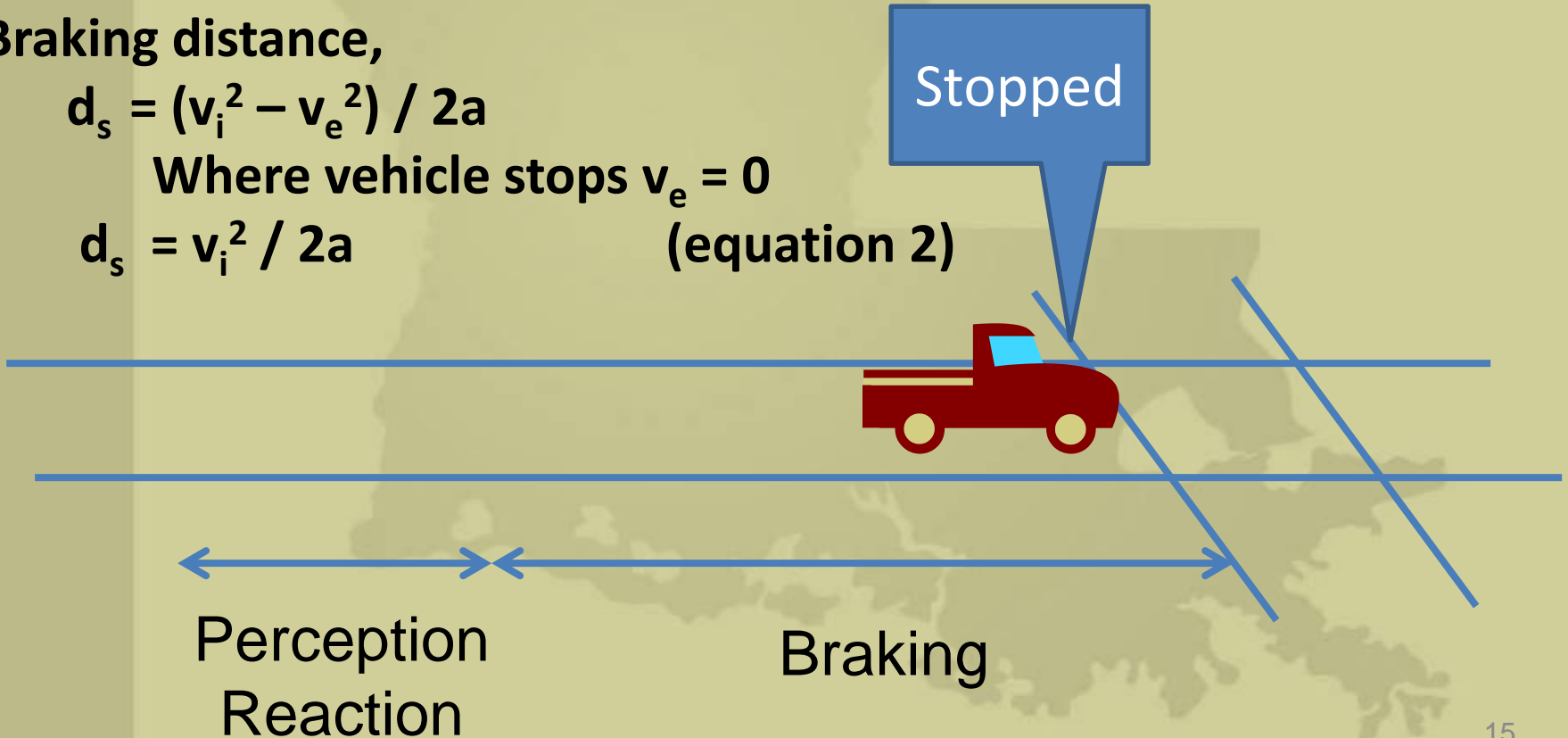
$$d_{pr} = t_{pr} \times v_i \quad (\text{equation 1})$$

