Scuba Diver Theory

Your entry into the underwater world

Equipment

Pressure, Volume & Density

Underwater Environment

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Scuba Diver Theory
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Table of Content

Introduction

This booklet was written to help you to learn the basic concepts of scuba diving and to prepare you for participation in a scuba diver course that is conducted by a certified instructor. A Scuba Diver certification allows you to dive under the supervision of a dive professional to depths not greater than 12 metres.

Each section of the text is preceded by a statement that defines the knowledge that is expected of you at this level of training. These performance requirements are found at the top of the corresponding paragraph at the right.

Equipment

Divers use a lot of equipment. As a beginning diver you have to know the selection criteria and especially be aware how to use the equipment. In this chapter we cover the equipment items that are used by Scuba Divers.

Describe the function of a diving mask.

A diving mask allows you to see underwater. The human eye needs airspace in front of it to be able to see clearly. This airspace is provided by a diving mask. The closer the glass of the mask is to your eyes, the greater your angle of vision will be. It is thus recommended to have a low volume mask. In order to keep water out of the mask, it needs to seal well against your face, without a need of pulling the mask strap uncomfortably tight. To test if a mask fits well you should look up to the ceiling and place the mask in position without pulling the strap around your head. When inhaling lightly through your nose, the mask must seal against your face. If it does not – try another model.

To prevent injury, the mask should be equipped with safety glass (such as tempered glass). The idea is that in case of breaking, the pieces of glass do not have sharp edges that could damage your eyes. To equalize (discussed later) divers need to pinch their nose from time to time. Also for pressure related reasons, the nose of the diver must be within the mask (goggles will not work for diving). The mask must thus have a nose pocket that keeps the nose within the airspace of the mask, but allows the diver to pinch it. People wearing glasses can find diving masks with corrective lenses – there are also many divers using contact lenses while diving, but when removing their mask most of them must close their eyes to prevent loss. To prevent blurred vision underwater due to condensation

against the glass of the mask, divers apply a product to the inside of the mask, or simply spit in it, then rinse the inside.

Describe the use of a snorkel.

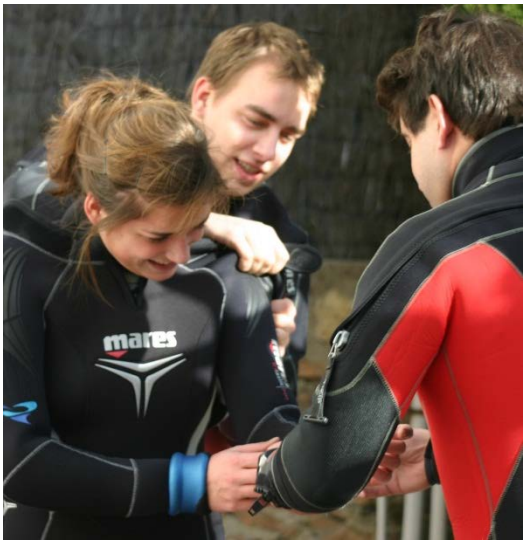
A snorkel is used for breathing at the surface. Snorkels may neither be too long, nor have too large a diameter. Snorkels designed for divers will fulfill these requirements. They do not have a mechanism to keep water out of the snorkel. A diver must thus know how to clear a snorkel of water (without lifting the head above the water) in order to use it for breathing. Those who are able to exhale sharply frequently prefer the "tube" type snorkel, but you will also find many divers using a snorkel with a valve close to the mouthpiece that makes the clearing easier.

Describe the difference between full foot and open heel fins and explain the conditions in which they are used.

Fins are used for propulsion. With all your equipment you are too heavy and have too much drag to use normal swimming strokes. There are two types of fins – fins with a foot pocket that are frequently used in pools and for dives from a boat and open heel fins that are more suitable for most open water conditions. The reason is that they are used in combination with booties. These provide both thermal insulation and protect the diver against stings and cuts while entering and exiting the water. The fins should be adapted to the strength of your legs. If they are too flexible for your strength, the blade will fold too much and you will not be able to swim efficiently, but if the blade is too rigid, you have a high risk of leg cramp during the dive.

Describe why divers need exposure protection and what dictates the choice of one of the options available to divers.

Divers need thermal insulation. In water you lose body heat surprisingly fast – a rule of thumb is that the speed is up to 25 times faster than in air of the same temperature. When you begin to shiver during a dive you should consider that to be an important warning sign and leave the water immediately in order to dry up and get warm. It should be obvious that it is best to prevent such a situation, and that can be done by wearing appropriate thermal protection. A dive suit will not keep you warm, but it should delay the cooling of your body enough to allow you to stay warm and comfortable for the duration of the dive. The correct thermal protection thus depends on the diving conditions. Until you have adequate experience of your own, you should always ask a local diving professional for advice on the correct exposure protection.



