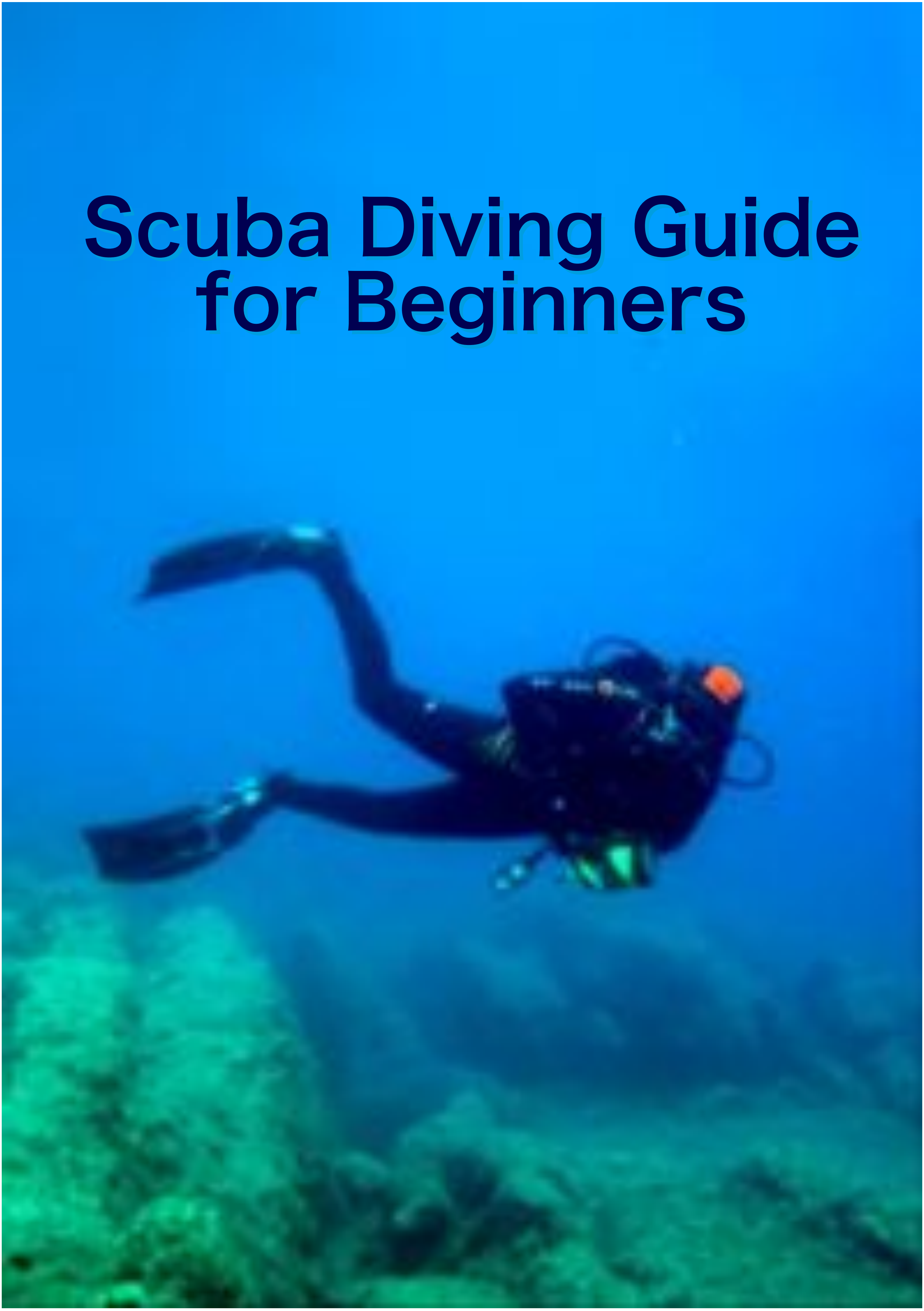
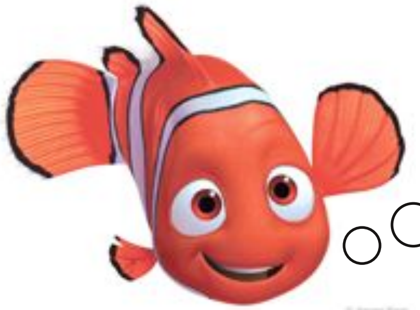
Scuba Diving Guide for Beginners





HI! My name is Nemo and I will give you useful tips through this guide!

Introduction

Scuba diving is an amazing sport because it enables you to explore the fascinating and mysterious underwater world. SCUBA refers to self-contained underwater breathing apparatus. The development of modern scuba diving began in the 1943. It was incited by Jacques Cousteau and Emile Gagnon. In its beginnings scuba diving was used in the navy and commercial operations like pearl diving. As a recreational sport it developed over the last 20-30 years. Even dough it is a recreational sport, scuba diving is not all fun and games. It is a serious and high-risk sport because our body is exposed to unnatural environment. However, you should not be discouraged by that fact. If you are familiar with, and follow all the procedures you should not have any problems during your dives. In order to understand and apply basic scuba diving principles you must learn about diving equipment, basic physics, chemistry and medicine concerned with diving along with some simple diving exercises. When you learn this and pass the theoretical and practical test by some diving association you become a licensed diver. Divers are divided into categories according to their level of knowledge and experience . I learned scuba diving basics, took the test by CMAS (World Underwater Federation) and got the CMAS certificate. Diving on Mljet, a beautiful island in Croatia, was my dream for many years, so as soon as I became a licensed diver I went to Mljet on scuba diving with my scuba diving club "Bosnia". In this guide I will share what I have learned through the process of learning and reaching my goal- diving on Mljet.

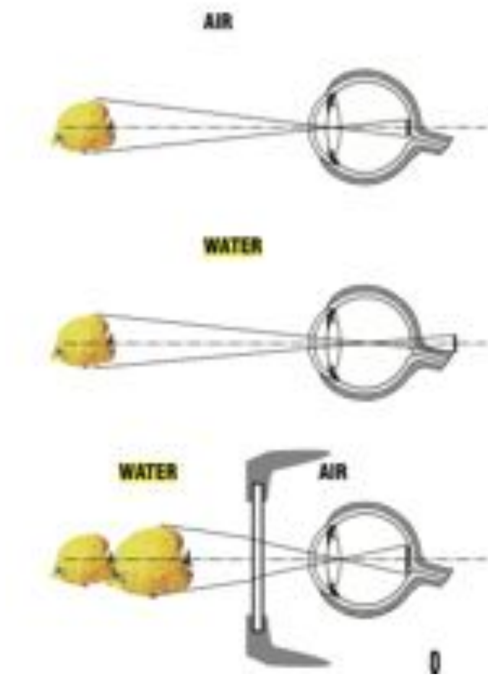
Now you are porbably thinking: Why would I read about physics and medicine? Boring! Believe it or not, it is quite interesting! Believe me :)

Chapter 2

Diving Equipment

Scuba mask

A scuba mask is a part of diving equipment which makes your dives comfortable by creating an air space in front of the eyes. Without a scuba diving mask our diopter in the water is +32. However because of the bigger index of light refraction object are still unrealistic and seem 33% bigger and 25% closer.



Scuba mask types

Snorkeling Mask

This is a mask mostly used in recreational diving

Purge Mask

It mostly used by underwater photographers and commercial divers because the water is eliminated by simply blowing air out of the nose. This means your hands are free and you can hold a camera or some tools

Full Face Mask

This type of a diving mask protects the entire diver's face from the water and contains a mouthpiece and a demand valve which enable the diver to breath. It is the best type of masks for protection from infections

Mask with prescription lenses

If you have diopter then you need a mask with prescription lenses in order to see properly underwater

What can I do to defog my mask?

It is a very common problem that a mask fogs causing sight problems during a dive. You can solve that problem in several ways:

Commercially Prepared Solution.

You can buy a commercial mask defogger solution at a very low price. It is long lasting and effective.

Saliva

Sounds disgusting, but it really does work! Spit in the mask, rub on the glass and rinse.

Toothpaste

Clean your mask with a toothpaste (non-gel). Works like a charm!

Seaweed

Rub the most greasy and disgusting seaweed you can find in the sea and rinse the mask out. This should keep it from fogging!

Construction of a diving (snorkeling) mask

Skirt is made of silicon gum and can be in a variety of colors. It has to fit the diver's face and have a nose pocket to enable the equalizing of pressure in the ears and sinuses (it is done by pinching ones's nose shut and blowing through the nose)

The glass has to be tempered so in case of breaking it falls apart into small, regular pieces. The glass can be made from one or two parts. The shape of the frame must secure a wide sight field. The bigger the volume of the mask, the smaller the sight field

The strap is usually made of the same material as the skirt and is placed above the ear line on the top of the head. It is attached to the frame of the mask by adjustment buckles.

Buckles are a part of the frame and are constructed so that adjusting the strap size is easily done even underwater

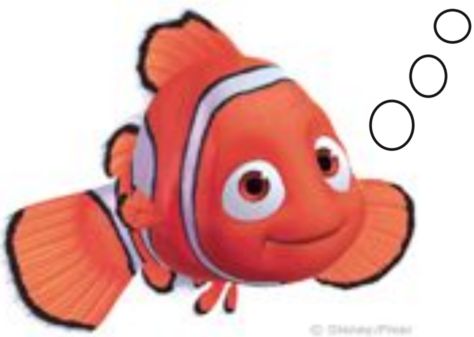
Putting on a diving mask

Place the mask on your face. There should be no hair between the mask skirt and your face

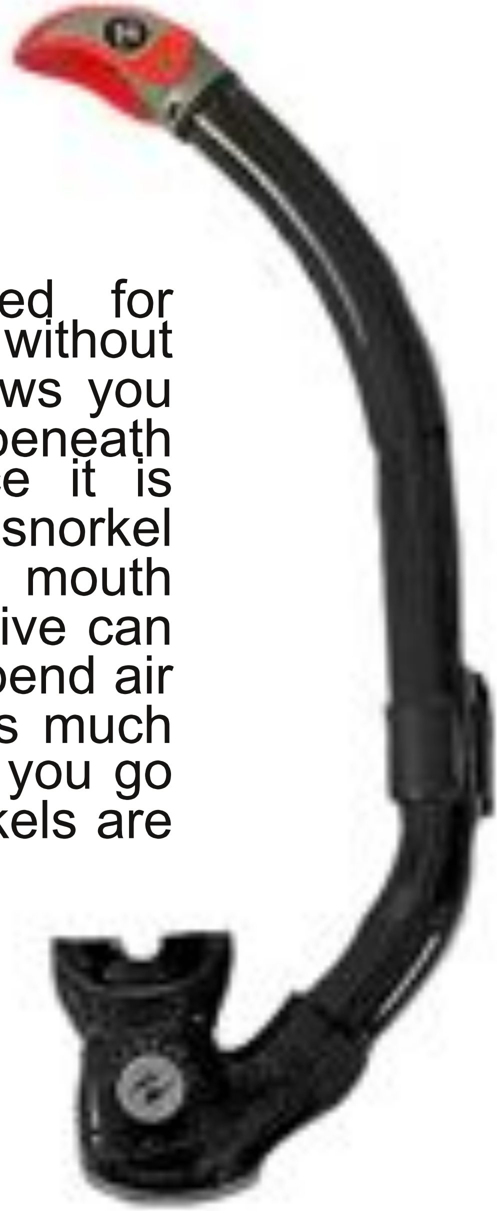
Pull the strap on the occiput

How will I know that a diving mask fits my face?

Place the mask on your face without using a head strap. There should be no hair between the mask skirt and your face. Inhale with your nose and hold. The mask should pull back towards your face. If the mask fits you, there will be no air leakage and the mask will stay in the same position as long as you



Scuba Snorkels



A scuba snorkel is used for breathing on the surface without lifting your head. This allows you to observe the marine life beneath you. While on the surface it is desirable to always have a snorkel or a regulator in your mouth because an unexpected waive can hit you. You don't want to spend air on the surface, but have as much as possible available when you go on a dive. This is why snorkels are used in scuba diving.

- A snorkel is basically a curved tube with a mouthpiece.

- It is usually made form plastic or rubber which follows the anatomic shape of the head.

- The mouthpiece is usually made from silicon rubber because it is comfortable for holding in the mouth. Many kinds of mouthpieces are made in combination with valves for easier exhaling. If the snorkel gets filled with water blowing will clear it up.

Fins

Diving fins enable propulsion through the water.

Basic styles of scuba fins are:

- Full foot fins
- Open heel adjustable fins
- Long Blade fins
- Force fins and
- Mono fins

All of them have pretty much the same construction: flexible blade for propulsion and a foot pocket. The blade is made of rubber, plastic, carbon materials or the combination of all of these.

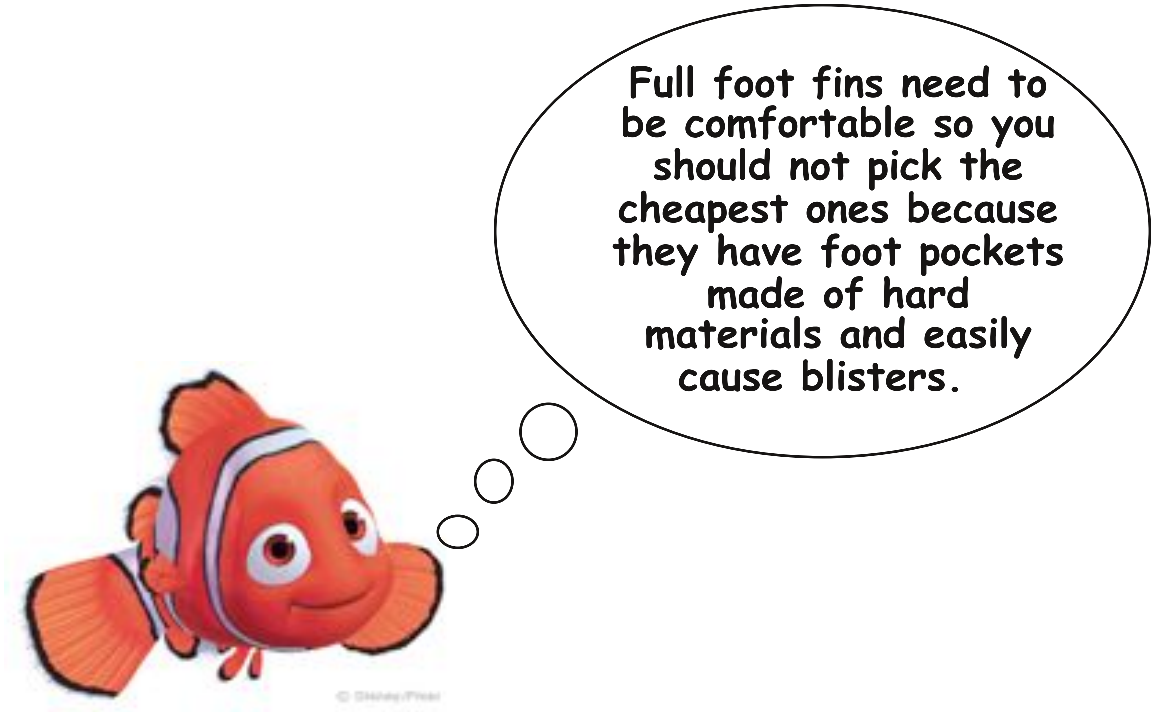
Fool foot fins

Fool foot fins are light and compact. Their use is wide spread among divers. They are worn on bare feet, but if you want to wear neoprene socks (page 11) you need bigger sized fins than on bare feet. How much bigger depends on the thickness of your neoprene socks.

How to put on fool foot fins?

1) Place your foot in the foot pocket and roll the heel, so it's inside out

2) Flipp the heel up and that is basically it!

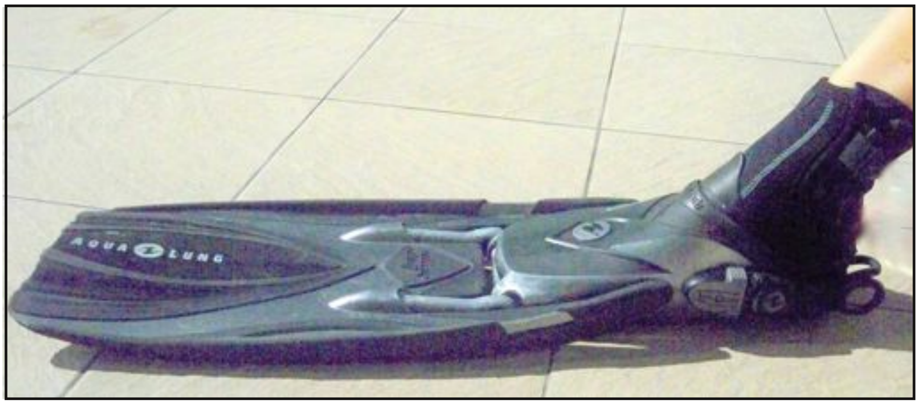


Open heel adjustable fins

These fins are the most used for scuba diving. They have enough power to propel you and your gear. You need to wear boots (page) when wearing these fins. They have adjustable straps and buckles which are attached to the fin in a similar way like in a diving mask.

Putting on open heel fins

Place the strap under the foot pocket



Put the bootie in the foot pocket

Pull the strap over the bootie in the lower part of Achilles tendon and tighten the strap

Long blade free diving fins

Long blade free diving fins are much longer than standard open heel fins. The long blade provides bigger propulsion, speed and power. Free divers prefer this kind of fins on water hunts or competitions.They come in an open heel version (strap) and fool foot version, but the use of fool foot version is more wide spread

Force fins

Force fins have an innovative design. They differentiate from other fins by their propulsion principles.Force fins are similar to a fishes' tail. They are very efficient and give the diver great speed.

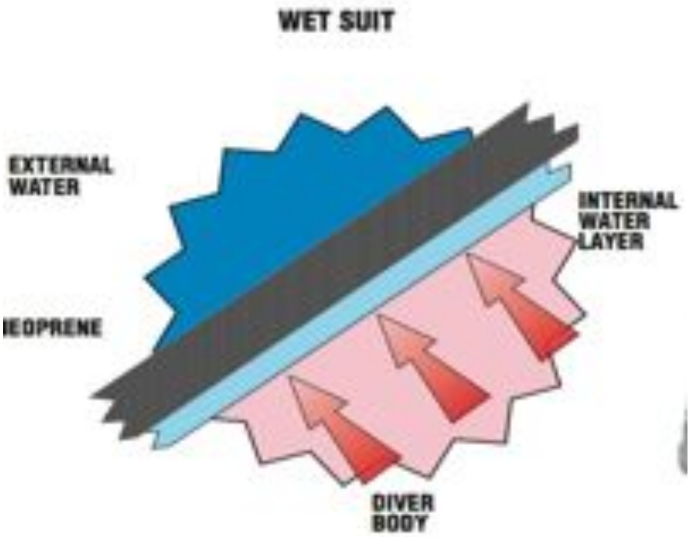
Mono fins

This kind of fins are mostly used on competitions. Their shape resembles the fins of marine mammals like dolphins and whales. The blade is wide and in one piece. The foot pocket is made from rubber or silicon for both feet of the swimmer. The blade is made of layers of fiberglass or carbon which gives it firmness.

Putting on mono fins

Wet suits

A wet suit is an essential piece of equipment. It's used for keeping a diver warm. When entering water a diver's body temperature gradually starts to drop because water conducts heat 25 times faster than the air. Wet suits also protect divers from cuts, abrasions, and stings which occasionally happen during dives.



Wetsuits are made from foam neoprene, a synthetic rubber that contains small bubbles of nitrogen gas. Nitrogen gas has a very low thermal conductivity and prevents losing body heat. Wetsuits trap a layer of water between the suit and the body. This water gets warmed by body heat and represents an insulator. A diver without a wet suit can easily get hypothermia (see page 61 a).

If it takes a longer period of time to get to a diving location we should not put on the suit on the beginning of the trip because our body can get excessively heated up and that is called hyperthermia. If we jump in the water heated up we can get hydrocution. That is sudden narrowing of tissues and blood vessels because of jump into a clod environment. That leads to sudden forcing of the blood into the bloodstream from the legs to the central part of the body where heart is located. This sudden burden overloads the heart and can cause a heart attack.

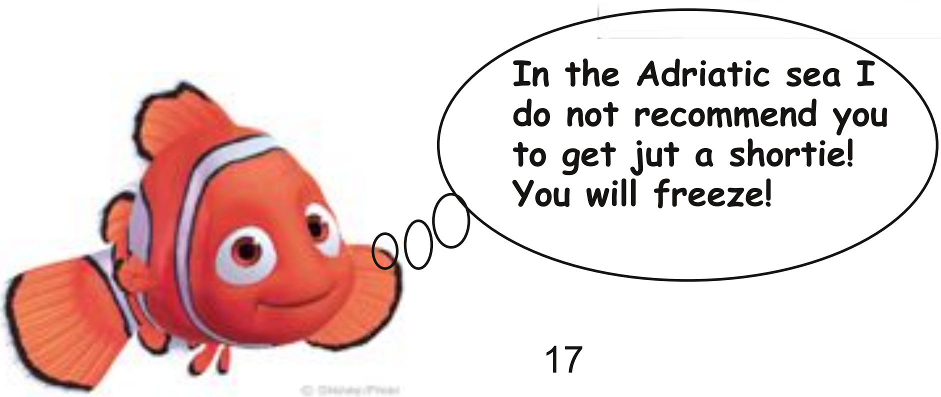
Choosing a wet suit

The colder the environment you dive in the more insulation you will need. The body mass and construction of a diver also affect how much insulation is needed. A larger diver needs less insulation than a smaller diver. A muscular diver needs less insulation than a larger or obese diver. The more active you are underwater the more heat your body generates, and you need less insulation. You should think about all these factors when choosing a diving suit.

Types of wet suits

SHORTIES

They are used in warm waters where insulation is not necessary. They provide protection from small injuries such as scratches and stings. They are sometimes worn under or over a full lenght wet suit for additional insulation in colder waters.



FULL-LENGTH WETSUITS

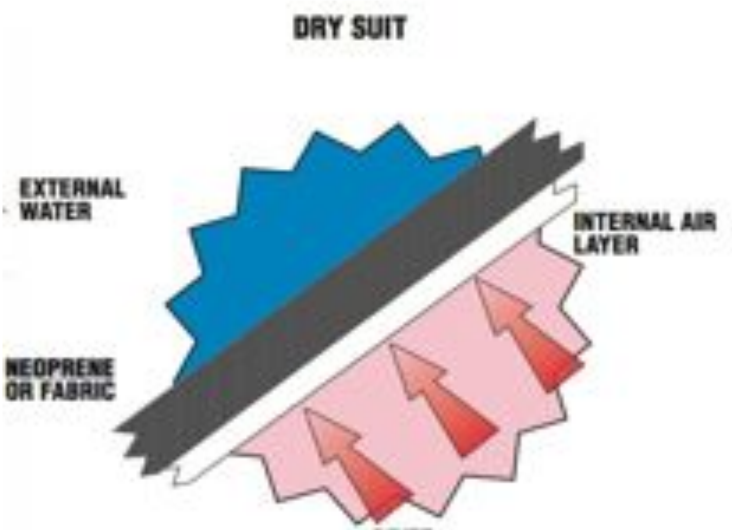
Full-length wet suit is mostly used in scuba diving. It covers the entire body except the face, fists and feet. This kind of wet suits come in different thicknesses 2-9 mm. You choose the thickness by the temperature of the locations you plan to dive in. These suits provide protection from scratches and scars which often occur during dives.

