WHY DO THINGS FLOAT?

8

You must have seen that some things float in water while others sink. Have you ever tested something that floats in water.

A Game

Take a test tube. Fill it half full of water. Add to it about 15-20 ml of kerosene. Now put 2-3 coloured plastic buttons, 1-2 pins, pieces of match sticks, little balls of paper, little pebbles, a little bit of sand, pieces of wax etc. into the test tube, one after the other. See what happens.

Cover the top of the test tube with your hand and shake it well. Wait for a little while and see what happens.

Which of these things float on kerosene? (1)
Why did they not sink in kerosene? (2)
Which of these things sink in kerosene but float in water? (3)
Why did they hang midway? (4)
Which things sank even in water? (5)
Why did this happen? (6)
Even after thoroughly shaking the mixture of water and kerosene, why does kerosene stay above the water? (7)
On the basis of your answers, divide the things into the following three groups :

(a) things that float on kerosene

(b) things that sink in kerosene but float on water

(c) things that sink in water. (8)

In this game, why do things behave differently? What will float and what will sink? How can we make iron float in water? Such questions will be answered in this chapter. But one thing should be clear. In our everyday language, we use the word 'heavy' in two different ways.

We say -

"One quintal of iron is heavier than two quintals of wood."

We also say -

"Iron is heavier than wood."

The same word 'heavy' is used in both these cases, but it has different meanings. Scientists try to use one word to mean just one thing. Therefore, in scientific language, in place of the second sentence, we shall say - "Iron is denser than wood."

Relative Density - How dense is what

Suppose you make two pillows of exactly the same size. You fill one with 1/2 kg of cottonwool, and stuff 2 kg cottonwool into the other one.

In which pillow is the cottonwool more densly packed, the heavy one or the light one? (9)

In your kit there are equal sized blocks of iron and wood.

Which of these two blocks is heavier? (10)

Accordingly, in scientific terms we would say, "iron is denser than wood."

Now take the blocks of iron and wax from the kit.

Make a guess as to whether iron is more or less dense than wax. (11)

From your experience, can you say whether iron is more dense or less dense than cement? (12)

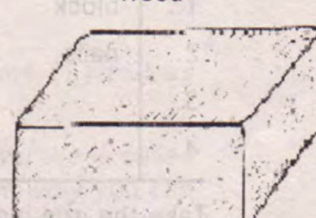
Iron

Suppose there are two similar test tubes filled with equal volumes of two different liquids. Now whichever test tube is heavier, the liquid filled in that test tube would be called denser than the other.

In just the same way we can compare a liquid to a solid.

Wood

Take two similar test tubes. Fill one to the top with sand and the other with water.



Guess which test tube is heavier. (13)

Now tell whether sand is more dense or less dense than water? (14)

When you pour sand into water does it float on water or sink to the bottom? Does your answer agree with that of the provious question? (15)

Wax

From these examples you see that of two substance of equal volume, the heavier one is said to be more dense. If we compare a solid to a liquid, we have to be sure that the solid and the liquid are both of the same volume. Then we have to see if the solid is heavier or lighter than the same volume of liquid. This is how we can find out if a solid is more dense or less dense than a liquid. To tell, among different things which is more dense and how many times more dense, we have to find out their relative densities.

What is relative density? How is it measured? These questions will be answered once we have finished doing the next experiment.

> In this chapter you will have to use a weighing balance repeatedly. Before you do each experiment check your balance to be sure that it is accurate. The procedure for checking the accuracy of your balance is given in the chapter "Principle of Balance."

Relative Density of Iron

This experiment will be done with three or four things made of iron. You can use the iron block given in the kit. In addition you can use a large iron nail, an iron weight, or some other piece of iron. Whatever you use, make sure that its volume is at least 20 cubic cm.

Experiment 1

Take an overflow can (*aplavi bartan*) and a beaker from the kit. Wash and dry the beaker. Weigh the dry beaker.

Now make a table like the one shown below in your note book.