Braking distance,

$$d_s = (v_i^2 - v_e^2) / 2a$$

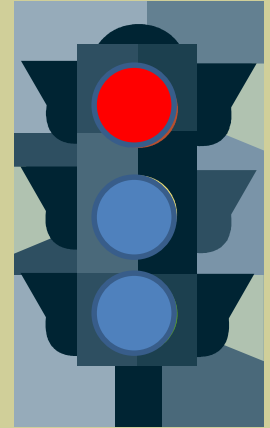
Where vehicle stops  $v_e = 0$

$$d_s = v_i^2 / 2a \quad (\text{equation 2})$$



# Yellow Time Physics

## Step 1: Consider Vehicle Stops



Distance traveled during perception reaction,

$$d_{pr} = t_{pr} \times v_i \quad (\text{equation 1})$$

Braking distance,

$$d_s = v_i^2 / 2a \quad (\text{equation 2})$$

Total distance traveled from perception to the stop bar,

$$d_{sb} = d_{pr} + d_s$$

$$d_{sb} = (t_{pr} \times v_i) + (v_i^2 / 2a) \quad (\text{equation 3})$$

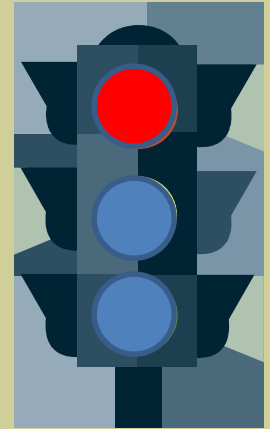
Perception  
Reaction

Braking





# Yellow Time Physics



Step 2: Consider Vehicle Does Not Stop

Time to travel total distance from perception to stop:

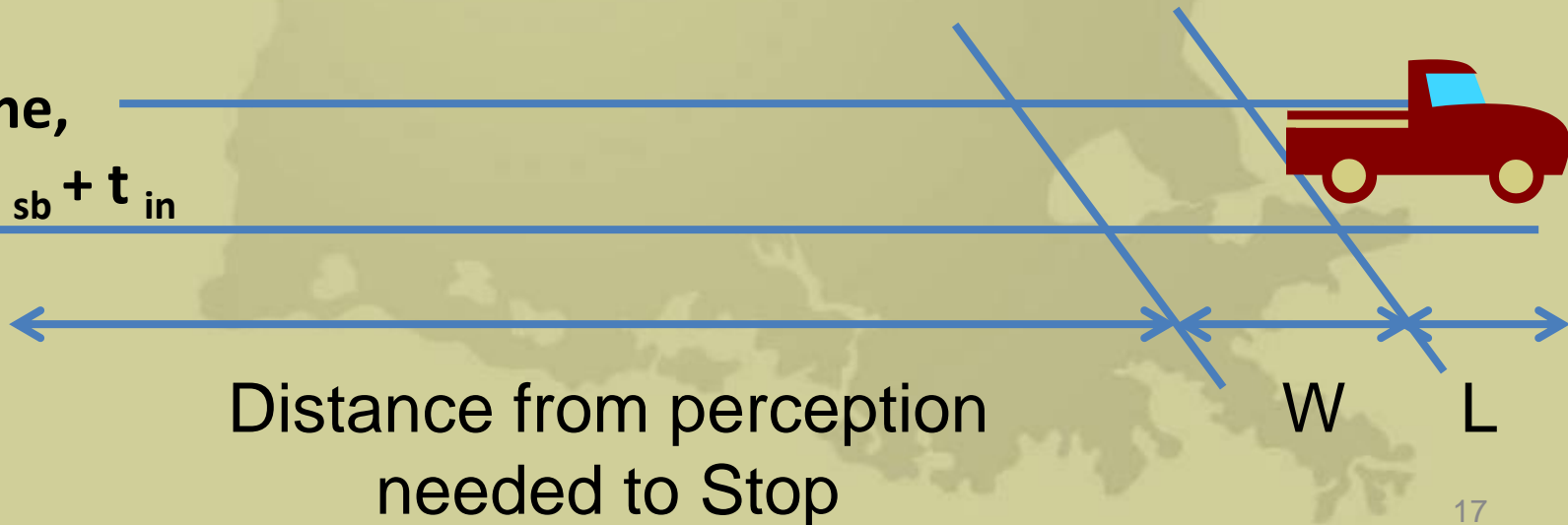
$$t_{sb} = d_{sb} / v_i \quad (\text{equation 4})$$

Time required for a vehicle ( $L$  in length) to travel thru the intersection ( $W$  in width),

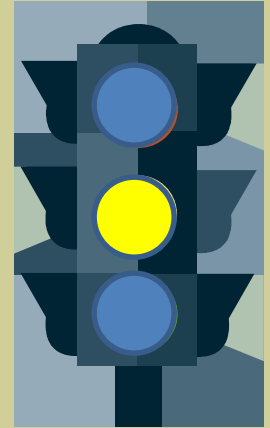
$$t_{in} = W + L / v_i \quad (\text{equation 5})$$