SEMI-DRY SUITS

Semi-dry suits are designed for colder waters, but they are used in warmer waters as well. They are the same as normal neoprene wet suits, but they have better seals at the wrists, ankles and neck. This means that the water which gets trapped under the suit does not come out.

SCUBA DRYSUITS

Scuba dry suits do not let any water into the suit. Instead of water, trapped air is an insulator. They provide the best thermal protection, but of course they are the most expensive ones. Dry suits have changeable internal volume which is regulated by a valve on the chest. Using this kind of suits requires special education.



Dry suits are the best for cold and extremely warm waters!

How to choose a wet suit?

Custom made suits are made by your body measures and are a diver's best fit. Of course this cost more than a regular wet suit. If your body shape is different than average and you have a hard time finding clothes you should consider this option.

Do not order suits online if you have never tried that model because it might not fit you body shape.

Try on suits in the store. Take your time. You will probably spend hours finding your size. The wetsuit should not not too tight, so that you can not breath or move, but it should not be loose either. A loose suit lets water flow through the suit you would feel like you do not have a suit at all. Do not not rush, and don not compromise. Find the model which fits you just right, or do not buy one at all.

Dressing A Wetsuit

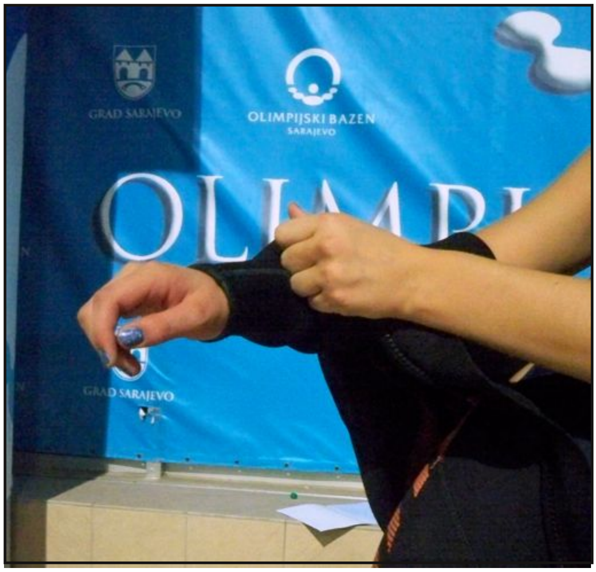
If you are putting a full length wetsuit (long legs) it is easier to begin sitting down.

1) Put each leg (one at a time) through the ankles and work the suit up to you knees. If you suit has skin seals, carefully stretch the openings. Be careful that you do not damage the seals with your nails.

2) If your suit has knee pads, work them into the right position before proceeding to the next step.

3) Stand up and pull the suit over your hips. Make sure that the crotch is in the right position.

4) Dress the arms just like you did with the legs (one at a time). Work the suit up to the elbow before putting in on the rest of the upper body.



Once you put on the whole suit zipp it up and you dressed your wet suit!

Undressing A Wetsuit

To take off your wetsuit, peel it off inside out. Open the Zipper and work your shoulders free and then peel each arm out (turning the suit inside out as you go) one at a time. Roll the suit down doing the same for each leg. The trick is to peel the suit off, turning it inside out as you go.

This is how it looks in practice:


ZEN
GRAD SARAJEV


GRAD SA


SARAJEVO

Maintaining Your Wetsuit

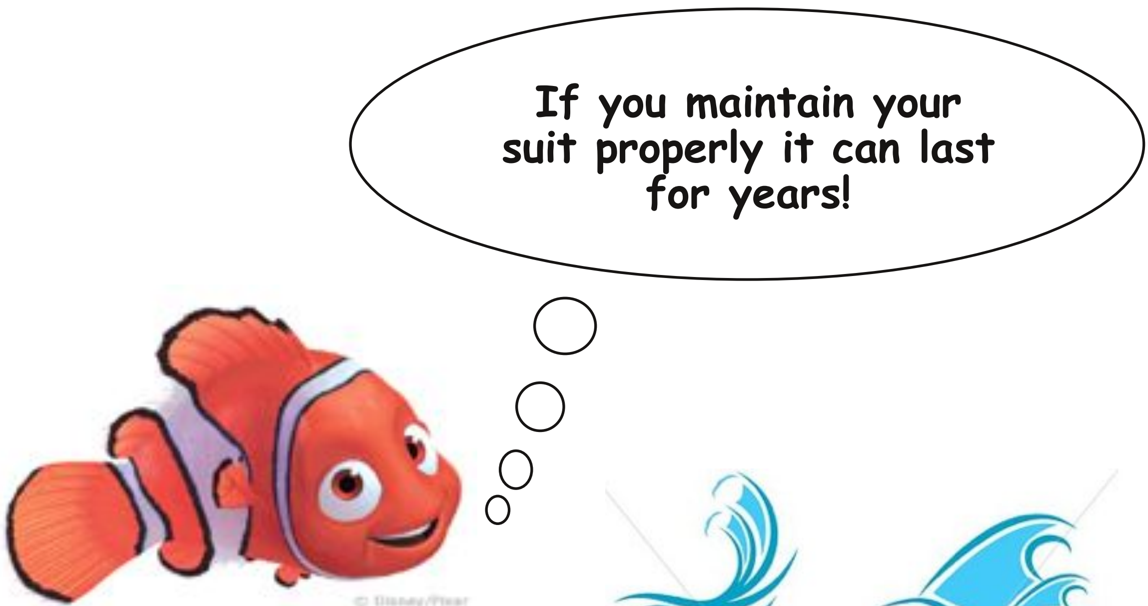
Rinse it out in fresh, clean water after each dive. This will remove salt and filth, which can cause it to rot.

Let your suit dry in the open air, out of the direct sun light because it damages the neoprene.

When your suit dries put it on a wide wooden hanger in a cool dry place.

Wash your suit once in a while with a special wet suit shampoo.

Occasionally lubricate zippers to prevent degradation of metal or plastic.



Scuba gloves and footware

It is recommended to wear gloves and footwear along with a suit because limbs are very sensitive to cold

Neoprene gloves provide a good protection from cold, scratches and stings. Gloves come in different thickness. Even dough the thicker gloves are better insulator it is hard to move your fingers in them and you might have a problem with manipulating your equipment.

Footwear depends on the fins you use. If you use fool foot fins you should use neoprene socks which provide protection from the cold. Remember to buy bigger fin size if you plan on wearing neoprene socks.

If you have open heel fins you should wear booties, which look like shoes, have a plastic sole and are made of neoprene. They also protect you from injuries on a boat and scratches. They are not easily torn unlike the socks because they have a rigid sole.

Maintaining your scuba gloves and footware

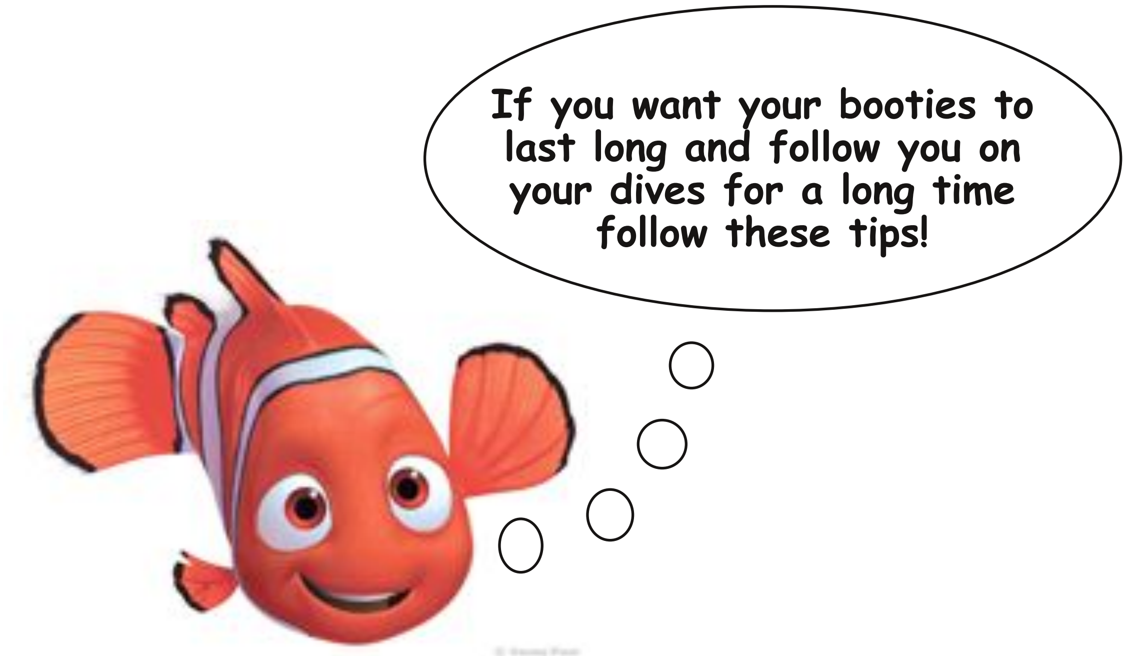
Rinse - Rinse your scuba diving boots in fresh water after each dive

Soak - Soak your gloves and footwear for about 15 minutes when you come home from diving. Use a special wet suit shampoo or baby shampoo.

Inspect for Damage - Check for any rips or tears. They are much easier to fix when they are small

Store Properly – Do not keep you booties in a drawer. This creases the boots and causes them to lose some of their insulation properties

Do not store or dry your scuba booties in direct sunlight or in the dryer!



Scuba cylinders

A diving cylinder is a container which enables the diver to carry breathable gas underwater.

The cylinder is made from a steel or aluminium bottle and a mechanism which regulates the gas-flow. The bottle is a cylindrical container.

It has one closed end, and one which has a neck with a threaded hole on it. The hole enables a valve group to be placed for regulating the gas-flow. Those groups can be predicted for one or two regulators (see page 32).

Valve group predicted for one regulator

Valve group predicted for one regulator

Tank valve with O- ring which is used to assemble the yoke fitting to the tank valve (see page 34)

Tank valve

Information about the bottle like: its volume, weight, number, maximum pressure, test pressure, date of manufacture, name of the manufacturer, when was it last tested, serial number, for which medium (air, oxygen, other gasses or gas mixtures) is it made for and the material it is made from, are marked on the top of the tank.

Tanks need to be tested. The test consists of checking inside and outside for corrosion and pressure resistance test using pressure of 50% higher than in normal use. Usually the first test is carried out 4 years after the date of construction and then after every two years.

We need to maintain our diving cylinders in order to avoid accidents with unpredicted consequences. When the tanks are transported they need to be stabilized so they would not move. We should put a protective net over the tank in order to prevent mechanical damages of the surface. Unless on flat ground, we should always place the tanks in a lying position on the ground to prevent any kind of tank damaging. After diving the cylinder must be washed and stored in a dry place.

Cylinder with a protective net

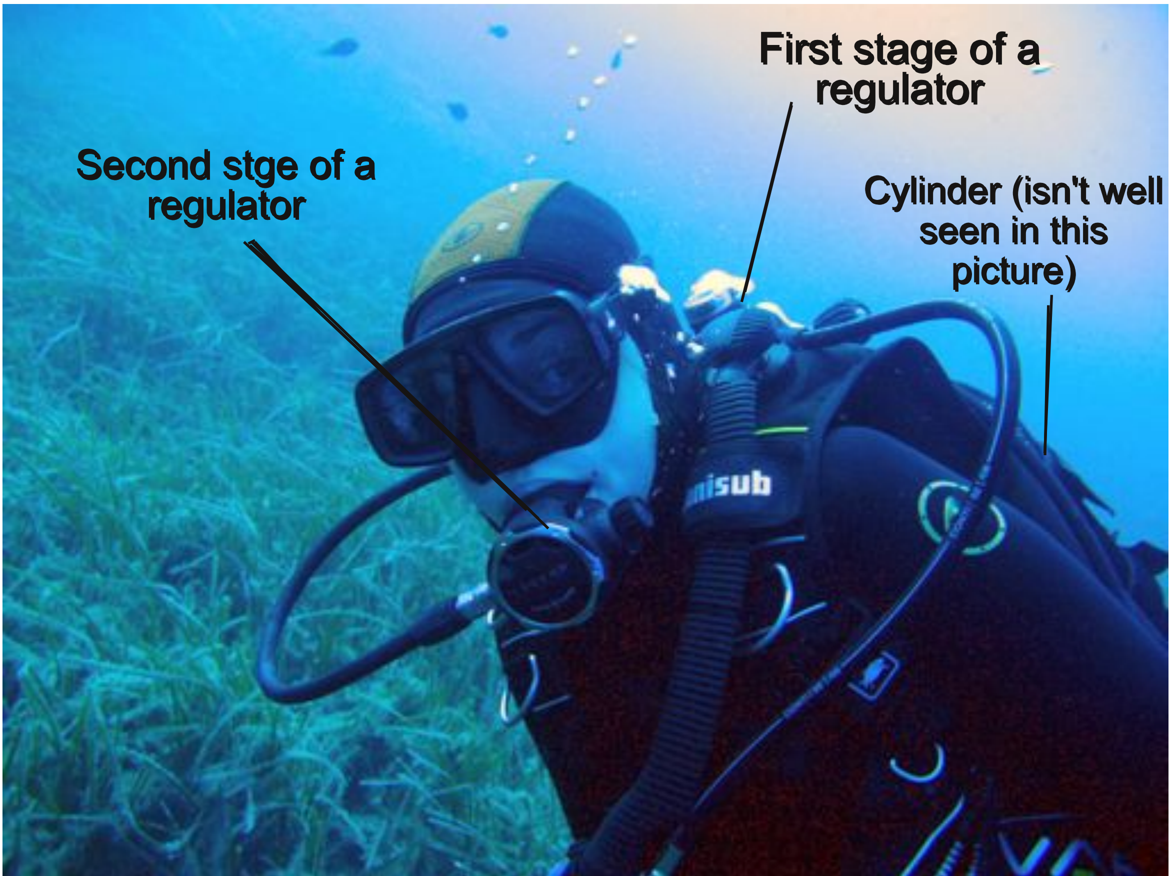
The tanks are filled in diving compressors. If the compressor is not working properly and there is a presence of oil fumes or higher amounts of CO or CO2 it can come to poisoning and have a tragical outcome. Cylinders are filled by licensed people!

Regulators

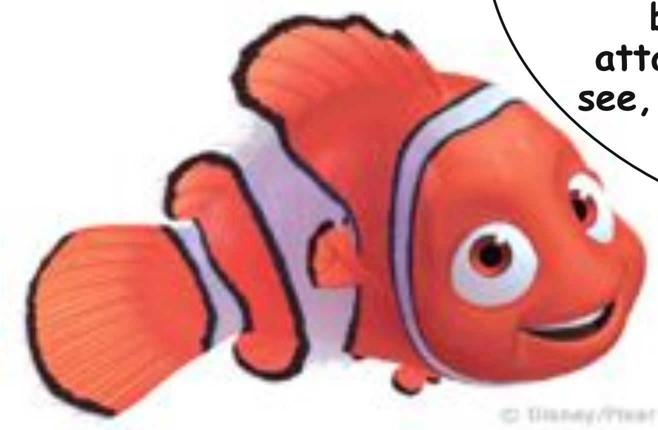
A scuba regulator is one of the most important parts of the equipment. It enables us to breath underwater. Without it, scuba diving as we know it would not be possible. Breathing on a certain depth is possible only if the air we breath is on the same pressure as the surrounding. If the pressure is not the same, the lungs will not be able to inflate properly. The task of the regulator is to provide the diver on every depth with air under the same pressure as around his lungs. In conclusion, the regulator reduces the source, high pressure from the diving cylinder onto the surrounding pressure.

A scuba regulator is made of two different parts: the first stage, which is connected to the top of the diving cylinder and the second stage, which is connected to the first stage by a rubber hose. In the past regulators had only one stage, but now days such regulators are extremely rare.

The regulator coonected to the cylinder used by a diver



It is probably hard for you to understand what is a regulator, how it looks like and how it is used. Well, here is a diver in action. She has a cylinder on her back and a regulator attached to it. As you can see, The 2nd stage is in the diver's mouth!

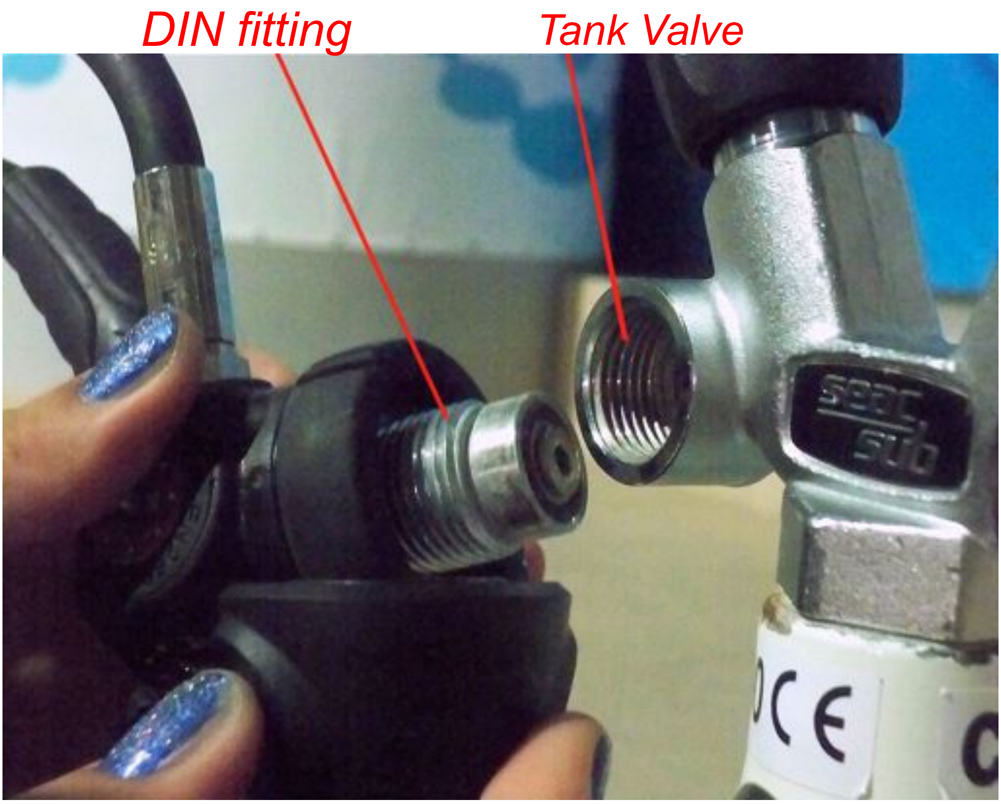


1st stage

The first stage attaches to the scuba tank, either with a knob/screw type mechanism called a yoke fitting or a fitting with a thread called DIN fitting. DIN fitting screws directly into the tank valve, and Yoke fitting screws onto an O ring.

yoke fitting

Tank valve with O-ring

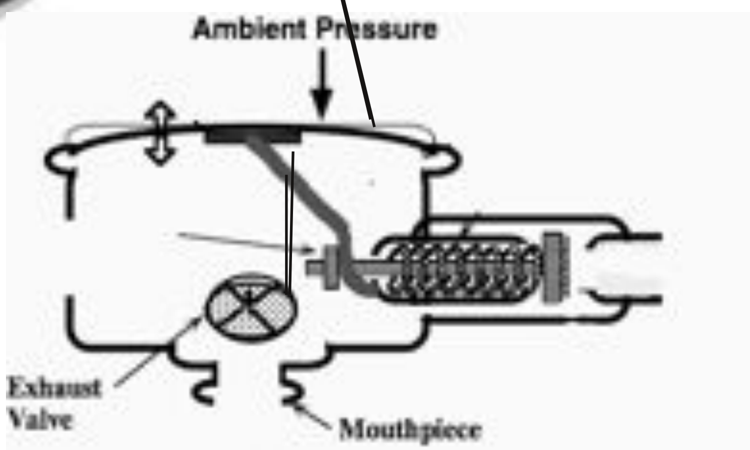


The first stage reduces the high pressured air from the tank to a lower pressure of around 8-10 bars above the ambient pressure. A valve opens in the 1st stage and allows some of the low-pressure air to flow into the hose which connects the 1st stage and the 2nd stage, and then it closes again. When the diver inhales that air, the 1st stage detects a decrease in the pressure of the hose. Then it allows more air to flow in the hose, replacing the air that was inhaled by the diver. The adjustment of the air pressure in the hose when depth changes is automatic. 1st stage can be balanced or unbalanced. A balanced first stage delivers pressure at a constant rate in the whole dive. It is not affected by the amount of pressure in the tank (it decreases as the air is used). We also classify the first stage as sealed or unsealed, meaning can water enter the first stage. If you dive only in warm waters an unsealed should be just fine, but if you plan on doing any cold water diving you should buy a sealed one so the first stage does not freeze.

2nd stage

The second stage goes in your mouth and delivers air on demand. It reduces the pressure in the hose, which coms from the first stage, to the pressure of the surrounding water making it possible to breathe. The second stage consists of the mouthpiece, an exhaust valve and an emergency purge valve/button. The exhaust valve lets the air escape into the water when you exhale. It does not let water in. When the emergency purge button is pushed, it forces air to flow continuously into the second stage chamber.

Mouthpiece *Emergency purge valve*



Scuba regulator maintenance

1) Regular service is very important.

2) You can keep your scuba regulator in great shape by simply cleaning it after use. Secure the dust cap and rinse the rest in clean fresh water. After diving in salt water you should soak your regulator in warm tap water

3) Wipe hoses down with a light spray of silicone to keep them supple

4) Don’t store the regulator with sharp objects, and if possible let the hoses hang down from the first stage, or coil everything loosely

5) If you’re not diving for a while, store your regulator in a closed bag to prevent degrading of the synthetic parts

Regulator connections (accessories)

Regulator accessories are connected either to low pressure or high pressure hoses. Low pressure hoses are on the same pressure as the breathing gas and the high pressure hoses are on the pressure which is in the diving tank. The hoses are marked with LP (low pressure) and HP (high pressure). Besides that they do not differentiate in looks.

Regulator with some connections

Octopus

It is advisable to have an alternative source of air for safety. It is a safety measure in case the regulator stops working or if somebody in the diving group runs out of air. It is connected to a low pressure hose and it is yellow

Pressure gauge

The pressure gauge is linked through a hose to the high pressure of the first stage and shows the pressure in the cylinder, so a diver can tell how much air he has left in the tank.

Depth gauge

Depth gauge measures the depth during a dive. It has a pointer that shows the maximum depth reached during the dive and the current depth on the dive.

