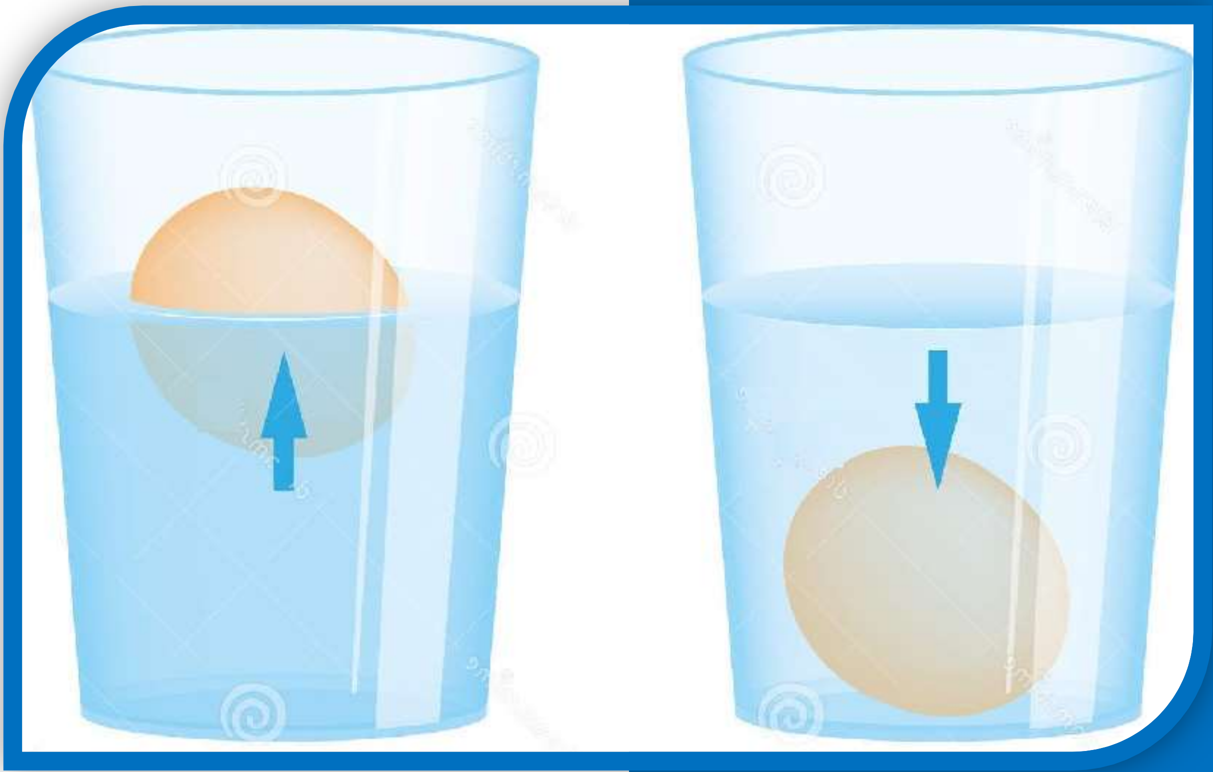
2020

FLOATING AND SINKING



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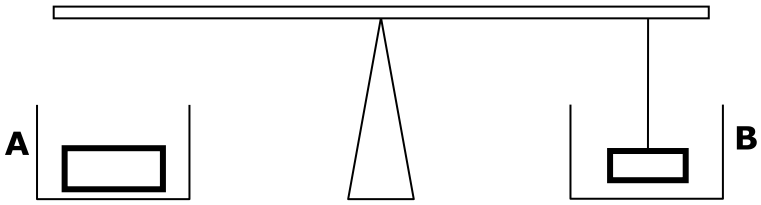
SINKING

1. State Archimedes principle. (1mk)

- ✓ ***When a body is totally or partially immersed in a fluid, it experiences an upthrust equal to the weight of the fluid displaced.***

2. Fig below shows a uniform bar in equilibrium.

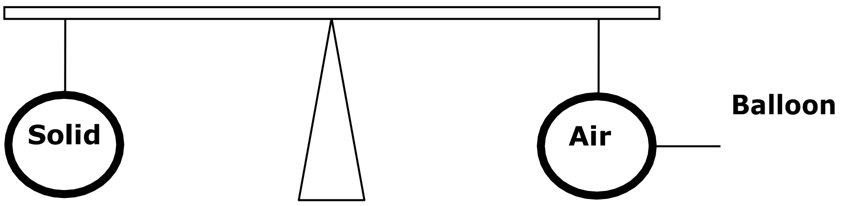


When water is added into the beakers A and B until the weights are submerged, its observed that the bar tips* towards B. Explain this observation.

(2mk)

- ✓ *A is bigger compared to B hence the experiences a greater upward force(Upthrust) than B making it topple.*

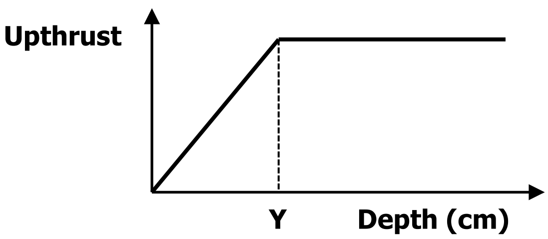
3. The system in the figure below is at equilibrium.



State and **explain** what may be observed as temperature of surrounding is increased. (2mks)

- ✓ *The bar tilts anticlockwise because the air in the balloon expands lowering its density*
- ✓ *The bat tilts in anticlockwise direction. Increase in temperature causes an increase in volume of air in the balloon.*

4. A glass block is suspended from a spring balance and held inside a beaker without touching the beaker. Water is added gradually into the beaker. The figure below shows the variation of the upthrust on the block with depth of water in the beaker.



State the reasons for the change observed at depth Y. (1mk)

- ✓ As water is increased, upthrust increases.When fully submerged ,upthrust remains constant.

5. A solid displaces 8.5 cm^3 of liquid when floating on a certain liquid and 11.5 cm^3 when fully submerged in the liquid. The density of the solid is 0.8 gcm^3 Determine:

Volume displaced (floating) = $8.5cm^3$
Volume displaced (submerged) = $11.5cm^3$
Density of solid = $0.8g/cm^3$

i) The upthrust on the solid when floating. (3mk)

Weight of the solid=ℓv
$= (0.8\times11.5)\times10^{-2}$
$= 9.2\times10^{-2}N$

A floating body displaces its own weight:
thus, weight of liquid displaced $=9.2\times10^{-2}N$
Upthrust=Weight of fluid displaced= $9.2\times10^{-2}N$

ii)The density of liquid. (3mk)

$U= \ell vg$
$9.2\times10^{-2}=\ell\times8.5\times10^{-6}\times10$
$\ell=1082.35kg/m^3$

ii) The upthrust on the solid when fully submerged (3mk)

$U= \ell vg$
$= 1082.35\times11.5\times10^{-6}\times10$
$=0.1245N$ $=1.245\times10^{-1}N$

6. A block of length 80cm cross sectional area of 3cm^3 and density 1300kg/m^3 is completely immersed in a liquid of density 1030 kg/m^3. Determine :-

(i) The mass of the block. (1mk)

m= ℓv

= 1300× (80×3) ×10^{-6}m^3

=0.312kg

(ii) The weight of the block in the liquid. (3mk)

Upthrust= ℓvg

= 2.4×10^{-4}×1030×10

= 2.472N

Weight in air=3.12N

Upthrust=Weight in air- Weight in liquid

Weight in liquid=Weight in air – Upthrust

= 3.12N-2.472N

=0.648N

7. When the block is completely immersed in water the pivot must shift by **0.05 m** to the left for the system to balance. The density of water is **1000kgm^{-3}**.Determine:

(i) The upthrust **U** on the block. (4mk)

(ii) The volume of the block. (3mk)

8. A block of metal of volume 80cm^3 weighs 3.80N in air. Determine it's weight when fully sub merged in a liquid of density 1200kgm^{-3}

Weight in water=Weight in air – Upthrust

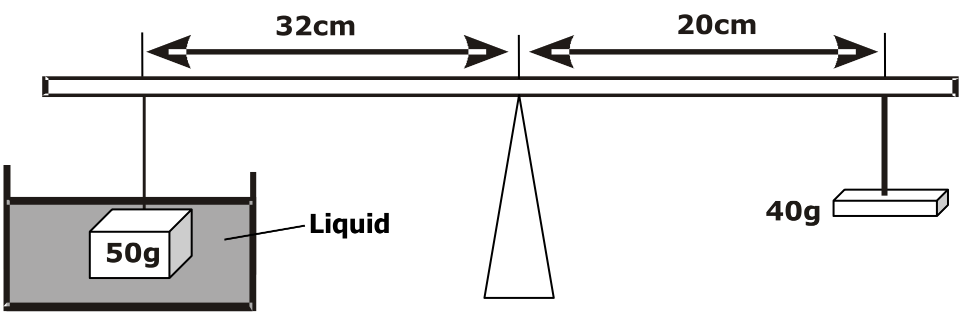
Upthrust= ℓvg

= 1200kg/m^3×80×10^{-6}m^3×10N/kg

= 0.96N

Weight in water = 3.80N – 0.96N = 2.84N

9. The figure below shows a block of mass 50g and density 2000k$^{g/m3}$ submerged in a certain liquid and suspended from uniform horizontal beam by means of a string. A mass of 40g suspended from the other end of the beam puts the system in equilibrium.



(i) Determine the upthrust force acting on the block. (3mks)

ΣCWM=ΣACWM

(0.4N×0.2m)+(U×0.32m)=(0.5N×0.32m)

0.32U=(0.5N×0.32m)- (0.4N×0.2m)

$$U=\frac{(0.16Nm-0.08Nm)}{0.32m}$$

$= \frac{(0.08Nm}{0.32m}$

$= 0.25N$

(ii) Calculate the density of the liquid (3mks)

Volume of block $= m/\ell$

$= \frac{50\times10}{2000}$

$= 2.5\times10^{-5}m^3$

$U = \ell vg$

$0.25 = \ell\times2.5\times10^{-5}m^3\times10kg$

$\ell=1000kg/m^3$

(iii) Calculate the new balance point of the 50 g mass (the 40g mass remains fixed) if the liquid was replaced with one whose density was $1500Kg/m^3$ (3mk)

New Upthrust $= \ell vg$

$=1500\times2.5\times10^{-5}\times10$

$= 0.375N$

From principle of moments $\sum CWM=\sum ACWM$

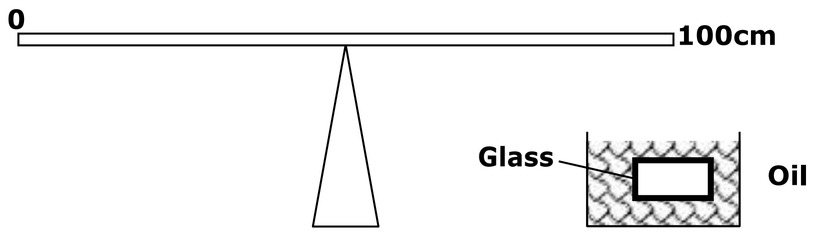
$(0.4N\times0.2m)+(0.375N\times x)=0.5\times x$

$0.08Nm=0.5x-0.375x$

$0.08=0.125x$

$x=0.64m$

10. Figure shows a uniform metre rule balanced by a rectangular glass block that is totally immersed in oil of relative density 0.89. The block has a volume of $2.1 \times 10^{-2}m^3$ and density of glass is $2500kgm^{-3}$.



Find the position of the pivot if the mass of rule is 97g. (3mk)

Density of oil Rd= $\frac{\text{Density of oil}}{\text{Density of water}}$

$0.89=\frac{\text{Density of oil}}{1000kg/m^3}$

Density of oil$=890kg/m^3$

Upthrust on the block$= \ell vg$

$= 890kg/m^3 \times2.1\times10^{-2}m^3\times10$

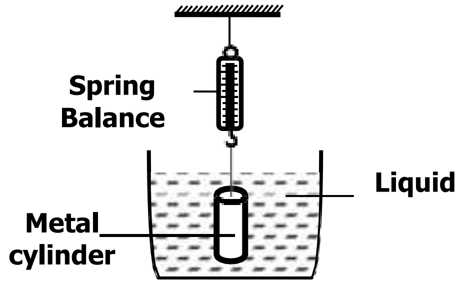
$= 186.9N$

Mass of the block$=\ell\times v$

$= 2500\times2.1\times10^{-2}$

$= 52.5kg$

11. In an experiment to determine the density of a liquid a uniform metal cylinder of cross- sectional area **6cm²** and length **4cm** was hang from a spring balance and lowered gradually into the liquid as shown below.



