4.6 Finding the density of liquids using a densimeter

Task

Construct a measuring device for the density of liquids.

In a preliminary experiment determine how far a test tube sinks in water and in a salt solution. Make a hydrometer and determine with it the density of various liquids.

Use the space below for your own notes.

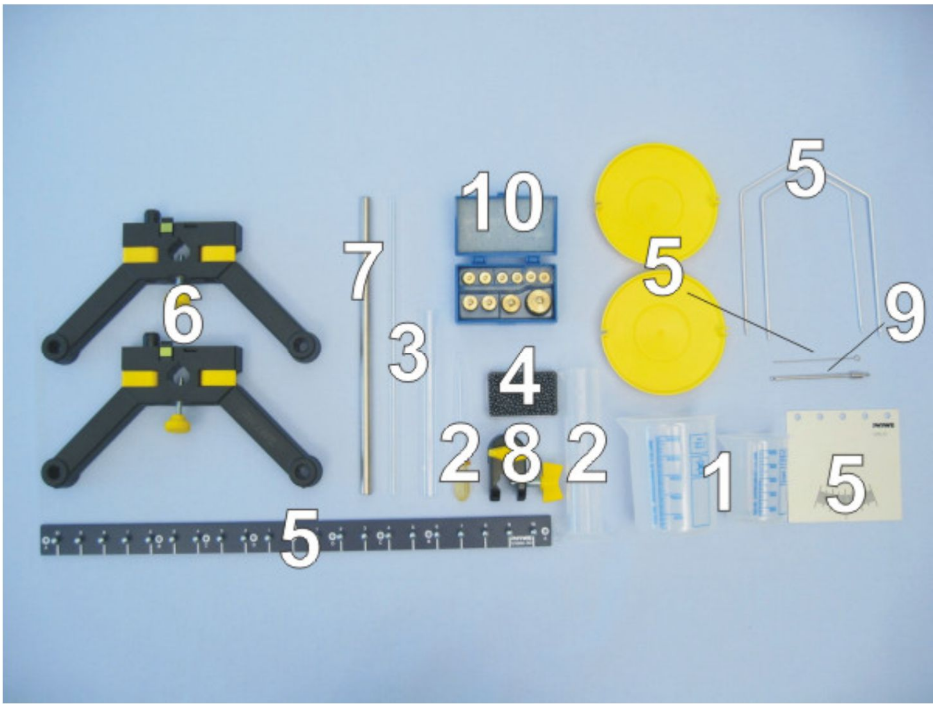
Material

Material from "TESS advanced Physics Set Mechanics 1, ME-1" (Order No.15271-88)

Position No.	Material	Order No.	Quantity
1	Beaker, plastic, short form, 100 ml	36011-01	1
1	Beaker, plastic, short form, 250 ml	36013-01	1
2	Graduated cylinder, 50 ml, plastic	36628-01	1
2	Pipette, with rubber bulb	64701-00	1
3	Test tube, *d* = 16 mm, *l* = 160 mm, 10 pieces	37656-03	1 piece
3	Glass tubes, *d* = 8 mm, *l* = 250 mm, 10 pieces	36701-68	1 piece
4	Lead shot, *d* = 3 mm, 120 g	03990-00	
5	Balance pan, plastic	03951-00	2
5	Plate with scale	03962-00	1
5	Lever	03960-00	1
5	Pointer for lever	03961-00	1
6	Support base, variable	02001-00	1
7	Support rod, stainless steel 18/8, *l* = 250 mm, *d* = 10 mm	02031-00	1

8	Bosshead	02043-00	1
9	Holding pin	03949-00	1
10	Set of precision weights, 1g...50g, in case	44017-00	1
Additional Material			
	Sodium chloride, purest, 250 g	30155-25	30 g
	Petroleum ether, 50 - 75 ºC, 500 ml	31711-50	
	Scissors		1
	Scale (millimetre) paper, 20 mm x 170 mm		

Material required for the experiment



Setup

Set up a stand with the support base (Fig. 1). Put the support rod in the support base and tight it with the screw (Fig. 2).