Total time,

$$T = t_{sb} + t_{in}$$



# Yellow Time Physics



## Step 3: Yellow Time

Total time,

$$T = t_{sb} + t_{in}$$

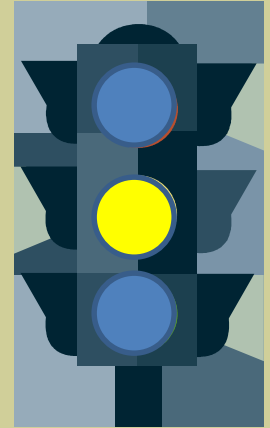
$$T = (d_{sb} / v_i) + (W + L / v_i) \quad (\text{equation 4 + 5})$$

$$\text{Also } d_{sb} = (t_{pr} \times v_i) + (v_i^2 / 2a) \quad (\text{equation 3})$$

$$T = (((t_{pr} \times v_i) + (v_i^2 / 2a) / v_i)) + (W + L / v_i)$$

$$T = ((t_{pr} + (v_i / 2a)) + (W + L / v_i)) \quad \text{ITE Equation}$$

# Yellow Time Physics



## Step 3: Yellow Time

### ITE Equation

$$T = ((t_{pr} + (v_i / 2a)) + (W + L / v_i))$$

### Perception Reaction Time, $t_{pr}$

1.0 sec ITE

1.5 sec Older Driver Handbook

1.64 sec for simple conditions (2011 Green Book)

2.5 sec for complex conditions (2011 Green Book)

2.5 sec for warning signs (2009 MUTCD)

Distracted Driving: 2011 TTI Study on Response Time

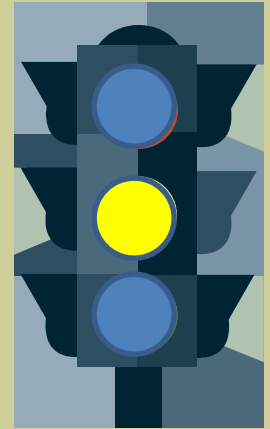
Condition	Mean
Control	1.754
Writing	4.302
Reading	3.278

# Yellow Time Physics

## Step 3: Yellow Time

### ITE Equation

$$T = ((t_{pr} + (v_i / 2a)) + (W + L / v_i))$$



### Velocity, $v_i$

Posted Speed Limit

85<sup>th</sup> Percentile

Turning Vehicles

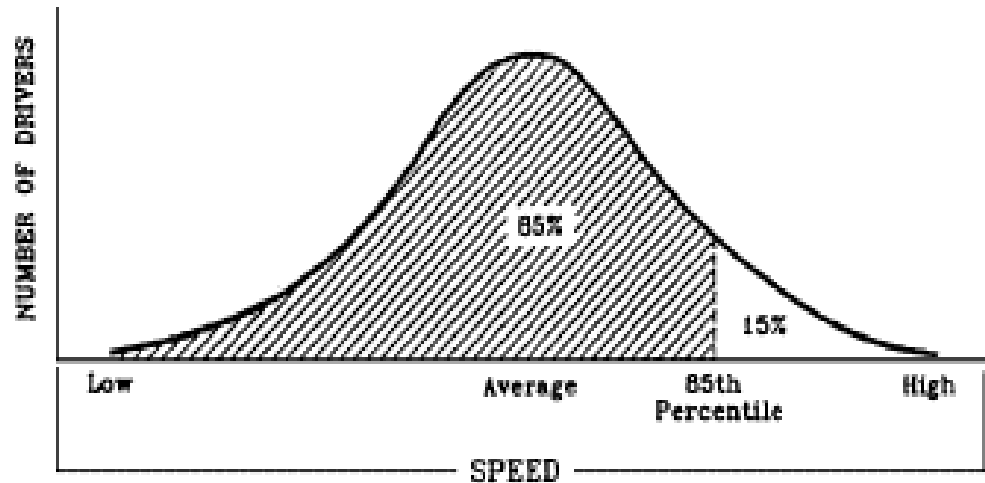
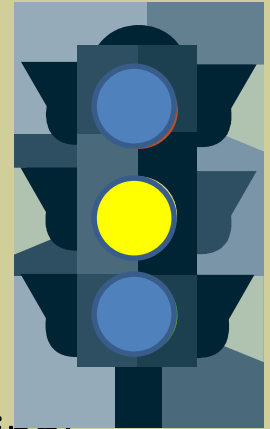


Figure 3-2 Speed distribution showing the 85th percentile speed (Krammes et al. 1996).

