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Physics Tips and Strategies to Help You through PADI IDC Exams

In all the years I have been involved in IDCs, the Physics exam is by far the most common "stress causer" that effects IDC candidates. Sadly often, it is the mere thought of doing Physics, even just the word that deters some candidates more so than their ability to answer the question.

Often, when getting a question wrong the candidate will reply, " I knew that, I don't know why I didn't do it". A candidate could do that multiple times on an exam. The more times a student does that the more pressure builds for the next exam.

Good news is that PADI does not expect you to be a physics professor. They just want you to have a general knowledge of physics and apply it to scuba diving. They would like you to understand the cause and effect.

As you will see, some of tips are very simplified. Some physic equations can be quite complex. We have tried to simplify it for the ease of learning. Because PADI only needs a basic understanding of physics then the simple approach should be enough to get you through.

Some of the questions in the instructor exams are not that difficult. Some buoyancy questions can be no more than a division and a subtraction. It is no more difficult mathematics that we would do in day to day life.

Often it is not complexity of the mathematics, it is more the state of mind of the candidate that gets in the way.

As you will see these tips do not tell you how to answer the questions, they try to help you prepare for an exam and understand some of the topics involved in physics and scuba diving.

1. Think the question through

Most candidates get tied up with the mathematics of the question rather than what the question is asking.

Often when counselling candidates on the why they got the question wrong, the issue was that they went straight into answering the question, rather than understanding what the question is asking.

Take the time to work out what the question is asking. You can't answer a question before you truly understand what the question is about.

One good way to understand a question is to place it into a practical application to everyday scuba diving. Most of the questions can relate to things that occur every time you dive. You just to find the likeness. For example, buoyancy and displacement is what allows a person to float on water. A lot of students elect to do the float when doing their PADI Open Water waterskills. Partial pressure increase, density, increased air consumption also occur every time we dive.

If you can't make a connection then ask you PADI Course Director for one. It is vital you understand what is going on before you can answer the question.

BIG TIP: Understand what is happening with the question before learning the mathematics of answering the question.

2. Draw the picture

I have either taught or done literally 1000's of physics questions over the years. Virtually all of them I have drawn a picture. Not a little scribble, a full page diagram with all of the possible details I can. This helps me visualize the answer before I start.

Of all of the tips I will give I think that this is one of the most important. It helps you understand the question and guides you to an approximate answer.

For example: The exams are littered with pressure and flexible container (balloon) questions. I draw different size balloons according to depth. I then know approximately what the size of the balloon should be which leads to the next tip.

3. Eliminate obvious wrong answer

Statistics and probabilities are wonderful things. All PADI I.E exams are multiple choice and you have four answers to choose from. You have a one in four chance of getting the question correct.

What this means is, theoretically the law of averages would say that even if you knew nothing about Physics (or any other topic for that matter) and you guessed every question, the minimum you should get is 25%.

A lot of the PADI questions have one and more often two questions that are clearly wrong and easy eliminated. By understanding the question and drawing a picture, this becomes a much easier task. If you eliminate two of the answers you now have a 50% chance of getting the question correct.

So now, let us say you do know 60% of the physics (we would hope you do before I.E day) and you were able to eliminate two of the four answers of the remaining questions. You would have a 50% chance of getting those correct (20%) and you add that the 60% you do know and BAM! You have passed the exam.

What eliminating incorrect answers does is allows you to focus on the possible correct answers, which in turn makes your calculations a lot easier.

For the record, the most common reason candidates get questions incorrect is failing to convert kilograms to litres or visa versa or doing the question for salt water instead of fresh water or visa versa. The later is usually reading the question incorrectly. Make sure you FW or SW is clearly marked on your diagram as well as litres or Kilograms.

4. Water has weight, weight creates pressure

Water has weight and weight has pressure. With water, this pressure can push up or push down.