Buoyancy compensator and dry suit linflation hoses

They are connected to the low pressure port of the first stage

Every diver needs to have a manometer, depth gauge, and a diver watch (a water proof watch which can hold the pressure of dives you plan on doing) in order to plan and monitor a dive. As already said there are instruments which have multiple functions like a console. The most advanced and now days widely used instrument is a diving computer.

Dive Computers

Calculating these safety stops has always been one of the main problems in diving. Safety stops are made during emerging to reduce the amounts of nitrogen in our body. Safety stops are time which a diver must spend at a constant depth to avoid decompression sickness. In the past it was done with deco tables but now days it is mostly done by diving computers. These are diving computers which have options even to connect to your tank and calculate the amount of air left, but all dive computers tell the basic info:

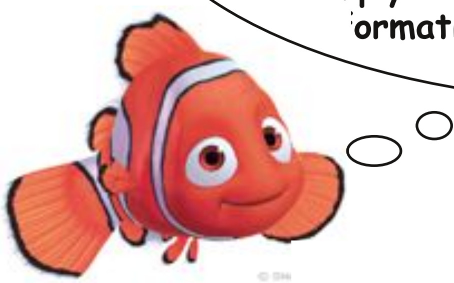
1. Amount of time underwater
2. Current depth
3. Safe time remaining at that depth
4. No decompression time limits by depth for your next dive
5. Alarm or signal - Most computers will alert you if you are ascending too fast or need a decompression stop.

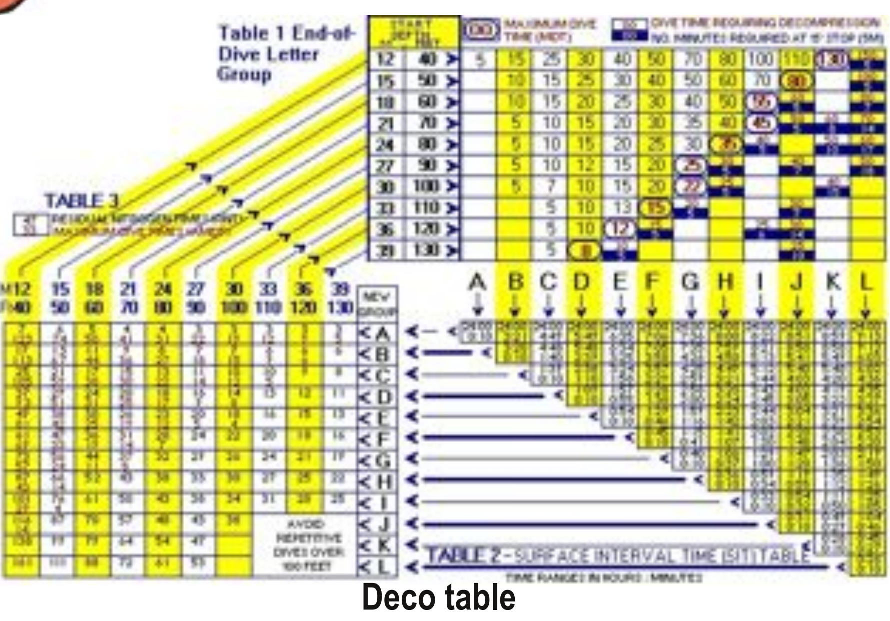
Many basic computers will also tell you

6. Surface interval time
7. Time to fly - how long you need to wait before flying
8. Water temperature
9. Maximum depth

The great thing about dive computers is that you can keep a record of you dives, because the information about them stays in the computer. The info erases after certain amount of dives (all depends on the model of the dive computer), but you can transfer the data to your computer and have a full overview of your dives. Dive computers are still developing and gaining new features which make our dives easier, but we should not rely just on our computer. I will not talk about the features of dive computes or how do they work because each model is unique and differentiates from the others. Do not be scared, using dive computers is not hard and you do not need any special training. You just need to carefully read the instruction manual from the manufacturer and get used to your new diving instrument.

We need to keep in mind that it just a machine and that it can brake or shut down because it has no more power. We need to plan the dive the old fashion way before the dive using deco tables in order to be safe and have a well planned and safe dive.By the way deco tables are simply tables which calculate stops using the ormation how long and deep is a dive!





Deco table

Buoyancy compensator device

A buoyancy compensator device or a BCD is a very important piece of equipment which allows the diver to have neutral buoyancy during the whole dive. When a diver immerses he is being exposed to bigger and bigger surrounding pressure. At a bigger pressure gasses compress to smaller volumes. Thus, when a diver immerses he is pulled to the bottom, that is he has negative buoyancy. It is vice versa when he is emerging. A diver wishes to archive neutral buoyancy so he would not be pulled up or down. That state is similar to a complete weightless state as for astronauts. Achieving neutral buoyancy with a BCD is done by regulating the amount of air in it. Generally we should inflate it when immersing and blow the air out of it when emerging. The BCD is inflated directly from a low pressure hose in the first stage. Therefore, we use the air from the tank for inflating the BCD, except in emergency cases when the BCD can be inflated with the air from our lungs over the manual inflator (or oral inflator).

The BCD consists of:

1) A system of belts and straps for fixing it to the tank

2) Inflator hose with a valve which regulates the amount of air in the tank

3) Deflator which does the opposite of inflator

4) Pockets on the side.

Most BCDs also have rings on the front for attaching additional gear and backplate for comfort. There are also other additions depending on the price of the BCD

Buoyancy compensator maintenance

1. Wash your BCD in fresh water after every dive

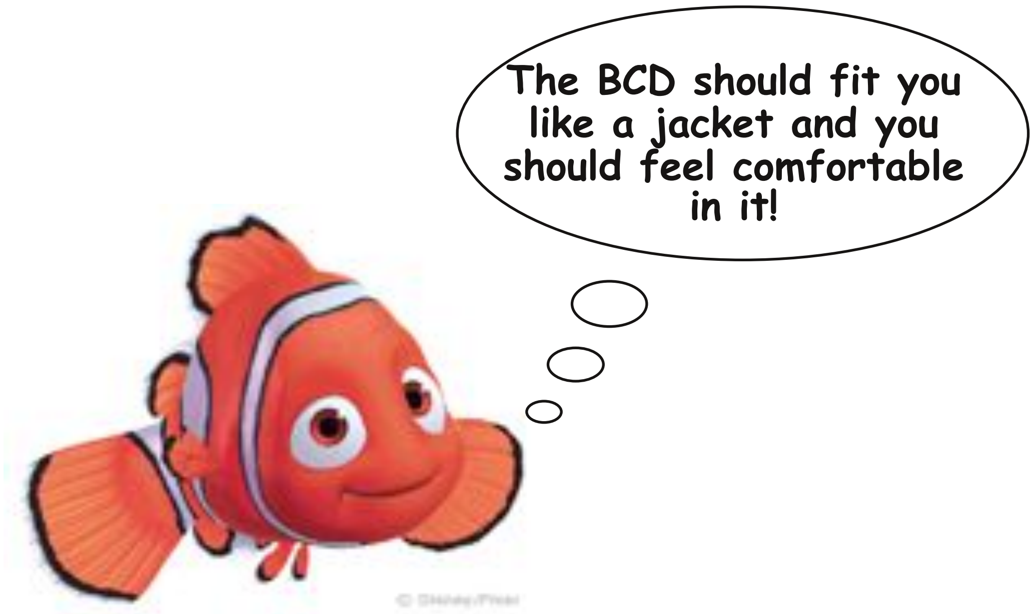
2. Rinse the inside of your BCD by putting fresh water through the manual inflator

3. Empty the jacket by tuning it upside down and draining the water through deflator on the bottom side of the BCD

4. Inflate the jacket slightly to see if any water remains

5. Store the jacket in a cool dry place on a hanger. The jacket should be slightly inflated.

6. If the jacket has not been used for more than 6 months, have it serviced at a dive shop.



Weight belts

Weights are essential for achieving neutral buoyancy

Weight are made of lead and they are fixed to the weight belt which has a release buckle. You can also buy belts which have pockets to hold weights. Some BCDs have pockets for putting weights, but the bad side is that weights can fall out of the pockets if they are not sealed. Now days belts with pockets in which lead shots are put are used a lot. They are much more comfortable, but more expensive as well. The amount of weights which should be carried depends on the thickness of the suit (the suit is made out of gas bubbles and thus has positive buoyancy), equipment, type of water and the type of dive.

Traditional weight belt

Belt with pockets for lead shots

There is a test you can do in order to see how much weights do you need to cancel the buoyancy of a wet suit. Put the wet suit on the water and place weights on it. When it starts to sink its buoyancy is canceled.

Signal Equipment

Communication in diving can be visual (sign language and surface markers), light and sound communication.

For sound communication we use <u>shakers,</u> <u>diving horn,</u> <u>whistle</u> and we can also bang metal objects against the diving tank and produce sound. Long sound signals on the surface always mean calling for help or warning!

Shakers are basically metal tubes with two metal beads in it. They produce sound when shaken.

Diving horns usually connect between the low pressure hose and the BCD. They use the air from the diving cylinder to make noise.

A regular plastic whistle usually comes with the BCD. It is useful on the surface when we signalize our position to a passing boat.

Light signals are flash lights. A flash light is necessary in night dives, an it is usually used in daily dives when you are going through tunnels, looking under ledges, diving on a wreck etc.

Read the instructions form the manufacturer very carefully and remember the maximal pressure your lamp can be exposed to and how long do its batteries last.

A dive light can be easy lost while diving. Most lights come with a wrist strap , but it is safer to attach your light to your BC with a flexible leash.

In order for your lamp to last long, rinse it in fresh water after every dive. For ensuring your light will work when you go on a dive check the seals and the batteries before you get in the water.

Diving knife

A diving knife is not used for killing fish or attacking sharks as many people think after they first hear about this piece of equipment. It is used for releasing a diver when caught in a fishing net and for hitting the blade on the tank as a signal sound. A diving knife must be strong, have a comfortable handle and be well sharpened. Knifes are mainly worn on the inside of the calf, or on the upper arm. After use should be rinsed with fresh water, dried and then coated with oil.

Diving Bag

Bags are used for storing your equipment. There are different types of bags on the market. You should choose the one that best fits you. In choosing your bag you should consider: how much equipment do you want to carry in it, how big is that equipment, do you travel and how strong does your bag need to be. Remember a bag can never be too big!

Surface marker buoy

A floating buoy is a piece of safety equipment that marks the place where diving is taking place. In some countries dive law requires flags. On the top of the buoy is a blue and white flag known as an “A” FLAG. This flag has an international definition of ”I HAVE DIVERS DOWN, KEEP WELL CLEAR AT SLOW SPEED”. Instead of this flag you might see a red flag and a white diagonal stripe on it. During night dives the buoy has to have a flash light on it, so it would be visible.

When you decide to
buy diving equipment talk to
experienced divers and trainers

COMMUNICATE

and COLLABORATE

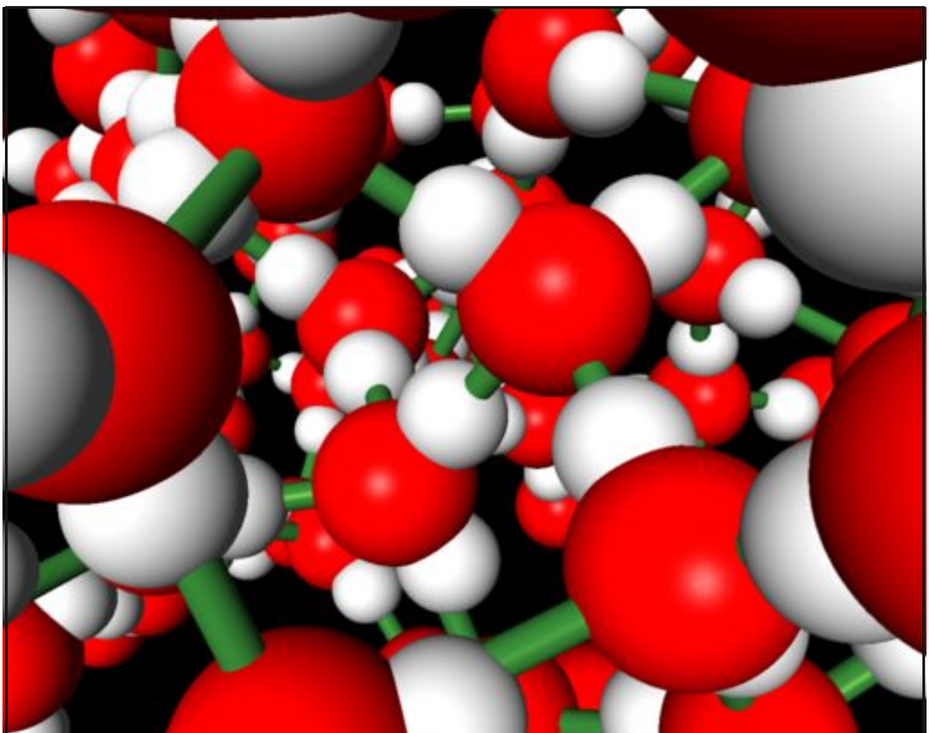
in order to find the best solution for you! Buying equipment is very important for your safety and comforts!

Chapter 2

Diving Physics and Chemistry

This chapter describes the laws of physics which are concerned with diving and affect humans in the water. Understanding of principles in this chapter is essential for safe diving.

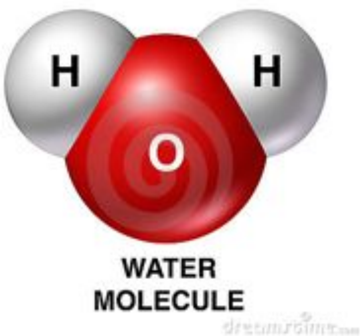
The human body is adapted to conditions on land where the pressure is approximately 1 bar. On this pressure our body functions normally, without any difficulties. However in the water the pressure rises making it impossible for longer staying. However, scientist have invented equipment which allows us to stay underwater longer and safer without permanent consequences on our health. Two major problems our body faces underwater are the affects of higher pressure and problems related to the gas mixture under pressure which we breath from the dive tank. In order to understand those problems we first need to learn the basic physical and chemical characteristics of water in which the divers stay, and air which the divers breath.



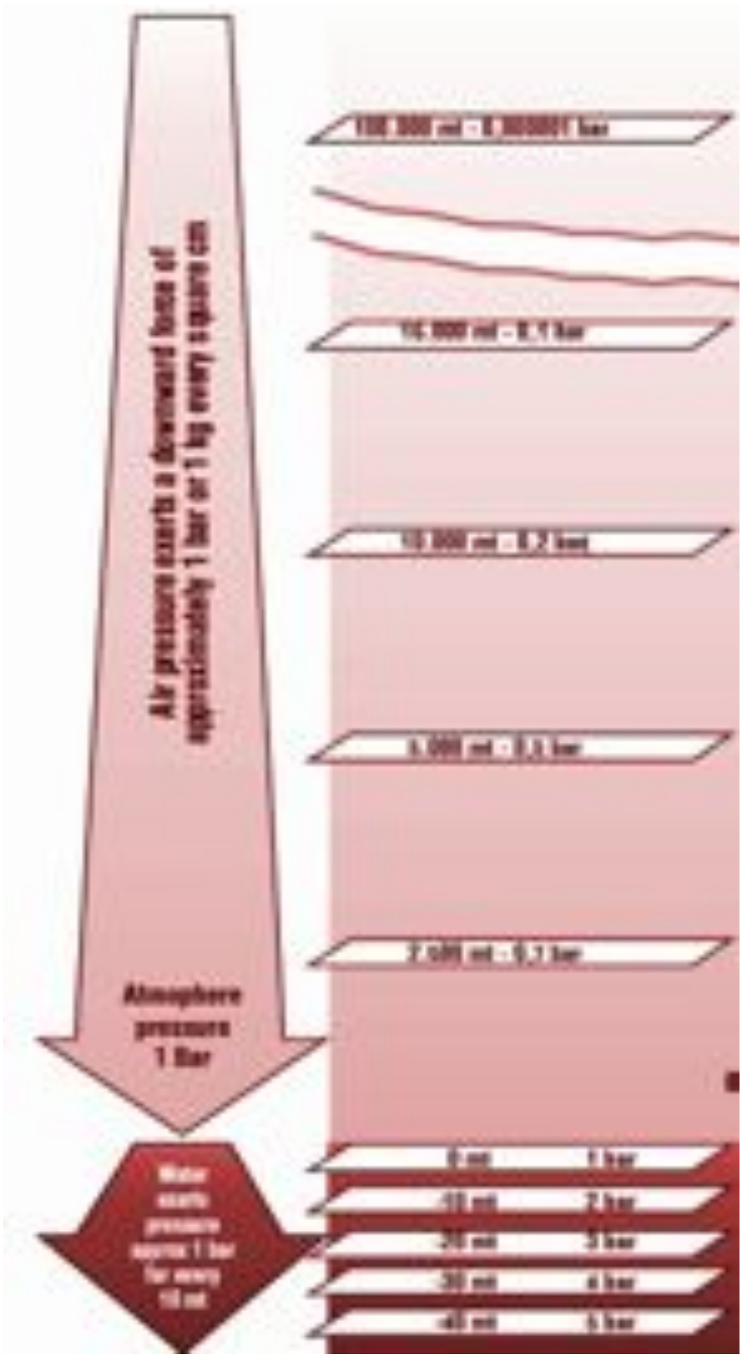
water molecules

Physical and chemical characteristics of water

Water is made of two hydrogen and one oxygen atom with an admixture of gasses, minerals and other elements. It is a fluid which changes its shape based on the container it is placed in. Sea water has its salinity which gives it bigger mass and density than fresh water.

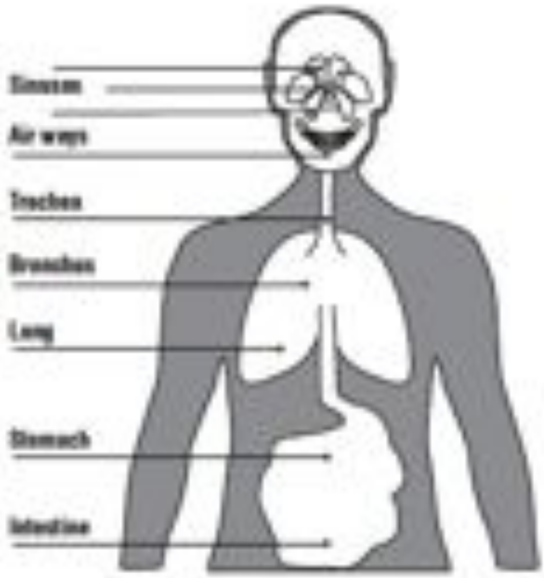


The volume of water changes directly proportional to the pressure, so it is incompressible, unlike gasses. Because of this fact the pressure in water rises 1bar every 10 meters .

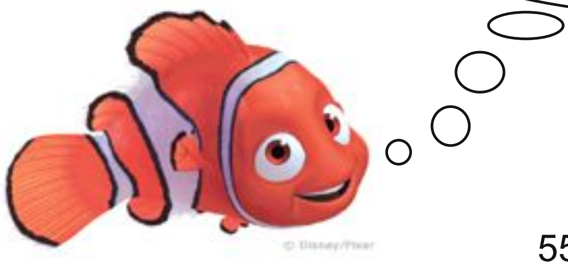


Your wet suit is made out of millions of gas bubbles. As we already said gasses are compressible and water is not. Because of this you should always let some water get in your wet suit. Otherwise your body will be squeezed by your wetsuit at higher pressure.

When we are exposed to bigger pressure we feel the pressure only on the parts of our body which have volumes filled with air (because air is compressible). Thus we feel the pressure on our eardrum (we equalize the pressure by valsalva maneuver), lungs (we equalize the pressure by breathing air under the same pressure from the regulator) and sinuses (the air under pressure enter sinuses independently).



Note: Valsalva maneuver is done by exhaling while pinching one's nose shut.



Unlike solids pressure in fluids (gasses and liquids) is transferred uniformly in all directions. Pascal's law which states :

“If pressure is applied to a non-flowing fluid in a container, then that pressure is transmitted equally in all directions within the container”

Thus, the pressure of the air breathed from a cylinder is transmitted in all directions and to all cavities in the same strength, and a body immersed in a fluid is not crushed by the weight of the fluid because the pressure tends to surround it by exerting the same force on its whole surface. For this reason it is possible to dive on big depths without being crushed by the weight of the water.

Pressure envelops a diver

Pressure is transferred uniformly in all directions

Buoyancy of objects in water

Buoyancy is the tendency of a body to float caused by the upthrust (vertical force) described in Archimede's law.

Archimede' s law states:

" A body immersed in water will receive an upthrust equal to the weight of water it displaces"

Upthrust = [volume of the part of the solid immersed in fluid] x [density of fluid] x gravitational acceleration.

The weight of the water displaced by the rock is equal to the upthrust

This law describes buoyancy. Some common terms to describe buoyancy are:

Positive Buoyancy: the tendency of the body to float. In this case the weight of the body is less than the upthrust force

Neutral Buoyancy: the body neither floats nor sinks. In this case the upthrust and the weight of the body are the same

Negative Buoyancy: the tendency of the body to sink. In this case the weight of the body is bigger than the upthrust force

Every diver tends to have neutral buoyancy by achieving equilibrium between the body, the equipment and the weights.

Neutral balance means more safety, control and comfort underwater. In order to achieve neutral buoyancy we need to consider the relation between the volume and weight of: our body, the density of the liquid we dive in, and the equipment we dive with.

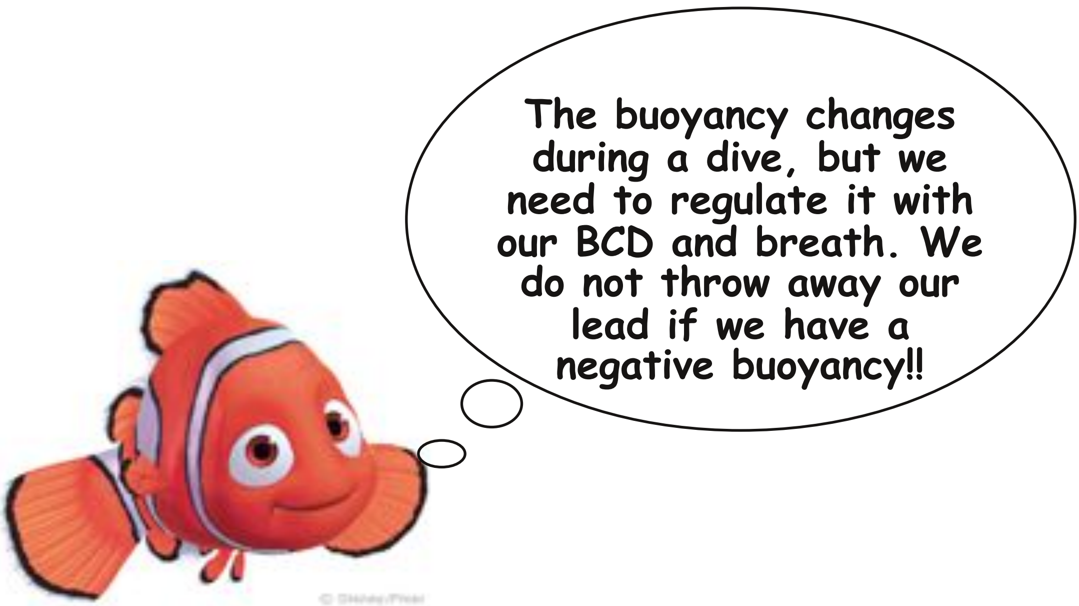
Every diver needs to asses how much weights he needs according to his own body shape, thickness of his suit (suit is made of millions of bubbles, so it has positive buoyancy), weight and number of diving cylinders (more cylinders equals more weight) he carries and the density of water he dives in (bigger water density means bigger upthrust and more weights are needed to sink).