The up thrust was calculated from the spring balance and it was found to be **0.6 N** when the cylinder was fully submerged. **Determine:**

(i) Volume- of the metal cylinder. (3mk)

Volume of cylinder=$6cm^2 \times 4cm$

$= 24cm^3$

$= 24\times10^{-6}m^3=2.4\times10^{-5}m^3$

(ii) Mass of the liquid displaced by the cylinder. (2mk)

Upthrust=Weight of fluid displaced

=mg

$0.6=m\times10$

m=0.06kg

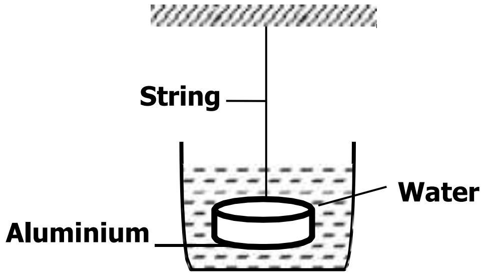
(iii) Density of the liquid (3mk)

D=m/v

$= 0.06/2.4\times10^{-5}$

$= 2500kg/m^3$

12. The figure below shows a piece of aluminium suspended from a string and completely immersed in a container of water. The mass of the aluminium is 1kg and its density is $2.7 \times 10^3 kg/m^3$



Calculate the tension in the string.

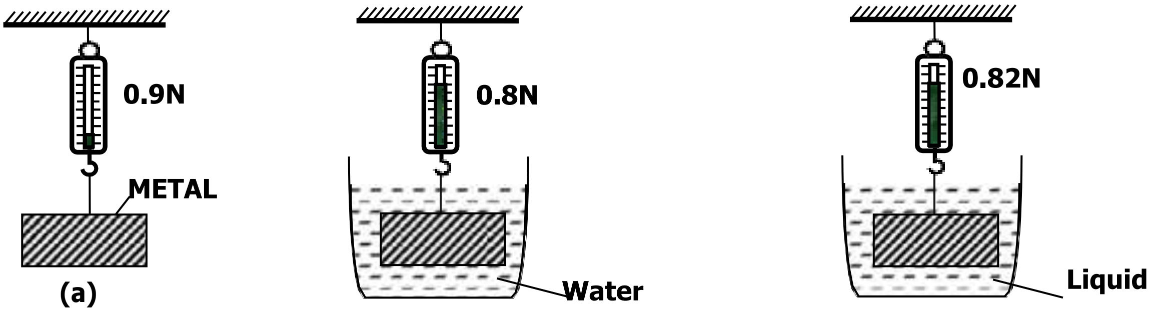
Volume of Aluminium=$27\times10^3kg/m^3=3.704\times10^{-4}m^3$

U= ℓvg

$= 1000\times3.704\times10^{-4}\times10= 3.704N$

Tension=10N-3.704N=6.296N

13. The figure **below** shows the same block weighed in air, water and liquid. Given that the reading of the level of water becomes 150cm³ when the metal is fully immersed.



(a) (b) (c)

Determine:

(i) Density of the metal. (3 marks)

$R.D = \frac{Weight\ in\ air}{Upthrust\ in\ water}$

$= \frac{0.9N}{0.1N}$

$= 9$

Density of metal $= 9 \times 1000 kgm^{-3}$

$= 9000 kgm^{-3}$

(ii) Water level before the solid was immersed. (2mk)

Volume of new level=150cm3

Volume of block $= 1.0\times10^{-5}\times10^{6} = 10cm^{3}$

New level $= 150cm^{3} - 10cm^{3}$

$= 140cm^{3}$

(iii) Explain why the spring balance gives different reading in figure (b) and **(c)** with the same metal block. (2 marks)

✓ Upthrust is dependent on the density of the liquid. C having a higher reading shows it had a lower density compared to B.

FLOATING

1. State the law of floatation. (1mk)

A floating body displaces its own weight of the fluid in which its floats.

2. i) State the two forces that act on an object that is partially immersed in water. (2mk)

a) Upthrust
b) Weight

ii) What third force would be in play if the object was to move inside the fluid. (1mk)

Viscious drag

3. Explain how a submarine is made to float and sink in water (1mk)

By use of large floatation tanks which can be filled with water when required to sink or filled with air when required to float.

4. A balloon is filled with a gas which is lighter than air. It is observed to rise in air up to a certain height state a reason why the balloon stops rising. (1mk)

The upthrust force on the balloon equals the weight of the balloon contents and its fabric.

5. **You are provided with the following:-**

~ A block of wood
~ A spring balance
~ Thin thread
~ Overflow can
~ A small measuring cylinder
~ Some liquid

With the aid of a labeled diagram describe an experiment to the law of floatation. (5mk)

Using the spring balance, weigh and record the weight of the block in air

- Fill the eureka completely with water
- Place the measuring cylinder under the spout
- Lower the block of wood slowly into water until the string slackens (the block floats)
- Collect the displaced water using the measuring cylinder
- Repeat the procedure to attain more results
- Compare the weight of displaced water with the weight of block in air
- They are equal (same) verifying the law of a floating object displaces its own weight of the fluid in which it floats

6. A solid copper sphere will sink in water while a hollow copper sphere of the same mass may float. Give a reason for this.

A copper sphere is hollow and displaces a large volume of water to provide enough upthrust equal to its own weight, while a solid copper sphere sinks since it is denser than water.

7. Give a reason why a steel rod sinks in water while a ship made of steel floats on water. (1mk)

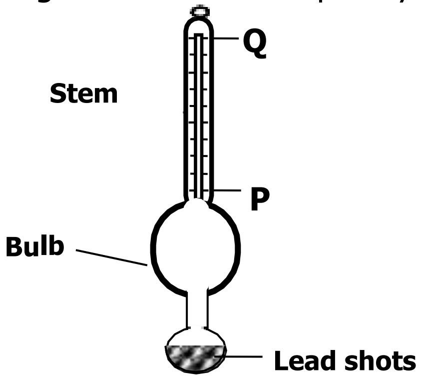
A ship is hollow and displaces a large volume of water to provide enough upthrust equal to its own weight, while steel rod sinks since it is denser than water.

8. When a piece of metal is placed on water, it sinks. But when the same piece of metal is placed on a block of wood, both are found to float. Explain this observation.

9. State one use of a hydrometer (1mk)

Its used to measure relative density of liquids.

10. Figure shows a simple hydrometer.



i)State the reason why the bulb is wide. (1mk)

To displace large amount of the liquid.

ii)State the purpose of the lead shots in the glass bulb (1mk)

To make the hydrometer float upright.

iii) How would the hydrometer be made more sensitive? (1mk)

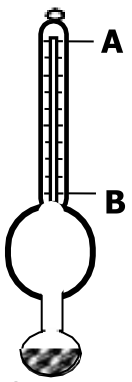
Making the stem more arrow.

(iv) Describe how the hydrometer is calibrated to measure relative density. ` (2mk)

The stem is graduated from top to bottom unevenly spaced.

(v) Indicate on the diagram above the minimum and the maximum measurement to be taken. (1mk)

11. The figure below shows a diagram of a hydrometer which is suitable for measuring the densities of liquids varying between 1.0 and 1.2g cm^{-1}



$1.0g/cm^3$

$1.2g/cm^3$

On the diagram indicate the label corresponding to 1.0 and 1.2 g/cm^3 (2mk)

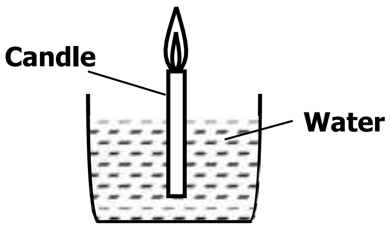
12. A flat test tube containing lead shots is immersed in a fluid, where it floats as shown. What is the use of the lead shots? (1mk)
To make it float upright.

13. A test-tube does not float upright on water, but floats upright when loaded with sand. Give one reason for this observation. (1mk)

Sand provides for some weight at the bottom making the tube float upright.

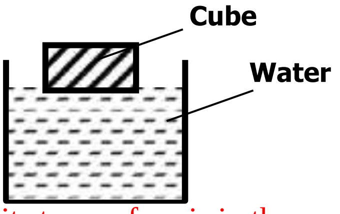
14. A cork and a stone are both held under water and released at the same time.
(i) State the observation that would be made (1mk)
The cork would move upwards while the stone would move downwards
(ii) Explain the observation above (1mk)
Cork floats because it is less dense

15. The figure below shows a burning candle, weighted, nondrip candle floating upright in water. Explain what happens after the candle burns for sometime. (2mk)



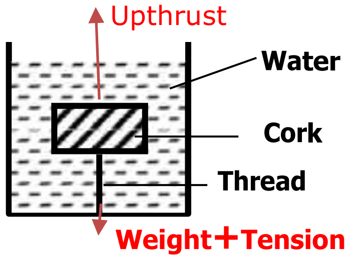
As the candle burns the weight reduces, the greater upthrust pushes upwards therefore it rises relative to the base of the container.

16. The figure below shows a cube of a certain wood whose density is the same as that of water. The cube is held on the surface of the water in a long cylinder. Explain what happens to the cube after it is released.



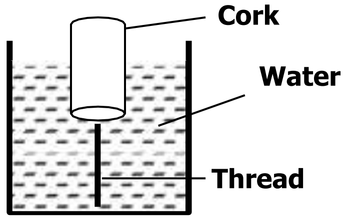
The cube sinks until its top surface is in the same level with the surface of water.The upthrust thus balances the weight of the cube.

17. Fig. 6 shows a piece of cork held with a light thread attached to the bottom of a beaker. The beaker is filled with water.



i) Indicate and label on the diagram the forces acting on the cork. (3mk)
ii) Write an expression showing the relationship between the forces. (1mk)
Upthrust=Weight+Tension.
iii) If the thread breaks name another force which will act on the cork. (1mk)
Viscious drag.

18. Figure shows a cork floating on water and held to the bottom of the beaker by a thin thread



i) Name the force acting on the cork. (3mks)
ii) Describe how each of the forces mentioned in (i) above changes when water is added into the beaker until it fills up.(3mks)
Tension increases as upthrust increases while weight remains constant.

19. A car ferry has a uniform cross-sectional area of $1000m^2$ and floats in water of density $1000kgm^3$. **How** deep will it sink if 10 cars each of mass 1000kg are taken aboard? (3mks)

20. A balloon used to carry instrument for meteorological department up into the atmosphere has a capacity of 30 m^3 and is filled with hydrogen . The weight of fabric of balloon is 30N. (Determine of hydrogen is $0.089Kgm^{-3}$ and of air is 1.29 Kg m^{-3} , g = $10Nkg^{-1}$) (4mks)

21. A balloon of volume $2000m^3$ is filled with hydrogen of density $0.09Kg/m^3$. If the mass of the fabric is100kg and that of the pilot is 75kg, what will be the greatest mass of equipment that can be carried by the balloon when operating in air of density $1.25kg/m^3$ (4mk)
i) Volume of water=$2000m^3$ Mass of hydrogen=0.09×2000=180kg
Weight of hydrogen=1,800N
ii)Volume displaced=$2000m^3$
Mass of air displaced=2000×1.25=2,500kg
iii) Mass of fabric and pilot=75+100=175kg
Weight of content balloon=1,750N
Upthrust=Weight of air displaced=25,000N
Maximum load possible=Upthrust-Total weight of balloon and content
= 25,000N-(1800-1750)=21,450N

22. A balloon of volume $1.2x10^7$ cm^3 is filled with hydrogen gas of density 9.0 x 10^{-5}/g/cm^3. Determine the weight of the fabric of the balloon.

23. A balloon made up of a fabric weighing 80N has a volume of 1x $10^7 cm^3$. The balloon is filled with hydrogen of density 0.09 Kgm^{-3}.Calculate the greatest weight, in addition to that of the hydrogen and its fabric which the balloon can carry in air of average density $1.25kgm^{-3}$. (4mk)

Hydrogen $=0.09kg/m^3=9\times10^{-5}g/cm^3$ Fabric =80N Volume$=1.0\times10^7cm^3$

Weight of hydrogen$=1.0\times10^7cm^3 \times9\times10^{-5}g/cm^3$

$=900g=0.9kg\times10=9N$

Total mass of balloon +fabric=0.9+80N=80.9N

Mass of air displaced$=\left(\frac{1.25kg/m^3}{1000}\right)\times1.0\times10^7$

Weight of air displaced=125N=Upthrust

Load=Upthrust -Weight of balloon

=15N-80.9N=44.1N

24. A balloon weighs 10N and has a gas capacity of $2m^3$. The gas in the balloon has a density of $0.1Kgm^{-3}$. If the density of air is $1.3Kgm^{-3}$. Calculate the resultant force of the balloon when it is floating in air.

Weight of air in balloon$=2.0\times0.1kg/m^3\times10=0,2kg\times10=2N$

Total weight of balloon+content= (10+2)N=12N

Weight of air displaced(upthrust)$=1.3kg/m^3\times2m^3\times10=26N$

Resultant force=Upthrust-Weight of balloon

=26N-12N=14N

25. The rubber used to make a balloon weighs 0.1kg.The balloon is inflated to a volume of $0.5m^3$with hydrogen whose density is 9.0 $x10^{-2}Kg/m^3$.What is the maximum load the balloon can lift. (Density of air=$1.3Kg/m^3$) (4mk)

Weight of hydrogen=$9.0\times10^{-2}\times0.5=0.045+0.1$
Weight of ball+contents=0.045+0.1=0.145N
Weight of air displaced/upthrust=$1.3\times0.5=0.65$N
Load=0.65-0.145=0.505N

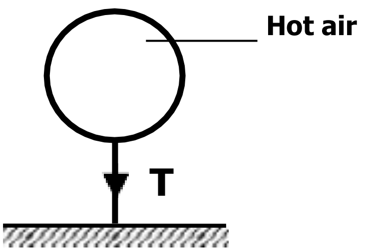
26. A hot air balloon is tethered to the ground on a windless day. The envelop of the balloon contains $1200m^3$ of hot air of density $0.8kg/m^3$. The mass of the balloon (not including the hot air) is 400kg. The density of the surrounding air is $1.3kg/m^3$.

i) Explain why the balloon would rise if it were not tethered. (2mks)
The upward force is greater than the total downward force resulting from the balloon and its contents.

ii) Calculate the tension in the rope holding the balloon to the ground. (3mks)
Mass of air= $1200m^3\times0.8kg/m^3$=960kg
Weight of hot air=9600N
Mass of balloon=400kg
Weight of balloon=4000N
Total weight of balloon +Hot air=9600+4000=13,600N
Density of surrounding=$1.3kg/m^3$
Mass of air displaced(U)=1200m3×1.3kg/m3=1560kg
Weight of air displaced=15,600N
Upthrust=Weight +Tension
Tension=Upthrust -Weight
=15600-13600=2000N

iii) Calculate the acceleration with which the balloon begins to rise when released. (3mks)
F=ma
a=f/m=2000/1360=1.471N/kg

27. A hot air balloon is tethered to the ground on a windless day as shown in figure 3



The envelope of the balloon contains $1200m^3$ of hot air of density $0.8kg/m^3$. Mass of the empty balloon is 400kg. Density of the surrounding air is $1.3kg/m^3$. Calculate the tension in the rope holding the balloon on the ground (3mks)

W = mg + ℓvg = (400 x 10) + (0.8 x 1200X10)
= 4000 + 9600
= 13600N
U = ℓvg = 1.3 x 1200 x 10 = 15600N
T = U – W = 15600N-13600N
=2,000N

28. A balloon of negligible weight and a capacity of 100m^3. It is filled with helium of density 0.18Kg/m^3 and is floating in air of density 1.2 Kg/m^3.

Calculate

(i) The upthrust on the balloon (2mks)

Upthrust=100m^3×1.2kg/m^3×10N/kg=1200N

(ii) Weight of helium (2mks)

Mass of helium=100×0.18=18kg

Weight of helium=180N

(iii) Lifting force on the balloon (2mks)

Lifting force=Upthrust -Weight

=1200-180=1020N

29. A mass of 120g half immersed in water displaced a volume of 20cm^3. Calculate the density of the object.

Density=$\frac{\text{mass}}{\text{volume}}$

=120/40=3g/cm^3

30. A solid displaced 5.5 cm^3 of paraffin when floating and is of volume 20cm^3. Calculate the density of the object.

Mass = 800 x 0.00001

=0.008kg.

Density=$\frac{m}{V}$

=$\frac{0.008}{20X10^{-6}}$

=0.4kgm^{-3}

31. An object weighs 1 .04N in air, 0.64N when fully immersed in water and 0. 72N when fully immersed in a liquid. If the density of water is 1000 kgm^{-3}, find the density of the liquid. (4mks)

Upthrust in Water=Weight in air-weight in water

= 1.04-0.64=0.4N

U=ℓvg

0.4=1000×v×10

Volume of object=4.0×10^{-5}m^3

Upthrust in Liquid=0.32N

0.32N=ℓ×4.0×10^{-5}m^3×10

ℓ=800kg/m^3

32. A body weighs 40N in air, 30N when in water and 35N when in liquid X. Find the relative density of liquid X. (3mks)

Relative density=$\frac{\text{Upthrust in liquid X}}{\text{Upthrust in water}}$

=$\frac{5.0N}{10N}$ =0.5

33. A block of glass of mass 250g floats in mercury. What volume of the glass lies under the surface of the mercury? (Density of mercury is 13.6×10^3).

$U = \ell v g$

$2.5 = 13600 \times v \times 10$

$v = 1.838 \times 10^{-5} m^3$

34. A right angled solid of dimensions 0.02m by 0.02m by 0.2m and density **2,700kg/m³** is supported inside kerosene of density 800kg/m^3 by a thread which is attached to a spring balance. The long side is vertical and the upper surface is 0.1m below the surface of the kerosene.

i) Calculate the force due to the liquid on the lower upper surface of the solid.

F=hρgA
= (0.3X800X10)X (0.02X0.02)
=0.96N

ii) Calculate the up thrust and determine the reading on the spring balance.

F= (0.1X800X10)X(0.02X0.02)
=0.32N
U=0.96-0.32
=0.64N
Weight of block=2700X8X10^{-5}X10
=2.16N
Reading= 2.16N-0.64N
=1.52N

35. A boat whose dimensions are equivalent to those of a rectangular figure of 5m long by 2m wide floats in fresh water. If this boat sinks 10cm deeper as a result of passengers climbing on board, determine the total weight of these passengers.

Volume of water displaced=5m×2m=10m×0.10cm=1m^3
Mass of water displaced=1000kg/m^3×1m^3=Mass of passenger
=1000kg

36. One fifth of the volume of an iceberg stands above the water surface. If the density of the seawater is 1.2g/cm^3, determine the density of iceberg.

37. A hydrometer of mass 10g is placed in paraffin of density 0.8g/cm^3. Determine the length of the paraffin if its bulb has a volume of 4cm^3 and its stem has a cross section area of 0.5 cm^2

A floating body displaces its own weight.
Mass of paraffin displaced=10g
Volume of paraffin displaced=10/0.8=12.5cm^3
Volume of stem in paraffin=volume of paraffin displaced-volume of bulb
=12.5-4cm^3=8.5cm^3
Volume=Ah
8.5cm^3=0.5cm^2×h
h=17cm

38. A wooden block measures 2cm by 5cm by 10cm floats in water with its length vertical. If three quarters of its length is submerged, determine;

(i) The density of the block (3mks)

Volume of the block submerged=3/4of100=75cm^3
Volume of water displaced=75cm^3
Mass of water displaced=ℓ×v
=1g/cm^3×75cm^3=75g
From the law of floatation; mass of the block=75g
Density=mass/volume
=75g/100cm^3=0.75g/cm^3

(ii) The volume of the block remaining above the surface when floating in a liquid of density $800kgm^{-3}$ (3mks)

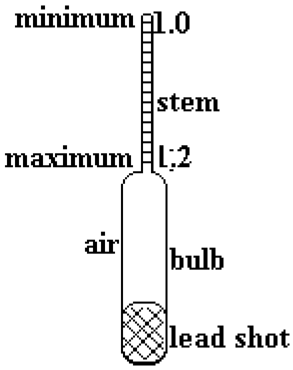
In paraffin ,the weight to be displaced=75g

Volume to be displaced=$75g \times 0.8g/cm^3$

$= 60cm^3$

Volume remaining=$100cm^3-60cm^3=40cm^3$

39. Draw a clearly labeled diagram of a common hydrometer which is suitable for measuring the densities of liquids varying between 1.0 and 1.2 g cm^{-3}. (2mk)



40. A boat of mass 1000 kg floats on fresh water. If the boat enters sea water, determine the load that Must be added to it so that it displaces the same volume of water as before. Density of sea water =1030 kgm^{-3} density of fresh water = $1g/cm^{3mn}$ (3mk)

Volume of fresh water displaced=1000/1=$1m^3$

Volume of sea water to be displaced=1000/1030=$0.9709m^3$

Difference in volume-1-0.9709=$0.029m^3$

Mass added=$0.029m^3 \times 1030kg/m^3$=30kg

Load to be add=300N

41. A certain solid of volume $60cm^3$ displaces $20cm^3$ of a liquid (density $600kg^{-3}$) when floating. Determine the density of the solid. (3mk)

Mass of liquid displaced=$20cm^3 \times 0.6g/cm^3$=12g

A floating body displaces its own weight: thus, mass of the solid=12g

Volume=$60cm^3$ thus, density=$12g/60cm^3=0.2g/cm^3$

42. When the block is completely immersed in water the pivot 0 must shift by 0.05 m to the left for the system to balance. The density of water is 1000 kgm^{-3}.Determine:

(i) The upthrust U on the block. (4mk)

Clockwise moments = anticlockwise moments

20.0 x (0.05 – x) = 0.5 x 10 x x

10 – 20x = 5x

10 = 25x

x = $\frac{10}{25} = 0.4m$

Balance point = 0.4 + 0.05 = 0.45m

20 x .0.25 = 0.25 x (5 – u)

1 = 2.25 – 0.45u✓1

0.45u = 2.25 – 1 = 1.25Nm

u = 2.778N

(ii) The volume of the block. (3mk)

u = veg

2.778 = v x 1000 x 10

v = $\frac{2.778}{10000} = 2.778 \times 10^{-4} m^3$

43. A hydrometer is floating in a liquid at temperature of 18^0C. If the temperature of the liquid is raised to 50^0C state the observation made (1mk)

Sink more due to decrease in density of the liquid which on turn decreases the upthrust.

44. A cylindrical beaker of uniform X – sectional area of $50cm^2$ and height 12cm floats in water with one third of its volume immersed. A liquid Q is poured into the beaker until it completely sinks. Density of water = $1.0g/cm^3$. Density of liquid Q = $1.25g/cm^3$

Determine

i) Weight of beaker (2mks)

Volume of beaker= 0.005X0.12

$=0.0006m^3$

Volume of water displaced= $\frac{1}{3}$X0.0006=$0.0002m^3$

Weight of water displaced= 0.0002X1000X10

=2N

Weight of beaker= 2N

ii) Upthrust of water before the beaker is completely immerse (2mk)

Upthrust=VXPXg

=0.0002X1000X10

=2N

iii) The volume of liquid Q used (3mks)

Volume of beaker= $0.005m^2$X0.12m

$=0.0006m^3$

45. A solid displaces $8.5cm^3$ of liquid when in a certain liquid and $11.5cm^3$ when fully submerged in the same liquid. The density of the solid is $0.8g/cm^3$. determine:-

(i) The upthrust on the solid when floating. (3mk)

i) Weight of the solid=ℓv

$= (0.8\times11.5)\times10^{-2}$

$= 9.2\times10^{-2}$N

A floating body displaces its own weight:

thus, weight of liquid displaced $=9.2\times10^{-2}$N

Upthrust=Weight of fluid displaced= 9.2×10^{-2}N

(ii) The density of the liquid. (3mk)

$U= \ell vg$

$9.2\times10^{-2}=\ell\times8.5\times10^{-6}\times10$

$\ell=1082.35kg/m^3$

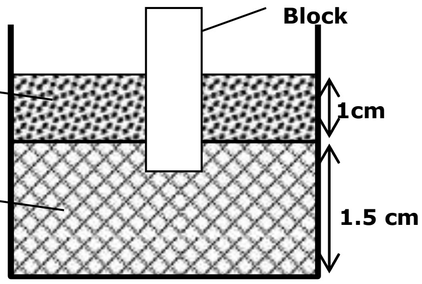
(iii) The upthrust on the solid when fully submerged. (3 mks)

$U= \ell vg$

$= 1082.35\times11.5\times10^{-6}\times10$

$=0.1245N \quad =1.245\times10^{-1}N$

46. The figure below shows a rectangular block of height 4cm floating vertically in a beaker Containing two immiscible liquid A and B . The densities of the liquid are 800 kg/m^3 and 1200 kg/m^3 respectively.



The cross sectional area of the block is 2cm^3

Determine

i) The weight of the liquid A displaced by the block (2 mk)

Volume immersed in A is cross – Area x Lenth

Vol = 2cm2 x 1cm = 2cm3 = vol liquid displaced.

