WHAT SHOULD YOU DO AT A YELLOW LIGHT? (04)

Your task: definitively prove what you should do for YOUR car, at a certain yellow light intersection, at a given speed (Vi) and distance (Da).

Things you need to research:
FOR THE INTERSECTION YOU PICK:
The distance (Di) from the edge of the intersection, through to the other side.
The time (Ty) from the time the light turns yellow till it turns red... (as exactly as possible)
The speed limit (Vsl) of the road you would travel.
YOUR CAR:
The length from the front bumper to the back bumper (Dcl)
The acceleration of your car, make and model. (A) (usually given as 0-60 in ___ sec)
See Car & Driver magazine road tests, AAA auto Guides, or research the Internet: some links are at http://homepage.mac.com/richtherrn/car.html
(try national safety board for example: http://www.nhsta.dot.gov)
The braking deacceleration of your car make and model. (A_B) (usually given as __ ft from 40 miph)
Your reaction time (Tr) between when you see the yellow light and you can react.

You will need to do all conversions appropriately (for example 0 to 60 miles per hour in 10 seconds to meters per sec per sec, and 60 to 0 mph in 20 ft to meters per sec per sec)
1 miph = 0.44704 m/s, 1 ft = .3048 meters

Hopefully you can come up with a formula for braking, dependent on distance from intersection and speed, and one for speeding up dependent on distance and speed and place these two inequalities on the same graph.

Safe braking is defined as when you step on the brakes and deaccelerate at your given speed, your stopping distance is less than that between the given distance your car and intersection. No part of your car is in the intersection under a red light!

Safe speeding up is defined as when you speed up and accelerate at the maximum for your given speed, you go the given distance between your car and the intersection, plus the distance of the intersection, plus the length of your car, and the time it takes you to do so is less than the time of the yellow light, so that no part of your car is in the intersection under a red light! Oh, also the maximum speed attained cannot go over the speed limit.

So for braking : distance traveled d
f(v)=d, so that d<Da
for speeding up f(v)=d, so that for t=Ty. d>Da +Di + Dcl and Vf<Vmax

All conversions should be built in as constants... Find out if there is ever a case when you could choose to do either, or a case when you are in trouble (you can't safely do either!) BE CLEAR AND NEAT!!!!!

HONORS: Find the two mathematical inequality relationships that account for ALL the variables and plot them on a speed vs. distance away graph for that particular car, driver and intersection.
And make sure to write conclusions!

ACADEMIC: List for about ten different distances away and speeds what should be done for that particular car, driver and intersection, and show why. (Ignore speed limit). Find the answers asked for: at a particular speed what is the minimum safe accelerating distance, maximum safe braking?
And make sure to write conclusions!

BRAKING CASE:
we don’t care about time, or the length of the car.

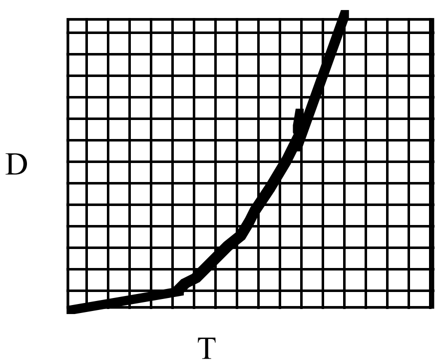
Your distance traveled will be your car’s velocity times your reaction time plus the rest of the distance traveled will be given by your car’s braking deacceleration (converted to m/s^2), and your car’s initial velocity. This total distance should be LESS than the distance from the car to the intersection.

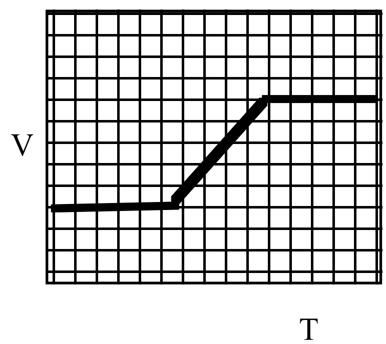
Distance traveled is d = Dreaction + D braking << Da

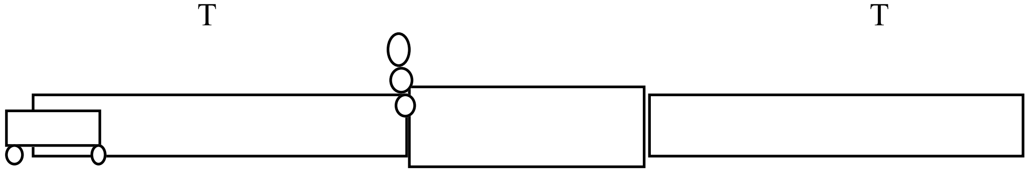
Dreaction=ViTr

Dbraking = $Vi^2/(2\ A_B)$

ACCELERATING CASE:
In the time of the yellow light your car must travel MORE than the distance from the car to the intersection PLUS the distance across the intersection PLUS the length of the car.
Your distance traveled will be your car’s velocity times your reaction time plus the distance traveled as your car accelerates up to the speed limit, given by the initial velocity, the car’s acceleration (converted to m/s^2), and the time of the yellow light left, then plus the distance your car travels while at the speed limit. A distance time, and velocity time graph of this case might be:







Distance traveled is

D reacting =	Vi Tr	PLUS	
D accelerating	Vi T + 1/2 A T^2 (Time left in yellow light)		PLUS
D at speed limit	VslT (ignore for academic,)		

