

The Importance of KR Ch. 1, Q. 5

Tiffani and Scott, my two students, were getting ready to do their Third Open Water Dive which was going to include the CESA. I went over the “rules” of the CESA and asked them “Why do you want to keep the second stage in your mouth as you ascend?” Scott replied, “Because that will keep your mouth plugged and you won’t inhale water.” While perhaps a reasonable response, it was NOT the one I had desired. Tiffani laughed and said, “As we ascend the ambient pressure will decrease and the First Stage may be able to deliver another breath. Remember Scott – Question 5, Chapter One – the Key to Scuba Diving!”

We all laughed because they had been drilled that there are two basic answers to ALL Scuba Related Questions – “It Depends” or “Question Five, Chapter One.”

Later I thought about Tiffani’s comments which showed that she really did understand the relationships described in the matrix that is Knowledge Review Question Five of Chapter One. She had learned a solid foundation on which she would be able to further her Scuba education. By spending quite a bit of time at the beginning of the class reviewing the various aspects of the Matrix, all of the students, even Scott, demonstrated a solid foundational knowledge that will help them all as they continue their education and diving adventures.

Rather than treating this one Knowledge Review Question as just one of many, perhaps our students could all be like Tiffani if we spent the time early in the course to delve into all of the ramifications of KR 5, Ch. 1.

So what IS KR Ch.1, Q 5? It is the matrix that shows the relationship between Depth, Pressure, Volume and Density:

Depth	Pressure	Volume	Density
Surface	1bar/ata	1	X1
10M/33'	2 bar/ata	½	X2
30M/99'	4bar/ata	¼	X4
40M/132'	5bar/ata	1/5	X5

What does all this tell the student? A lot, for once the student understands the simple relationships described in the matrix, the Instructor can then use those relationships to explain why things happen the way they do with Scuba. While not all of the following items need be discussed when the matrix is introduced in Chapter One, it

can be helpful to continue to refer to it since the student can build on the information already learned.

The first step toward understanding the matrix is the total comprehension of the real world effects shown by the “Volume” column. As the diver descends, a constant volume of air in a non-rigid container (such as the diver’s body!) will compress as the pressure increases. Likewise, as the diver ascends, a constant volume of air will expand as the pressure decreases. This has many real world diving consequences.

How often, and why, do I need to “clear my ears?” Ear clearing, mask squeeze and reverse block all come from the same basic issue that is explained by KR 1 – 5. The instructor may use these related questions to discuss the body’s air spaces and how the outside water pressure affects the air in those spaces. As the diver descends, the air in those spaces must compress due to the increased ambient pressure. In order to counter that compression, the dive must add air to “equalize” the pressure within the body to that outside the body which is exactly what the “volume” column describes. Likewise, as the diver ascends, air must be let out of those spaces to allow for equalization and if there is a blockage, like with a reverse sinus block, problems can arise.

Why do we need a “Buoyancy Compensation Device?” -- What does it “compensate?” From those two questions the Instructor can discuss what happens to a wetsuit (or dry suit) as you go deeper. The bubbles in the wetsuit’s neoprene compress as the diver goes deeper and the wetsuit loses some of its buoyancy. The diver then puts air into his BCD to “compensate” for the loss of buoyancy in the wetsuit. The reverse is also true. After putting air into the BCD at depth to compensate for the loss of buoyancy from the suit, when the diver ASCENDS the matrix proves the diver needs to let air out of the BCD because it will expand.

Once the student really understands the concept of increasing pressure while descending (and decreasing pressure while ascending), the instructor can switch gears and do a quick explanation of how a regulator works. What is the end result of the first and second stages? Air flows into the lungs at ambient pressure, which is greater with depth. One of the misconceptions students often have is that as you go deeper, the volume breathed increases, but it does not (at least not in any meaningful way). What changes is not the volume of air breathed but the density of the air that is breathed – and that changes because of how the regulator works.

Let’s assume the student goes to 10M/33 feet. Since the student will breathe the same volume of air with each breath, but at twice the density, then it follows that there are twice as many Oxygen and Nitrogen Molecules in each breath. With the student breathing twice as many molecules with each breath then a tank will only last half as long which begins to provide the students with the tools to answer “How long will a tank last?” The quick answer is, less and less time as you go deeper!

This discussion naturally leads to the full explanation of the Golden Rule of Scuba: Always Breathe – Never Hold Your Breath. By this time the student totally

understands that the lungs are filled with air that will expand as the diver ascends causing an over expansion injury unless the diver continues to breathe.

It is fun to come back to this topic when the student is taught the CESA and is told to “Keep the regulator in your mouth as you ascend.” This discussion can be revisited to explain WHY-- for as the diver ascends, the ambient pressure decreases and the first stage may then be able to provide that additional breath. (Note, unlike what some people think, the volume inside the tank does NOT change with depth since the tank is a rigid, closed system.)

The matrix can be a big help when discussing NDLS and Nitrogen loading. As long as the student understands that as he gets deeper he breathes air that is denser (and thus has more Nitrogen molecules), the instructor can show why the body absorbs more Nitrogen with deeper dives. Since there are more Nitrogen molecules in the lungs it becomes easy for the student to understand why the body would absorb more Nitrogen with a deeper dive. When the diver ascends the opposite is true – the diver has more Nitrogen molecules to get out of his body. This can help the student understand the basics of decompression and why they need to use the RDP, eRDPml or their Dive Computer to control the whole process.

Whether it is describing ear or squeeze issues, neutral buoyancy, nitrogen loading, how a wetsuit keeps you warm or the Golden Rule of Scuba, Knowledge Review Ch. 1, Question 5, has the foundational answers to these and most other Scuba Diving Questions.