D = M m = DXV = mass liquid displaced

= 800 x 2 = 4 0.16kg x 10 = 1.6N

1000

Weight of = 1.6N

Liquid A displ.

ii) The weight of the liquid B displaced by the block (2 marks)

Weight liquid B displaced

Vol = 2cm2 x 1.5 = 3.0cm3

Mass = 1200 x 3 =0.36kg

= 3.6N

iii) The mass of the block 1 mark)

Total mass = 0.36 + 0.16 = 0.52kg

$\frac{2.5}{4}$ – 0.52

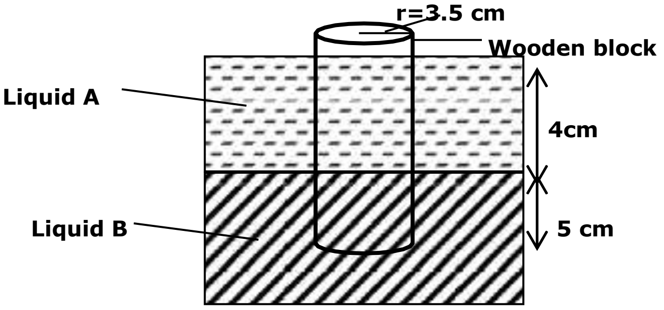
= $\frac{0.52 \times 4}{2.5}$ $\frac{0.52\text{x}10}{25}$ = 8.832kg

iv) The density of the block (1 mark)

D = M

v= $\frac{832}{8}$ = 104g/cm^3

47. A cylindrical block of wood has a radius 3.5 cm and height 10cm. if floats vertically in a beaker containing two immiscible liquids A and B. The densities of the liquids are 0.8g cm^{-3} and 1.2 gcm^{-3} respectively.



i) Determine the mass of the liquid A displaced by the block. (3mks)

Volume = 4 x π (3.5)2 = 154cm^3 √1

Mass = 154 x 0.8

= 123.2g

ii) the mass of liquid B displaced by the block (2mks)

Volume = 5 x π (3.5)2 = 192.5cm$_3$

Mass = 192.5 x 1.2

= 231g

iii) The density of the block. (2mks)

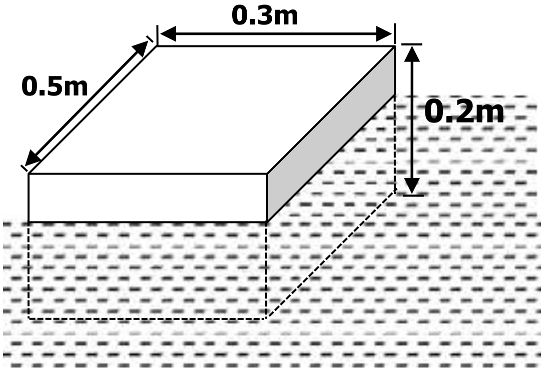
$$) \ d = \frac{m}{V} = \frac{231 + 123.2}{\pi(3.5)^2 \times 10} = \frac{354.2}{385} = 0.92 g/cm^3$$

(iv) Calculate the pressure of the liquid at the depth of 9cm (2mks)

$P = h\rho g = 0.09 \times 920 \times 10$

$= 828Nm^{-2}$

48. The diagram in fig below shows a block of wood floating to a depth of 0.18m in water. (Density of water = $1000Kg/M^3$)



a) Determine;

(i) Mass of the wood. (3mk)

Volume of water displaced=0.5X0.3X.18

$=0.027m^3$

Weight of water displaced= 0.027X100X10

=270N

Weight of wood= weight of water displaced.

=270N

Mass of wood= 27Kg

(ii) The density of the wood. (2mk)

Density of wood$=\frac{m}{V}$ $=\frac{27Kg}{3X10^{-3}}$

$=9000kgm^{-3}$

iii) Determine the number of frogs each of mass 500g which will make the block of wood to be just submerged if they sit on the block. (5mk)

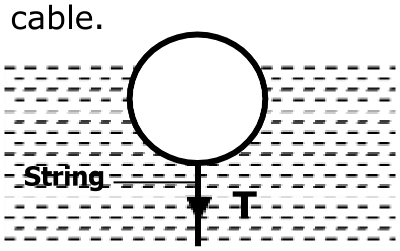
1 frog=500g

= 27000g

$= \frac{1X27000}{500}$

=54 frogs

49. The ball B shown below has a mass of 12kg and a volume of 50litres. It is held in position in sea water of density 1040 kgm^{-3} by a light cable fixed to the bottom so that $^4/_5$ of its volume is below the surface determine the tension in the cable.



Volume of water displaced = 3/4 x 40 = 30 1 = 0.03 m^3 *U/G*

Weight of buoy = mg = 10 x 10 = 100N

Weight of sea water displaced = density x gravity x volume

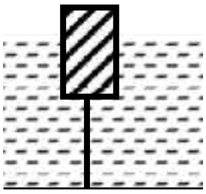
= 1.04 x 103 x 10 x 0.03 N = 312N

Weight of sea water displaced = Up thrust

Tension T = Up thrust - Weight of buoy = 312 - 100

T = 212N

50. An object of mass 50g floats with 20% of its volume above the water surface as shown below. The tension in the string is 0.06N.



a) Calculate the up thrust experienced by the object.

. i) U = 0.5 +0.06 ;

= 0.56N

b) Volume of water displaced.

= 50 x 10/1000

= 0.5N

Mass of water displaced = 0.5/10

= 0.05 kg

= V = m/ℓ

= 0.05/1000;

= $5X10^{-5}$ m^3

c) The density of the object

volume of object $= \frac{100}{20} X 5 X 10^{-5}$

= $0.00025m^3$

ℓ = m/v

= 0.05/0.00025

2000 $kglm^3$

d) What would happen if the string was cut

It will rise to the surface of water.

51. (a)The following readings were obtained for total mass M, of the test tube and lead shot and the depth, H of the test tube immersed as lead shot was added to the tube.

M (g)	**48**	**55**	**60**	**65**	**73**	**77**	**84**
H(cm)	**8**	**9**	**10**	**11**	**12**	**13**	**14**

Plot a graph of M against depth H (5mk)

(i) From the graph find the depth immersed when M is 90g (2mk)

(ii)Use this result to find area of the base of the tube (3mk)

(Density of liquid =1.2g/cm^3)

RELATIVE DENSITY

1. A piece of marble of mass 1.4kg and relative density 2.8 is supported by a light string from a spring balance. It is then lowered into the water fully. Determine the upthrust.