Fill all the observations from the experiment in this table. (16)

Table 1

S.No.	Name of object made of iron 1	Weight of the object 2	Weight of the beaker containing water displaced by the object 3	Weight of the water displaced by the object 4	(Weight of the object) /(weight of the water displaced by the object) 5
1.	block				
2.	nails				
3.					
4.					

Take the iron block and weigh it.

Fill in the weight of the iron block in column (2) of the table. (17)

Fill the overflow can with enough water so that a little water flows out of its spout. After the water stops flowing out, put the beaker under the spout. Lower the block carefully in the overflow vessel, so that no water splashes out.

The water displaced by the block will flow through the spout into the beaker. Wait a while to be sure that all of this water gets collected in the beaker.

Now weigh the beaker with the water in it and record the weight in column (3) of the table. (18)

From this weight subtract the weight of the dry beaker to get the weight of the displaced water. Write it down in column (4). (19)

Divide the weight of the block by the weight of the displaced water and write this amount in column (5). (20)

Repeat this experiment with other things of iron and record your observations in the table. (21)

Now take a close look at column (5) of the table.

Do the ratios in column (5) increase or decrease with the shape and volume of the object taken? (22)

Are these ratios very different from each other or are they almost the same? (23)

All groups should write down the values that they get in column (5) on the blackboard.

Carefully look at these values obtained by the other groups, and then answer questions (22) and (23) again. (24)

If one group has got a value which is very different from all the other groups, discuss it in the class and try to find reasons for it. (25)

Let us try to understand the meaning of the ratio in column (5).

When an object is submerged in water, an amount of water equal to the volume of that object is displaced. You have seen this in experiments in the "Volume" chapter in Class 7. That is why the volume of the water displaced by different things in experiment-1 is the same as their own volume.

Thus, the ratios in column (5) are the ratios of the weight of the object and the weight of an equal volume of water. This ratio tells us how dense something is as compared to water.

Now state what you think the numbers in column (5) tell us about iron? (26)

Find the average of the ratios in column (5). This average is called the **average relative density** of iron. In the same way you can find the relative density of any other substance. This can be written in the form of a formula as shown below:

$$\text{Relative density of a material} = \frac{\text{(weight of a solid made of that material)}}{\text{(weight of the same volume of water)}}$$

What unit is relative density measured in? Figure it out yourself. (27)

Experiment-2

Take the cement, aluminium, wax, hard wood, and soft wood blocks from the kit. In addition, find glass marbles, pebbles, a cork, and few other objects. If there's no aluminium block in the kit, you can use thirty 10 paise aluminium coins instead. You know how to find the relative density according to the method described in experiment-1. In case an object floats in water, stick a pin in it. Now with the help of the pin, slowly submerge the object in water so that the volume of water that flows out of the overflow vessel is equal to the volume of the object. Be careful that your fingers do not dip into the water and water does not splash out(Figure 1).

Figure -1

Arrange the material that things are made of in order of increasing relative densities. Make a table listing the materials and their relative densities in the same order. (28)

A riddle

You are given a 1 kg iron weight. Along with this you are also given a ball that also weighs 1 kg. How can you tell if the ball is made of pure iron or has other metals mixed in it? (29)

THE STORY OF ARCHIMEDES

About 2200 years ago, in **Syracuse** province in Greece, there was a scientist by the name of Archimedes. Once the king ordered his goldsmith to make a crown. The crown was beautiful but the king suspected that the crown might not be of pure gold - maybe there was some silver mixed in it. The king ordered Archimedes to find out whether or not the crown was made of pure gold, and to do so without destroying it. Archimedes had a big problem to tackle. For a number of days he was stuck, and he could not think of any way to solve the problem. One day when he got into his bathtub, he noticed some water overflowing. Archimedes had a sudden insight, and he jumped out of the tub and ran down to his laboratory naked, shouting "Eureka! Eureka!" (which means, "I found it! I found it!")

The experiments which you did at the beginning of the chapter were actually first done by Archimedes.

