

Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science

PROFILES IBSE Teaching/Learning Materials – Student activities

Compiled by the PROFILES Working Group of the Masaryk University, Czech Republic



Safety of human body: swimming and diving



A Module for IBSE

Instruction: **Science** (especially **Physics** and **Biology**)

Grades: 5th to 9th

Abstract

The main objective is the safety of the human body investigated by students with use of simple experiments. The safety of the human body in everyday living is the significant content for effective teaching-learning because of practical use and interest. This content can be implemented in family education as the transfer of information about the safety risks from school into families by means of students. This content develops better perceptions of science for students and society. Students are acquainted with human body parameters which can be expressed with the aid of quantities, units and laws. Also external conditions are very important for preservation of vital functions of the human organism including health. This module can develop students' knowledge, understanding and skills to understand science law; measuring unites; applying knowledge in every day practice, interdisciplinary (science) integration of knowledge from separate subjects (Physics + Biology). The main advantage of this module is his very high level of motivation.

STUDENT ACTIVITIES:

Scenario:

➔ *Read the stories and think about them:*

Who is right?

Peter went cycling with his parents. At noon they came to a river. It was really hot and Peter was very sweaty and looked forward to cool down. He wanted to jump into the cold water immediately. His mother stopped him and told him he had to wait to cool down, because otherwise he could even get drowned. Peter laughed, thinking it was a superstition that parents tell their children, because they are afraid that they might catch a cold. But he is hardy and is not afraid of cold water.

Death during diving

News from a TV broadcast: Yesterday famous singer D.N. tragically died during a scuba-diving in the seaside resort of H. Local police spokesman said that the exact cause of death will be clarified by means of autopsy ordered by the court. Senior instructor diving L.T. answered our query what can cause tragedy during diving - it may be a small injury, which is e.g. ruptured eardrum. Details will be included in subsequent news.

Problems and questions:

➡ *Carefully re-read the stories and write down the questions that occur to you:*

- 1.....
- 2.....
- 3.....
- 4.....
- 5.....

➡ *If you have just no ideas, select some of the following questions:*

- (a) What properties of water can cause health risks or even death of a man?
- (b) Which organs of the human body and why can be damaged during swimming and diving?
- (c) What kinds of swimming and diving in the water are risky?
- (d) Which rules of safe swimming and diving we follow?

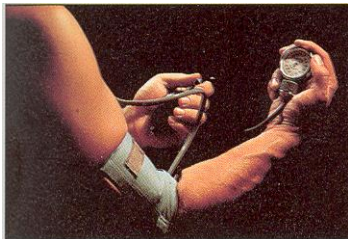
The following experiments help to answer questions:

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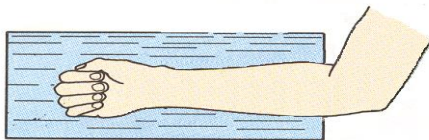
Tasks and experimenting:

❖ Experiment 1: Cold test of blood pressure

- ▶ *Measure and write down temperature of air in the classroom.*
- ▶ *Measure the normal blood pressure in the left arm using sphygmomanometer. Write this result down.*
- ▶ *Let the cuff on the arm - you will repeat the measurement again.*



- ▶ *Measure the temperature of cold water ready to cool the right hand classmates.*
- ▶ *Put the right arm into the bucket of cold water. Measure the pressure in left arm again. Once again write down the result.*



- ▶ *Compare the results and evaluate the condition of your vessels.*

Worksheet	Cold test of blood pressure			
1.	Room air temperature:		Left arm blood pressure:	
2.	Cold water temperature:		Left arm blood pressure after cooling of right arm in water:	
3.	Difference of temperatures of air and water:		Difference of blood pressures:	
4.	Results of measuring and observing:			

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Results and implications of experiment:

- *The cold phenomenon is caused by the vasoconstriction of vessels and decreased blood flow in the organs - primarily the skin and muscle capillaries are affected. If we are in a cold environment, the vessels in less important tissues, especially surface tissues such as skin and muscle, contract so the blood doesn't cool down and doesn't cool the body core temperature.*
- *Vasoconstriction of the surface vessels increases the blood pressure in the central artery. The amount of change depends on the condition of the vessels, on their reactivity. If the temperature change is rapid and in addition on the large surface of the body, can cause a rapid rise in blood pressure and the collapse of the body, which can cause death.*

❖ **Experiment 2: Modelling of ear-drum rupture under high water pressure**

- ▶ *The basic experiment aid is a plastic bottle with a wide neck.*



- ▶ *The bottle cap is drilled and valve of tire is screwed into it.*



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- ▶ *Overpressure in the plastics bottles in all experiments is made out by hand-pressing or by a small velocipede tire-pump.*



- ▶ *Instruments in plastics bottles are fixed on stands made out of copper wire, metal stick and wooden small plates (see picture).*



- ▶ *Cover the mouth of the test tube by the rubber membrane (of an inflatable balloon) and secure with a rubber band.*
- ▶ *Connect the velocipede tire-pump to the valve and pump - you produce overpressure of air in the bottle.*

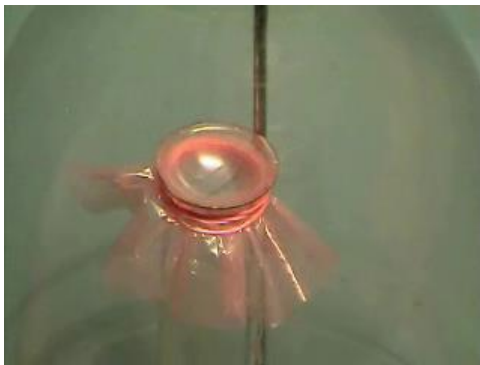


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- ▶ *The membrane under the influence of pressure is bent into the test tube.*
- ▶ *The deflection of the membrane increases with increasing overpressure.*



- ▶ *Replace the rubber membrane with a thin plastic membrane.*
- ▶ *Under the influence of pressure it is also bent into a test tube*



- ▶ *If overpressure in the bottle is sufficiently great, the plastic membrane ruptures.*



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The rubber and plastic membranes simulate behaviour of ear-drum during swimming, bathing and diving. Water in ear (ear canal) pushes on ear-drum similarly as air on membranes in the case of our experiment. The result of this pressure is deformation of the eardrum and in the case of high pressure (overpressure) rupture of the ear-drum.

Results and implications of experiment:

- *Deformational effect of overpressure force is demonstrated by the rupture of covering membrane on the test tube made out of a piece of plastics bag.*
- *The plastics membrane simulates the terminal behaviour of ear-drum during swimming, bathing and diving. Water in ear canal pushes on ear-drum by heavy force. The result is the rupture of ear-drum. The implication of this rupture is cutting pain and the loss of space-finding. This is the danger of death for the diver.*

❖ **Experiment 3: Compression of lung**

- ▶ *Inflate the rubber balloon inside a plastic bottle.*

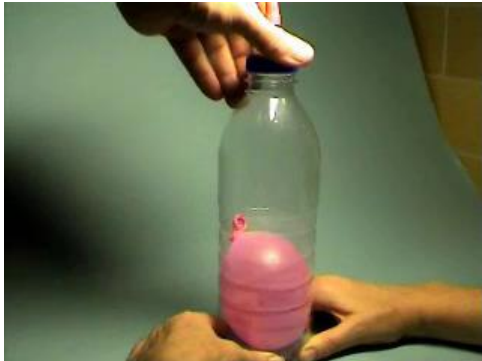


- ▶ *The over pressure in the bottle, caused by velocipede tire-pump, causes reduction in volume of the balloon.*



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- *After opening the bottle balloon expands again.*



Results and implications of experiment:

- *Deformational effect of overpressure force is demonstrated by changing volume of an inflated small rubber balloon.*
- *The overpressure under water during diving reduces the lung volume. We are able to breathe spontaneously only about one metre under the water surface. Air must be pumped into our lung by overpressure during diving. At a depth of ten metres the lung volume is reduced to half. If diver emerges too quickly, his lung can be fatally damaged.*

❖ **Experiment 4: Dissolving of air in blood**

- *The water in a pressurized bottle more air (gas) dissolve than under the normal atmospheric pressure.*



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- ▶ *After opening a bottle air bubbles from water will begin to release.*



- ▶ *After the moment it is released large amounts of bubbles.*



Results and implications of experiment:

- *Air is dissolved into the water in the over pressured plastics bottle. The air (nitrogen) is dissolved into blood during diving. Air embolism is the frequent reason of death after fast emergence.*
- *During diving the greatest danger is barotrauma which can cause varying degrees of damage of organs or even death. Barotrauma is caused by a pressure change within body which has been exposed to a certain period of overpressure and fast emergence on the surface leads to a sudden reduction in pressure. Due to the blood vessels dilate, pressure is changing and blood gases are released and blood starts to froth.*

Decision making:

Answers to questions:

➔ Briefly answer the questions that you are expressed at the beginning of your inquiry.

1.....

Answer:

2.....

Answer:

3.....

Answer:

4.....

Answer:

5.....

Answer:

(a) What properties of water can cause health risks or even death of a man?

Answer:

(b) Which organs of the human body and why can be damaged during swimming and diving?

Answer:

(c) What kinds of swimming and diving in the water are risky?

Answer:

(d) Which rules of safe swimming and diving we follow?

Answer:

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Conclusions and recommendations to the stories:

- ➔ In the left column of the table write down your suggestions and recommendations that in your opinion belongs to these stories. Discuss with classmates and teachers about your opinions. Corrections and additions write down in the right column.

Worksheet: Who is right?		
	My opinion:	Correction and supplement after the discussion
1.		
2.		
3.		
4.		
5.		

Worksheet: Death during diving		
	My opinion:	Correction and supplement after the discussion
1.		
2.		
3.		
4.		
5.		