Aim

To establish the relation between the loss in weight of a solid when fully immersed in

1. **tap water.**
2. **strongly salty water, with the weight of water displaced by it by taking at least two different solids.**

MATERIALS AND APPARATUS REQUIRED

A spring balance, a metal bob, a cotton thread, an overflow can, a glass beaker, tap water, salty water, an iron stand.

THEORY

1. **Fluids:** Gases and liquids flow and are thus called fluids.
2. **Buoyancy:** The upward force exerted by fluids on anybody is called the buoyant force and this phenomenon is known as buoyancy.
3. **Thrust:** The force acting on a body perpendicular to its surface is called thrust. S.I. unit is Newton.
4. **Pressure:** The thrust per unit area is called pressure.

   $$\text{Pressure} = \frac{\text{Thrust}}{\text{Area}}$$

   S.I. Unit = Nm^2 or Nm^{-2}. This unit (Nm^{-2}) is also called Pascal,

   $\therefore$ 1 Pascal (Pa) = 1 Nm^2
5. Weight of a body = Mass x acceleration due to gravity $W = mg$
6. When a body is immersed in water or liquid, the body displaces some liquid.
   The volume of liquid displaced = total volume of the solid.
7. The mass of liquid displaced can be measured as:
   Mass of liquid displaced = Volume × Density

   $$M = V \times D$$

   Weight of liquid displaced = Volume × Density × g (acceleration due to gravity)

   $$W = V \times D \times g$$
8. The body loses some weight when immersed in fluid; it can be found as follows:
   Weight of the body in air = W_1
   Weight of the body when immersed in liquid = W_2
   Hence loss in weight = $W_2 - W_1$
9. **Archimedes' Principle:** When a body is immersed fully or partially in a fluid, it experiences an upward force that is equal to the weight of the fluid displaced by it.

PROCEDURE

A. Find the zero error and least count of spring balance:

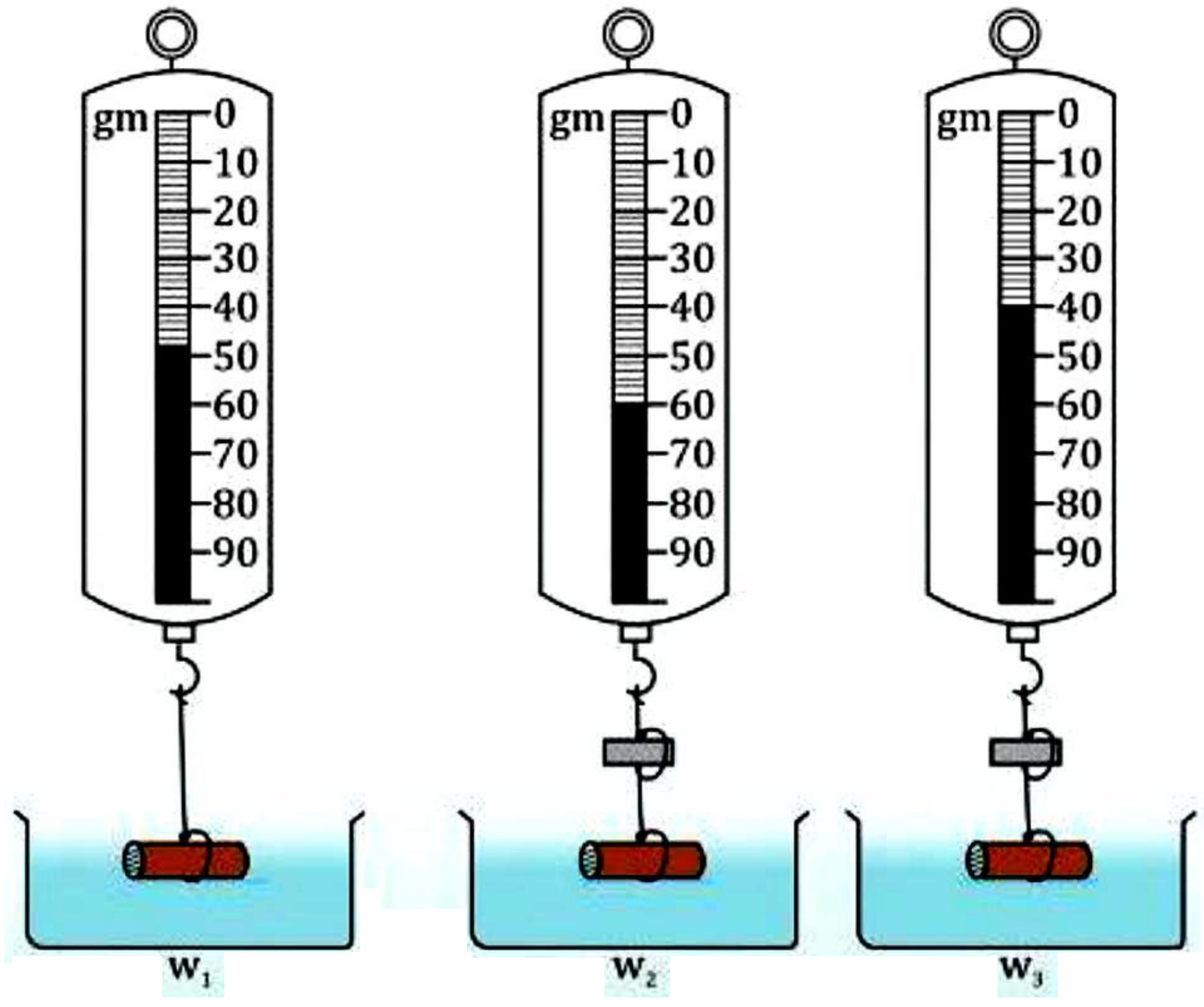
1. Take an iron stand and suspend a spring balance to it.
2. Study the spring balance, its scale and its least count.
3. Record your observations. If there is any error, record it as 'x' gf.