# Yellow Time Physics

## Step 3: Yellow Time

ITE Equation ,  $T = ((t_{pr} + (v_i / 2a)) + (W + L / v_i))$



### Deceleration, a

2.5 ft/s/s (coasting in gear),

**10.0 ft/s/s** (ITE for yellow and 2009 MUTCD for maneuver warning),

11.2 ft/s/s (2011 Green Book, 2009 MUTCD for stop warning signs)

16.0 ft/s/s (hard braking)

### Required NHTSA Truck Maximum Braking:

Old Standard, 355 ft at 60 mph

$a = 11 \text{ ft/s/s}$

2009 Standard, 250 ft at 60 mph (loaded),

$a = 15.5 \text{ ft/s/s}$

2009 Standard, 235 ft at 60 mph (empty),

$a = 16.5 \text{ ft/s/s}$

### Actual Passenger Vehicle Maximum Braking:

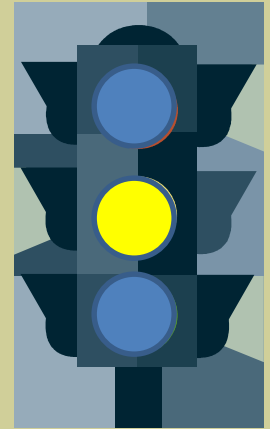
SUV, 60 mph in 150 ft,

$a = 26 \text{ ft/s/s}$

Car/Motorcycle, 60 mph in 120 ft,

$a = 32 \text{ ft/s/s}$

# Yellow Time Physics



## Step 3: Yellow Time

### ITE Equation

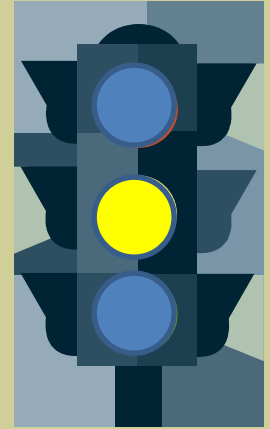
$$T = ((t_{pr} + (v_i / 2a)) + (W + L / v_i))$$

Table 5-7 Duration of change period intervals

Approach Speed, mph	“ $t + v/2a$ ” Terms, s (YELLOW)	Width of Intersection, ft				
		30	50	70	90	110
“(W+L)/v” Term, s (ALL-RED)						
25	3.0 <sup>a</sup>	1.4	1.9	2.5	3.0	3.5
30	3.2	1.1	1.6	2.0	2.5	3.0
35	3.6	1.0	1.4	1.8	2.1	2.5
40	3.9	0.9	1.2	1.5	1.9	2.2
45	4.3	0.8	1.1	1.4	1.7	2.0
50	4.7	0.7	1.0	1.2	1.5	1.8
55	5.0	0.6	0.9	1.1	1.4	1.6
60	5.4	0.6	0.8	1.0	1.2	1.5

<sup>a</sup> The 2003 MUTCD recommends a minimum duration of 3 seconds for the yellow change interval.

# Yellow Time Physics



ITE Equation ,

$$T = ((t_{pr} + (v_i / 2a) ) + (W + L / v_i )$$

Yellow should range from a 3 second minimum to a 6 second maximum.

All red should range from 1 to 2 seconds (maximum of 6 seconds).

# Attempts to Legislate Yellow Time

## HB 987 of 2012

Any municipality or local governing authority in this state shall use a standard caution light duration as recommended by the National Motorist Association Foundation. A duration of **five seconds shall be used as the absolute minimum** caution or "yellow light" interval duration for any intersection in this state. This shall be the standard yellow light time regardless of the posted speed limit.

## HB 880 of 2012

Any municipality or local governing authority in this state which utilizes automated enforcement systems to issue traffic citations shall use the **maximum** caution or "yellow light" interval duration of **six seconds** as recommended by the National Motorist Association Foundation and the Institute of Transportation Engineers' Technical Committee for all intersections, **as the absolute minimum** caution interval duration for any intersection utilizing an automated enforcement system.

**An amendment was submitted in Committee to require the Yellow Time be set as:**

$$T = VT + V/A$$

(note the units)    **sec = (ft/sec x sec) + ( ft/sec / ft/sec/sec )**

$$\text{sec} = \text{ft ?} + \text{sec}$$



# Thank You

