Questions to a Traffic Engineer

Engineering Basics

Question 1. What is engineering practice?

Engineering practice is the application of the physical and mathematical sciences.

This definition is every State's engineering practice statute or State guideline. It is the definition according to Accreditation Board of Engineering and Technology (ABET). States get their definition from ABET. The Encyclopedia Britannica, Merriam-Webster's dictionary and the ITE Constitution have the same definition. It is also the definition in engineering texts.

Question 2. What are the physical sciences?

Physics, chemistry, earth sciences.

Question 3. What is physics?

Physics is the study of the real world. Human beings included.

Question 4. Does physics apply to the motion of vehicles approaching a signalized intersection?

Yes

When the answer is "no" or "partially applies", the person does not practice engineering. The person uses non-scientific methods--by definition systematically wrong and thus worse than capricious, to do his work. Engineering practice is predicated on the truth that the physics always applies.

Questions about the ITE Yellow Change Interval Formula

A driver is approaching the intersection at the speed limit and the light turns yellow . . .

Regarding the ITE formula that sets the duration of yellow lights:

$$\boldsymbol{Y = t_p + \frac{1}{2}\left[\frac{v}{a + Gg}\right]}$$

Question 5. Using the ITE formula, how long is the yellow light?

A. 50% of the time it takes a driver to stop
B. 100% of the time it takes a driver to stop
C. 150% of the time it takes a driver to stop

Question 6. What kinds of traffic movement does the ITE formula apply thereby giving sufficient yellow time? (For other movements, the ITE formula computes too short of a yellow time.)

A. Turning traffic
B. Traffic moving toward and straight through the intersection
C. Unimpeded traffic approaching straight toward and going through an intersection at the constant speed of the speed limit, where the driver knows the exact location of the critical distance (The critical distance is the closest point upstream from the intersection where the driver can still react and stop comfortably.)
D. Traffic performing avoidance maneuvers
E. Commercial vehicle movements

Question 7. The moment the driver no longer has the distance to comfortably stop, at what speed must he maintain in order to reach the stop bar (limit line) before the light turns red?

A. He must continue at the speed limit.
B. He can go faster than the speed limit (beat the light).
C. He can be cautious and go less than the speed limit.
D. He can decelerate (for example—to prepare to turn) into the intersection.

Question 8. To give the legally moving driver the distance to stop, what must be the minimum value for "v" for any traffic lane?

A. The speed limit or approach speed, whichever is greater
B. Half the speed limit
C. The approach speed
D. It does not matter. The yellow only needs to be the MUTCD 3.0 second minimum.

Question 9. Where is "v" supposed to be measured?

A. At the stop bar
B. At the critical distance upstream from the intersection. The critical distance is also known as the comfortably stopping distance, or the point of no return.
C. 600 feet upstream from the intersection
D. Depends on the traffic lane

Question 10. Is deceleration "a" is supposed to be . . .

A. Comfortable deceleration
B. Emergency deceleration

Question 11. Deceleration 11.2 ft/s^2 is . . .

A. A comfortable deceleration measurement.
B. An emergency deceleration measurement.

11.2 ft/s^2 is the 90th percentile deceleration under emergency conditions. (AASHTO Green Book, 2011, p3-3)

Question 12. Where is "G", the grade of the road, supposed to be measured?

A. At the stop bar
B. At the critical distance
C. At the midpoint between the stop bar and the critical distance
D. It is the average grade of road through the critical distance.
E. 600 feet upstream from the intersection

Question 13. What is kinematics?

Kinematics is a branch of physics that describes the motion of objects without considering the mass of each or the forces that caused the motion.

Question 14. There is a "2" in the ITE formula. Where does the "2" come from?

The "2" comes from physics' stopping distance equation (eq. 3-16): distance = $v^2/\mathbf{2}a$. Where v is the velocity of the vehicle at this distance where it starts decelerating at "a".

The critical distance is the comfortable stopping distance + the distance a driver travels during the perception-reaction time.

Question 15. A driver approaches the intersection. The light turns yellow. What must the driver do?

> If the driver is farther from the intersection than the critical distance, then the driver has the distance to stop. He must stop. If the driver is closer to the intersection than the critical distance, he must proceed at the speed limit "v" or more toward and into the intersection.
>
> Time = distance/velocity. Dividing the critical distance by the constant speed "v" renders the ITE formula.

Question 16. True or False? "If we increase the length of the yellow light, drivers will treat the yellow as a green light, drivers will disrespect the yellow and/or drivers will crash more."

> **False.** This is a rumor. None of these things have been shown to be true in 100 years. Not even once. While the engineer proclaims this to justify keeping a short yellow, there is no study, no paper, nothing ever supporting him. The rumor was officially discarded in 1959 (p. 131) in the same paper from which ITE drew its yellow light formula. The rumor was debunked again in 1961 by Olsen and Rothery's paper, *Driver Response to the Amber Phase of Traffic Signals*. The opposite of what the traffic engineer claims is true: There are dozens of studies containing millions of examples showing that when the yellow is lengthened, drivers are now able to obey the yellow resulting in permanent drastic reductions in red light running.

Question 17. Because perception-reaction time and deceleration have known ranges, and measurements of road grade and approach speed have statistical error, the computation of the yellow change interval has a tolerance. The tolerance in the yellow change interval can be computed by the mathematical technique of error propagation. Error propagation is a standard practice by engineers and physicists. What is the approximate *engineering tolerance* of the yellow change interval when properly using the ITE formula?

A. ± 0.0 seconds
B. ± 0.3 seconds
C. ± 3.0 seconds
D. ± 6.0 seconds

> Law enforcement typically sets the grace time on a red light camera to 0.3 seconds or less. Because the actual tolerance is about 3 seconds, the police punish drivers for running red lights within the error of the engineering calculation. You will find that very few traffic engineers know about error propagation. Without this knowledge of the physical sciences, traffic engineers believe drivers should be punished with 0 tolerance. 0 tolerance is an oxymoron in any branch of engineering.

Prepared by Brian Ceccarelli, P.E. I explain the mathematics behind these answers in "The Derivation of the Yellow Change Interval Formula" and "The Uncertainty in the Yellow Change Interval".