One of the simple experiments I like to do during the IDC is do get candidate to lay down a 1.5 litre bottle of water on them. Then one of our six litre bottles, then two six litre bottles and so on. The candidate can feel the weight on the water, pushing on them. This is pressure.

Theoretically this is what happens when we dive. The deeper we go, the more water we have on top of us and that creates more pressure.

Now this is where we need to trust science a bit. Water cannot compress and when we dive we theoretically have water pressure pushing down and water pressure pushing up. As you should know, our body is mostly made up of water. Therefor, if the water in our body cannot compress, we do not feel that pressure. Basically the water in your body becomes one with the surrounding water.

In the scuba diving world what does compress is air and there will be questions about this. Flexible containers, wetsuits, BCD etc, will all compress and a lot of questions will refer to this.

Because salt water weighs more (heavier) than salt water creates more pressure. Always remember that a litre of fresh water weighs 1.0kg (that is the metric system) and a litre of salt water weighs 1.03kg. It should be easy to remember salt water has the weight of the water, plus the weight of the salt.

5. Displacement

When thinking of displacement, a simple way of getting our head around it is you and water. You can float on water only if you spread out on top of the water, do your best starfish impersonation so to speak. But what you cannot do is walk on water.

In this equation two things remain the same, one is the water and one is our body weight. The only thing that changes is the amount of our body we place in direct contact with the water (displacement). What we do when we want to float is we displace more water. Our starfish impersonation displaces more water than the soles of our feet. The more water that is displaced the greater chance we have of floating, if that is our goal.

When we do these equations and when we draw them, often it is simple as having a force pushing up and a force pushing down and whichever is greater wins. That will determine is something is positively buoyant (floats) negatively buoyant (sinks) or neutrally buoyant (hovers in mid water).

Before you start any of these questions, understand what is pushing up and what is down.

To do this you need to know the weight pushing down (the object in kg) and the weight pushing up which is the displacement (in litres) x the weight of the water (1.0 kg for fresh water) or (1.03kg for salt water). You then should know if the object is going to float, sink or be neutrally buoyant.

PADI will then often ask how do we make it float or sink.

These questions are normally a lot easier than they seem to be on paper. With an understanding of the questions, a clear head and I nice drawing you really should not have an issue with them.

6. Salt water/ Fresh water – Kilograms /litres

If I had a dollar for every time a candidate got a physics question wrong because the forgot to convert and answer from kg to litres or did the calculation for salt water instead of fresh water or the other way around, I would be a very happy man.

These are by far the two most common reasons why a candidate gets a question wrong.

It comes from not reading the question properly, or rushing the question. Slow down, read the question and make sure that your diagram clearly states what type of water and what the answer should be, either kilograms or litres.

7. Conduction/Radiation/Convection

There are three different ways we can have heat again and heat loss. In most PADI Physics exams there is a question about this. The two most common that effect us in scuba diving is Conduction and Convection. The least influence is Radiation. Here is a brief explanation about each:

Conduction:

This is the most common in scuba diving. This is where the two items come in direct contact. The classic example is a spoon mixing a cup of hot coffee/tea. The spoon would go in at room temperature but will become hotter after stirring the tea. In scuba diving, a hot diver will become cooler when in contact with cold water.

Convection:

Convection does happen in scuba diving and is a little more difficult to explain and to understand.

Convection is heat transmission in fluids. In diving, water heated by your skin becomes less dense. This causes the warm water to rise and be replaced by cooler water. For this reason, even without a current and you remaining motionless, water flows over you skin carrying away heat.

Radiation:

This is the least relevant to scuba diving (unless you count sunburn). Radiation is the heat given off a hot object. This can be the sun, a fire or radiator. The two different items do not actually come in contact with each other and the heat from one object will cause a rise in temperature or burning of the other.

8. Refraction/visual reversal

Refraction:

Refraction results when light shifts when going from water into air. i.e the water you are diving in and the air in your scuba mask. Underwater, this makes thing seem closer than they really are or larger than the realer are.