Based on the experiments you've done, can you think what Archimedes' insight was? Think about it and discuss it among yourselves. If you still cannot understand how he solved this problem, ask your teacher and write down the answer in your own words. (30)

Relative densities of liquids

In experiment 1 and 2 we found out relative densities of solids. Now we shall find out relative densities of liquids.

Instead of a solid we shall take a quantity of some liquid.

$$\text{The relative density of a liquid substance} = \frac{\text{weight of a certain volume of the liquid}}{\text{weight of the same volume of water}}$$

Based on this formula, what is the relative density of water? (31)

Experiment 3

You can do this experiment with peanut oil, mustard oil, diesel, kerosene, salt solution, milk etc. For this experiment each group should get a small glass bottle which weighs atleast 10 gram and which can contain about 50 millilitre liquid. Take the cap off this bottle. Wash the bottle with clean water and dry it. Weigh the bottle. Fill the bottle to the brim with water and weigh it again. While weighing, take care not to spill out any water. Now empty out the water and dry the bottle completely. Fill the bottle with the liquid whose relative density you want to find. Wipe the bottle from outside.

Is the volume of liquid in the bottle the same as the volume of water which filled the bottle earlier? (32)

Weigh the bottle filled with the liquid. Be careful not to spill any liquid.

Make the following table in your note book and write your observations in it. (33)

Table-2

Weight of empty bottle (x) =

Weight of bottle filled with water (y) =

Weight of water in the bottle (y-x) =

No. Liquid	Weight of bottle filled with liquid(Z)	Weight of liquid (Z-X)	Relative density of liquid (z-x)/(y-x)
1. mustard oil			
2. kerosene			
3. salt solution			
4. diesel			
5.			

Find out the relative density of the liquid using the formula which was given at the beginning of the experiment and write it down in the last column. (34)

Use the same method to find out the relative densities of other liquids and add them to the table. (35)

Based on the table, divide the liquids into two groups:

Those which have 'densities less than water' and those with 'densities greater than water'. (36)

You found the relative density of one solution of salt. If the amount of salt in this solution is increased, would the relative density increase of decrease? (37)

Perform an experiment to verify your answer.

Some questions

Take another look at the observations recorded in Table 2. Divide the things you experimented with in two groups. Put the things that sink in water in one group and those that float in water into the other.

Do all the things which sink in water have relative densities greater than or less than 1? Do all these things have densities greater than or less than that of water? (38)

Do all the things which float in water have relative densities greater than or less than 1? Do all these things have densities greater than or less than that of water? (39)

Based on the answers to these questions tell:

Would things which have relative densities greater than 1 sink or float in water? (40)

Would things which have relative densities less than 1 sink or float in water? (41)

Would things which have relative densities greater than 1 sink or float in kerosene? (42)

Would a liquid which has relative density less than 1 float or sink just like a solid which has relative density less than 1? Give the basis for your answer. (43)

A special property of things that float

In experiment-1 we saw that an iron block sinks in water. But why does a ship made of iron float in water? In the same way, how can a brass *lota* , a steel bowl, or a clay lamp float in water?

Let us do some experiments and find the answers to these questions.

Experiment 4

Take a beaker or some other container. Put it on one pan of a balance. Put enough sand or some other thing on the other pan to restore balance. Take an overflow vessel and fill it with water. When water stops flowing out of its spout, put the beaker or the container under the spout. Take a wooden block. Wet the block first and then gently place it in the overflow vessel.

Take care that the block remains away from the spout. Remember that the floating block should not be completely submerged in water like in experiment 2. It should float freely and the water it displaces should be collected in the beaker (figure 2).

Return the beaker containing the displaced water to the same side of the balance as it was earlier. Take the wooden block out of the water and put it on the other side of the balance along with the sand or other things.

Are the arms balanced now? (44)
Is the weight of the block equal to the weight of the water it displaced? (45)

Now we will do the same experiment with other things that float in water. Take some other things that float in water, like a block of wax, a rubber ball, a small bottle containing a little sand, a small steel bowl etc. Carefully repeat the above experiment with each object.