These divers are neutrally buoyanced and do not stick to the floor or go towards the surface

The diver may change his buoyancy in different ways. By adding weights to the weight belt, breathing in and out changes the volume of his lungs, and regulating the amount of air in the BCD by increasing or decreasing the volume of the BCD.

Note: *more volume = more upthrust, less volume = less upthrust.* If you are sinking (negative buoyancy) you inflate the BCD. If you are going towards the surface (positive buoyancy) you should deflate your BCD:

Note: It is better to have 1 kg lead more than less. Namely when you are emerging you have les air in you cylinder and thus it weights less. We always make safety stops or decompression stops. If not, we can get a bad disease or even die. If you do not have enough lead, the upthrust will bring you to surface because of the reduced weight of the cylinder.



Water resistance

The bigger your surface area is, the bigger the resistance. Bigger resistance equals harder swimming and getting tired sooner. The smallest resistance is when you dive in a horizontal position. When you inflate your BCD the resistance increase because the surface area of the diver increases.

Heat loss in diving

Heat loss is called hypothermia. it is caused by a lowering of the body temperature to about 30 degrees C and can lead to serious heath problems. Hypothermia causes respiratory problems. It also reduces the brain and heart activity causing anxiety, disorientation and coma. It is very important to be properly equipped for dives. Never dive without a wet suit! If a diver gets hypothermia we need to remove the diver ‘s wet clothing, dry him, cover him with blankets, and keep him warm all over. Therefore, when you feel cold on a dive, tell that to your dive leader and start surfacing because the water is warmer at shallow waters. Remember, ALWAYS wear a wet suit!

Overheating in diving

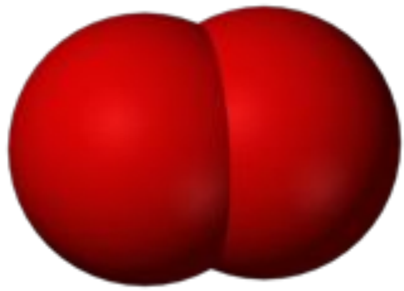
Overheating of the body is called HYPERTHERMIA. It occurs after excessive exposure to heat. This happens when a the diver in a dry diving suit is stays under the sun for a considerable time. Symptoms such are headache, excessive sweating, respiratory difficulties, and even loss of consciousness may occur. The diver with hyperthermia should be undressed, taken to a cooler environment and given a lot of water to drink.

In order to wear your suit before getting to the location without overheating you can let water in your suit. If the boat trip is very long then you can take off the upper part of the suit.

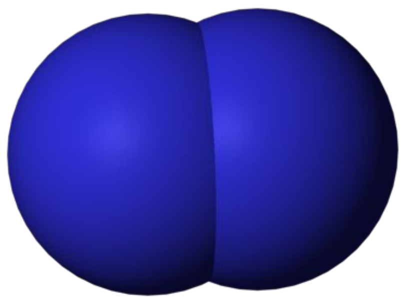
Properties of air and its components

Air is a mixture of gasses consisted of 21% Oxygen, 78% nitrogen and 0,03% carbon dioxide. These components have different properties which are important to know.

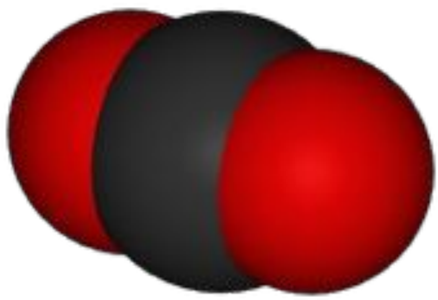
Oxygen is a colorless, settles and tasteless gas which is one of the most important for preserving life on earth.



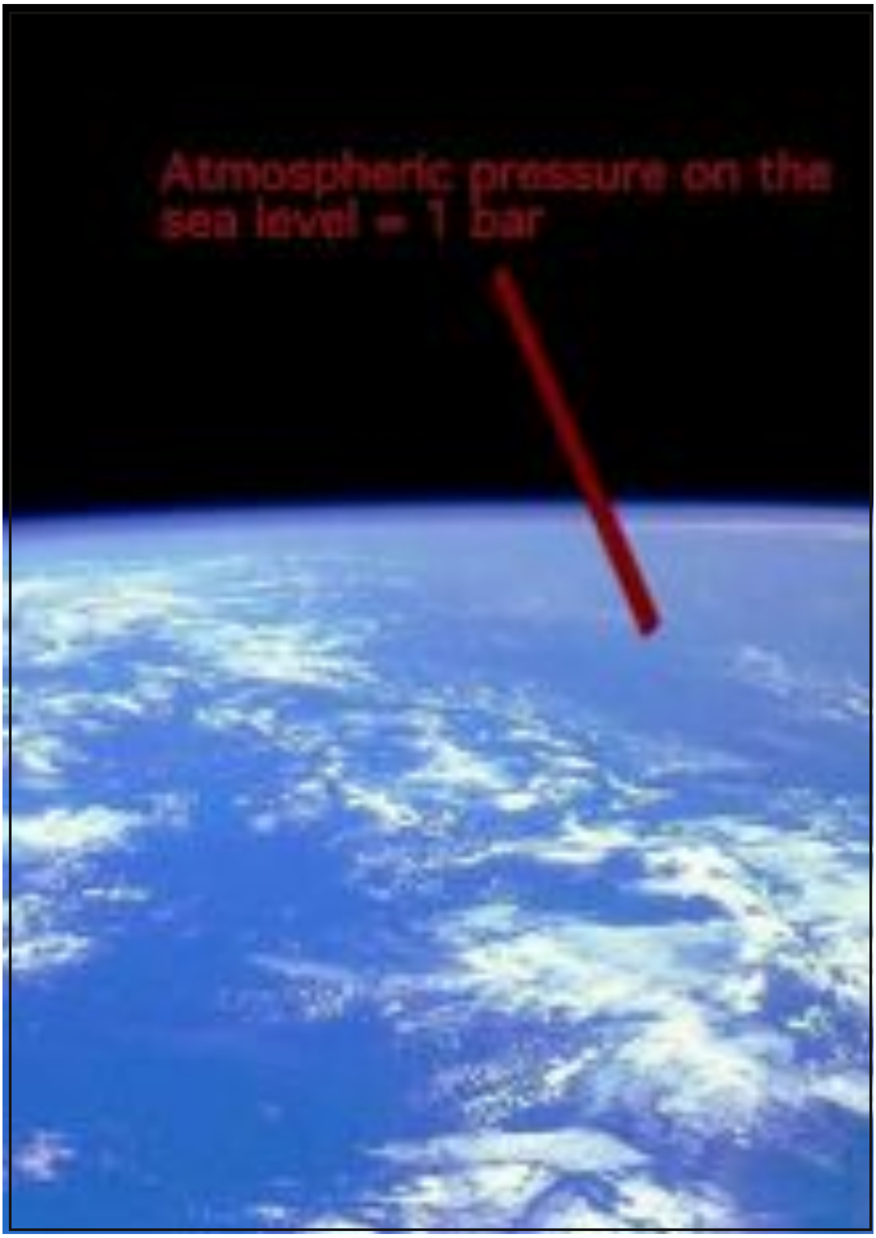
Carbon dioxide is heavier than air, colorless and has an acidic taste. When we have to much CO2 in our lungs we inhale, so we can say that CO2 is a breathing stimulator.



Nitrogen is an inert gas without color, smell or taste. In normal conditions it doesn't affect life processes, but in pressure changes it can change its aggregate state from liquid to gas and cause decompression sickens.



Pressure



All gasses in the air make an unique atmospheric layer around the Earth, which at the sea level acts under the pressure of 1 bar. The pressure decreases as the altitude increases. The pressure in water is a completely different story.

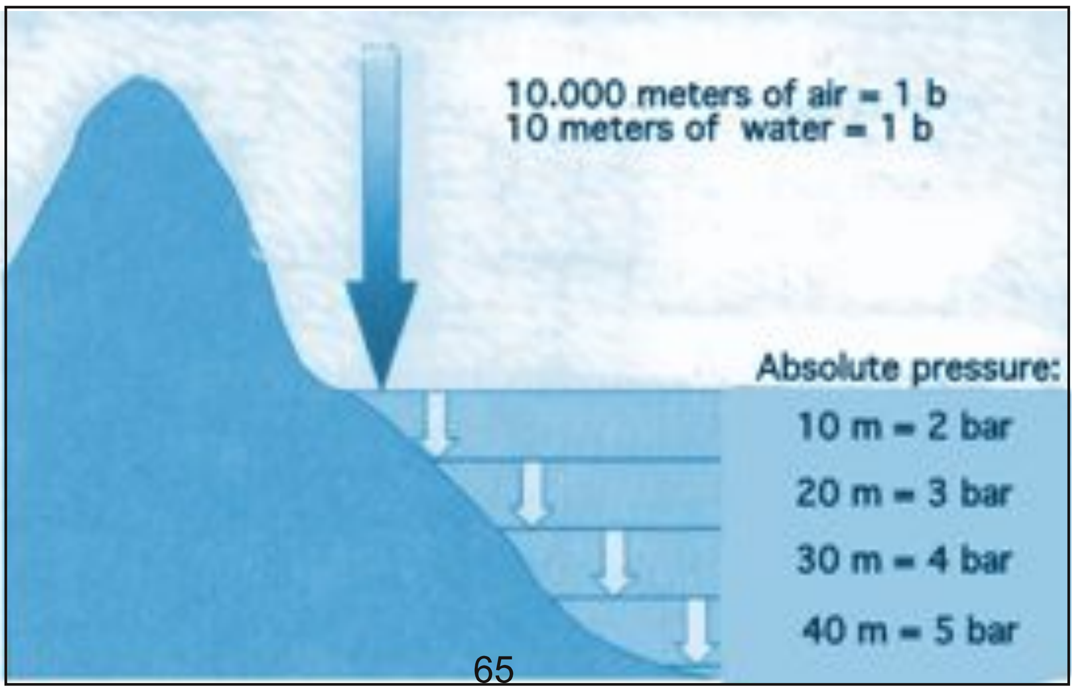
Water Pressure

The pressure of water is called hydrostatic pressure. It rises one bar every 10 meters. On 10 meters it is 1 bar, on 20 meters 2 bars etc. The sum od the pressure of the atmosphere and the hydrostatic pressure gives the absolute pressure which acts on a body.

10 meters of salt water + 1 bar of atmospheric pressure= 2 bars

20 meters of salt water + 1 bar of atmospheric pressure= 3 bars etc.

The absolute pressure= (depth/10 +1) bar

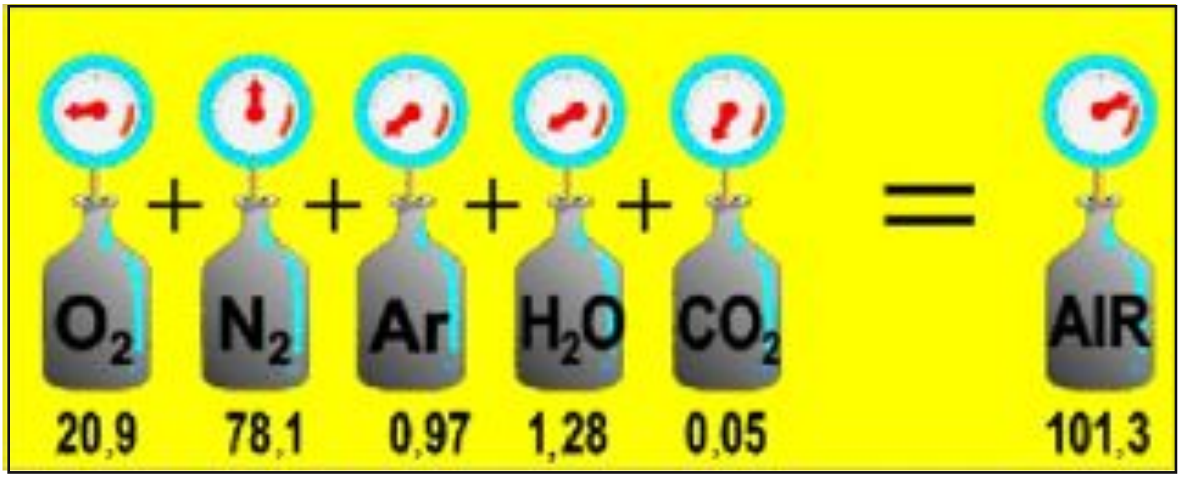


Partial pressure

Dalton's Law States:

" The total pressure exerted by a mixture of gases is equal to the sum of the pressures that would be exerted by each of the gases if it alone were present and occupied the total volume"

The pressure of a substance= $p_1+p_2+p_3$. At sea level with a pressure of 1 bar, the partial pressure of the oxygen is 0.21 bar and the partial pressure of nitrogen is 0.78 bar. When we add them up (along with other smaller components of air) we get the total pressure exerted by the mixture we call air.



While underwater a diver breathes compressed air under ambient pressure. At a depth of 10 meters, the pressure inside the lungs will be the equivalent of the ambient pressure, 2 bar. Thus, the partial pressures of each of the gases shall increase.

Partial pressure of some gas at some depth = partial pressure of that gas on 1 bar x the absolute pressure on a given depth

Example:

Partial pressures of oxigen and nitrogen on given depths:

1 bar (sea level) - 02 oxygen, 0.8 nitrogen
2 bar (10 meters) - 0.4 oxygen, 1.6 nitrogen
3 bar (20 meters) -0.6 oxygen, 2.4 nitrogen etc

The solubility of gasses in fluids

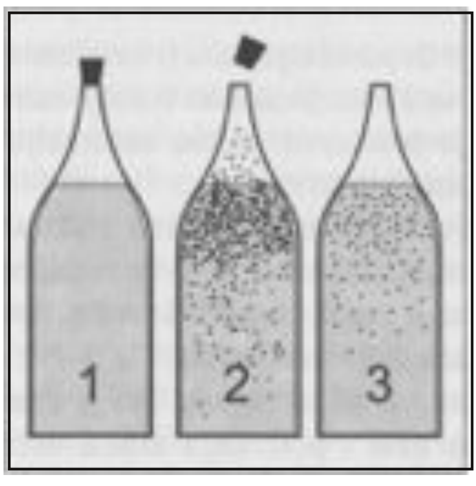
The Henry's law describes the solubility of gasses in fluids:

"At a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid."

That means that that the deeper the diver descends the greater the quantity oxygen and nitrogen passes into the blood stream and the tissues. The increase in the partial pressure of the oxygen causes no problems at the recommended depths for recreational diving. However, the quantity ofnitrogen absorbed (which is 4 times greater) can cause serious health problems. This is why divers do decompression stops (stops at one depth according to deco tables) and safety stops (3 minutes on three meters should be done on every dive), to release the accumulated nitrogen out of the body.

Different gasses get absorbed at a different rate and same

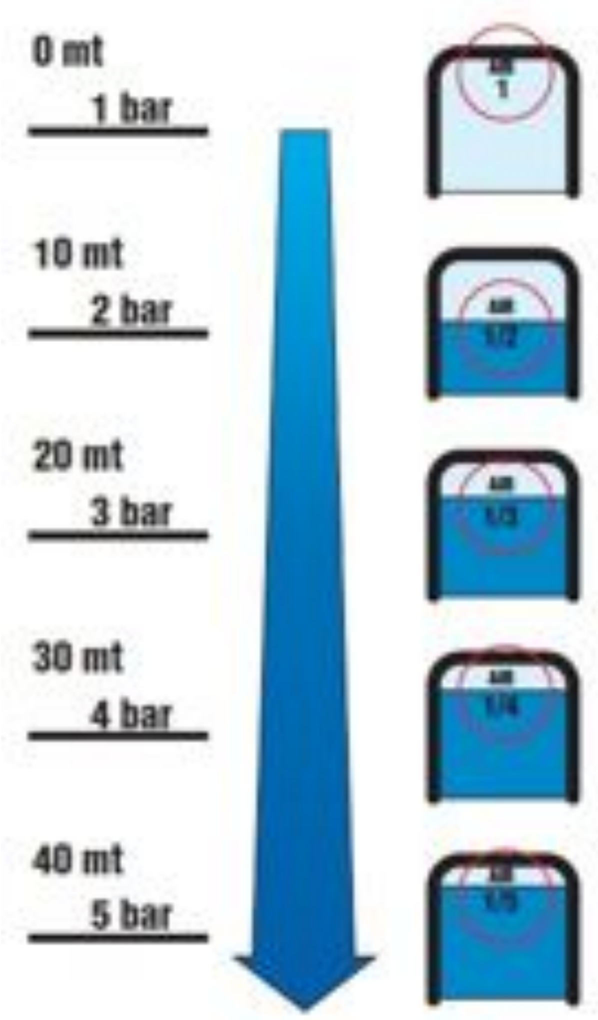
We can explain Hanry's law on a simple case of a soda drink. While the cap is on the gas (CO_2) is dissolved in the soda, When we take the cap off, the pressure lowers down- that is becomes the same as the atmospheric. As the pressure lowers down the fluid absorbtion powers lower down so the gass is released in a form of bubbles. If we slowly open the cap the bubbles do not form. The same thing happens with the nitrogen dissolved in our body. If we emerge too fast it turns into bubbles causing decompression sickness (see page 100).



Pressure and volume

The Boyle's law explains the realtion between the pressure and volume :

"At a constant temperature the volume of a gas varies inversely with absolute pressure while the density of a gas varies directly with absolute pressure"

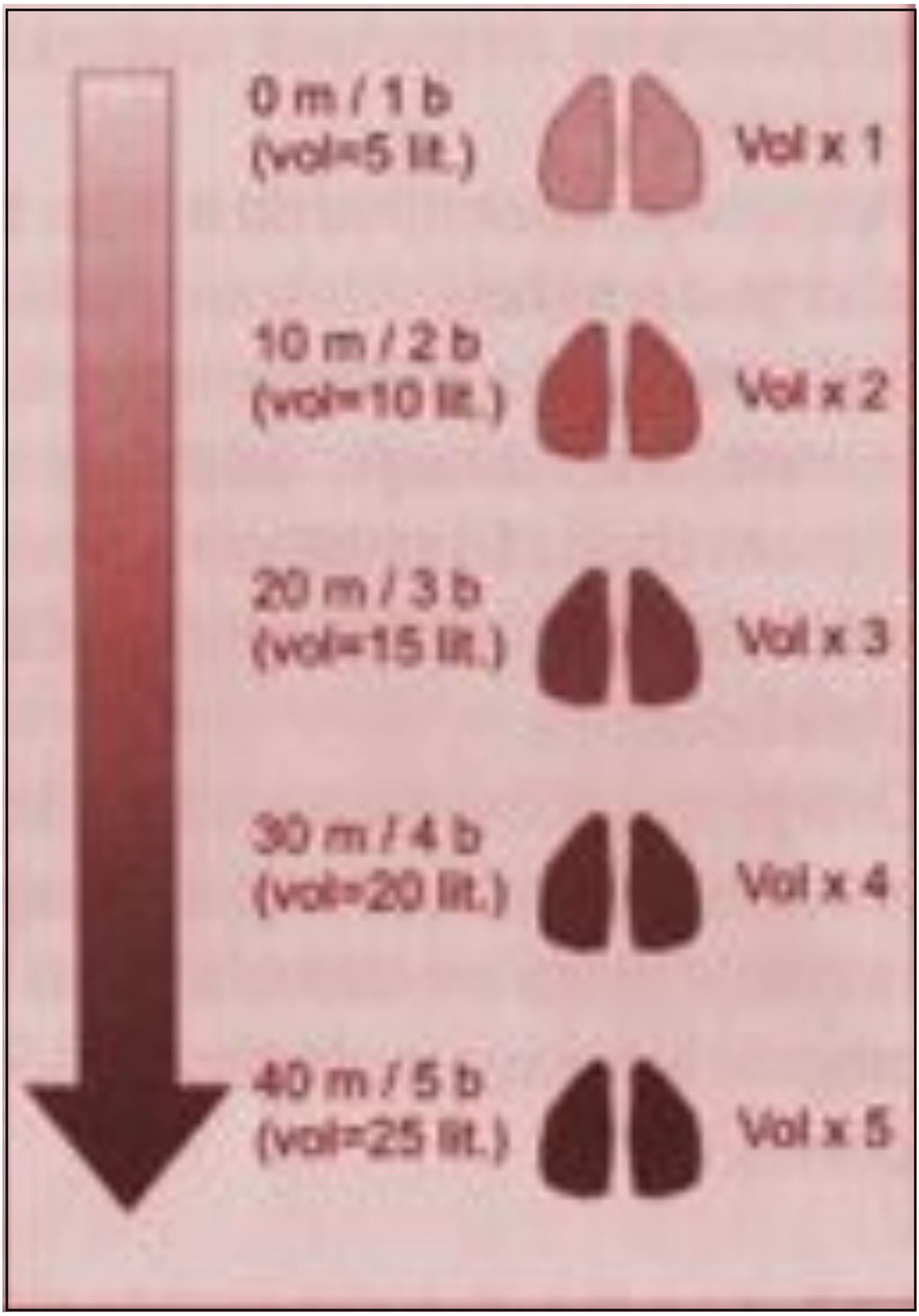


In apnea (breath hold) diving the volume of air in the lungs decreases.

