Activity worksheet: Archimedes' principle

Name	Group	Date

What you will learn

With the Archimedes' principle simulation you will find out which forces act on a body in a liquid, what the upthrust depends on and why some bodies float and others sink.

How to work. Each activity has three steps:

1. **Predict.** Before looking at the simulation, write down what you think will happen and why.
2. **Observe.** Set up the simulation, watch what happens and note down the data.
3. **Explain.** Compare what happened with your prediction and explain why.

If your prediction turns out to be wrong, don't rub it out: getting it wrong and understanding why is the best way to learn.

Each activity has a link that opens the simulation already set up. If you have the worksheet on paper, go to **simulaciencia.es/en/simulations/arquimedes** and set it up as described under "Set up the simulation".

Data. The simulation uses g = 9.8 N/kg. Volume is in litres (L), mass in kilograms (kg), density in kg/L and forces in newtons (N). The upthrust is calculated with $E = V_{submerged} \cdot \rho_{liquid} \cdot g$ and the weight with $P = m \cdot g$.

Before you start

What do you think now? Write T (true) or F (false). You will come back to this table at the end.

Statement	T or F
a) Heavy things sink and light things float.	
b) If an object sinks, the water does not push it up.	
c) The deeper an object is, the harder the water pushes it up.	
d) If an object floats, the upthrust is greater than its weight.	
e) An object that floats in water floats in any liquid.	

Activity 1. Why does the block float?

Set up the simulation: Free values mode, mass 50 kg, volume 100 L, liquid density 1.000 kg/L and **Free-body diagram** switched on. Open the simulation ready to use

Predict. The block is floating still. Which force is greater, its weight or the upthrust from the water? Or are they equal?

My prediction

Observe. Wait for the block to stop and write down the data.

Weight P (N)	Upthrust E (N)	Submerged volume (L)	Label on the diagram

Explain.

1. Why is the block still if two forces act on it?
2. What is the mass of the water that would fill the submerged volume? What is its weight? Compare it with the upthrust.
3. Write Archimedes' principle in your own words.

My answers

Activity 2. More and more mass

Set up the simulation: Free values mode, mass 50 kg, volume 100 L, water (1.000 kg/L) and the diagram switched on. Open the simulation ready to use

Predict. If you increase the mass without changing the size of the block, will it sink further? Will there come a point when it goes to the bottom? At what mass?

My prediction

Observe. Set the mass to the values in the table and wait for the block to stop each time.

Mass (kg)	Density of the block (kg/L)	Submerged volume (L)	Upthrust E (N)	Floats or sinks?
50				
80				

Mass (kg)	Density of the block (kg/L)	Submerged volume (L)	Upthrust E (N)	Floats or sinks?
100				
150				

Explain.

1. While the block floats, how is its density related to the fraction that stays under water?
2. With 150 kg, why can the upthrust not grow any more? Which force appears on the diagram when the block touches the bottom, and how big is it?

My answers

Activity 3. Deeper means more upthrust?

Set up the simulation: Free values mode, mass 150 kg, volume 100 L and water. Open the simulation ready to use

Predict. The block sinks. As it goes down, will the upthrust increase, decrease or stay the same?

My prediction

Observe. Reload the page to watch it fall again. Look at the “Upthrust (E)” card while the block goes down, already completely covered by water.

Upthrust while going down, covered (N)	Upthrust on the bottom (N)

Explain. What does the upthrust depend on: the depth or the submerged volume? Why?

My explanation

Activity 4. Change the liquid

Set up the simulation: Free values mode, mass 150 kg, volume 100 L and water. The block is on the bottom. Open the simulation ready to use

Predict. Without touching the block, what would have to happen to the liquid for the block to float?

My prediction

Observe. Raise the density of the liquid to the values in the table.

Liquid density (kg/L)	Floats or sinks?	Submerged volume (L)	Upthrust E (N)
1.00			
1.50			
2.00			
3.00			

Explain. Why does the block need to submerge less volume to float in a denser liquid?

My explanation

Activity 5. Blocks of the same size

Set up the simulation: Real materials mode, liquid **fresh water**. All the blocks measure 100 L. Open the simulation ready to use

Predict. Before choosing each material, write down whether you think it will float or sink in fresh water.

Observe. Choose each material and write down the data when the block stops.

Material	My prediction	Density (kg/L)	Weight P (N)	Upthrust E (N)	What happens?
Cork					
Wood					
Aluminium					
Lead					
Gold					

Explain.

1. What do the materials that float have in common?
2. Aluminium, lead and gold have very different weights. Why do they get the same upthrust?

My answers

Activity 6. Challenge: icebergs, plastic and iron

Set up the simulation: Real materials mode, a block of **ice** in **fresh water**. Open the simulation ready to use

Predict. Will more of the iceberg stick out in fresh water or in seawater? Will a block of iron float in any liquid?

My prediction

Observe. Try the combinations in the table.

Block	Liquid	Floats or sinks?	Submerged volume (L)
Ice	Fresh water		
Ice	Seawater		
Plastic	Fresh water		
Plastic	Oil		
Iron	Fresh water		
Iron	Mercury		

Explain. Is it true that an object “floats” or “sinks” on its own? What does it depend on?

My explanation

Apply what you have learnt

Solve these problems without the simulation. Write the formula, the calculation with its units and the result. Use g = 9.8 N/kg and the density of fresh water, 1.00 kg/L.

1. A 40 L block is completely under water. What upthrust does it get?
2. A 10 L piece of cork (density 0.24 kg/L) floats in water. What volume is under water? What percentage of the cork sticks out?

3. A 3 kg stone takes up 1.2 L. Calculate its weight and the upthrust it gets in water. Does it float or sink? How much does it “weigh” in water (P − E)?
4. A 2000-tonne ship floats in the sea (1.025 kg/L). What volume of water does it displace? Give it in m^3.

Problem	Working and result
1	
2	
3	
4	

Review your ideas

Go back to the “Before you start” table. Would you change any of your answers? Write which one and explain why, using something you saw in the simulation.

What has changed in my ideas

Going further (Year 12)

1. With 150 kg and 100 L in water, draw the free-body diagram of the block on the bottom and calculate the normal force before looking at the simulation. Check your result.
2. Find the minimum mass at which a 120 L block sinks in seawater (1.025 kg/L). Check it in the simulation using free values.

My answers

Self-assessment

Put an X to show how confident you feel at the end.

I can...	Yes	Nearly	Not yet
Draw the weight and the upthrust on a submerged body			

I can...	Yes	Nearly	Not yet
Calculate the upthrust with $E = V_{submerged} \cdot \rho_{liquid} \cdot g$			
Predict whether a body floats by comparing its density with that of the liquid			
Explain what fraction of a body stays under water when it floats			
Use a prediction and an observation to change an idea I had			

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