Each time see whether or not the weight of the object is equal to the weight of the water it displaces. Copy table 3 in your note book. One student should also copy the table on the black board.

Write your observations in the table. (46)

Record your observations both in your note book as well as on the black board. If a group's result is different from the rest of the class, that group should repeat the experiment.

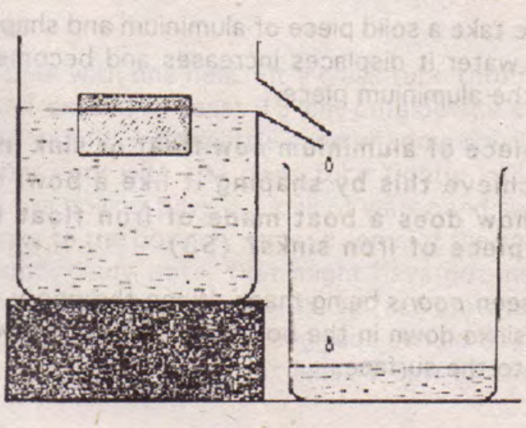


Figure-2

Table 3

No.	Name of the object	weights equal	weights not equal
1.	wooden block		
2.	wax block		
3.	rubber ball		
4.	....		
5.	....		

When all the groups have finished recording their results take a look at the table on the blackboard and discuss it among yourselves.

Can you think of any special property which things that float in water have? Write it down in your note book. (47)

Archimedes was the first person to find out about this special property. He also did experiments with things that sink in water. We have not discussed these experiments in this chapter.

Experiment 5

Get some cigarette foil. Wet it with water. Fold it in half. After folding it, press it tightly between your fingers so that no air is caught between the layers. Fold the foil again and press it down tightly again. Do this at least 4 or 5 times. Put it in water and see whether it floats or sinks. Now open up the foil and shape it into a small bowl. Put this bowl in the water in such a way that it floats.

The cigarette foil is made of aluminium.

Is the relative density of aluminium greater or less than 1? Look at the results of experiment 2 before answering. (48)
Is the weight of a solid piece of aluminium more or less than the weight of the water it displaces? (49)
What is the relation between the weight of things that float and the weight of the water they displace? (50)

Suppose we take a solid piece of aluminium and shape it so that the amount of water it displaces increases and becomes equal to the weight of the aluminium piece.

Will this piece of aluminium now float or sink in water? (51)
Can we achieve this by shaping it like a bowl or boat? (52)
Now tell how does a boat made of iron float in water even though a piece of iron sinks? (53)

You have seen *pooris* being made. When the poory is first put into the pan it sinks down in the boiling oil, but after a while it puffs up and floats to the surface.

Explain why this happens in your own words. (54)

Experiment 6

Fill one third of a test tube with sand or soil. Fill a boiling tube with water and carefully float the test tube in it. Tie a loop of string around the test tube at the water level (Figure 3).

Remove the test tube and dissolve one spoonful of salt in the water in the boiling tube. Now float the same test tube in it again.

Does the test tube now sink into the salt solution more or less than earlier? (55)

Look at the table of Experiment 3 and tell whether a salt solution has a relative density greater or less than 1. (56)

Clean the boiling tube and fill it with kerosene. Put the boiling tube in an empty beaker so that kerosene does not spill out.

Now float the same test tube in the boiling tube again.

This time does it sink more or less than it did in water? (57)

Look at the table of experiment 3 and tell whether kerosene has a relative density greater or less than 1. Based on this experiment can you answer the following questions:

Will things which float in water sink more or less in liquids that have relative densities greater than water? (58)

Will things which float in water sink more or less in liquids that have relative densities less than water? (59)

Watery milk or milky water?

If milk has water mixed in it, how can you tell how much it has been diluted? There is an instrument you can use just for this purpose. It is called a **lactometer**. By using it we can find out minute differences in relative densities. In this experiment we shall make a lactometer.

