

10. “Retroreflectivity 101” - Did you “get” it?

If you're new to Retroreflectivity this was a lot to “get.” Are you challenged to see what you learned? You may have learned more than you think and testing your knowledge is another good way to learn! (plus a couple questions to have fun with - Not sure? You can skip them!)

Correct answers are discussed on the page following.

“Self Test” on: What is Retroreflection? *THE BASICS*

Here's a little self-test to see how much you remember. And giving yourself a “self-test” is also an excellent way to learn and remember this information.

All questions are followed by several statements which are true or not. For questions #1-#7 there is a single correct statement. For questions #8-#11 there may be several correct statements. Print out the Test and then circle the numbers that you think are true. Don't read ahead or go back to a previous question once you've moved on to the next. Correct answers are on the following page.

1. Almost every object we see in our daily lives reflects light in all directions. This kind of reflection is:
 - a. mirror reflection
 - b. retroreflection
 - c. diffuse reflection.

2. Compared to the road (surface) ahead, signs and markings need to be seen:
 - a. much further ahead (at a longer distance)
 - b. only when the vehicle is close to them

3. Retroreflection is a special kind of reflection where the light is reflected:
 - a. entirely back into the source (headlight).
 - b. in all directions equally
 - c. back toward the source (headlight) but spreading out into a very narrow cone.

4. Retroreflective materials look bright to a driver at night because:
 - a. they reflect more light overall than any other type of material.
 - b. they reflect light diffusely at a high efficiency.
 - c. the driver is closer to the sign when he reads it.
 - d. they reflect the light from the headlight back toward the headlights but spreading slightly in a very narrow cone.

5. The Cone of Retroreflection is:

- a. centered around the brightest portion of the headlight beam.
- b. about 15 degrees.
- c. centered on the line from the headlight to the sign.
- d. similar to the headlight beam, it can be seen from the side when it's foggy.

6. The Cone of Retroreflection is:

- a. nominally of uniform brightness across its diameter from edge to edge.
- b. much brighter at the edge of the cone, dimmer at the center.
- c. much brighter at the center, much dimmer at the edge.
- d. larger for a brighter headlight, smaller for a dimmer one.

7. As a result of the characteristics of the Cone of Retroreflectivity, a sign:

- a. is brighter to the driver of a large truck than to the driver of a small sports car at most approach distances.
- b. is brighter to the sports car driver than to the truck driver at most approach distances.
- c. is equally bright to both drivers.

For questions #8, #9 and #10, mark each of the statements that is correct: (more than one)

8. The observation angle:

- a. can be used as a measure of the cone of retroreflection.
- b. is the most important angle in the geometry of retroreflection.
- c. becomes larger and larger as the vehicle approaches the sign.
- d. is a laboratory measurement angle, defined by ASTM, which has little meaning in the analysis of retroreflectivity of a road sign.
- e. has nothing to do with the cone of retroreflection.
- f. becomes larger and larger as the sign is twisted on its mounting.
- g. would be the smallest possible if the driver looked at the sign directly over the edge of the headlight.

9. The entrance angle:

- a. has very little to do with the Cone of Retroreflection.
- b. determines in which part of the Cone of Retroreflection the driver will see the sign.
- c. is exactly 0° when the light from the headlight is exactly perpendicular to the sign.
- d. is larger for the truck than for the sports car in the same position.
- e. is the angle between a line from the headlight to the sign and a line that is perpendicular to the sign.

- f. as it increases, some materials stay fully retroreflective while others have much lower retroreflectivity.

10. The unit in which retroreflectivity of a material is measured is R_A , which is:

- a. the same as “Coefficient of Retroreflection”
- b. a measure of exactly how bright a sign is in one specific type of road situation
- c. a single value achieved by specific material which is a measure of how efficient it reflects light at all distances.
- d. a measure of the efficiency of a material at only one specific set of observation and entrance angles.

11. Regarding the headlight beams that illuminate a sign or marking:

- a. recent headlights have become brighter and therefore illuminate signs better and signs of a given material are brighter.
- b. when a sign is so located that it is far out of the bright portion of the headlight beam it requires a material with high angularity.
- c. headlights on recent vehicles project less light upward toward most signs; the drivers see the signs as dimmer.

The answers (and explanations) are on the following pages.

ANSWERS: “Self Test”- What is Retroreflection? *THE BASICS*

1c	Light reflected from a surface in every direction is: <i>Diffuse reflection</i>
2a	Signs and markings must be seen far ahead to be of use to the driver.
3c	Retroreflected light is reflected back toward the source (headlight) but it must spread out slightly in a very narrow cone or the driver wouldn't be included within it and the sign or marking wouldn't be seen by the driver.
4d	The light retroreflected from a distant sign or marking is only bright because it is concentrated in a very narrow cone. Retroreflected materials do not reflect more light overall than some other materials. If the signs were only bright when close, they would not do their job.
5c	The Cone of Retroreflection is centered on the line from the headlight to the sign. That line is the same as the axis of the Cone of Retroreflection and it is where the brightest portion of the retroreflected light is concentrated. It has nothing to do with the headlight “beam.” It could never be bright enough to light up fog. It is about a degree or two; much smaller than 15°.
6c	The retroreflected light in the Cone of Retroreflection is concentrated at its axis (that line from the sign or marking to the light source, the headlight). At the edge of the cone the retroreflected light is much less intense (bright). How strong the headlight is doesn't affect the size of the cone.
7b	As a result of the differences in the intensity of the retroreflected light within the Cone of Retroreflection, a given sign is seen as brighter by the sports car driver than by the driver of a large truck.
8a 8b 8c 8g	The Observation Angle can be used as a “measure” of the Cone of Retroreflection and is certainly the most important angle in the geometry of retroreflection and in assessing the retroreflectivity requirements of a sign or marking. The fact that the Observation Angle becomes larger and larger – and at an increasing rate of change – as the vehicle approaches a sign is very important in assessing the importance of observation angle with sign performance. Yes, the Observation angle seen by a driver would be the smallest possible if he placed his eye right on the edge of the headlight. While Observation Angle is defined by ASTM in a laboratory-test context it is also very important in analyzing the performance of a roadsign or marking. When a sign is “twisted” on its mounting it doesn't change its location and therefore the Observation angle doesn't change.

<p>9a 9c 9e</p>	<p>Yes, entrance angle changes have very little or nothing to do with the Cone of Retroreflection. Entrance Angle is defined as 0° when the light from the headlight strikes the sign “head-on” – which is at 90°. It is measured as some positive value by the angle between the perpendicular to the sign and the line from the headlight to the sign. Entrance angle has nothing to do with the Cone of Retroreflection, is not affected by the type of vehicle the driver is in, and <u>all</u> materials drop substantially – but not necessarily equally -in retroreflectivity as Entrance Angle becomes significant.</p>
<p>10a 10d</p>	<p>The unit in which Retroreflectivity is expressed is defined as the Coefficient of Retroreflection which is generally abbreviated to the symbol: R_A. It is a measure of the efficiency of a material at a particular geometry. While a high value may contribute to the brightness of a sign, the R_A value is not a measure of sign or marker brightness. One numerical value is sometimes used for simplicity to refer to a particular material; that value applies at only one set of observation and entrance angles.</p>
<p>11c</p>	<p>Headlights of very recent vehicles project <u>less</u> light upwards (toward most signs) and thus drivers of these vehicles see signs as dimmer than do drivers of older vehicles. When a sign is located far out of the headlight “beam” it receives far less light; no material can reflect light it doesn’t receive and the best material cannot make up the deficiency.</p>