Correct thermal protection can range from bathing clothes up to a suit that provides airspace around the body of the diver (a dry suit). Most dives are made in a wetsuit. These are made to limit the flow of water around the body. When you enter the water, water will enter the suit. This water will warm up with your body heat. It is the combination of this warm water and the neoprene barrier between the cold water outside the suit and the warm water inside which provides the thermal insulation. Most suits have a 3, 5 or 7 millimetre thick neoprene barrier. The suit must fit snugly to limit the amount of water inside but may not be too tight. Some suits have seals around the wrist, ankles and neck and are equipped with waterproof zip-

pers to further prevent flow of water in and out of the suit. These are called semi-dry suits.

In colder water divers also wear neoprene gloves and a hood. Booties are an exception. Even in the warmest water you can observe divers wearing booties. The reason is the protection they provide against cuts and stings in addition to the thermal protection they offer. As a part of your diving course you will receive information on the exposure protection recommended for local diving.

List the key feature of a weight system.

The neoprene of a dive suit gives a diver positive buoyancy. Depending on the thickness of the suit it can be impossible to descend without having weights. If a diver carries weights they must be worn in a manner that allows immediate dumping in an emergency. To prevent confusion for somebody who assists you in ditching your weights divers wear weights so that the release is operated with the right hand. The release is the key feature on a weight belt. It must be constructed in a way that makes ditching the belt a one-hand operation. Weights must be fixed in their position, because changing the position of the weights from one time to the other changes the trim (position in the water) of the diver. Slipping weights may get lost unintentionally. Divers never use more weights than absolutely needed. In some cases the weights are not worn on a belt but integrated in the scuba unit.

List the main components of a typical scuba unit.

A typical scuba unit consists of a cylinder with compressed air, a construction to carry the unit on land and to wear it in the water, a flotation device that allows you to establish positive buoyancy at the surface and to make sure that you neither float nor sink when diving, a regulator that is used for underwater breathing and an alternate air source to present to another diver

needing to share your air. It is also equipped with a gauge to allow you to monitor your air supply. In some cases this instrument is combined with the other instruments that are discussed later.

Describe how scuba cylinders should be handled and how a cylinder valve is operated.

The cylinder is made of steel or aluminum and holds air at high pressure (200 to 300 times the atmospheric pressure). Cylinders with green and yellow markings do not hold air, but a gas called Nitrox and should not be used by divers at this level of training. Cylinders should not be left standing without supervision. Because of the high pressure they hold cylinders are subject to regulations with respect to testing their condition on a regular basis. Dive schools are required to respect these regulations which vary from country to country.

The regulator is attached to the cylinder valve. There are two common types of attachments. DIN regulators screw into the cylinder valve and yoke regulators have a metal yoke that comes around the valve. The valve must match the regulator being used (this normally involves placing an insert or leaving it out). Once the regulator is attached the cylinder must be opened completely to allow for a maximum diameter of the passage for air to flow to the regulator. Before removing a regulator the valve must be closed and the pressure purged from the regulator.

Describe the basic functioning of a scuba regulator, list the hoses attached to the first stage of a scuba regulator and explain their purpose.

The part of the regulator that attaches to the cylinder valve is called the first stage. The part with the mouthpiece is called the second stage. The first stage reduces the pressure in the cylinder to an intermediate pressure (on land this is about 10 times the atmospheric pressure). In many cases you will find four hoses attached to the first stage. Two of them lead to mouthpieces. One can be connected to the buoyancy device and the other leads to a pressure gauge. This latter hose has the same pressure as the pressure in the cylinder. The other three have intermediate pressure. When you breathe from the mouthpiece the second stage reduces the intermediate pressure to ambient pressure.

When you take the mouthpiece of the second stage in your mouth it can be filled with water. You can clear the water from the second stage by exhaling into the regulator or by briefly pushing the purge button (in that case put your tongue against the mouthpiece as a splash guard). When you keep the regulator in your mouth after having cleared the water from it you can exhale and inhale as you wish because water will not enter the second stage again. However, every time you take the mouthpiece out of your mouth, you must clear the second stage of water before inhaling again. The second stage has a membrane that flexes inward when you inhale. The membrane activates a valve that allows air coming from the first stage to enter. You will find that breathing underwater is rather easy and that there is neither resistance nor delay when you inhale. You exhale into the second stage. It is equipped with a valve in the lower

part of the housing that allows the air exhaled into the second stage to escape.