B. Find the weight of solid metal bob in air:

1. Take a metal bob, tie thread to it and suspend it on the hook of the spring balance.
2. Record the weight of the metal bob in air.

C. Find the weight of the metal bob immersed in tap water and record the apparent loss in weight

1. Take an overflow can, fill it with water such that its water level touches the spout of the overflow can.
2. Keep an overflow can under the spring balance such that the metal bob gets fully immersed in the water of the overflow can.
3. Keep a beaker whose weight P_1 is recorded, at the mouth of the spout of overflow can.
4. As soon as the metal bob is suspended in water the weight on spring balance scale is recorded. This loss in weight is due to buoyancy (W_2).
5. Collect the water that has overflown in a beaker till the last drop that comes out of the spout.
6. Weigh the beaker with water (P_2).
7. Calculate the weight of the displaced water ($P_2 - P_1$).
8. Calculate the loss in weight of the metal bob when immersed in water.



$$\text{R.D.} = \frac{\text{weight of floating object in air}}{\text{apparent loss of weight of floating object in water}} = \frac{W_2 - W_1}{W_2 - W_3}$$

D. Find the weight of metal bob immersed in salty water and record the apparent loss in weight.

1. Prepare salty water by taking a 500 mL beaker and adding 300 mL of water in it and dissolving common salt till the saturated solution is obtained.
2. Take the same metal bob and repeat the steps from 1 to 8 as given in PROCEDURE 'C' Tabulate your observations.

Observations and Calculations

1. Zero error in spring balance = (x) = ... gf.
2. Least count of the spring balance = ... gf.
3. Density of water = ... $g/cm.^3$
4. Weight of empty beaker P_1 = ... gf.

Table A: Verification Of Apparent Loss in Weight of Solid Body in Tap Water.

S.No.	Weight of metal bob in air W_1 (gf)	Weight of metal bob in tap water W_2 (g)	Loss in weight of metal bob $W = W_1 - W_2$ (gf)	Weight of beaker		Weight of displaced water $P_2 - P_1$ (g)
				Empty P_1 (gf)	with water P_2 (gf)	
1.						
2.						
3.						

Table B: Verification Of Apparent Loss in Weight of Solid Body in Salty Water.

S.No.	Weight of metal bob in air W_1 (gf)	Weight of metal bob in tap water W_2 (g)	Loss in weight of metal bob $W = W_1 - W_2$ (gf)	Weight of beaker		Weight of displaced water $P_2 - P_1$ (g)
				Empty P_1 (gf)	with water P_2 (gf)	
1.						
2.						
3.						