Let us make a lactometer

Experiment 7

Take a rubber cork with one hole. Fit a glass tube through the hole. The tube should extend at least 15 cm outside the cork. Take a boiling tube and carefully put a little sand or some small iron nails in it. Fit the rubber cork with the glass tube tightly into the boiling tube. Now put the boiling tube in a pail of water and see if it floats or sinks. If it sinks to the bottom, remove some of the sand or pieces of iron, also remove any water that might have got inside when it sank. If the boiling tube floats above the surface of water, add some more sand or pieces of iron. The boiling tube should float in water in such a way that only some part (at least 5 cm) of the glass tube

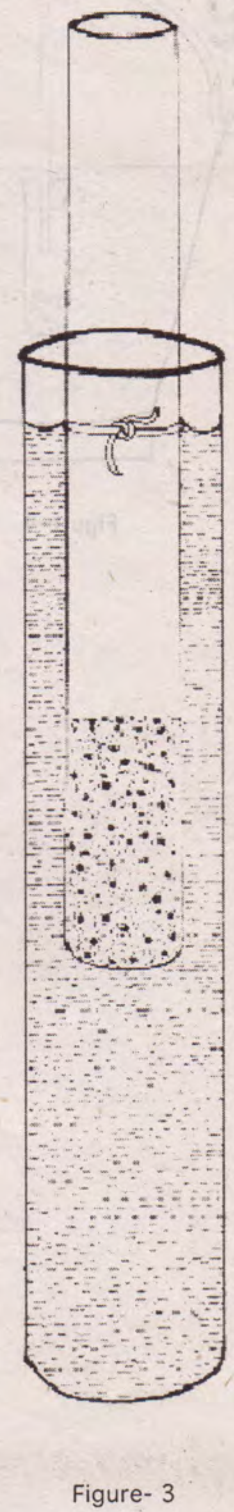


Figure- 3

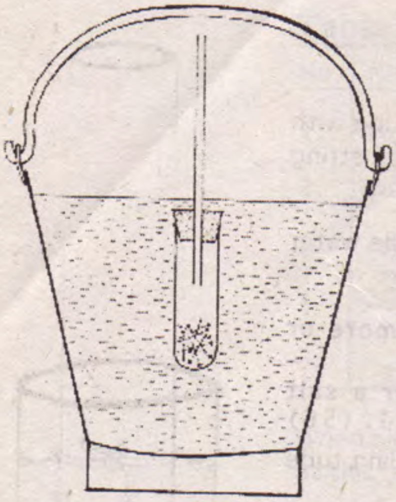


Figure-4

sticks out of water. The rubber cork and the boiling tube should be under water, as shown in figure 4. Mark the water level on the glass tube by tying a piece of string around it at that level. Your lactometer is now ready.

Now take out the lactometer and dissolve about 5 spoonfuls of salt in a bucket of water. Then float the lactometer in it again.

What happens? (61)

In the same way dissolve another 5 spoonfuls of salt in the water and see what happens when you put the lactometer in it. (62)

If you want you can repeat this two or three times. You can also make an instrument of this kind at home. You can use a plastic bottle instead of glass tube. The relative density of milk is greater than one. But if there is water mixed with the milk, the relative density of the mixture will be slightly less than that of pure milk. This slight difference can be measured with your lactometer.

Second Riddle

Suppose a *lota* (a container) is floating in a bucket of water. We make a mark at the water level on the bucket.

Now we press the *lota* down so that it fills with water and sinks.

What effect would this have on the water level in the bucket? Would it rise or fall or stay where it was earlier? (63)

Do this experiment yourself and check your answers. (64)

Based on the property of floating things which you have learnt, write an explanation of this riddle in your own words. (65)

Third riddle

Suppose a *lota* is floating in a bucket of water, and the *lota* has a little water in it. The water level in the bucket is marked.

If water in the *lota* is now poured into the bucket and the empty *lota* is floated in the water, what will be the effect on the water level in the bucket? (66)

Do this experiment yourself and write down your observations. (67)

Write an explanation for this effect on the water level. (68)

NEW WORDS:

relative density   lactometer