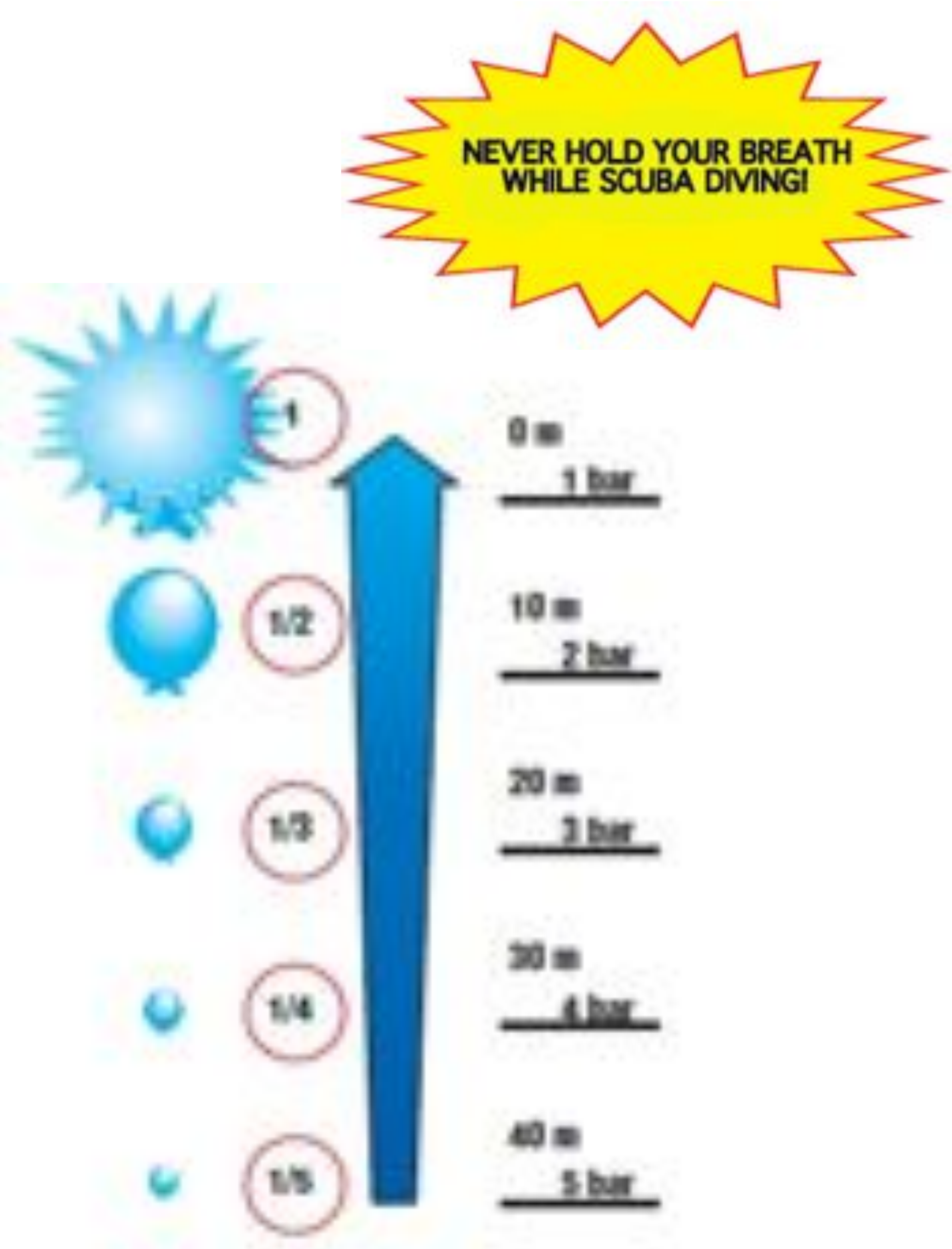
In apnea you inhale only once before descent, so if you exhale you release oxygen needed for your survival.

In scuba diving the actual volume and density of inhaled air in lungs changes according to the ambient pressure. Volume is inversely proportional to the pressure, and density is directly proportional to the pressure. If we have a lung capacity of 5 liters, on surface (pressure of 1 bar) with a full breath we inhale 5 liters, but under pressure of 2 bars we inhale 10 liters because of the density of the air. The capacity of the lungs does not change! When we start going towards the surface in a dive, the pressure decreases and thus the volume of the air increases. If we hold breath our lungs can burst. YOU NEED TO BREATH CONSTANTY DURING SCUBA DIVING!

Change of volume of air in the lungs while scuba diving:



What happens if we do not breath during scuba diving. The blue baloon represents lungs:



Temperature and pressure

The law which explains the relation between the volume and temperature at a constant volume is Gay-Lussac's law which states:

”The pressure of a gas of fixed mass and fixed volume is directly proportion to the gas's absolute temperature.”

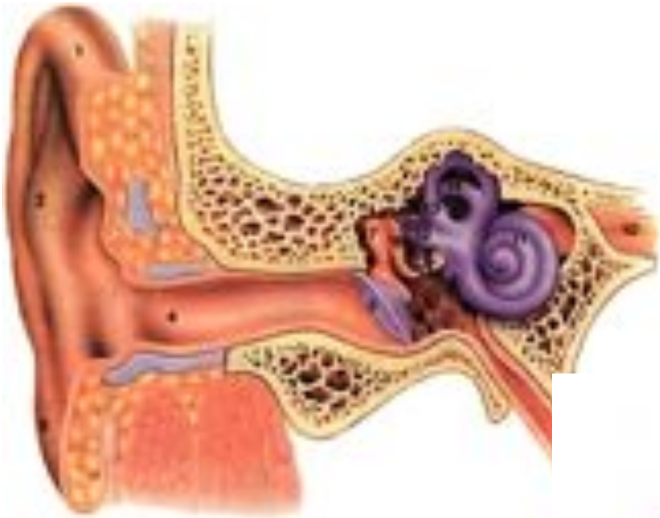
The most obvious application of this law in diving is when filling diving cylinders. Namely the bottles heat up when filled and this the pressure is bigger in them. A hot cylinder with 200 bars will have aprox. 180 bars when it cools down.

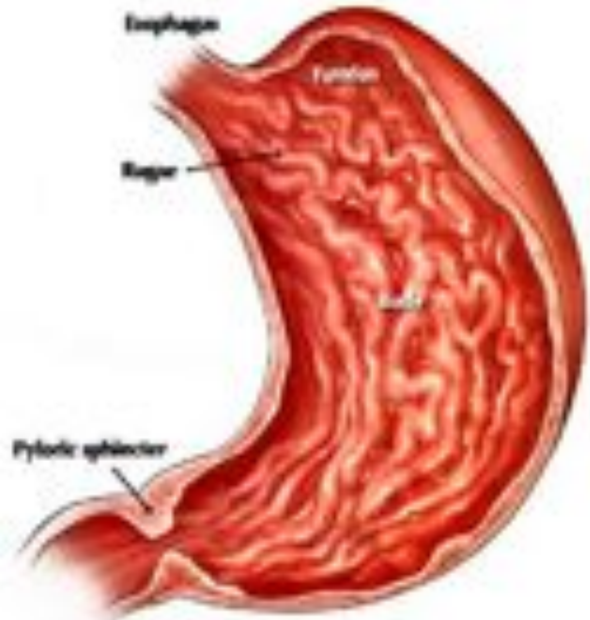
Always check how much bars do you have in you cylinder after you get in the water, that is just before the dive. It is possible that the cylinder cooled off and you loosed pressure, and thus air for your dive!

In order to fully understand this topic talk to experienced divers and trainers. COLLABORATE AND COMMUNICATE to understand!

Chapter 2

Diving Medicine

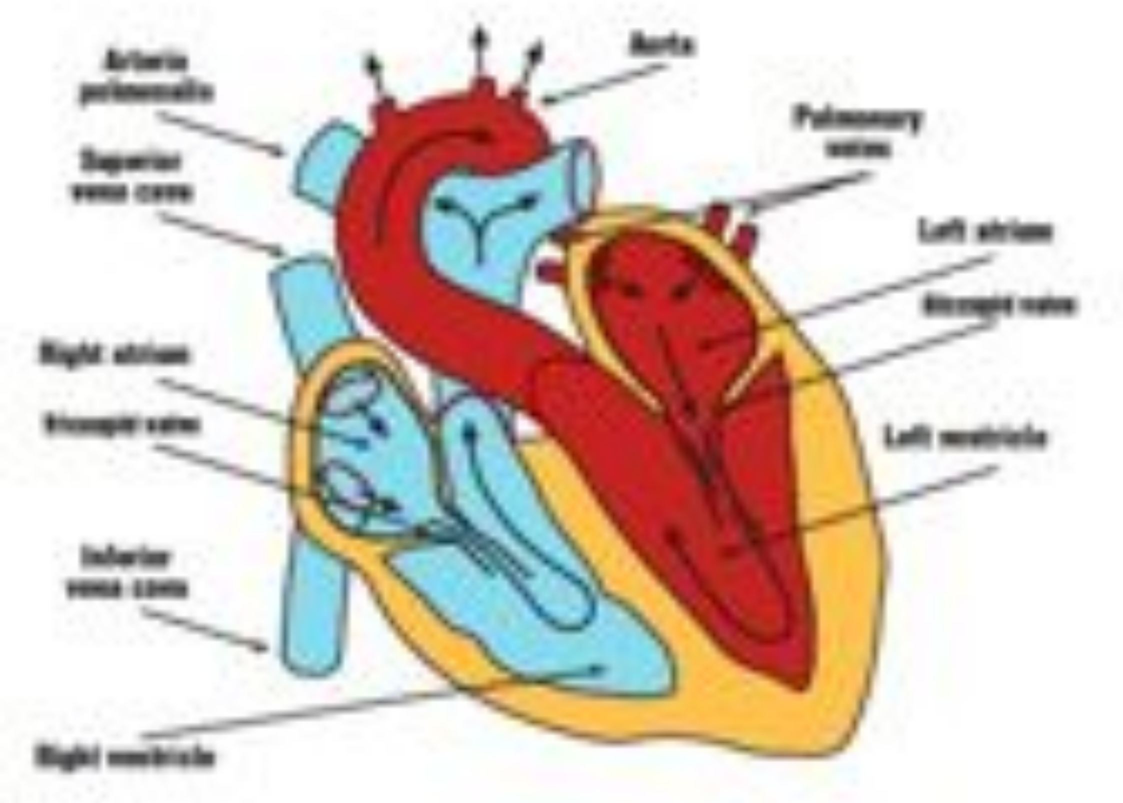




Why is it important to know diving medicine?

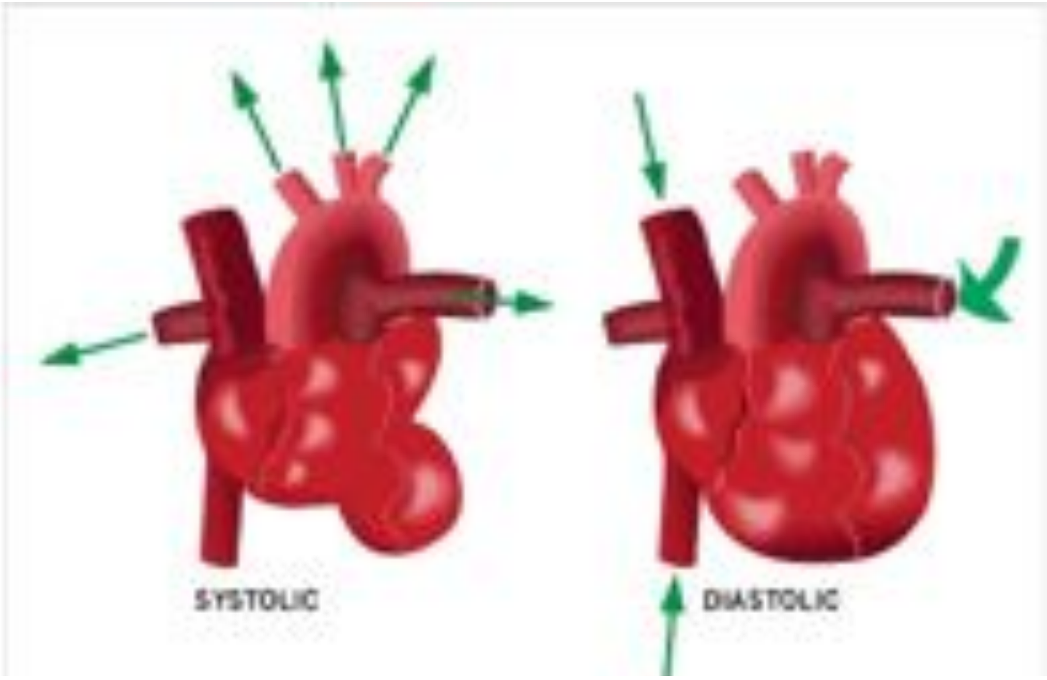
It is very important to understand this chapter because of your safety and safety of your diving group. It is essential for good and effective handling of emergency situations.

The cardiovascular system



The function of the circulatory system is to transport and distribute oxygen and to remove remains of carbon dioxide. The central element of the circulatory system is system the heart, which is divided vertically in the left and right side of the heart. The left side of the heart is responsible for the transportation of the blood enriched in oxygen - the right side of the heart is responsible for the transportation of the blood with carbon dioxide and poor in oxygen. Horizontally, it is divided into two parts the atria and the ventricles. The atria receives the blood and the ventricles pump the blood. The right ventricle pushes the blood towards the lung via the pulmonary arteries, and returns the blood rich with oxigen through the pulmonary veins, which go to the left atrium. From there the blood goes into the left ventricles where it is pumped throughout the body via the arteries. After that it returns through the veins to the right atrium.

Cardiac movement is divided into two phases: “systolic” and “diastolic”. The systole is a contraction which allows release of the blood, and the diastole allows the heart to be filled with blood.



Blood is carried by:

The main arteries - thick and wide,resistant to high blood pressure

The arteriole - small in width, regulate the flow of blood according to the requirements of the various organs

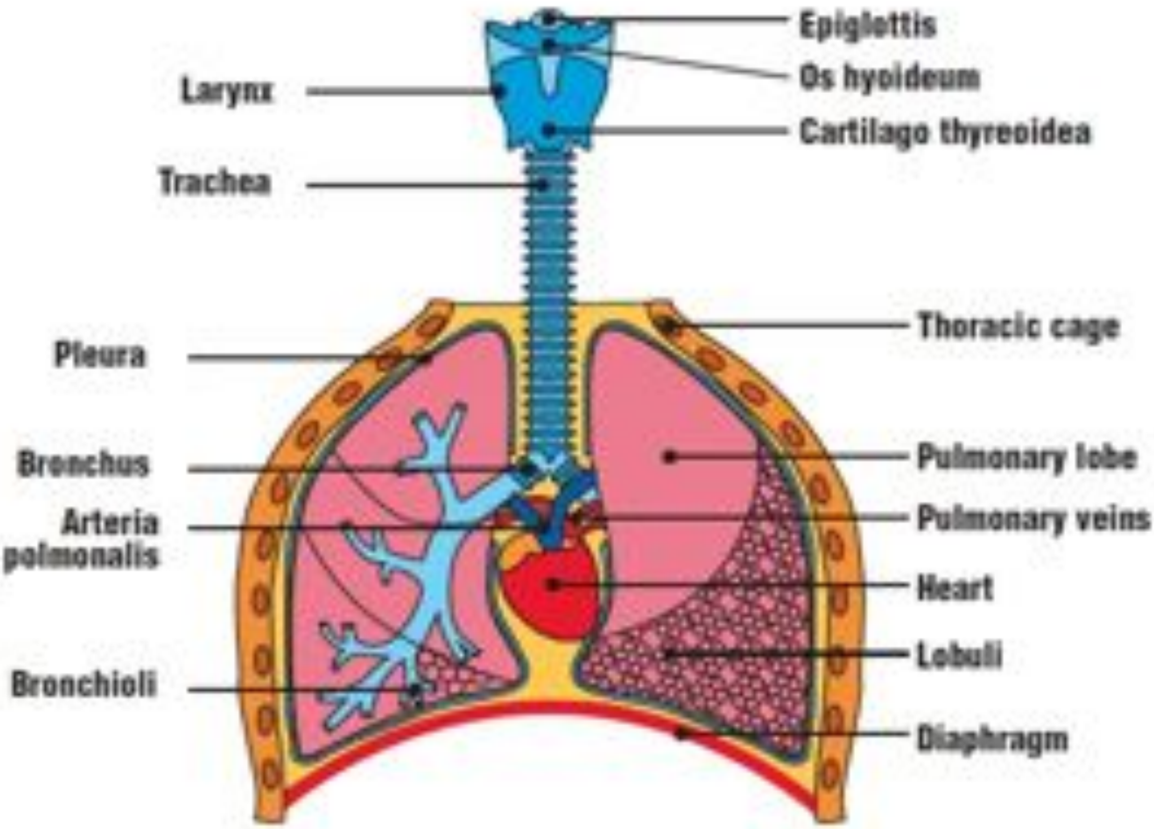
The capillaries - the blood slows down considerably to allow tissue exchange.

From the capillary the blood goes into the venule, from there into the larger veins, and finally to the veins that return to the heart.

The respiratory system

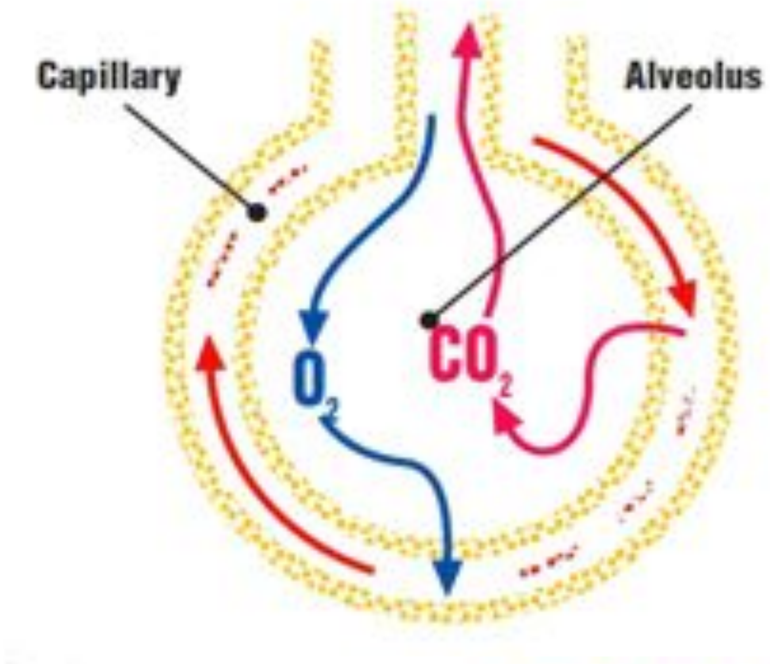
The function of the respiratory organs is gas exchange. This is done by absorption into the blood through the following: The respiratory airways (connect the lungs with the outside), the alveoli (the place where gas enters the bloodstream), and the capillaries (link the alveoli with the heart).

The respiratory airways are divided in two sections: upper and lower. The upper airways are nose, mouth, sinuses, pharynx and larynx. Their task is to carry air to the lungs while purifying and adding moisture to it. The lower airways are trachea, bronchi, bronchiole and alveoli. Over the bronchioli and alveoli the respiratory exchange takes place.



THE ALVEOLI AND THE CAPILIARIES

Alveoli are organs used for the gas exchange and have a vast surface area (between 40 and 100 square meters in adults). Oxygen and carbon dioxide are carried from the breathed air into the blood, because of the difference in partial pressure, through the membrane of the alveoli. When we breath in the air the partial pressure of oxygen is bigger in the lungs than in alveolus, so the alveolus receive the oxygen to even up the partial pressure. Once oxidized the blood carries to the left atrium via the pulmonary veins prior to being distributed throughout the body.



DIFFERENT PRESSURE
Capillary pCO_2 > Alveolar pCO_2
Alveolar pO_2 > Capillary pO_2

p is partial pressure

Hearing in water

Structure of a human ear

The three major parts of the human ear are the outer ear, the middle ear and the inner ear.

Sound travels from the outer ear to te middle ear and finally to the inner ear.

Outer ear

The outer ear or external ear is a visible part of the ear. The outer ear consists of the following two parts:

Ear Flap (Pinna) - The sound waves enter the ear through the ear flap.

Ear Canal - The ear canal is about 2 cm in length. It increases the sound waves and channelizes them to the middle ear. Sweat glands are present in this canal. They secrete earwax.

Midddle ear

The middle ear is located between the outer ear and the inner ear.

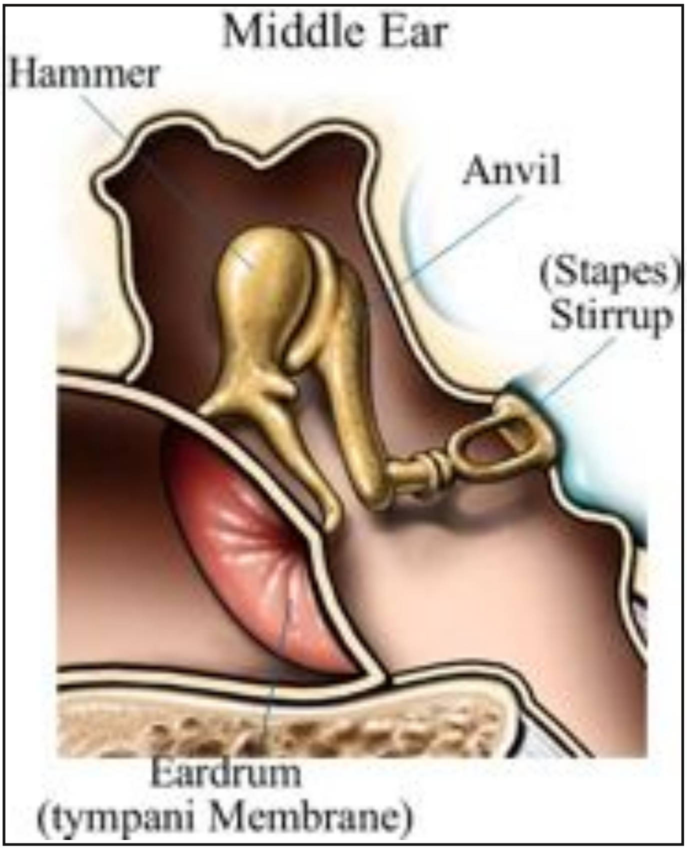
The middle ear is an air-filled cavity and consists of the following parts:

Eardrum - a thin membrane that presents a distinction between the outer ear and the middle ear. It vibrates as soon as it receives the sound waves

Hammer - is a tiny bone located next to the eardrum. The vibrations from the eardrum cause the hammer to vibrate.

Anvil - is another tiny bone next to hammer. It vibrates in response to the vibration of hammer.

Stirrup – similar to hammer and anvil, stirrup is a tiny bone in the middle ear. It also vibrates and passes the sound waves to the inner ear.