Table A → $W_1 - W_2 \cong P_2 - P_1$ Table B → $W_1' - W_2' \cong P_2' - P_1'$

RESULTS

1. It is clear that weight of water displaced by the glass stopper is equal to the apparent loss in weight of glass stopper in water. The loss in weight of both the solids used in this experiment when fully immersed in tap water and strongly salty water are approximately equal to the weight of water displaced by them, respectively.
2. When the glass stopper is weighed in two different liquids such as tap water and salty water separately, the loss of weight is more in salty water, i.e., in denser liquid. Thus, larger the density of liquid in which the solid is immersed, larger the weight of liquid displaced or larger the buoyant force. This verifies **Archimedes Principal**.

PRECAUTIONS

1. Carefully study the spring balance used for the experiment.
2. Fill the overflow can above the mark of the spout, allow extra water to overflow through the spout without disturbing it. Use this overflow can for the experiment.

3. Do not allow the suspended solid mass i.e. metal bob/stone to touch the base and sides of the overflow beaker.

VIVA VOCE

Q1. Why can't we call solids as fluids?

Ans. Solids cannot flow, so they are not fluids.

Q2. Can fluids exert pressure?

Ans. Yes, fluids exert pressure in all directions.

Q3. In what direction does the buoyant force on an object immersed in a liquid act?

Ans. The buoyant force acts in an upward direction.

Q4. What do you understand by the term buoyant force?

Ans. An upward force experienced by a solid, when partly or wholly immersed in a fluid is called buoyant force.

Q5. State two factors which determine the magnitude of buoyant force.

Ans. **(i)** Buoyant force is directly proportional to the volume of the fluid displaced by a solid.
(ii) Buoyant force is directly proportional to the density of fluid in which the solid is immersed.

Q6. In what direction does the buoyant force, on an object immersed in a liquid act?

Ans. The buoyant force on an object immersed in a liquid act in the upward direction.

Q7. State the formula for calculating the relative density (RD) of a liquid by Archimedes' Principle.

Ans. RD of the liquid $= \frac{\text{Apparent loss in weight of solid in the liquid}}{\text{Apparent loss in weight of solid in water}}$.

Q8. State the law of floatation.

Ans. The law of floatation states that the weight of a body is always equal to the weight of the liquid displaced by the body.

Q9. What is meant by buoyancy?

Ans. The property of a fluid to exert an upward force on a body immersed in it, is called buoyancy,

Q10. Is Archimedes' principle applicable to gases?

Ans. Yes, Archimedes' principle is applicable to both liquids and gas.

Q11. What are fluids?

Ans. Anything that flothat flowed a fluid. All liquids and gases are fluids.

Q12. Why do you feel light while swimming?

Ans. While swimming, water (fluid), exerts an upward force on the body this is called upthrust or buoyant force, because of this buoyant force we feel light.

Q13. On what factor does the magnitude of the upward force depend?

Ans. The magnitude of the buoyant force depends on the density of the fluid.

Q14. Why does the plastic bottle float on water?

Ans. When the upward force acting on the bottle is more than the downward force acting on the bottle then it will float.

Q15. What is relative density?

Ans. The relative density of a substance is the ratio of its density to that of water.

$$\text{Relative density} = \frac{\text{Density of a substance}}{\text{Density of water}}$$

Q16. Why does the pointer of a spring balance move up when the stone suspended from it is immersed in water?

Ans. When the spring balance with stone is immersed in water, the stone experiences an upward force called buoyant force. It is due to this property the spring balance pointer moves up to show the loss in weight due to buoyancy.

Q17. What will be the effect on the apparent loss in weight of a stone if it is immersed in salty water instead of tap-water?

Ans. The stone when immersed in salty water will displace water with more mass than as compared to the tap-water (density of salty water is more as compared to tap-water).

Q18. A spring balance calibrated in newton, reads 19.6 N. What will be its mass in grams at your place?

Ans. As, $w = mg$,

$19.6 = m \times 9.8$

Hence $m = 19.6/9.8 = 2\ kg = 2000\ g$

Q19. You are given two measuring cylinders of least count 1.0 ml and 2.5 ml, respectively. Which one would you prefer to determine the density more accurately?

Ans. The measuring cylinder with the least count 1.0 ml will give more accurate reading.

Q20. Why is the density of water at 80 °C less than its density at 30 °C?

Ans. The density of a liquid and a gas change with temperature. With the increase in the temperature its density will decrease gradually.