The reserve second stage (called either alternate air source or octopus) functions exactly the same way as the main second stage. It is meant to be presented to another diver who has a problem with his air supply. Other divers are equipped with the same system and can thus offer you air from their cylinder should you need it. It is advisable to attach the alternate air source to your equipment in order that it is both clearly visible and easy accessible. Normally you will find a feature on the buoyancy device for attaching the alternate air source. The exhalation valve of the second stage is the lowest point. The exhaust tee is thus an indication of how to put an alternate air source (just as the main second stage) in your mouth. If you put it upside down it may not be possible to clear all the water from the second stage before inhaling.

Describe the use of a submersible pressure gauge (analogue or electronic) and at what pressure a dive should be ended.

The hose to the pressure gauge should be attached to the buoyancy device. This is to prevent it from swinging around and damaging underwater life. The pressure gauge works under water and is called a submersible pressure gauge or SPG. As a diver you should check the reading on your SPG on a regular basis. The red zone on the dial is the reserve and should only be used in emergencies. For your safety, but also to prevent damage to the equipment, you should not use the reserve unless there is an absolute need to do so. Most dive operation will require you to respect a 30 to 50 bar reserve. Digital gauges will not have a reserve zone but will have some electronic feature that draws your attention to a low air situation. The SPG may be combined with other instrumentation in a single console or a single digital instrument.

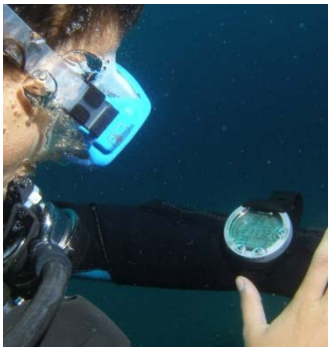
Describe how a diver carries a scuba cylinder on the back (support system with straps or mounted in the BCD) and explain how air can be added to a BCD and how the air can be released.

The last hose connects to the inflator on your buoyancy device. The inflator is the mechanism that allows you to fill the buoyancy device with air. By filling air into the device and by letting the air escape a diver has control over buoyancy. This is why it is called buoyancy control device or BCD. In most cases the BCD also functions as the system of carrying the cylinder on your back during diving and to lift the cylinder on land. Sometimes you find cylinders that have dedicated straps for this purpose. The bladder of the BCD is made of a material that is resistant to cuts and punctures but it will not harm to protect it against impact. The aforementioned inflator is the mechanism which inflates air into the BCD. It will also have a mechanism to allow oral inflation in an out-of-air situation. There are normally several options to remove the air from the BCD. Air will only come out at the highest point and it can thus be of help to have different options that can be used in different body positions. Some systems automatically select the highest point. Both during inflation and deflation of the BCD it is best to do so in short bursts in order to prevent rapid changes in your buoyancy. Only push the inflator mechanism momentarily. For deflation it is best to make use of the system that allows most control. For safety a BCD is equipped with dump valves. These are activated automatically when you overfill the BCD and are equipped with a cord that allows you to rapidly dump air. They are not intended for “normal” buoyancy control

Depending on the make and the type of the equipment you use the procedures for setting up the scuba unit and for disassembly and maintenance after use may vary. These procedures are part of the practical sessions of a diver course.

To monitor the duration of the dive and the depth a diver is equipped with instrumentation. In most cases the depth gauge and timing device are an integral part of a dive computer. A dive computer not only gives the data regarding time and depth but also calculates the exposure of the diver to nitrogen. This must be done to prevent decompression sickness. Prevention of decompression sickness is part of dive planning. For a supervised diver the dive planning will be done by a dive professional. The instruments are used to verify that the dive is made within the parameters of the dive planning (regarding dive duration and maximum depth) and to obtain the data that is needed to log the dive.

Point out on the display of a dive computer where to read depth and dive time.



Dive professionals need information of your dive experience in order to decide the parameters of the dives and the diving conditions in which they can allow you to dive. It is common amongst divers to log all dives and training events in a logbook. Such a logbook can be a "physical book or folder" in which all data is entered and where certification cards, medical certificates and other documents are assembled. Many divers keep their logbook in the internet. Such services allow divers to assemble scans of forms and verifications of certification next to their logged dives.

Explain why divers are required to log dives and which options are available.

It is possible that the local diving circumstances require additional equipment. This could be, for example, a dive knife in locations where entanglement is a risk. In any case it is recommended to have a signalling device, such as a whistle, with you to attract attention at the surface in case you need assistance.