Dtraveled has to be more than Da + Di + Dcl so Da < D traveled - Di - Dcl
(**HONORS: Critical Velocity is speed at which car will reach speed limit in time of yellow light)
EXAMPLE ANSWER TO TEST YOURSELF:
A 3 meter car that goes 0-60 in 12 seconds, and brakes from 60 mph in 180 feet, with a driver reaction time of 0.2 seconds. The car is traveling 30 mph in a 45 mph zone, 25 meters away from an intersection that is 12 meters across with a 2 second yellow light.
This driver is stuck... would have to be closer than 15.2 meters to speed up in time, and farther than 23.9 meters away to brake in time legally! In fact, in this situation, there is ALWAYS a range of distances for a given speed in which the driver can’t brake, and can’t speed through the intersection in time, even with NO speed limit!☹

NAME________________
DATA:
Car Year _________ Make __________ Model_________
Car Length in meters (Dcl) ___________________

Car Year _________ Make __________ Model_________

Acceleration 0 to 60 mi p h in ______ sec. (T_{60})

A = (Vf-Vi)/T when Vi is zero so A = .44704 (60 miph) / T_{60}

Car Acceleration in m/s^2 : (A) ___________

Car Year _________ Make __________ Model_________

Braking deacceleration from 60 mi p h in feet. ________ ft (D_{60})
$Vf^2 = Vi^2 + 2 A D$ so $A = - Vi^2/2D$

$A_B = (.44704 * 40)^2 / (2* .3048* D_{60})$

Car Braking Acceleration in m/s^2 : (A_B) ___________

Reaction Time (Tr) in seconds_________________ (from class T = sqrt(2D/g))

Intersection LOCATION:

Intersection Length in meters (Di)______________

Yellow light time in seconds (Ty) ______________

Speed Limit on Road (Vsl) in m/s ____________

*** USE THIS DATA TO ANSWER QUESTIONS!!!

**All conversions should be built in as constants... Find out if there is ever a case when you could choose to do either, or a case when you are in trouble (you can't safely do either!) BE CLEAR AND NEAT!!!!!
HONORS: Find the two mathematical inequality relationships that account for ALL the variables and plot them on a speed vs. distance away graph for that particuliarr car, driver and intersection.
And make sure to write conclusions!
ACADEMIC: List for about ten different distances away and speeds what should be done for that particuliarr car, driver and intersection, and show why. (ignore speed limit). Find the answers asked for: at a particuliarr speed what is the minimum safe accelerating distance, maximum safe braking?
And make sure to write conclusions!.......
°Traveling at the speed limit, (and other speeds) what is the farthest away safe braking distance for your car?
°Traveling at the speed limit, (and other speeds) what is the closest safe accelerating distance for your car?
°Is there a speed and distance at which it is not safe to do either??? SHOW WORK!!!!
°Is there an intersection which by its nature is typically "unsafe"?
°How could this data be useful? What should we do with this data? °How has doing this project made you think about physics and driving, and your own driving habits?

ACADEMIC (don't worry about values over speed limit):

Initial Speed_____ (mi ph) = __________ m/s

Reaction Distance______ Braking distance__________ Distance to be safe_______

Reaction Distance______ Accelerating distance_____ Distance to be safe_______

WORK:

Initial Speed_____ (mi ph) = __________ m/s

Reaction Distance______ Braking distance__________ Distance to be safe_______

Reaction Distance______ Accelerating distance_____ Distance to be safe_______

WORK:

Initial Speed_____ (mi ph) = __________ m/s

Reaction Distance______ Braking distance__________ Distance to be safe_______

Reaction Distance______ Accelerating distance_____ Distance to be safe_______

WORK:

Initial Speed_____ (mi ph) = __________ m/s

Reaction Distance______ Braking distance__________ Distance to be safe_______

Reaction Distance______ Accelerating distance_____ Distance to be safe_______

WORK:

ACADEMIC (don't worry about values over speed limit):
Initial Speed_____ (mi ph) = __________ m/s

Reaction Distance______ Braking distance__________ Distance to be safe_______

Reaction Distance______ Accelerating distance_____ Distance to be safe_______

WORK:

Initial Speed_____ (mi ph) = __________ m/s

Reaction Distance______ Braking distance__________ Distance to be safe_______

Reaction Distance______ Accelerating distance_____ Distance to be safe_______

WORK:

Initial Speed_____ (mi ph) = __________ m/s

Reaction Distance______ Braking distance__________ Distance to be safe_______

Reaction Distance______ Accelerating distance_____ Distance to be safe_______

WORK:

Initial Speed_____ (mi ph) = __________ m/s

Reaction Distance______ Braking distance__________ Distance to be safe_______

Reaction Distance______ Accelerating distance_____ Distance to be safe_______

WORK:

Honors: Show work for each speed…. State whether it is below the critical velocity, above, or above speed limit.

Dist Acc if Vi<Vcrit	Dreact+Dacc
Dist Acc if Vi>Vcrit	Dreact+Dacc+Dat speed limit (time is time to accelerate)
Dist if Vi> SL	D=VslTy

SPEED	DISTANCE away to Brake?	Accelerate?

FUNCTION:

BRAKING   Da > f (Vi)

ACCELERATING   Da < f (Vi)

GRAPH: