

DENSITY OF MATERIALS IN FLOATING / SINKING PHENOMENA: EXPERIMENTAL PROCEDURES AND MODELLING

TEACHING AND LEARNING ACTIVITIES

ORIGINAL VERSION

MATERIALS SCIENCE PROJECT

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AND IMPLEMENTATION OF
RESEARCH-BASED ICT-ENHANCED
MODULES ON MATERIAL
PROPERTIES

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UNIT 1: INTRODUCTION TO FLOATING/SINKING AND THE METHOD CONTROL OF VARIABLES

In this part we will discuss about floating and sinking of bodies in response to the sinking of the Sea Diamond cruise ship. To investigate this phenomenon we will seek the factors affecting the floating or sinking of bodies in a liquid.

Through these inquiry procedures we will approach an important method of experimental physics: the control variables method.

1.1

FLOATING SINKING

Observe the pictures shown on the computer. Identify 3 objects that you see on the ship and 3 objects you see inside the ship.

Write down the names of the objects you identified.

Why are there life vests on the ship?

1.2

SINKING AND FLOATING OBJECTS

Observe the sketch of a ship. Draw the mouse pointer on the objects so as you read their names.

If we throw the objects from the ship in the sea, which ones will float and which ones will sink?



DISCUSS WITH YOUR GROUP AND WRITE IN THE FOLLOWING TABLE THREE OBJECTS THAT YOU THINK THEY WILL FLOAT AND THREE OBJECTS THAT YOU THINK THEY WILL SINK.

OBJECTS THAT WILL FLOAT	OBJECTS THAT WILL SINK

In your opinion, why will one of the objects you selected float?

In your opinion, why will one of the objects you selected sink?

1.3

THE MODEL OF A SHIP

Observe the model of the ship that you have on your desk.

In your opinion, what material is it made of?

Look in the interior of the ship.

What do you see?

If we put the ship in a vessel with water, what do you think:

Will it float or will it sink?

Put the small ship in the vessel.

What do you observe?

Can you force it to sink? If yes, in which way?

Why did the ship sink?

1.4

DOES AN OBJECT'S WEIGHT AFFECT ITS FLOATING OR SINKING?

SOFTWARE: ROOM "TESTING BODY WEIGHT"

1 ST EXPERIMENT WITH CORK	2 ND EXPERIMENT WITH CARBON FIBRE
We have two bodies made of cork, of exactly the same shape, which is cube, but of different weight. (real experiment)	We have two bodies made of carbon fibre, of exactly the same shape, which is cube, but of different weight. (software)
I predict If I drop the heavier cube in the water, will it sink or will it float? Why? 	I predict If I drop the heavier cube in the water, will it sink or will it float? Why?
I check - observe 1st trial The heavier cube..... 	I check - observe 1st trial The heavier cube.....
I check - observe 2nd trial The lighter cube	I check - observe 2nd trial The lighter cube
I conclude about both cubes. Does their weight affect their floating or sinking? 	I conclude about both cubes. Does their weight affect their floating or sinking?

I draw general conclusions.

Does the **weight of bodies** affect their floating or sinking?

.....

.....

What led you to draw this conclusion?

.....

.....

UNIT 2: STUDY OF THE FACTORS AFFECTING FLOATING/SINKING

In this unit we will control other possible factors affecting floating and sinking.

2.1

DOES THE WIDTH OF A VESSEL AFFECT FLOATING?

SOFTWARE: Room “Testing width of containers”

We have a narrow and a wide vessel filled with water. We have a piece of wood.

I predict

If I drop the **piece of wood** in the narrow vessel, will it sink or will it float? Why?

If I drop the **piece of wood** in the wide vessel, will it sink or will it float? Why?

I check - observe

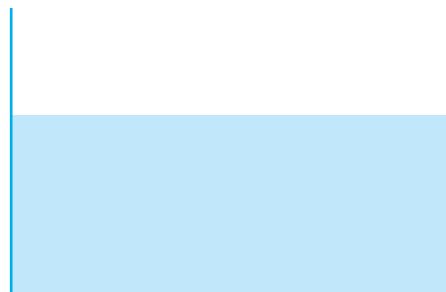
1st trial

In the narrow vessel, the piece of wood.....



2nd trial

In the wide vessel, the piece of wood

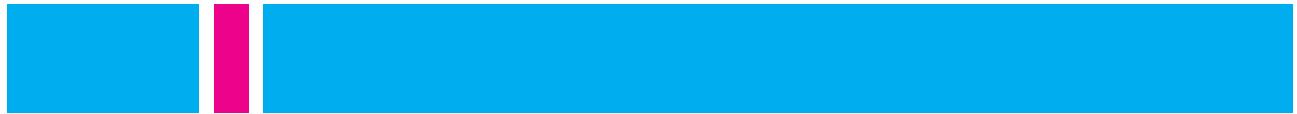


I conclude:

Does the width of the vessel affects the sinking of the wooden body?

Yes

No



How did you come to this conclusion?

What should you observe in order to come to the opposite conclusion?

2.2

DOES THE WIDTH OF A VESSEL AFFECT SINKING?

SOFTWARE: Room “Testing width of containers”

On the computer screen we had a narrow and a wide vessel filled with water. Now, we have a cube of marble.

I predict

If I drop the cube of marble in the narrow vessel, will it sink or will it float? Why?

I predict

If I drop the cube of marble in the wide vessel, will it sink or will it float? Why?

I check - observe

1st trial

In the narrow vessel, the cube of marble.....



2nd trial

In the wide vessel, the cube of marble



I conclude:

Does the width of the vessel affects the sinking of the cube of marble?

Yes

No

How did you come to this conclusion?



What should you observe in order to come to the opposite conclusion?



I THINK ABOUT WHICH FACTORS I KEPT FIXED AND WHICH ONE I CHANGED.

	1 ST EXPERIMENT - FLOATING	2 ND EXPERIMENT - SINKING
Circle the factors that you kept constant in each experiment	Shape Material Width of the vessel Weight Liquid	Shape Material Width of the vessel Weight Liquid

2.3

DOES THE KIND OF THE LIQUID AFFECT FLOATING OR SINKING?

SOFTWARE: Room “Testing Liquids”

On the computer screen you see two vessels filled with oil and mercury respectively and an iron cube. Suggest an experiment that will help you to explain if the kind of liquid (oil, mercury) affects the floating and the sinking of a body.

Describe in detail how you will do the experiment.

Try your suggested experiment on the computer.

Describe in detail (a) the steps you followed, (b) what you observed, (c) your conclusions.

(a) The steps we followed are:

(b) We observed the following:

(c) Our conclusions are:

2.4

DOES THE KIND OF THE MATERIAL OR THE SHAPE OF AN OBJECT AFFECT FLOATING OR SINKING?

SOFTWARE: Room “Testing body material and shape”

On the computer screen we see two different materials: cork and rubber having the shape of cube and sphere. Also, you see a vessel filled with water. Suggest as many experiments that are required in order to investigate whether the kind of the material or the form of an object affects the floating and the sinking of a body.

Experiment

Describe in detail what actions you will take to investigate what is required.

Try your suggested experiment (s) on the computer.

Describe in detail the steps you followed, what you observed, your conclusions.

(a) The steps we followed are:

(b) We observed the following:

(c) Our conclusions are:

Experiment

Describe in detail what actions you will take to investigate what is required.

Try your suggested experiment (s) on the computer.

Describe in detail the steps you followed, what you observed, your conclusions.

(a) The steps we followed are:

(b) We observed the following:

(c) Our conclusions are:



Experiment

Describe in detail what actions you will take to investigate what is required.

Try your suggested experiment (s) on the computer.

Describe in detail the steps you followed, what you observed, your conclusions.

(a) The steps we followed are:

(b) We observed the following:

(c) Our conclusions are:

UNIT 3: A CRITERION FOR DESCRIPTION AND PREDICTION OF FLOATING/SINKING IN THE WATER

In this part we will seek a criterion in order to explain and predict the floating or sinking of an object in water.

3.1

NEW MATERIALS

SOFTWARE: Room “Information about materials”

Fill in the following table taking into account the information appearing on the computer concerning the three materials: glycerine, rubber and P.V.C.

	GLYCERINE	RUBBER	P.V.C.
NATURAL OR ARTIFICIAL			
APPLICATION			
ENVIRONMENTAL IMPACTS			

3.2

REPRESENTING THE HEAVIER – LIGHTER RELATION

SOFTWARE: Room “Weighing Materials 1”

On the computer screen, you can see 3 cubes made of wood, rubber and iron, all of the same size.

Compare the weights of the iron and the rubber cube and the weights of the rubber and the wood cube. Then, look at the empty squares that correspond to these 3 materials.

Write under each of the squares the name of each material, starting from the heavier one and concluding with the lighter one.

Draw the objects in a way that the heavier object is distinct from the lighter one.

3.3

REPRESENTING THE SAME RELATION FOR MORE MATERIALS

SOFTWARE: Room "Weighing Materials 2"



3.4

LET'S FIND A WAY TO PREDICT WHEN AN OBJECT FLOATS OR SINKS IN THE WATER

SOFTWARE: Room "Floating Sinking of Models"

On the computer screen you see the water cube containing 4 dots. Also, you see the water vessel which you will drop in first the wood cube and then the rubber cube.
Put the wood cube in the water. The cube floats.

How many dots are there in the wood cube? Are there less or more than in the water cube?

Put the rubber cube in the water. The cube sinks.

*How many dots are there in the rubber cube?
Are there less or more than in the water cube?*

From the above experiments, I conclude (fill in the blanks with the correct word):

When the cube of the material has dots than the water cube, it floats.	Less More
When the cube of the material has dots than the water cube, it sinks.	Less More



GLYCERINE	
<p>Glycerine is an artificial, thick and sweet tasting liquid. Glycerine is derived both from petroleum and plants. It is used as a sugar substitute in foods and beverages, such as biscuits and liquors. Also, it is used as ingredient of pharmaceuticals and medical products as well as of personal care products, e.g. soaps, toothpastes, skin care products, shaving foams. Although glycerine is considered as a product of low risk, it may cause eye or skin irritations.</p> <p>The cube of glycerin has more dots than the water cube.</p>	 <p>VEGETAL GLYCERINE</p>  <p>CANDIES CONTAINING GLYCERINE</p>
	  <p>PERSONAL CARE PRODUCTS WITH GLYCERINE</p>

RUBBER	
<p>Natural rubber is derived from trees. However, it is possible to produce rubber from petroleum as well. Natural rubber can be yielded without being destroyed. It is used in the construction of vehicle tyres and tubes, for isolation and proofing of doors and windows, for manufacturing gloves, balloons, carpets and textiles. Several microorganisms putrefy, namely "eat", natural rubber. As for artificial rubber, there has not been found any solution yet so as it does not pollute the environment.</p> <p>The cube of rubber has more dots than the water cube.</p>	 <p>A TREE PRODUCING RUBBER</p>  <p>SHOES MADE OF ARTIFICIAL RUBBER</p>
	 <p>A BABY MATTRESS MADE OF NATURAL RUBBER</p>

P.V.C. (POLYVINYL CHLORIDE)

P.V.C. is an artificial product which is compounded from petroleum and chloride. It is used for the construction of windows cases, doors, tubes, floors, upholsteries, shutters etc.

Of all plastics, it is considered to have the worst environmental impacts.

The cube of PVC has more dots than the water cube.



GLOVES OF P.V.C.



CARPETS AND
UPHOLSTERIES OF PVC

UNIT 4: WHEN DOES AN OBJECT FLOAT AND WHEN DOES IT SINK IN A LIQUID?

In this part we will seek a criterion in order to explain and predict the floating or sinking of an object in more liquids.

4.1

LET'S FIND OUT IF THE WAY TO PREDICT OF AN OBJECT FLOATS OR SINKS IN THE WATER COULD BE USED FOR OTHER LIQUIDS AS WELL

SOFTWARE: Room "Floating Sinking of Models 2"

What will we do to check if the following rule applies to another liquid, glycerine for instance?

When the material cube has less dots than the water cube, it floats. When the material cube has more dots than the water cube, it sinks.

Write in detail the steps that you will follow.

Carry out your experiment on the computer.

What do you make out of the above rule? Does it apply for glycerine or not?

Yes

No

How did you figure out?

4.2

FLOATING AND SINKING OF OBJECTS THAT ARE CONSTITUTED BY MORE THAN ONE MATERIALS

We place a piece of glass in the vessel full of water.

What do you observe? Does it float or sink?

Is the glass more or less dense from that water?

We place a bottle (with no liquid) in the vessel full of water.

What do you observe? Does it float or sink?

Is the empty bottle more or less dense than water?

Can you explain, why while a piece of glass is denser than water, the empty bottle is less dense than water?

UNIT 5: LET'S SALVAGE THE SEA DIAMOND

Based on our knowledge and experiences, gained in the aforementioned four units, we will seek suitable ways for the salvage of: a) a statuette, b) an iron made physical model of the Sea Diamond cruise ship. In parallel, we will discuss the factors (e.g. the cost and the risk) which could affect our decisions in relevant situations.

5.1

LET'S SALVAGE SEA DIAMOND IN A SIMULATION

SOFTWARE: Room "Sea Diamond"

Sea-Diamond is a big cruise-ship that has sunk near Santorini island. Click one of the holds of the model of SD. Notice that it fills with water. Fill all the holds of the ship with water.

What do you observe? Could you explain why Sea-Diamond sunk?

Click again one of the holds of the ship. Notice that the hold does not contain water anymore. Click all the holds so as to evacuate the water from all the holds.

What do you observe? Could you explain why Sea-Diamond comes to the surface?

Is this a real ship or a model of a ship? Why do you say so?

If this ship is a model in which way does it help us?

5.2

LET'S SALVAGE THE STATUE

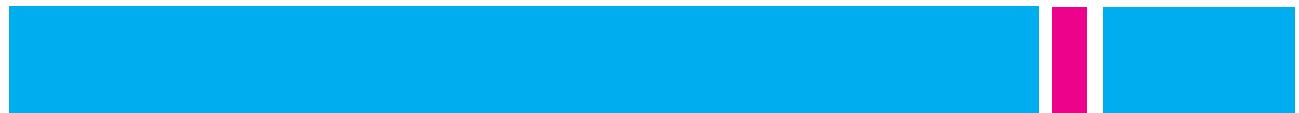
A valuable statue has been found in the bed of the sea of Santorini, near the sunken ship Sea-Diamond. Environmentalists and archaeologists were worried because of the pollution that could cause the ship and destroy the statue.

Could you propose a way so as the statue comes up to the surface of the sea?

Please describe analytically the materials that you need, the procedure that you will follow and the conditions that should exist.

There were two different proposals for this problem. Environmentalists proposed a construction which consists of a buoy and a net, because it can be easily and quickly constructed and it is a cheap solution. Archaeologists proposed that they should construct a special box so as to protect the statue from possible knocks on the rocks, on the way to the surface of the sea. Nevertheless this proposal is expensive because we need a tow track so as to pull the box with the statue up to the surface. So this solution needs more time and money so as to be accomplished.

Which one of these two solutions would you choose? Why?



Please try both solutions.

Did both of these solutions succeed?

Why did they succeed?

Why did they not succeed?

5.3

LET'S SALVAGE SEA DIAMOND

Could you propose a way so that this ship comes to the surface of the sea?

Please, describe analytically the materials that you need and the procedure that you will follow.

Please, write down a solution that you propose using the materials that you have been given, so as to pull up the ship. Could you support the solution?



*Please try the solution that you proposed.
Could you explain the result of the solution that you tried?*

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