List the three states of buoyancy (positive, neutral and negative) and describe the actions available to a diver to change their buoyancy.

With the BCD, you can alter your buoyancy. At the surface, positive buoyancy allows you to float without effort. Negative buoyancy means that you sink. Underwater you need to maintain control over the depth of the dive. To do this you need neutral buoyancy. Neutral buoyancy means that your weight and the upward force (lift) of the water are exactly in balance. The upward force of the water is equal to the weight of the water that you displace. If the weight of the water being displaced is bigger than your weight you have positive buoyancy. You create such a situation by inflating your BCD. The bigger BCD displaces more water and thus gives more lift. You reduce the upward force by venting air from the BCD. With an empty BCD you should be able to descend (not sink). An empty BCD with the correct amount of weights should result in neutral buoyancy – when you do nothing you should neither go up nor down. Descending thus requires some action on your part to start a downward movement. These actions are learned in the practical sessions of a diving course.

Explain the effect of wearing a dive suit and the quantity of air in the cylinder on the buoyance of a diver.

If you were not wearing a dive suit and if you are neutrally buoyant with an empty BCD your buoyancy would not change with increased depth. With a dive suit, the situation is different. The neoprene of the suit has small pockets of air which are compressed with increased pressure. This reduces the volume of water being displaced and thus reduces the upward force. You must compensate for this loss of buoyancy by adding air to the BCD every few metres that you descend. On your ascent for the same reason, you must release air from the BCD every few metres. The idea is to always have ample positive buoyancy at the surface and to always be neutrally buoyant under water.

From the beginning to the end of the dive you will become lighter because of the consumed air from the cylinder (the difference in weight between a full and an empty cylinder is a few kilos). For this reason divers tend to measure the correct amount of weights to wear using an almost empty cylinder. With

the correct amount of weights, an empty BCD and a normal lung volume, you should float at eye level – when exhaling you should sink a little deeper in the water. Every time you change equipment you need to check for the correct amount of weight. In salt water you require more weights than in fresh water.

Underwater your breathing affects your buoyancy. When you feel that you are beginning to move upward, it should be enough to exhale. That actually works a lot better than trying to swim downwards. Experienced divers use breathing as a tool to control their position in the water as second nature. In practical training there will be exercises in which you control your buoyancy both by breathing and by altering the amount of air in your BCD.

Pressure, Volume & Density

Maybe you have already experienced pressure changes when flying. Another example would be driving through the mountains. In both cases, the pressure changes are relatively small and only noticed in the ears. Underwater, pressure changes occur faster and are bigger. As a diver, you have to know how to deal with changing pressure and have to be aware of the consequences. That is the subject of this chapter.

You have probably already experienced pressure changes when travelling by plane or when driving a car through mountains. There is a difference in pressure in relation to altitude. At higher altitude the pressure is lower. In the atmosphere we measure pressure in millibar. The changes in pressure are so little that they are expressed in thousands of a bar. Underwater we use the unit bar, indicating that the pressure changes we are dealing with are much higher than we are used to on land. For a diver the atmospheric pressure at sea level, averaging 1013.25 millibar, is rounded to 1 bar. Descending only to 1 metre depth in water would results in a 0.1 bar pressure increase. In comparison, you would need to ascend to 1,000 metres in the mountains in order to experience a 0.1 bar pressure decrease.

List the pressure at the surface and at 10, 20 and 30 metre depths.
Explain the effect of increasing depth on density and air consumption.

The pressure underwater increases 1 bar for every 10 metres in depth. The pressure at 10 metres is thus double (2 bars) the pressure at the surface and the pressure of 3 bar at 20 metres depth is three times as high as the atmospheric pressure. Increasing pressure has consequences for the density and volume of gases. The increase in density is equal to the increase in pressure. At 10 metres depth the pressure is double the atmospheric pressure at sea level – also the density is double the density at sea level. This means that a given volume of gas holds twice as many molecules – the air is thicker. For a diver this means that the air in the cylinder lasts only half as long at 10 metres depth than it would at the surface and that a diver at 30 metres depth (4 bars pressure) would consume the air in the cylinder four times as fast as at the surface. In the range of recreational diving you will not feel the increased density of the air, but it does indicate the need for frequent monitoring of the SPG.

Depth	Pressure	Volume	Density
0 metre	1 bar	1 (full)	x1
10 metres	2 bars	1/2	x2
20 metres	3 bars	1/3	x3
30 metres	4 bars	1/4	x4

Describe the effect of pressure on volume.