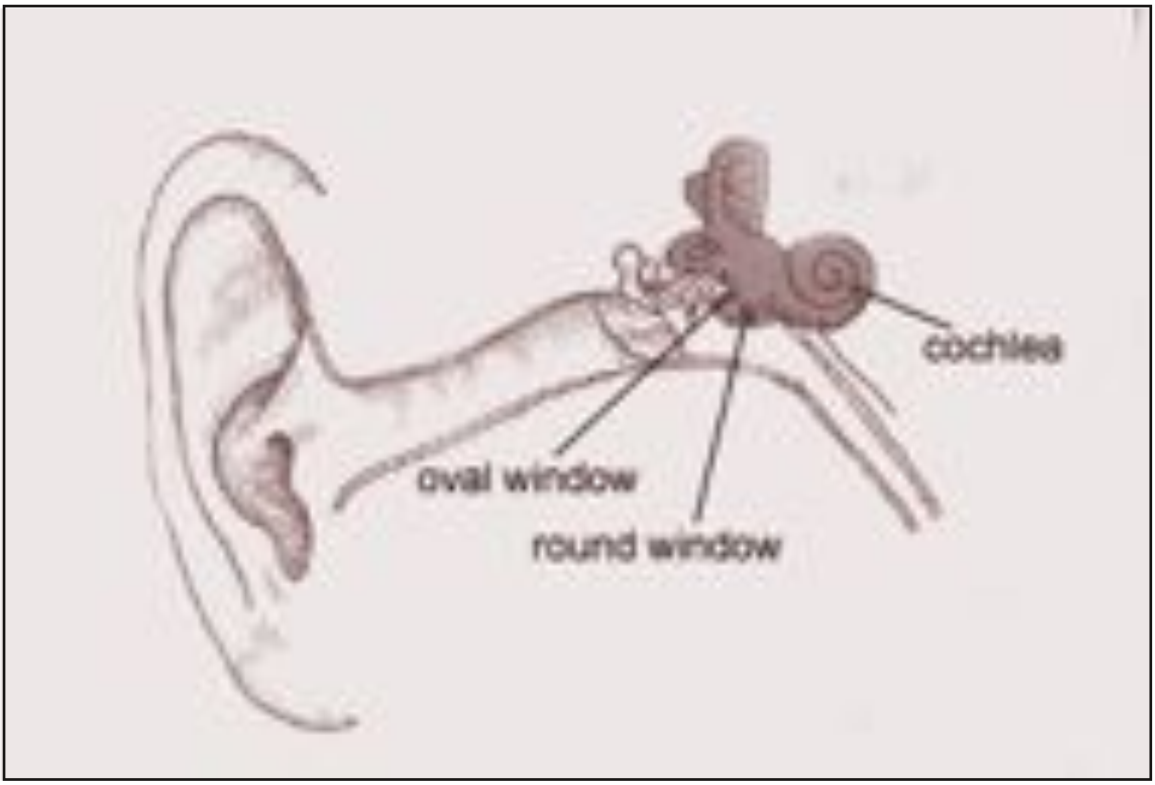
Inner ear

The inner ear is the inner part of the ear. It is filled with a water-like substance and consists of hearing and balancing organs. The inner ear consists of the following parts:

Cochlea - is a rolled structure that can stretch to about 3 cm. The membrane of cochlea consists of numerous nerve cells.

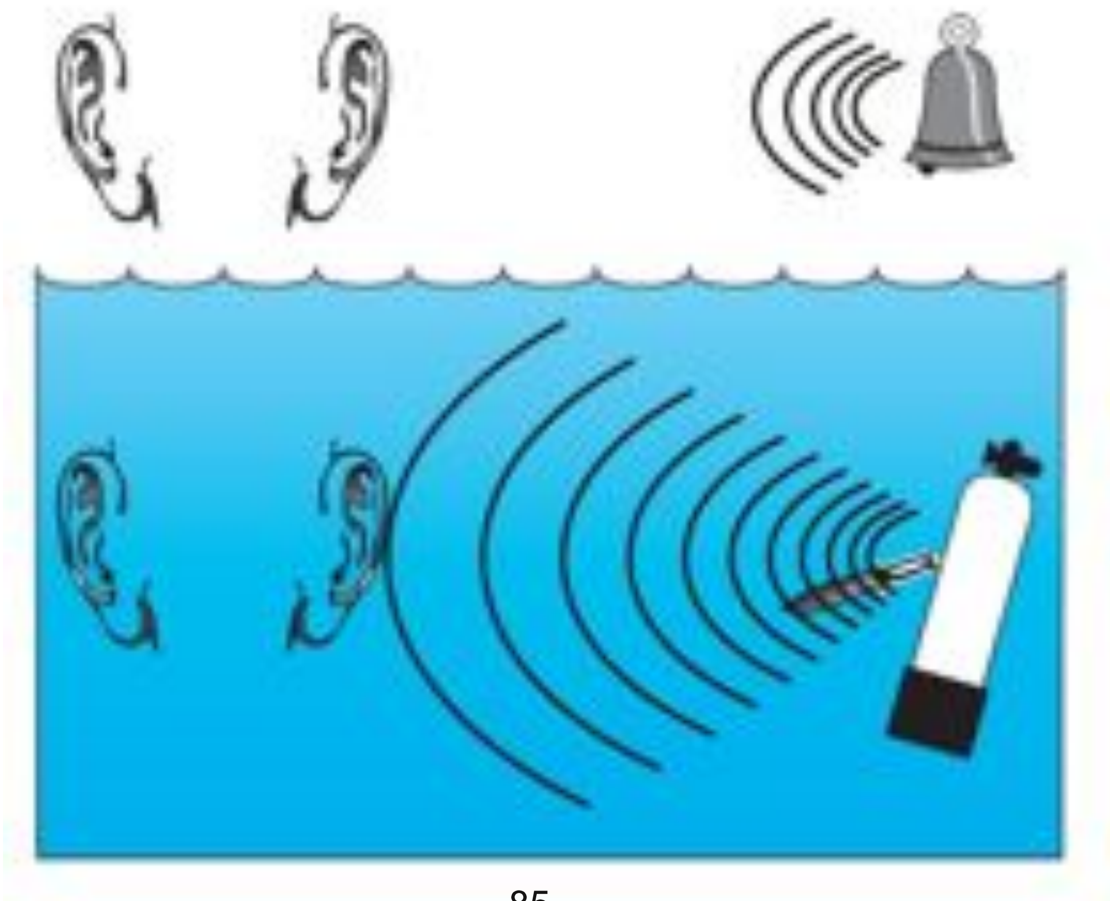
Semicircular Canals - are fluid-filled loops, attached to the cochlea and help maintaining the balance.

Auditory Nerve - the electrical impulses, generated by the nerve cells, are then passed to the brain.



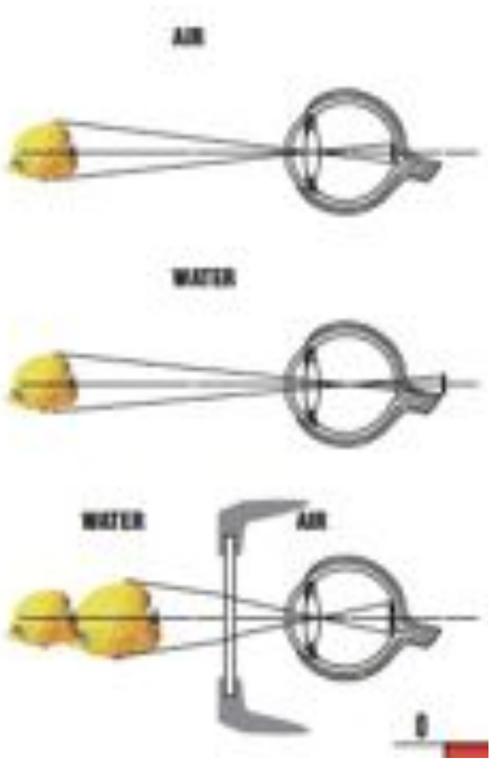
Hearing in water

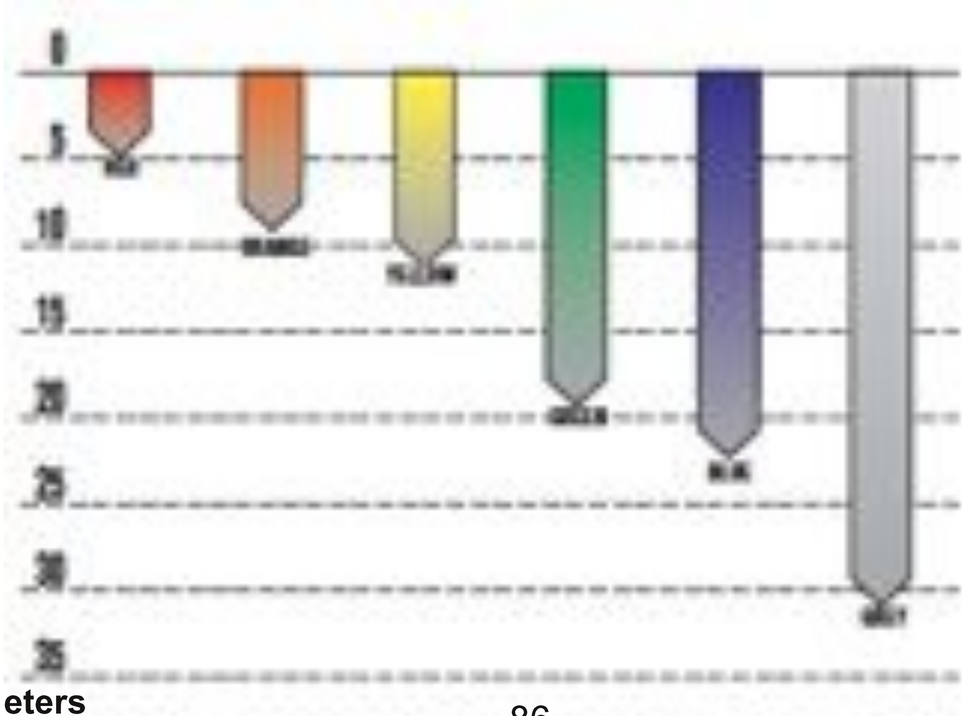
Underwater sounds are transmitted much more quickly because water has a greater density than air. While the speed of sound in air is 330 m/s underwater is 1500 m/ s. Sounds made to call attention, like hitting a knife on metal can be heard at great distances. In the atmosphere the sound is received through the above explained ear parts. In the water because of the speed of sound we receive the sound waves over our scull and get completely surrounded by sound. Thus we can not determine the direction of the sound. Pay attention on the noises and if you hear an engine while ascending wait for the sound to go away.



Sight in water

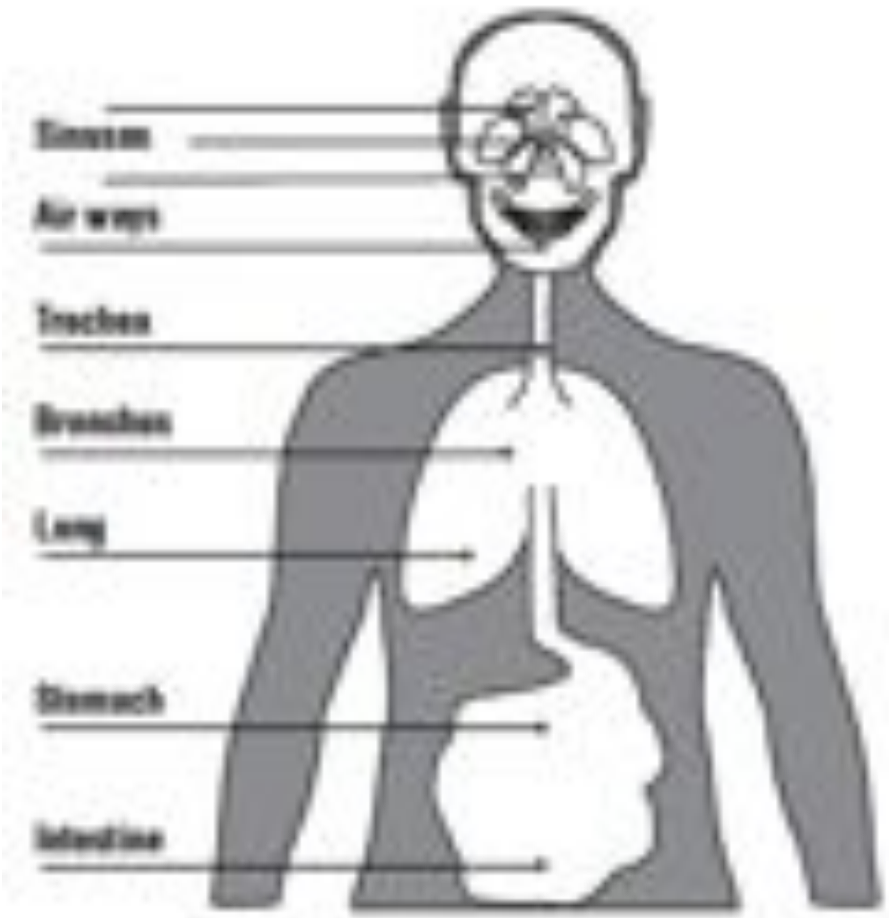
Sight doesn't present a major problem in diving. However when the eyes are in direct contact with water the vision is unfocused, everything is blurry because the rays of light coming from the viewed object undergo a index of refraction different to that of the air. To be able to see clearly underwater we need our eyes to be in contact with air, that is wear a mask. However because the bigger index of light refraction objects underwater seem closer and bigger for about 1/3 and closer for about 1/4. As water absorbs light the colors are lost. The warm colors are lost first. In order to see colors underwater a diving light must be used.





Effects of high pressure on human organism

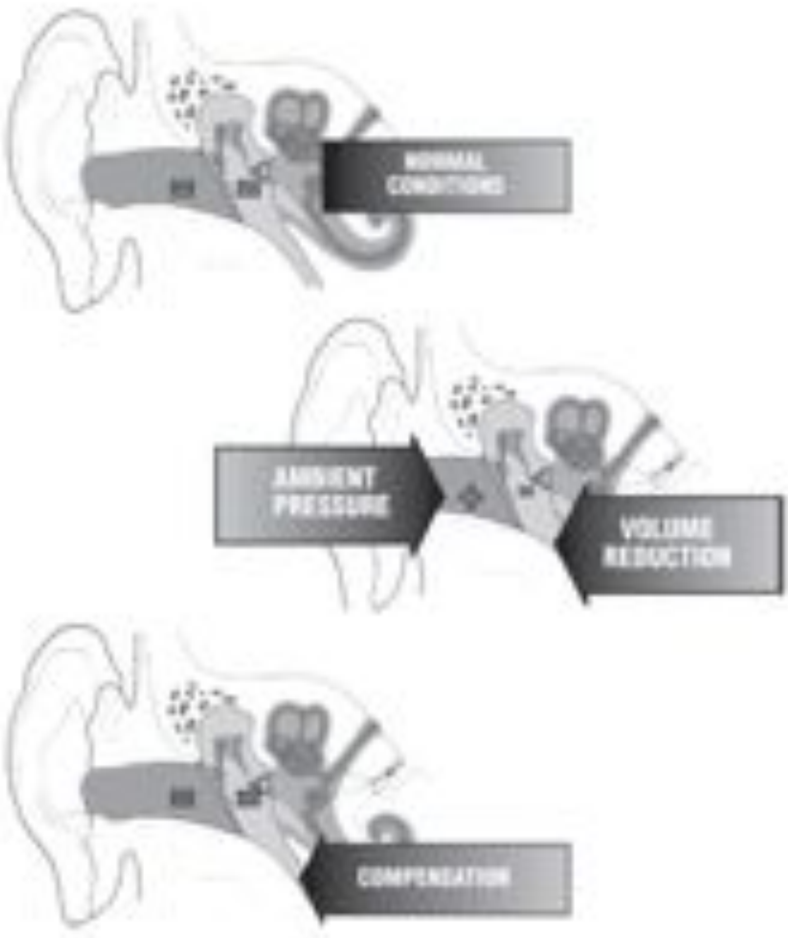
If the ambient pressure increases gas at that pressure is introduced into organs. In order to compensate the volume of the organ doesn't change. When the pressure is reduced this gas under pressure expands and must be able to be released, in order to avoid an increase in volume of the organ. The respiratory airways are compensated automatically because they are in contact with the air at ambient pressure through the air breathed through the regulator. We feel the change in pressure only in body parts filled with air because air is compressible, and water is not.

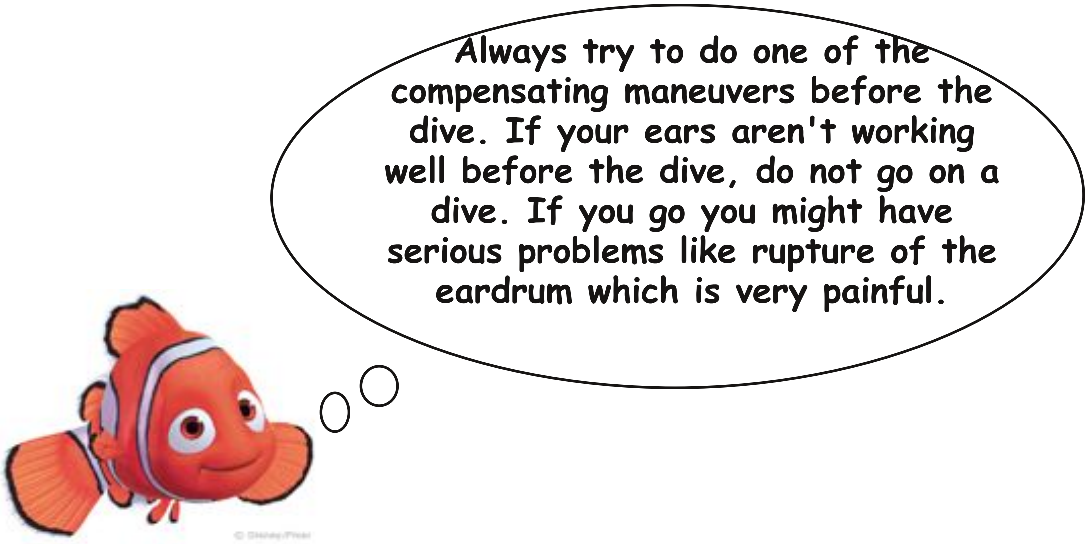


Body parts filled with air

Reduction of volume

The rising external pressure causes a reduction in volume of air-filled organs. In the stomach and intestine this variation in volume doesn’t normally present any problems but in the ear it causes the crash of the Eustachian tube. It it necessary to introduce air to bring back the volume of the middle ear to its original dimension and the eardrum to its natural position. The most common and effective methods for achieving compensation are Valsava (pinching one's nose shut and blowing throug it) and Fresnel maneuver (closing the nose and moving the tongue upwards). Compensation must be carried out before the ear start to hurt: too long a wait can result in reduction in the volume of the air inside the middle ear and that can make the maneuver difficult or hardly possible at that moment.





Disorder and barotrauma of the middle ear

The most common kind of ear barotrauma experienced by recreational divers is the middle ear barotrauma. Middle ear barotrauma is caused by the inability of the diver to clear the space in the middle ear through the Eustachian tube. Common causes of an ear barotrauma are ineffective equalization techniques, congestion, exceedingly forceful equalizations, or skipped equalizations. An ear barotrauma can occur at any depth, but is most common at shallow depths where the pressure change per a foot is the greatest.

A middle ear barotrauma may occur on descent, when a diver's inability to equalize causes a vacuum in the middle ear, sucking the eardrum and tissues in the middle ear and eustachian tubes inwards. On ascent, the inability to equalize the middle ear air space can cause a build-up of excessive pressure, flexing the eardrum outwards.

Signs and Symptoms of a Middle Ear Barotrauma

On Descent:

Build up of pressure, pain, inability to equalize

If a diver continues to descend without equalizing, the eardrum will bursts. This is usually followed by a rush of coolness as water flows into the middle ear which can cause fainting.You can go on a smaller depth and try to equalize.

On Ascent:

The signs are the same as on the descent. Try to go a bit deeper and equalize the pressure if possible.

After the Dive:

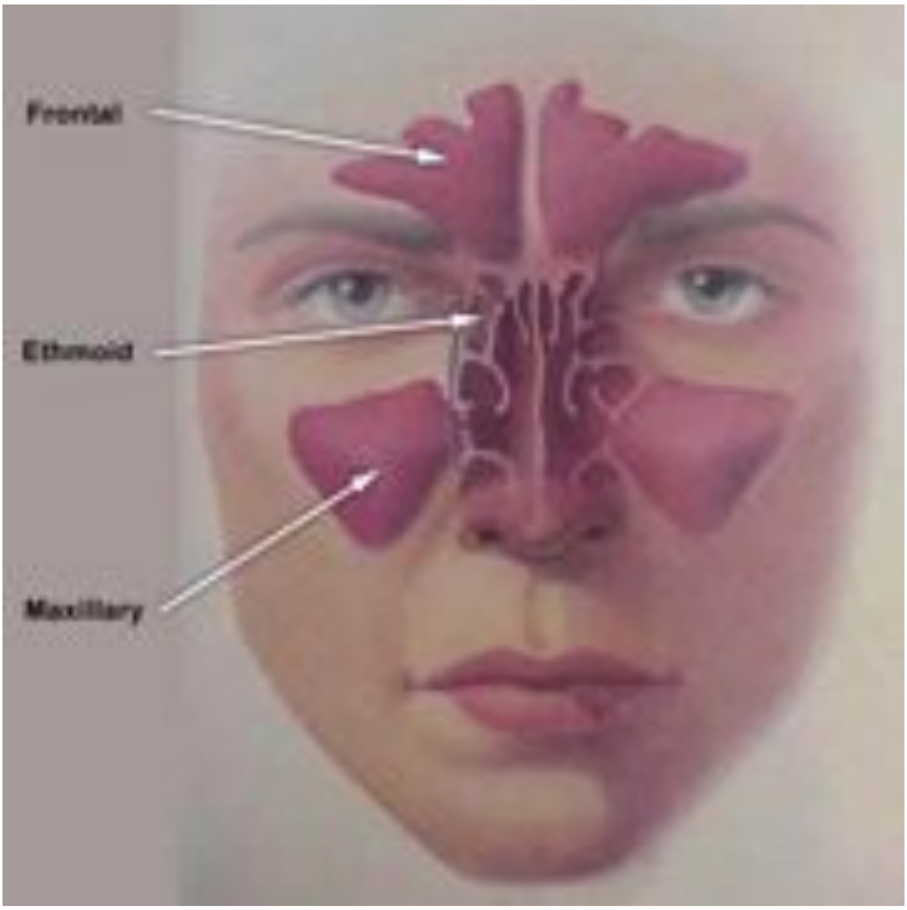
Middle ear barotrauma may be recognized after a dive by the feeling of water in the ears that does not go away. This is caused by the accumulation of blood and body fluids in the eardrum and middle ear, not by water.

Bad hearing, dizziness, popping or crackling sounds while moving the jaw, soreness of the eustachian tubes and ears, squeaking noises during equalization, and fluid leaking into the throat from the eustachian tubes are all signs of a middle ear barotrauma.

If you notice these problems during a dive stop, tell that to your buddy and dive leader! After the dive go see a doctor! Do not panic! This problem is treatable, but until it is completely treated do not dive!

Sinus squeeze

Your sinuses are air-filled cavities that join onto the nasal passages. When you ascend or descend, the pressure in each sinus must adjust to match the air pressure in the nose. For those with healthy normal sinuses, this occurs automatically. But if the sinus openings are plugged by polyps, mucous, or congestion, "sinus squeeze" occurs. Mild cases can be treated by simply slowing your ascent and descent, and blowing gently into your nose - just as you do to equalize the pressure in your ears. More severe cases may require use of decongestants in pill form. If sinus problems are chronic, your doctor can prescribe a steroid nasal spray to decrease swelling and sensitivity in the nose.