Visual Reversal:

Where as refraction makes things look closer, visual reversal makes things look further away. Turbidity caused visual reversal and is formed bya combination of water clarity, contrast and the amount of light.

9. Molecules heat and cold.

Atoms and molecules when hot travel faster, when cold travel slower.

Where this would affect us in scuba diving is with a scuba diving cylinder. If that cylinder gets hot i.e it is left in the sun the pressure will increase. This is one of the main reasons why a bust disk valve was invented.

Another way a cylinder can get warm/hot is during filling. The reason for this is we are forcing air through a small hole with the air molecules bouncing off the edges of cylinders. This creates heat. It is why a tank is warm, but more importantly the pressure will be higher. But as the tank starts to cool, the pressure will decrease. It is not magic, it is physics.

One scenario that often occurs is a tank that is refilled between dives. When the diver is about to dive they may have 220-230 bar. As soon as the jump in the water the tank will cool and they start to breath. After 10 minutes of diving they first check their air and find they have 170 bar and cannot understand why they have used 50 – 60 bar in 10 minutes. The answer is not so much the air that they consumed, but the cooling of the molecules.

PADI do ask questions in exams about the same occurrence in flexible containers (balloons). This does not have a lot of relevance to scuba diving but it does help understand the pressure/heat/cold relationship.

If the flexible container does get hot, the molecules again move faster, however, because the container can flex, then instead of a pressure increase, the container will expand, possibly until it busts.

Everything that we have spoken about reverses if the molecules get cold. The pressure will decrease in a scuba cylinder and a flexible container should shrink.

10. Ambient pressure/Total Pressure/Gauge pressure

Total Pressure:

Is as it says, the total pressure which includes both the water pressure and the atmospheric pressure. This is the most common one that we use in scuba diving.

Absolute Pressure:

Absolute pressure and total pressure are virtually the same. For the purpose of answering PADI exam questions take them as being the same unless you want to go into very scientific reasons why.

Gauge Pressure:

Uses 1ata/bar as a zero point. So effectively it does not include the atmospheric pressure. It is what is used to determine usable pressure therefor it is used mostly for pressure gauges, hence the name.

11. What is Partial Pressure

As you learnt in your open water course the deeper you dive the denser the air that you breathe gets.

When on the surface, air is 79% Nitrogen and 21% Oxygen. Because we are on the surface we can express it as a percentage or partial pressure.

As you would know, if you dived to 10 metres, the density would be 2x or twice that on the surface. You would think that you would just double the percentages and state 158% Nitrogen and 21% Oxygen. However you cannot do this as that would suggest that the air has doubled in size i.e 100% to 200% because the amount of air has remained the same. The air has compressed and nor is thicker or denser.

Because you cannot express the answer as a percentage (%) we use partial pressure. Not the absolute scientific way of working out the answer, however you can easily just place use a decimal point. i.e 158% would be 1.58pp or 21% would be .21pp. You always follow the pp with the gas you are referring to. 1.58% pp Nitrogen or .21pp oxygen.

Important Tip: The percentage the air remains the same at any depth. i.e at the surface it is 79% Nitrogen and 21% Oxygen. Even though the air gets denser as we dive, the percentage remains the same. At 10m, 20m even 50 metres the air will still be 79% Nitrogen and 21% Oxygen. The partial pressure will still increase.

12. Calculations

1 Litre of salt water weighs 1.03 kg
1 Litre of fresh water weighs 1.0 kg

Pressure Increases by 1 ATM every 10 metres of salt water
Pressure Increases by 1 ATM every 10.3 metres of fresh water

Pressure changes in salt water = 0.100 ATM per metre or 1 ATM per 10 metres
Pressure changes in fresh water = 0.097 ATM per metre or .97 ATM per 10 metres

Because water is denser than air, sound travels 4 times faster underwater
Water conducts heat 20 times faster than air.

Archimede's Principle relates to buoyancy.
Dolton's Law refers to Partial Pressure.
Boyle's Law relates to pressure and volume