Knowing that a given volume of gas holds more molecules when pressure increases it is logical that a given number of molecules fill a smaller volume when density increases. When holding a jar filled with air upside down while descending you will notice that the volume of the air bubble reduces in size and that the water level in the jar will rise with increasing depth. Calculating the exact volume is simple – just divide 1 by the pressure – at 10 metres (2 bars) the volume is 1 divided by 2 (half of what it was at the surface) – at 20 metres (3 bars) 1 divided by 3 (a third of the surface volume) and so on. The official "physics formula" is pxV=constant (p = pressure and V = volume). Constant means that the result of the multiplication has to stay the same. This means that volume also changes on the way up – if the pressure is reduced to half of what it was before, then the volume will double and a decrease in pressure to a third of what it was will triple a volume.

Explain how pressure change results in a need to adjust buoyancy when changing depth and how to do that.

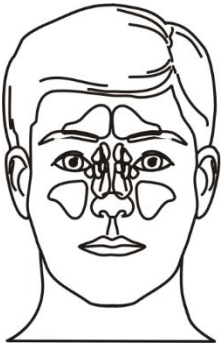
The relationship between pressure and volume has more consequences than the relationship with density. You are already aware of one of them – when descending the small bubbles in the neoprene of your suit reduces in volume. This makes the suit thinner which reduces your total volume and thus the upward force of the water. It is necessary to compensate for this change of volume by changing the air volume in your BCD. Air spaces other than the tiny ones in the suit cannot be allowed to change their volume. This means that a diver has to take actions to keep volumes constant. This involves adding air to these spaces on the way down and venting access air on the way back to the surface. Fortunately liquids and solids are not compressible, so most of your body and your equipment are not affected – you only have to take action for volumes holding air.

The main natural air spaces are your lungs, ears and sinuses. The main artificial air space is the inside of the mask. Other natural air spaces that have been reported to have caused some problems in rare cases are stomach, intestines and teeth. Divers who use a dry suit will have to take action to keep the volume of air in the suit constant. The techniques used to equalize the pressure in air spaces in order to keep the volume constant are simple but may never be forgotten or ignored. Failing to equalize may result in pressure related injury – a barotrauma (baro for pressure, trauma for injury).

Explain how pressure changes (may) affect ears, sinuses, masks, lungs, suits, teeth and stomach, how to avoid problems for each and what to do if a problem does occur.

Every breath you take has the same pressure (and thus density) as the pressure around you. A normal inhalation is enough to fill your lungs with air with the correct density – the deeper you go the denser the air will be, which explains the increased speed with which your supply is used up. When you hold your breath, the density of the air in the lung has the correct density for the depth where you took your last breath, but not for a shallower or greater depth. For a diver it is thus important to breathe continually and never hold your breath. This is considered to be the most important rule for scuba divers. Holding your breath on the way up can result in serious injury. Even when you do not have your regulator in the mouth and cannot inhale, you should still not hold your breath, but keep the airway open by letting a small stream of bubbles escape from your mouth. Problems with the lungs during descents are rare, but you do need to apply the most important rule for scuba divers on the way back to the surface at all times.

Explain why a diver must never hold his breath while under water.



You do not have to take any action to equalize your sinuses. They are connected to the air space in your mouth and nose by a rather rigid tube which lets air pass without any problems. Sometimes this passage is blocked. This can happen due to swollen tissue when you have a cold. In that case there is nothing you can do – when you have a cold you should not dive. Medication to reduce swelling is not an option. The medication may wear off while you are under water, resulting in a barotrauma on the way up (called a reverse block).

The passage between the air space in your mouth/nose and your ears is soft and normally closed. This explains the need to "pop" the ears when you are driving in the mountains or flying in an airplane. Divers must equalize their ears early and often when descending – starting at the surface and then every metre or so. You will find that excess air will escape from the ear on the way up without any action from the part of the diver. Your instructor will ask you to pinch your nose and slightly exhale against it. Do not force, because that could cause damage to the ear. Another technique is to wiggle your lower jaw. The passage, the Eustachian tube, requires a little assistance – you are not forcing air into the ear, but just helping a little to open the passage. The moment the passage is opened the flow of air to the ear will follow automatically due to the difference in pressure between the two airspaces. If equalizing does not work you can try to combine the two techniques. If it still does not work you can ascend a metre or so and try again – if it still does not work you will have to abort the dive.

The mask needs some attention during a descent. Due to the increased pressure, the mask will be pushed against your face. Initially this only causes discomfort, but in extreme cases blood vessels in the face may become damaged. The resulting coloration of the skin will then be visible for hours or days. This problem is easy to prevent by exhaling through the nose from time to time. This is the reason why the diving mask must have a nose pocket. On the way back to the surface the excess air in the mask will escape by itself.