Sinuses

Teeth barotrauma

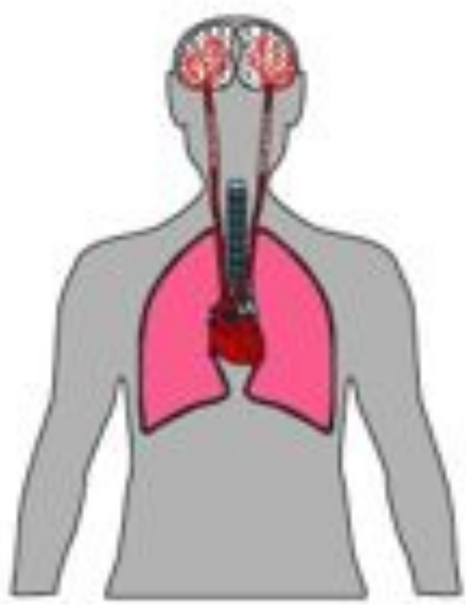
Teeth barotrauma can occur if air gets trapped in a hole in a tooth and can not get out on ascent. As the air expands the tooth starts to hurt and bursts. This can cause fainting.This does not happen in healthy teeth, but in bad teeth. You can prevent this by regularly going to the dentist.

Embolism

During ascent the air in the lungs expands. If breath is held during ascent in scuba diving this expansion of the air first enlarges the lungs to their maximum, and then causes a progressive growth of the pulmonary alveoli, if the diver continues to ascend without breathing out, the result can be a pulmonary barotrauma (a trauma of the lungs caused by pressure). In this case tiny air bubbles are able to pass into the blood stream, or can tear and cause the release of larger bubbles. The prevention of this medical state is regular and continuous breathing. Never hold your breath during ascent, even in the pool. The seriousness of a pulmonary stretching depends on the effect that pressure exerted on the walls of the pulmonary alveoli resulting in stretching or rupturing of the tissue. The most serious case is when bubbles come in to the blood stream. The consequences of passing bubbles from the lacerated alveoli to the neighboring tissues may be: pneumothorax mediastinal emphysema or subcutaneous emphysema.

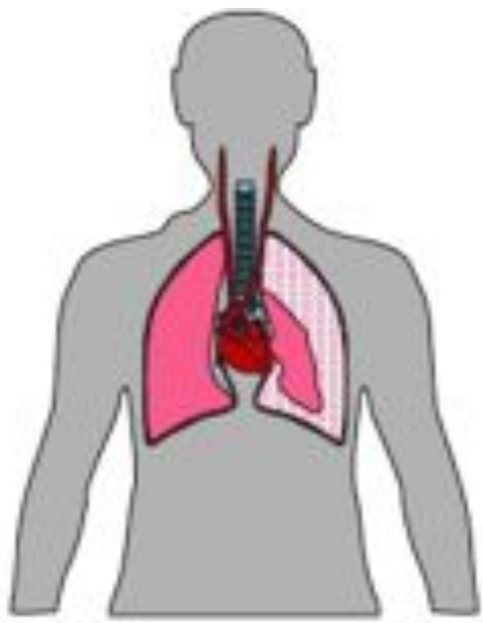
Air embolism sindrome

The bubbles escaping from the ruptured alveoli, once they reach and are pushed along the aorta, can reach any part of the body and may stop in the small vessels. This can block circulation of the blood, and therefore of oxygen in the areas below the embolus. Symptoms and effects:
dizziness, blurry vision, breathing problems, heart disturbances, and paralysis.

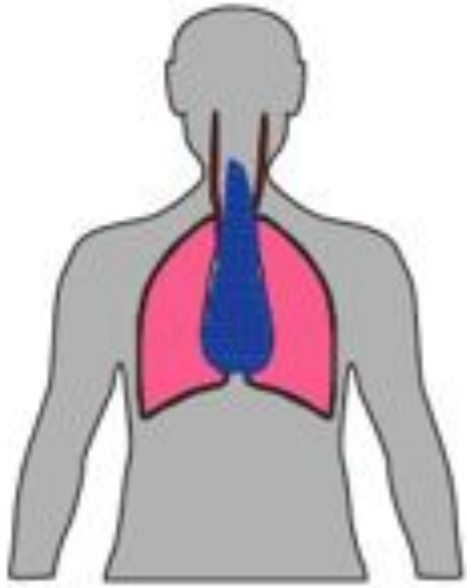


Pneumothorax

If the alveoli and pulmonary membrane rupture and air gets in the space around the lungs Pneumothoraxs occurs.
The symptoms of pneumothorax consist of intense chest pain
along with coughing of blood and difficulty in breathing.

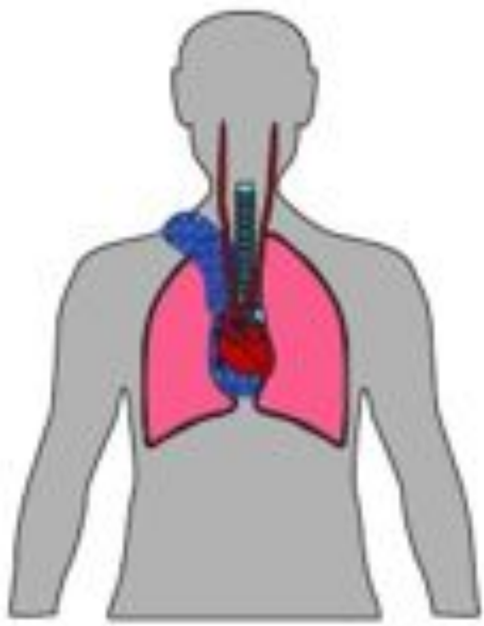


Mediastinal emphysema



If the alveoli and pulmonary membrane rupture and air gets trapped between the tissues around the heart and the major large blood vessels Mediastial emphysema occurs. The first symptom is a pain in the inside of the rib cage. In addition, the trapped air that presses against the lungs, the heart, and the large blood vessels, causes breathing difficulties and possible loss of consciousness.

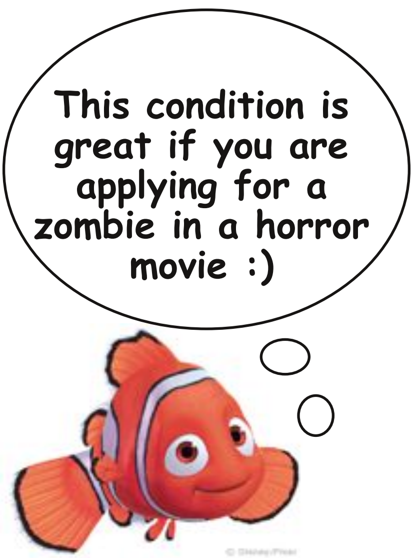
Subcutaneous Emphysema



If the alveoli and pulmonary membrane rupture and air penetrates under the skin around the lungs or the neck subcutaneous emphysema occurs. The symptoms are a “sense of swelling” at the neck and a change in the sound of the voice.

Squeeze

It is always necessary to compensate the mask, as you go deeper underwater the volume of the air inside the mask is reduced and it is pressed into the soft tissues of the face. This can be avoided by blowing air through the nose into the mask to maintain a constant internal volume. If this is not done then small blood vessels around the eyes burst. It can cause bruising, blood spots over the white of the eye, and swelling. It rarely causes injury inside the eyeball. This type of hemorrhage isn't dangerous. See the doctor immediately if there is loss of vision, twinkling lights, shadows in your vision, or increasing pain. Wet suit squeeze occurs when increasing the external pressure leads to decrease in thickness of neoprene suits, which then adheres firmly to our skin. The first preventive measure of protection from this nasty phenomenon is the use of neoprene suits of an appropriate size. Tight wetsuit can cause squeeze and discomfort discomfort. Also, ALWAYS put water in your wet suit to prevent squeeze becuase water is not compressible and will not change its volume during the dive!



Mask squeeze

Gas related problems in diving

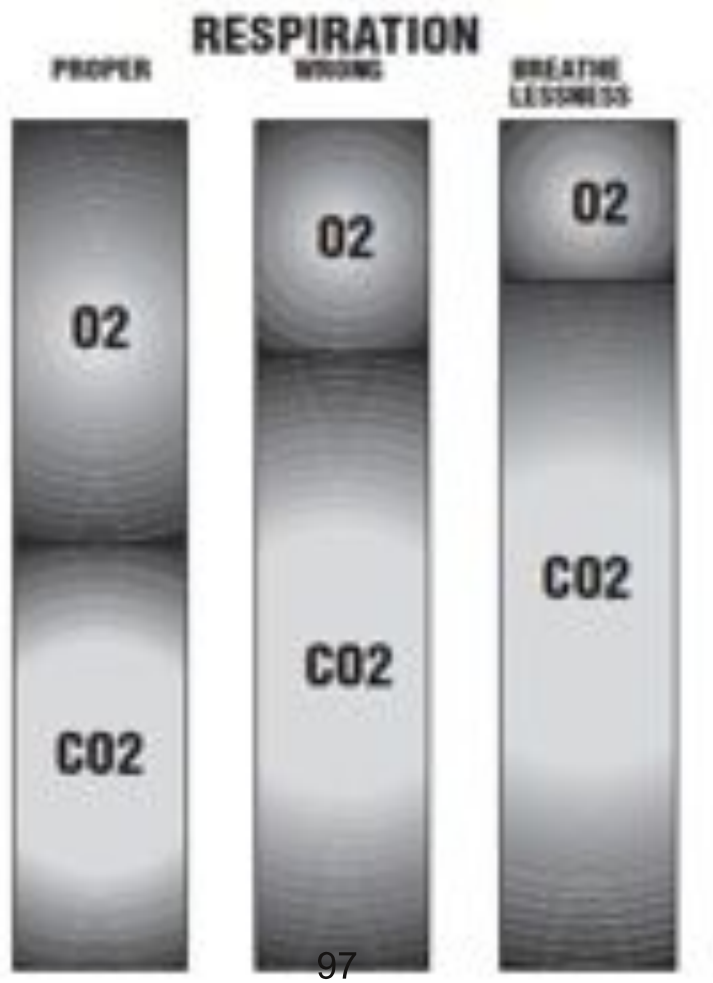
Hypoxia

Hypoxia is a situation when there is not enough oxygen for all cells of the body. When scuba diving, hypoxia can occur after a sudden interruption of the air supply (too long dive, or malfunction in equipment) or can develop gradually if we do not breat regurarily (effect of excessive physical work or incorrect breathing). The symptoms of hypoxia are inability to concentrate and impaired movement. The diver suffering from hypoxia should be taken to the surface as soon as possible, treated with oxygen and, if necessary, given artificial respiration.

Hypercapnia

Hypercapnia is a condition where there is too much carbon dioxide (CO_2) in the blood. Hypercapnia occurs in shallow and fast breathing, often due to physical work. Hypercapnia normally triggers a reflex which increases breathing and access to oxygen. A failure of this reflex can be fatal. Hypocapnia is the opposite of hypercapnia, and happens in hyperventilation in apnea (breath hold diving).

It is very important to breath normally. Breath slowly, not with full lungs, but not shallow. Find your rhythm of breathing. You are breathing properly if you are relaxed and do not have "a hunger for air"

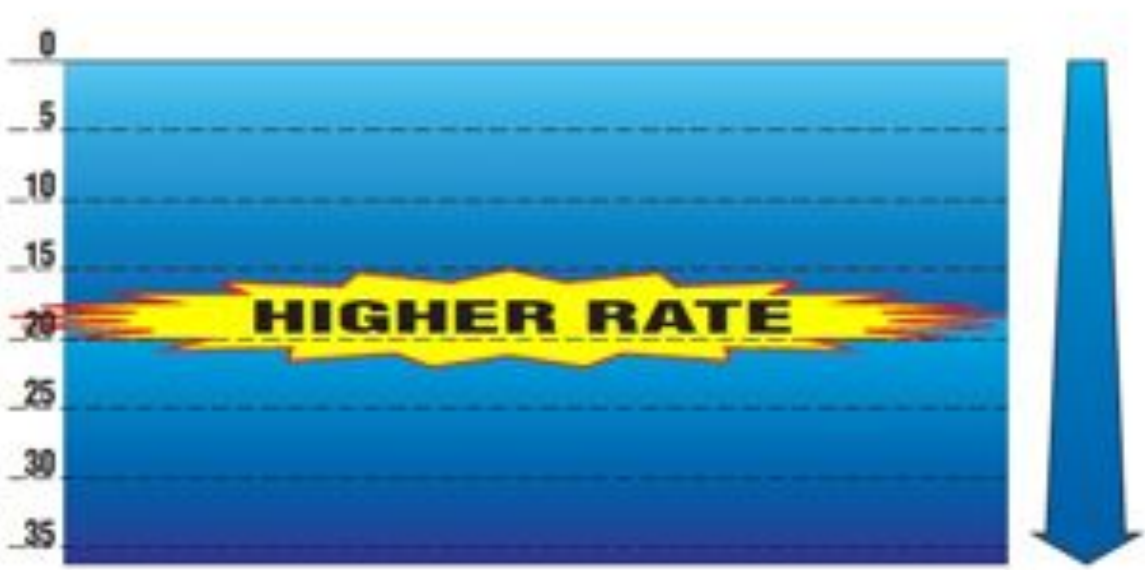


CO_2 Poisoning

CO_2 poisoning is happens when a diver breaths air that contains an excessive amount of CO_2. This happens if the breathing mixture was not prepared properly by people who work on diving compensators (machines which fill diving cylinders). Symptoms are feeling of warmth in the face and headache. It is necessary to ensure the casualty is immediately given pure air, or even better pure oxygen.

Nitrogen narcosis

Nitrogen narcosis is an effect of nitrogen under higher pressure on the brain which occurs to divers who go below 30 meters, due to the laws of partial pressures. The condition causes loss of motor function and ability to make reasonable decisions. The diver acts like he is "drunk", as with alcoholic beverages. Factors which increase the possibility of nitrogen narcosis are cold, stress, heavy work, CO2 retention, and hang over. This condition does not have any permanent consequences.



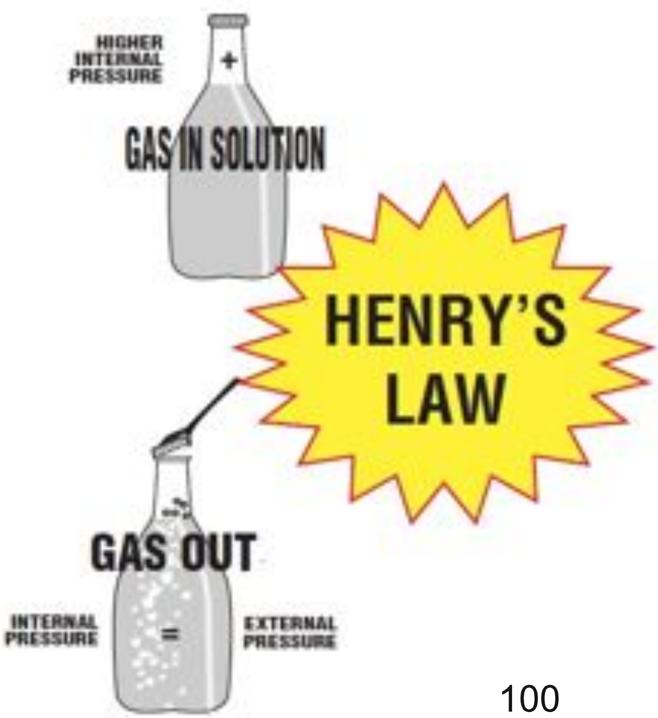
It has been stated that narcosis results in the feeling of one martini for every 15 meters

If you notice strange behavior of your buddy he might have nitrogen narcosis. Treatment of nitrogen narcosis is immediate controlled ascent to the surface, with the buddy or dive master observing the diver for unusual behavior. On the surface, administration of O2 and temporary brake in diving.

The divers affected by narcosis often do some funny things like start to chase pretty fishes, hear fish sing or talk, give their regulator to fish...It is said that you are the same under narcosis as when drunk due to alcohol beverages.

Decompression sickness

As we have seen during descent, the increase in pressure results in a rise in the partial pressure of the gas breathed. According to Henry's Law the pressure in the tissues increases at the same rate. These percentages vary directly proportional to the depth. Also, the longer spent at a given depth the more gas absorbed in the tissues. On ascent, maintaining a rate of 8-10 meters a minute the excess nitrogen is released from the blood through the lungs, at a partially higher pressure. According to the length and depth of the dive decompression stops (stops at one depth) are made according to the deco tables. If you ascend too quickly the nitrogen is cannot be released quickly enough and bubbles form in the divers body. This leads to Decompression Sickness. The symptoms differ based on the affected tissue. It usually appears shortly after surfacing. The symptoms of DCS (decompression sickness) can even two days after surfacing. Flying soon after diving may cause this disease. On most diving watches you have "no fly interval", the interval of time you are not allowed to fly unless you want to get this terrifying disease.



Skin decompression sickness

It ranges from a mild rash to an measles like rash or a bluish marble like pigmenting of the skin. The spotting is associated with severe DCS and is caused by the bubble blocking the blood vessels of the skin. Mild cases may disappear even if untreated. However medical help NEEDS TO BE SOUGHT IF ANY symptoms are seen, because these symptoms might be hiding serious neurological problems.

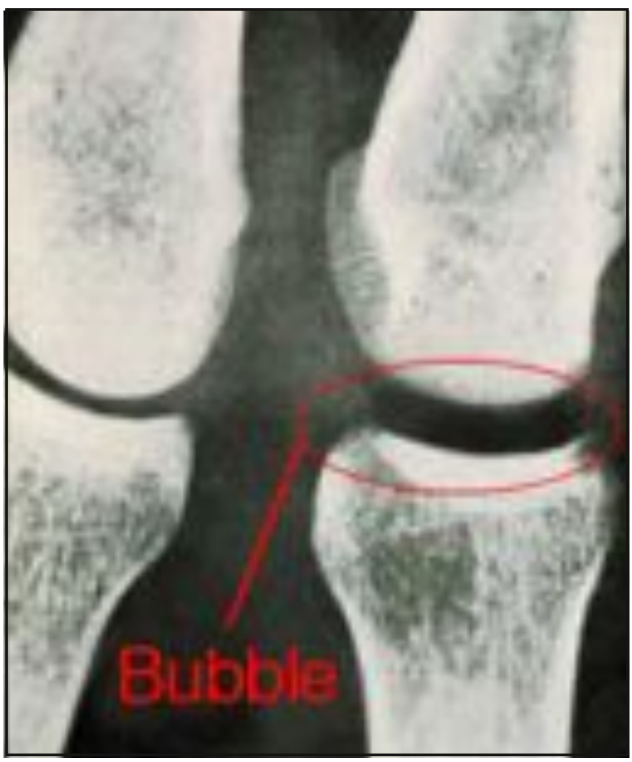
Marbling of skin

Joint decompression sickness

It usually starts as a feeling of tenderness or numbness at or near a joint, soon becoming a sharp, penetrating ache. The joint may swell and become red. The pain increases over the next 12 or 24 hours and will not be relieved by heat or pressure – as a bruise may be. Medical help must be sought, because serious neurological DCS may also be present.

DCS type two is most common in the shoulder.

Joints



Affected joint

Central nervous system decompression sickness

The brain and spinal cord have large blood supplies and are very sensitive to any bubbles in the blood stream. The symptoms for a CNS Decompression sickness are various and diverse. Common effects are; extreme fatigue, a strong feeling of malaise, pins and needles and numbness. Partial or total paralysis, loss of bladder function, blurred vision, confusion and even death can be the result of a CNS DCS. This is the most common type of DCS among sport divers and is usually associated with insufficient decompression stops.

FIRST AID

Contact the nearest Recompression Facility. 100% Oxygen must be given to the casualty as soon as possible after the accident and during the journey to the hyperbaric chamber (a room that allows an individual to breathe 100% pure oxygen at greater than 1 standard atmosphere of pressure). The application of pure oxygen guarantees greater oxygenation of the tissues and helps to lessen the risk of damage. The casualty needs to drink fluid at a rate of about 1 liter per hour because hydration helps the blood volume and reduces the risk of more bubbles forming.

It is very important to recognize the mentioned diseases if an accident happens. The faster you react the more chance of smaller consequences for the casualty. Communicate and collaborate. The whole diving group must work as a team to help the person in need. If you are just a begginer, you will not be i charge or first aid, but remember maybe the casualty will be your buddy and you will have to tell the dive master what is wrong and help your buddy safely surface. Thus, this chapter is very important for your safety and the safety of your diving team.

Diving associations

In order to become a certified diver you need to pass a training of one of diving associations. There are levels in each association marking the progress in knowledge, skills and experience of a diver. There are many diving associations, but here are just a few of them:

CMAS

World Confederation of Underwater Activities (CMAS) offers many levels and courses from beginner to advanced. CMAS trainings are very educational and respected. There are three diving stars and trainer stars. Of course there are additional courses for wreck diver, speleo diver and so on.

PADI

Professional Association of Diving Instructors (PADI) was founded in 1967. PADI offers many levels of courses and a quick learning course within a week for diving on small depths. This association is widely spread on attractive locations like Egypt so people could dive on holidays.

NAUI

National Association of Underwater Instructors (NAUI) offers curriculum guides and certification. The NAUI standards are said to be slightly higher than most, the curricula are more complete and NAUI certification is a little more challenging than other programs. (I do not know that for sure, since i only have a CMAS certification which was very hard to get! I had to pass a knowledge test, pool skills and practical skills in the sea).

SSI

Scuba Schools International (SSI) was founded in 1970. It offers school-based scuba diving education and scuba certification. An SSI certification card is accepted at all dive shops for rentals and diving packages.

PDIC

Professional Diving Instructors Corporation (PDIC) is a training association which offers education programs at every level from open water to Advanced Instructor.

Every begginner needs to have some basic practical diving skills which will be discusses in the next chapter

Chapter 3

Basic diving skills and exercises

Installation of the BCD on the diving cylinder

The diving tank in an upright position. The first step is to put the straps across the valve group and tighten the buckle folding. The neck of the diving tank and and top of the compensator should be on the same level. Firmly tighten the strap and ensure a solid connection between the BCD and the air tank.

1) Put the straps across the valve group

2) Place the BCD in the middle of the upper half of the tank

3) Firmly tighten the straps

Installation of the regulator on the diving cylinder

1) Tako the dust cap of your regulator

2) Place the regulator on the appropriate valve. DIN goes directly in the tank valve, and yoke goes into the o ring fitting

DIN fitting - tank valve, no O ring

Yoke fitting - valve with O ring

3) tighten the regulator onto the valve with locking screws

5) Hold the emergency purge button the the 2nd stage of the regulator and open the valve

6) Attach the inflator hose to the BCD

7) See how much air do you have in the bottle

8) Try to breath with the regulator and inflate your BCD

After diving, regulator should be removed from the valve groups in the following order:

1) Close the tank valve (clockwise);

2) Press the emergency purge button on the second stage to let the pressure out of the system

3) Check whether the pressure gauge dropped to zero (the system is empty);

4) Unscrew the tightening screw and take the first stage of the valve group

5) Remove any water droplets from the first degree, as well as a protective cap by blowing air from the tank in it(in an angle not directly into it);

6) Put the cap on the first stage

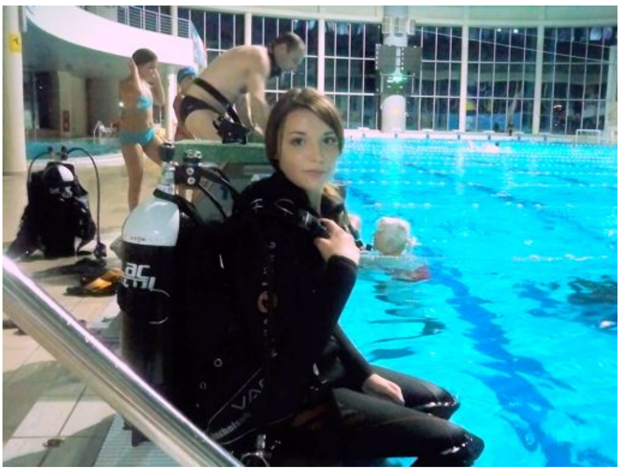
7) Rinse in fresh water

8) Drain water from shaking out of the second stage and leave the regulator to dry in shade

Putting on the scuba set and entering the water

If you are standing put the scuba set (cylinder along with the BCD and the regulator) on your back with the help of your buddy. It's easier and more practical to put on the scuba set in a sitting position, so you could adjust straps more easily and do not need anyone's help. Also, putting the diving set in standing position is not recommended to people with back problems. When assembling equipment and preparing to enter the water we need to keep an eye on the position of instruments like manometer and octopus so they do not get damaged.