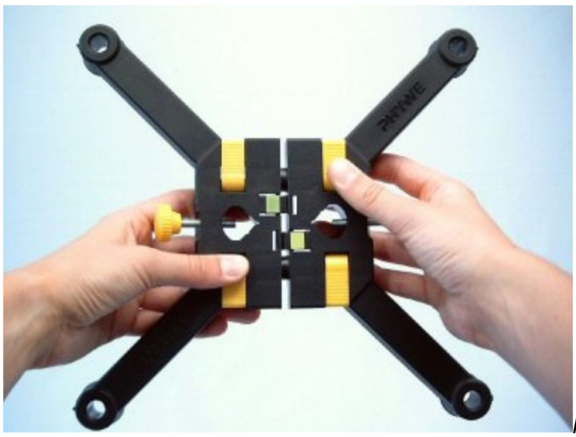


Fig. 1

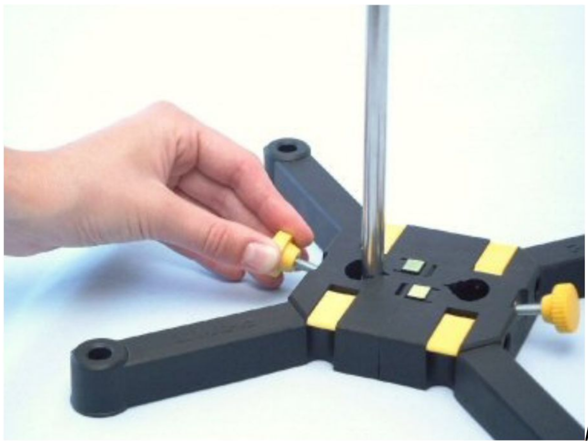


Fig. 2

Put the plate with scale in the middle of the lever, then, put the holding pin in the hole of the pointer and in the hole of the lever (Fig. 3). Fix the holding pin with the bosshead to the support rod (Fig. 4).

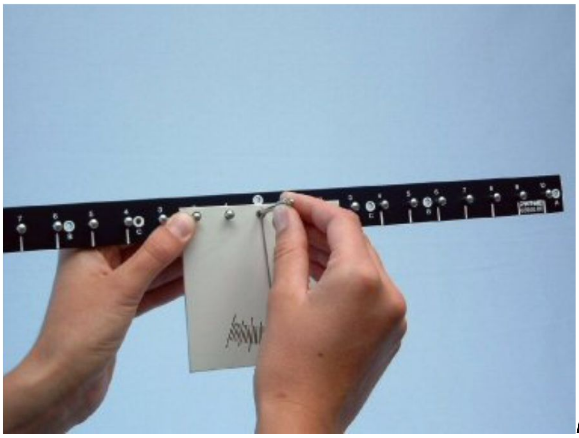


Fig. 3

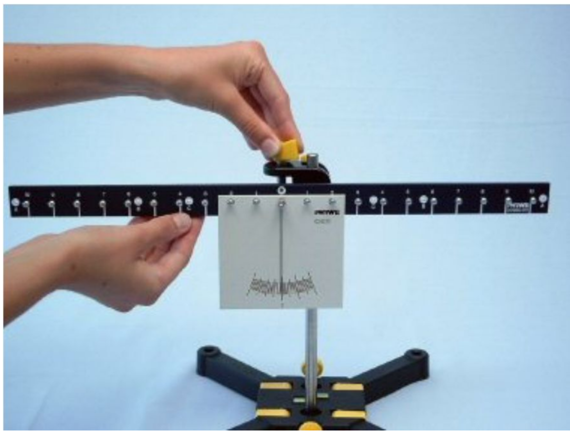


Fig. 4

Assemble the balance pans (Fig. 5) and hang each of them on the 10 mark of the lever (Fig. 6).

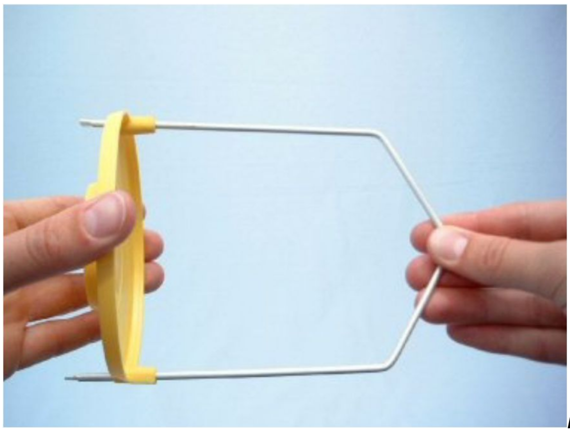


Fig. 5


Fig. 6

Place the 100 ml beaker on one balance pan and pour enough lead shot onto the other that the balance is in equilibrium (Fig. 7). Weigh 5 g sodium chloride (table salt) in the 100 ml beaker (Fig. 8).