Gas in the stomach and intestines does normally not cause any problem. The organs are flexible enough to allow for some compression or expansion of gases within. In extreme cases discomfort is reported during ascent, but if you stick to a "normal" diet, problems should not occur. Your teeth can be an issue. Healthy teeth are not affected by pressure and a correctly repaired tooth doesn't either. In some rare cases airspace is left open below a filling. During a long dive air can seep into this airspace but cannot exit fast enough on the way up. This can cause the tooth to break. This could be a very painful condition in a live tooth, but in these extremely rare cases of reversed block it more often than not concerns a tooth from which the nerves have already been removed.

In short – on the way down, equalize your ears and your mask and on the way up you stop the ascent for a moment when you feel discomfort in ears, sinuses, stomach/intestines or teeth. Never stop breathing and make sure your airway is always open. A barotrauma on the way down is also called a squeeze and a barotrauma on the way up is a reversed block or – in the case of the lungs – an over-expansion injury. This last one is the most serious (potentially it could even be fatal), but also the easiest to prevent. Never hold your breath.

Explain the relationship between the time and depth of a dive and decompression sickness.

You may have heard that divers have to prevent decompression sickness by interrupting their return to the surface in decompression stops. This is not really true for recreational divers. Normally recreational divers plan their dives in a way that avoids any obligation to make such a stop. However – it is common practice to make a safety stop at shallow depth (normally 3 to 5 metres for 3 minutes) before making the final ascent to the surface. The maximum depth of 12 metres for this certification level allows a dive time of well over two hours before decompression becomes a concern. Your cylinder will be empty long before. If you dive more than once a day, the previous dives must be taken into consideration during dive planning. Make sure that the dive professional that is planning your dives for you is aware of any previous dives you have made in the past 12 hours. A dive computer keeps track of your exposure to pressure. This is the reason why every diver should have his own dive computer and why divers do not switch computers between dives nor let others use their computer when they do not plan to dive for a few hours. Do not fly within 18 hours after surfacing from your last dive.

The Diver and the Underwater Environment

A dive is like traveling into another world. It cannot be compared with watching a documentary about the splendour of the underwater world on television. When diving, you are “in the middle” of it. Rather than being a passive observer, you have an active role. As an active participant you have to interact with the environment and other divers. This chapter is about your role during a dive.

Explain the recommended interval for a medical examination and list three substances that are not compatible with diving (medication, recreational drugs, and alcohol).

You do not need to be an athlete to be able to dive. You do need an acceptable health condition. In many countries it is a requirement that you have a medical certificate stating that you are fit for diving. In most cases the certificate should not be older than one year. In countries where this requirement does not exist, a medical is recommended. If you do not feel fit and well you should not go diving. It is common amongst divers that anybody can deny participation in a dive or abort any dive without being asked for a reason or justification – if you do not feel up to it just cancel.

Recreational drugs and alcohol do not mix with diving. Also medication may be of influence. If you do take medication you should tell your physician that you plan to go diving and ask if there are any concerns with the respect to the prescribed drugs. Special caution should be taken with any illness or drugs that cause dehydration. Due to the dry air in the cylinder (to prevent corrosion of the inside of the cylinder) you will dehydrate during the dive. When combined with a medical condition that causes the same problem. The combined effect might become too great. In any case – take precautions to remain hydrated during a dive trip.

Describe the possible consequences of physical and mental stress and how to avoid related problems.

As a supervised diver you have responsibilities toward those who dive with you, including the dive professional offering the dive in which you take part. It is normal to sense some stress before a dive, but if the level of stress becomes too high, it may affect your ability to perform the duties required of you. Stress can be caused by physical influences such as temperature, overexertion or pain. Mental stress is related psychological influences, such as being afraid of the depth of a dive, feeling claustrophobic in low visibility or other. Make sure others know how you feel and abort a dive (after signaling to the others that you intend to do so) if you do not feel up to it. Your mental condition and health should allow you to perform normal tasks. Any condition

that would lead to a recommendation not to participate in traffic should also be taken as a condition that excludes you from diving at that time.

Explain why a Scuba Diver needs an introduction to any environment different from the conditions in which the course has been conducted.

There is an enormous variation in conditions of a dive. This variation is one of the main attractions of diving but is also confronts the diver with a number of challenges that vary greatly from one location to the other. A Scuba Diver course can only prepare you to dive in the conditions you experience during the course. Different conditions affect divers. You learn to counteract such influences by actually diving in those conditions under the guidance of a scuba professional. It is not possible to learn handling conditions which are not present in the local environment. Every time you dive in another location you will need an introduction with a dive professional to learn how to go about in the local situation. You should be aware of a few general conditions that may vary. During your course your instructor will train you in the specifics of the dive conditions in the region where you take the training.