Relative density is the ratio of density of a substance(solid/liquid)

Mass of the marble=1.4kg

R.d=2.8

Upthrust=?

R.d=$\frac{weight\ of\ the\ solid}{upthrust\ in\ water}$

W=Mg

=1.4×10

=14N

2.8=$\frac{14N}{Upthrust\ in\ water}$

Upthrust=$\frac{14N}{2.8}$

=5N

2. A body weighs 22N in kerosene and 20N in water. If it weighs 30N in air, find the relative density of kerosene. (3mks)

Weight of the body in kerosene=22N

Weight of body in water=20N

Weight of body in air=30N

Relative density=?

R.d=$\frac{upthrust\ in\ kerosine}{upthrust\ in\ water}$

Upthrust in kerosene=30N-22N

=8N

Upthrust in water=30N-20N

=10N

R.d of kerosene=$\frac{8N}{10N}$

=0.8N

3. A solid of mass 100g and density 2.5g/cm^3 weighs 0.5N when totally submerged in a liquid. Determine the density of the liquid. (3mks)

Solid mass=100g

ρ of liquid=2.5 g/cm^3

weight of solid when fully submerged=0.5N

R.d=

4. A solid Y weighs 40N in air, 30N when in water and 35N in liquid X. Find the density of;

(i) Solid Y (2mks)

Weight of solid Y in air=40N

When submerged=30N

R.d of solid Y=$\frac{weight\ of\ solid\ Y}{UPTHRUST\ IN\ WATER}$

Upthrust in water=40N-30N

=10N

R.d=$\frac{40N}{10N}$

=4.

4=$\frac{oDensity\ f\ solid}{1g/cm3}$

Density of solid y=4x1g/cm^3

=4g/cm^3

(ii) Liquid X (3mks)

R.d of liquid x=upthrust in liquid/upthrust in water

Upthrust in liquid x=40-35

=5N

Upthrust in water=40N-30N

=10N

R.d=$\frac{5N}{10N}$

=0.5

density of liquid x=R.d x density of water

0.5x1g/cm^3

=0.5g/cm^3

5. A piece of metal is suspended from a spring balance and the balance reads 80N. when the metal is immersed in a liquid of relative density 1.2 the spring reads 70N. find

(i) The mass of the metal (2mks)

Weight of metal=80N

R.d of liquid=12

Apparent reading on immersion=70N

Mass of the metal=?

Mass=$^{weight}/_{gravity}$

= $^{80N}/_{10N/Kg}$

=8kg

(ii) The weight of the fluid displaced (1mk)

Weight of the liquid displaced =upthrust

Upthrust=weight in air-weight in liquid

=80N-70N

=10N

(iii) The density of the metal (4mks)

Density of metal=$^{mass\ of\ metal}/_{volume\ of\ metal}$

Volume of metal=?

Weight of fluid displaced=10N

R.d of the liquid =$^{upthrust\ in\ liquid}/_{upthrust\ in\ water}$

$1.2 = \frac{10N}{upthrust\ in\ water}$

Upthrust in water$= \frac{10N}{1.2}$

=8.33N

Weight of water displaced=upthrust=8.33N

Mass of water to be displaced $= \frac{8.33}{10}$

=0.833Kg

Volume of water that would be displaced =volume of metal

That is $\frac{0.833kg}{1000kg/cm^3}$

$8.33 \times 10^{-4} m^3$

Density of metal$= \frac{8kg}{8.33x10^{-4}}$

$= 9603.84 kg/m^3$

6. A body weighing 100N in air is found to weigh 80N when fully immersed in a certain fluid. Account for the difference in the two weights? (1mk)

- It's due to upthrust force that exists on objects immersed in a fluid making it feel lighter

7. The relative density of a solid is 2.4. Determine the up thrust it experiences when floating on water if the weight is 200N in air. (3 mks)

R.d of solid=2.4

Upthrust=?

Weight =200N

R.d$= \frac{weight\ in\ air}{upthrust\ in\ water}$

upthrust in water$= \frac{weight\ in\ air}{R.d}$

$= \frac{200N}{2.4}$

Upthrust=83.33N

8. A body weight 3,8 N in air and 2.8 N when fully immersed in water. Find the relative density of the body (Density of water is $1g/cm^3$) (3 mk)

Body weight=3.8N

Weight of the body when immersed in water=2.8N

R.d of body$= \frac{weight\ of\ body}{upthrust\ in\ water}$

Upthrust=3.8N-2.8

=1.0N

$\frac{3.8N}{1.0N}$

Relative density=3.8

9. A cylindrical metal solid of radius 3.0cm and height 7cm weighs 18.81N in air. Calculate;

(i) The density of the material making the solid. (3mk

Volume of metal=$\pi r^2 h$

$= 3.142 \times 3^2 \times 7$

$= 197.95 cm^3$

$V = 1.980 \times 10^{-4} m^3$

Density=$\frac{m}{V}$ $=\frac{1.881}{1.98x10^{-4}}$

$=9502.6Kgm^{-3}$

ii) Its apparent weight, when completely immersed in a liquid of relative density 0.8 (5mk)

Upthrust in water=VX ρX g

$=1.98X10^{-4}X1000X10$

=1.98N

$0.8=\frac{Upthrust\ in\ liquid}{1.98N}$

Upthrust in liquid =0.8X1.98N

=1.584N

Apparent weight = 18.81N-1.584N

=17.23N

10. An object weighs 1.04N in air, 0.64N when fully immersed in water and 0.72N when fully immersed in a liquid. If the density of water is 1000 kgm^{-3} find the density of the liquid. (4mk)

) Up thrust in liquid = 1.04 - 0.72 = 0.32N

Up thrust in water = 1.04 - 0.64 = 0.40

Density of liquid= Density of water x $\frac{\text{upthrust in liquid}}{\text{upthrust in water}}$

Density of liquid = 1000 *kg* m~^{3}x 0.32/0.40 = 0.8 x 10^3 *kg* m~^{3}

11. If the body weight 1.80N in air and 1.62N when submerged in a liquid of relative density 0.8, find

(i) The volume of the solid.

Upthrust in liquid =1.80N-1.62N

=0.18N

$0.8=\frac{0.18}{Upthrust\ in\ water}$

$=\frac{0.18N}{0.8}$

=0.225N

0.225= VX1000X10

$V=2.25X10^{-5}m^3$

(ii) The density of the solid

Density= $\frac{m}{V}$ $=\frac{0.18Kg}{2.25X10^{-5}}$

$= 8000Kgm^{-3}$