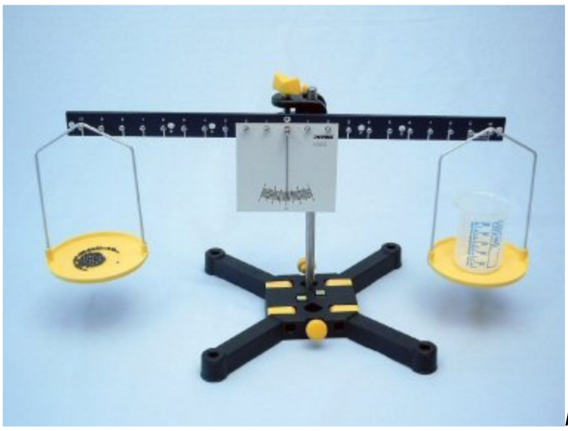


Fig. 7


Fig. 8

- Do the same with the 250 ml beaker and weigh 10 g table salt in it.
- Fill the graduated cylinder with 40 ml of water, add 5 g of table salt, mix until the salt is dissolved and then fill to 50 ml mark.

- Pour the salt solution into the 100 ml beaker.
- Rinse the graduated cylinder and dry it well.
- Prepare the second salt solution with 10 g table salt in the same way. Clean the graduated cylinder again.

In order to disassemble the support base you should press the yellow buttons (Fig. 9).

Fig. 9

Action

Preliminary experiment

Fill the graduated cylinder with 50 ml of water. Cut a strip of mm paper (2 cm x 17 cm) and add a cm-scale to it: 0 (bottom) to 16 (Fig. 10).

Fig. 10

- Stick the paper strip in the test tube (Fig. 11) and put it into the graduated cylinder. Add enough lead shot to it that the test tube sinks to about half its length (Fig. 12).
- Read the immersion depth on the scale and note its value h_w above Table 1 on the Results page.
- Fill the graduated cylinder with the first salt solution (5 g).
- Immerse the test tube with scale in the salt solution, read the measured value h_f and note it above Table 1, too.


Fig. 11


Fig. 12

Main experiment

Add a density scale to your mm-paper strip from which you can read the density directly.

Calculate the scale using the formula:

$h_f = \rho_w/\rho_f \times h_w$

h_f = Immersion depth of the unknown liquid

h_w = Immersion depth of water

ρ_f = Density of the unknown liquid

ρ_w = Density of water

Set the value h_w which you obtained in the preliminary experiment in the equation and use the values for ρ_f given in Table 1 on the Results page. Record the calculated values for h_f.

- Add the values for h_f to your paper strip and label them with the respective values for ρ_f.
- Place the so prepared paper strip into the test tube exactly as before.
- Make sure that you do not change the amount of lead shot!

- Use your home-made hydrometer to determine the density of the two salt solutions and of the petroleum ether.
- Rinse and dry the graduated cylinder each time you change liquids.
- Read the scale and record the measured values in Table 2 on the Results page.

Do not dump petroleum ether down the drain; collect it and use it again!

Results:

h_w = [ ] cm

h_f = [ ] cm

If you measured accurately you should get similar measured values:
h_w = 7.7 cm
h_f = 7.1 cm

Table 1

ρ_f in g/cm3	h_f in cm	ρ_f in g/cm3	h_f in cm
0.5		1.0	
0.6		1.1	
0.7		1.2	
0.8		1.3	
0.9		1.4	

Table 2

Liquid	ρ_F in g/cm3
Table salt, 5 g/50 ml	
Table salt, 10 g/50 ml	
Petroleum ether	

Evaluation

Preliminary experiment

Question 1:
Compare your measured values with each other; what do you notice?

Question 2:
Formulate your result in a "the-the" statement with reference to density and immersion depth:

Question 3:
Can you state an example from your own experience in sports?

Main experiment

Question 1:
Do the two salt solutions have different densities?

Question 2:
Can you state the reason for this?

Question 3:
What liquids have a larger density than water, which a smaller one?

Additional Tasks

How can you explain the formula with which you calculated the scale?

1.
From the preliminary experiment?

2.
Using Archimedes' principle.