Explain how visibility affects a dive.
Explain how the vision of a diver is affected underwater and how to adjust to that situation.

Visibility can differ from a few centimetres up to more than 30 metres. This will not only affect the

position between you and your buddy, but also the techniques used for a descent, underwater swimming and the ascent. You should be aware that objects seen underwater appear to be closer and larger than they actually are. When you try to grab something such as the ladder of the boat or when you try to stand-up in shallow water when returning to the beach you will need to adapt to this altered perception of distance. You will soon get into the habit of estimating correct distances, but in the beginning you will have to remind yourself that objects underwater are further away from you than you think they are (about 25% further away). Water has some filtering properties that result in loss of contrast and color with increasing depth. Many divers carry an underwater light (even on a bright day with good underwater vision) to increase enjoyment of the colorful underwater world.

Explain how hearing of a diver is affected underwater.

Underwater, sound travels several times faster than on land. You can still hear very well but the changed speed of sound impairs your ability to hear where a sound is coming from. It is like listening with a head-set in mono. Both ears hear the same thing at exactly the same moment. Since our sense of direction originates from the slight time difference in reaching each ear directional hearing does not function anymore.

Explain how to stay warm underwater and what to do if continued shivering begins.

Water temperature determines how much thermal protection is required. The temperature at depth can be considerably lower than at the surface. Sometimes the temperature changes are rather abrupt. The border between a layer of warmer and a layer of colder water is called a thermocline. It is self-evident that the exposure protection you choose should be adequate for the coldest part of the dive. A

correct choice of exposure protection should retard cold long enough to dive for the intended duration. If a bad choice was made (and you become cold too soon) you will start shivering as your body tries to generate heat. Shivering is a warning sign that must be taken seriously. End the dive and get out of the water to dry yourself and warm up.

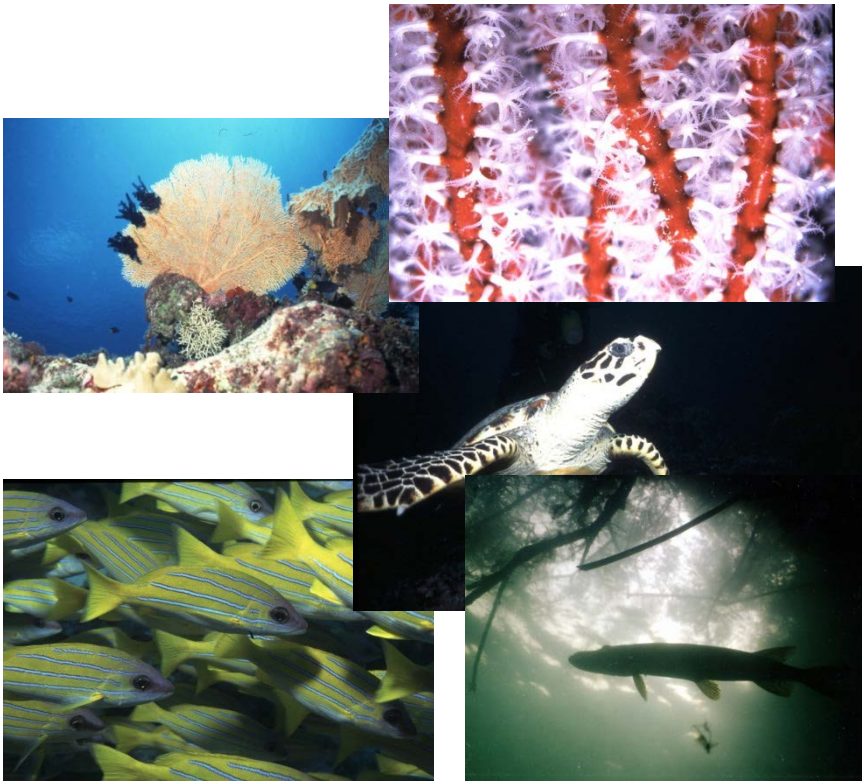
Explain how a diver should move underwater to avoid overexertion.