Since I have back problems, I will only demonstrate putting on the scuba tank in a sitting position

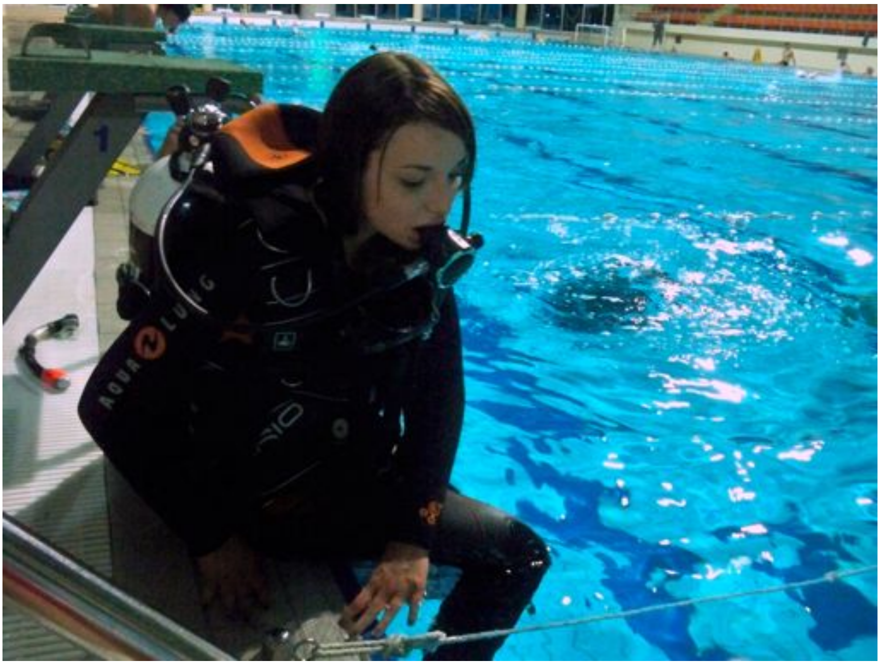


Put the scuba tank on your back

Tighten straps

The procedure for entering the water in the seated position is the following: 1) Before entering the water we have to inflate the BCD, then put the regulator in your mouth and check its dosage. 2) put your hands on the one part of the body, then rotate the body by putting the hands on the edge of the pool. Slowly plunge into the water.

1)



2)

Putting on the scuba set form the water

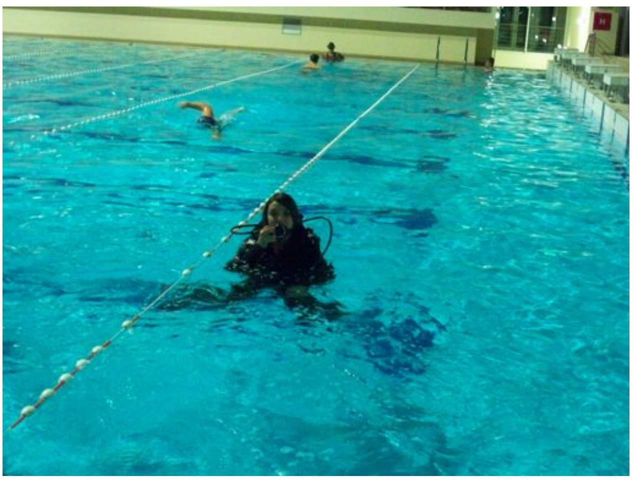
1) The BCD is inflated. The whole scuba set is floating.

2) "Sit" on the scuba set, drown it, put the arms in the straps and let it slide to your back

3) Lie on your back and tighten all the straps

Draining the regulator on the water surface

If you drop the regulator into the water it will fill with water. Put it back in your mouth and simply exhaust in it. Thus, you will drain the water from it. Another way of emptying is pushing the purge button while holding the regulator in the hand (do not put it in the mouth, but just below them).



1st way

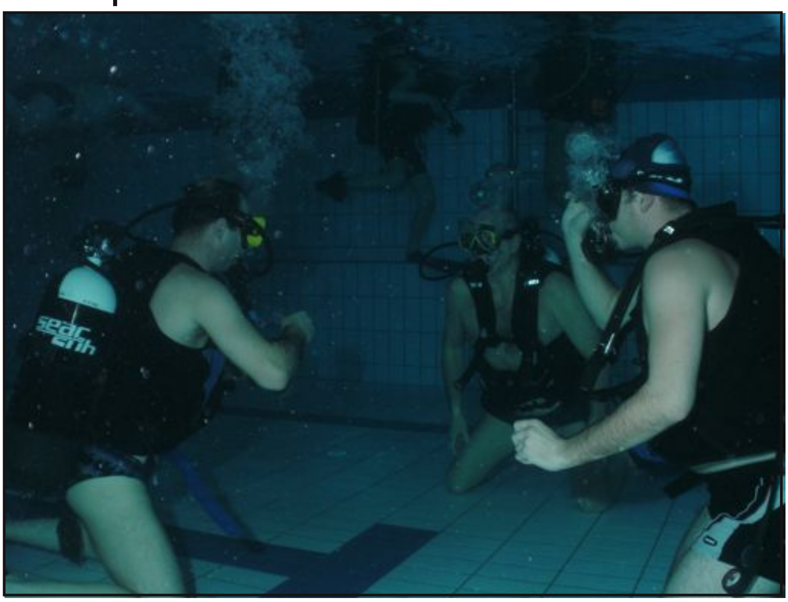
2nd way

Swimming with the scuba tank on the surface

Lie on your back and work with your legs form the hips. This way you will not get too tired. This technique comes in handy when you have to swim to the diving destination or a boat.

Correct position of divers on the bottom of the pool

Kneeling on the floor is the correct position of divers on the bottom of the pool



Emptying the mask

Tilt your head back, do not bend the body, press the top of the mask frame with your fingertips, or move the bottom edge of the mask, and exhale through your nose until you empty the water from the mask. Breathe from the regulator and do not hold your breath. Make sure that you do not lift the bottom edge of the mask too much, because otherwise water will be getting into the mask. The air released by the nose forces water down water from the upper part of the mask while in the mask remains only the air.

Buddy breathing

Buddy breathing is breathing with your dive buddy on only one regulator. Grab your buddy and pull him closely so you would not need much time to bring the regulator from his hand to yours. Signal your buddy with a sign showing a number of breaths you need to do in one breathing cycle. The best is 2 or 3 breaths. Then slowly swimm and breath. FIrst one of you breaths 2 or three times, and then hands in the regulator to his buddy. You do that until you surface. Do not breath more than agreed because your buddy might pass out of hypoxia.

Balancing

Balancing is actually achieving neutral buoyancy. That is necessary for good motor skills under the water and safety. If you constantly go up and down you might experience ear troubles and on decompression stops you will not be able to keep a steady depth which is necessary for exhaling excessive nitrogen from the bloodstream.

How do we balance?

We balance by inflating the BCD on descent and deflating it on ascent until achieving neutral buoyancy. With breathing in we will achieve slightly positive buoyancy. With breathing out we will achieve slightly negative buoyancy. You need to gain the feeling like you are floating, not going up or down, but just staying in one place. Put your body in a horizontal line and balance yourself with a BCD. Then, breath in and out to feel the change in balance due to volume of air in the lungs.

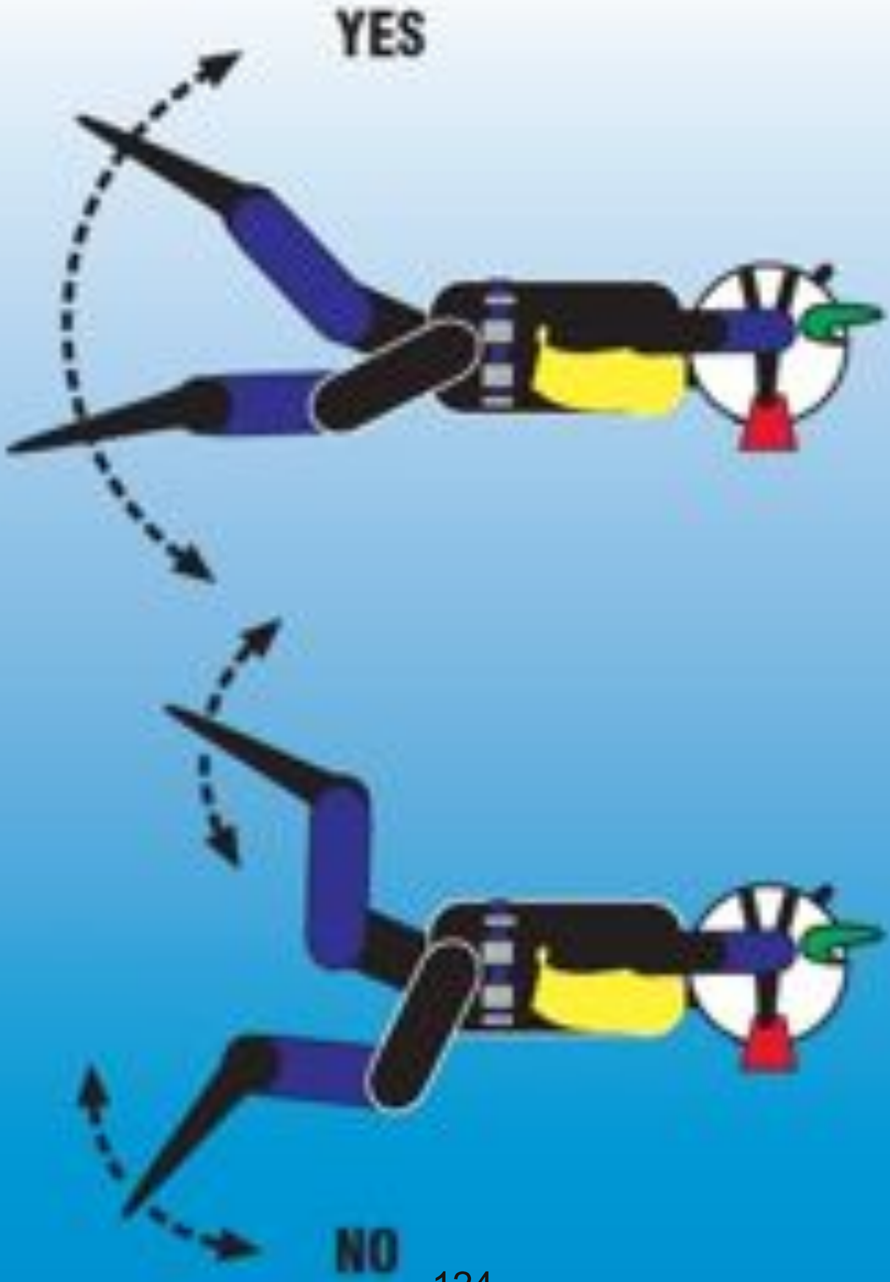
Practising Ballancing In The Pool

Once you learn how to balance it looks like this

The diver is not waving hands, and she is going steadily and straight with constant horisontal position. Swimming is from the hip and there are no knee movements.

Once you are well ballanced you feel like you are weightless!

When diving in the sea the position of the body should be horisontal and your face should face the sea bed. Legs work from the hips, not knees!



Methods of entering the water with all equipment from the boat

Put the regulator in your mouth. Hold the regulatro and the mask with you hand and push yourself to the water

Put the regulator in your mouth. Hold the regulator and the mask with one hand and make a step in the water

Sign language

Since in diving you can not talk a new way of communication was invented- sign language. It is very important to communicate in diving because otherwise accidents can happen.

OK -Did you understand ?

Down

Ok - I am OK - Are you OK ?

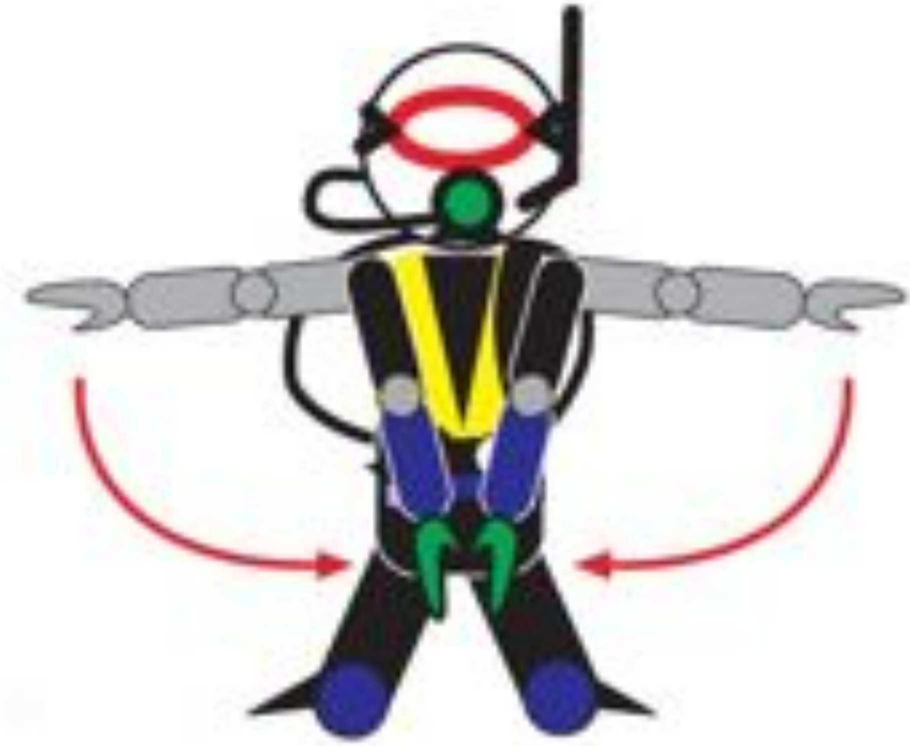
Go down - Down!

Up

Out of air

Go up - Up!

Tie



Everybody here

Dizziness

Wrong

Calm - Buoyancy

50 Atm

Inflate

You

Me

Direction

Slow down

No

Acceleration

Boat

Look (There..., Here...)

Shared respiration

Half pressure

Tank pressure

Cramps

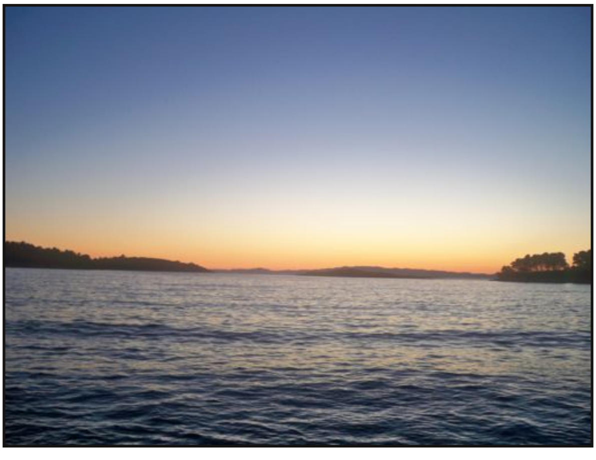
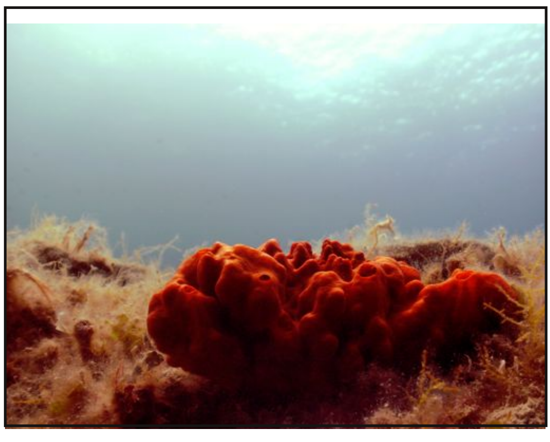
In order to master these exercises and skills you will need the help of your friends. Work together and learn! Once you learn this, help others!

skenirati
moju
diplomu i
brevet

Chapter 3

My Mljet diving adventure



Mljet is a beautiful island in Croatia with Mediterranean vegetation, deep blue and clean sea, and a variety of marine life. Mljet is well known for it's two salted lakes - Veliko and Malo Jezero. They are located on the northern part of the island. On a small island "Saint Helena" in the middle of Veliko Jezero lake, there is old Benedictine monastery. Northern part of the island Mljet is a National Park.

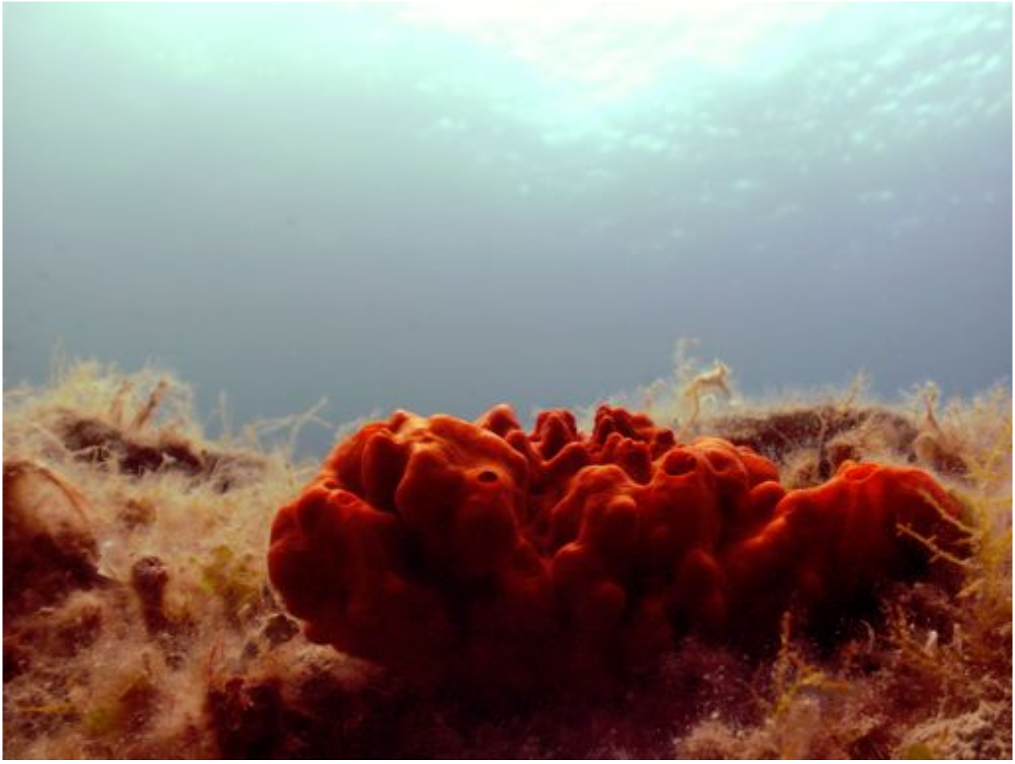
The beauty of the Mljet above the sea line

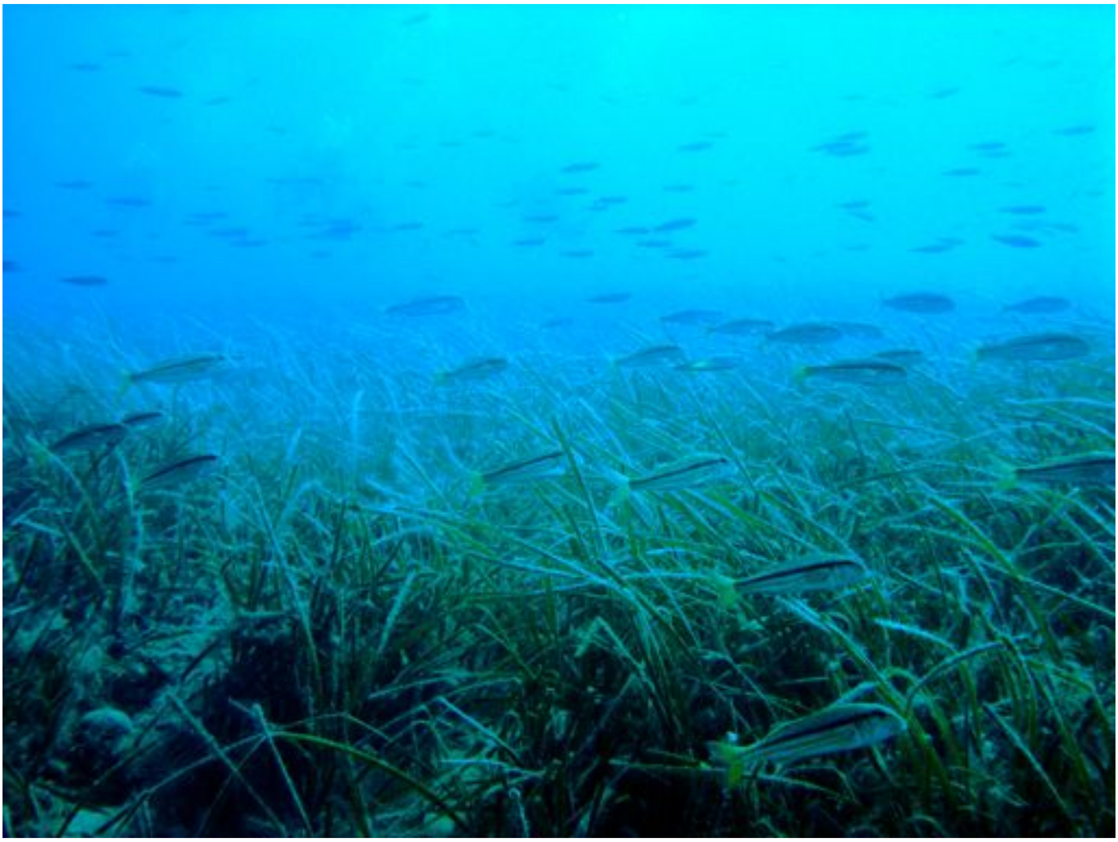
Malo Jezero

Saint Helena

Benedictine monastery window

The beauty of the Mljet "below the sea line"





My diving grup and I underwater

My diving grup and I on land

Before a dive

The awful feeling when cold water gets in your warm diving suit

Traveling to the diving destination

Help each other, collaborate!

I am a member of the diving club Bosnia. This is almost the whole club after one of the dives

Diving club Bosnia