Just walking through waist deep water at the beach will teach a key lesson for divers. Water is much denser than air and makes it more difficult to move forward. Divers must move slowly in order to prevent overexertion – moving twice as fast will cost four times as much energy. A diver should try to be hydrodynamic (just as cars are designed to be aerodynamic). This means that equipment should be worn close to the body, that a diver takes as little weight as possible to prevent a need to inflate the BCD and that the body is kept in a horizontal position. Overexertion leads to faster depletion of a diver's air supply. It can cause stress and with that lead to a dangerous situation. If you feel your respiratory demands increasing you should stop all movement, hold on to something or to your buddy and allow ample time to catch your breath. You may need to re-adjust your buoyancy before continuing the dive (badly adjusted buoyancy is a common cause of overexertion). In any case, you should continue the dive at a slower pace.

Describe the potential problems related to water movement.

Currents can be tricky and unpredictable in some regions and may be the main guide for the direction of the dive in others. Currents can always go into the same direction (like in a river), alternate direction on a regular schedule (like with tides), depend on the direction of the wind (like with currents along a beach) or be unpredictable. In some cases divers start a dive against the current to have it easier on the way back, but in other cases they will just drift with the current and are picked up by the boat at the end of the dive. In short – local procedures with respect to current vary enormously. For now it is important to remember that you will tire fast when swimming against the current and should thus avoid that whenever possible. When you end up in a strong local current do not try to swim against it, but try to get out of the zone by swimming in a 90° angle with respect to the direction of the current.

Bottom composition and underwater life are the biggest differences between the various diving locations around the world and are the main reason to visit as many different locations as you can. Your instructor will spend some time to inform you about the local situation and these two factors are a main focus of orientation dives on a new location.



Describe how a diver should avoid impact (damage) to the underwater world

A diver is a guest in the underwater world. Life underwater can be fragile and divers should avoid touching it to avoid damage. Most underwater life you see are animals – even if at first sight you think it is a plant. Always maintain neutral buoyancy to avoid bottom contact. If you need to position yourself on the bottom for any reason try to locate a place with sand only. Touching underwater life is only to be done by experts. Do not collect any souvenirs during a dive.

Explain how to stay close to a buddy and what procedure should be followed in case of separation.

Divers do not dive alone. All emergency procedures you learn in a scuba course are based on the availability of another diver to render assistance. It is also practical for suiting up and getting in and out of the water. Last but not least, it is more fun to enjoy the dive together with other divers.

Before the dive, you have to discuss with the other diver what you plan to do. The activities you plan during the dive, the limits with respect to time, depth and cylinder pressure, any special attention or assistance you might need and the functioning of you equipment (if anything is different from the standard configuration). You should also go through emergency procedures and make yourself familiar with each other's level of knowledge and skills and of your equipment.

In the event that you lose your buddy or the group you are diving with you should search underwater for no longer than one minute and then surface to re-establish contact. If your buddy does the same, the situation should soon be solved. When

surface conditions do not allow an immediate return to the surface, sometimes an alternate procedure is established. In that case a local dive professional can inform you about both the reasons and the procedure.

Describe underwater communication and state the meaning of 25 standard hand signals.

Underwater you have to communicate with your buddy. You can write short messages on a plastic slate with a normal pencil. There are some things that either must be communicated rather fast (such as running out of air) or happen so often that writing on a slate would soon become a nuisance. For those situation divers have developed hand signals. There are 25 standard signals that are known by all divers, but nothing prevents you from agreeing some additional signals with your buddy.


Okay
Okay with gloves
Okay at the surface
Okay - one hand occupied
Not okay
Go down
Level off at this depth
Go up
Come here
Which direction do we go?
I am cold
I have ear problems
I am low on air
I am out of air
Share air
Danger - point fist to location
You lead, I follow
Help! At the surface
Stop
Stay together
Slow down
That way
Go under (or over or around)
Me, or look at me
Hold hands

Explain why Scuba Divers are not prepared to dive without a scuba professional.

Training for Scuba Divers is aimed at preparing people for diving under the guidance of a dive professional. That means that tasks that can easily be performed for you (by a dive professional) are not included in your course. This relates to skills that are needed to help other divers (if you dive with a buddy, you have a responsibility toward that person), and skills for controlling a dive, such as navigating to the best locations. It also relates to theory. Before a dive is made many decisions have to be taken. They must be informed decisions. Such decisions must prevent medical issues (such as decompression sickness or narcosis) and take the possibility of an accident (and thus preparations for the management of such an event) into account. The decisions must also maximize the pleasure and enjoyment a dive can bring.

Taking decisions before a dive is called dive planning. The planning of dives for a Scuba Diver is done by a professional – simply because you were never trained to do that yourself. If you want to dive with other certified divers and become independent of professional guidance you can continue your training. The additional skills and the necessary knowledge are part of an Open Water Scuba Diver training program.

Index