Density Of Solid - Experiment, Viva Voce

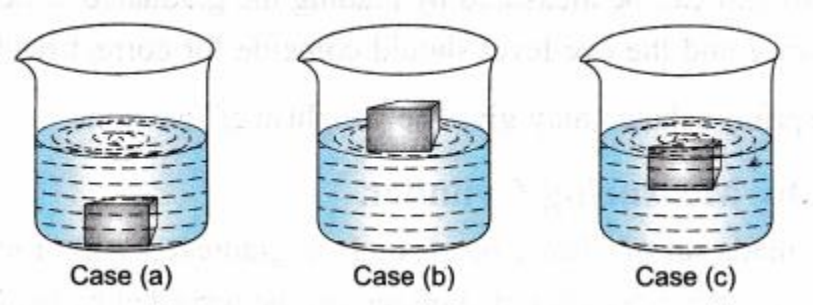
EXPERIMENT

Aim

To determine the density of solid (denser than water) by using a spring balance and a measuring cylinder.

Theory

1. **Density:** The density of a substance is defined as the mass per unit volume,[D= $\frac{M}{V}$]
   Here, D = Density of the body
   M = Mass of the body
   V = Volume of the body.
2. S.I. unit of density = Kgm^{-3} or Kg/m^{-3}
   c.g.s. unit of density = g/cm^{-3} or $g\ cm^{-3}$
3. **Floating bodies:** The density of water is 1 g/cm^3 (c.g.s. system) and 1000 kg/m^3 (S.I. system).
4. **Case (a)** If the density of a body is more than 1 g/cm^3 or 1000 kg/m^3 then the body will sink in water.
5. **Case (b)** If the density of a body is less than 1 g/cm^3 or 1000 kg/m^3 then the body will float on water.
6. **Case (c)** If the density of a body is same i.e. 1 g/cm^3 or 1000 kg/m^3 then the body will half float and half submerge in water.



Weight

1. The force due to the gravitational attraction of the earth that acts on a body is called weight.
2. (Weight) Force = mass x acceleration.
   Force = mass x acceleration due to gravity (g)

Force = mass x g
i.e Weight = m x g

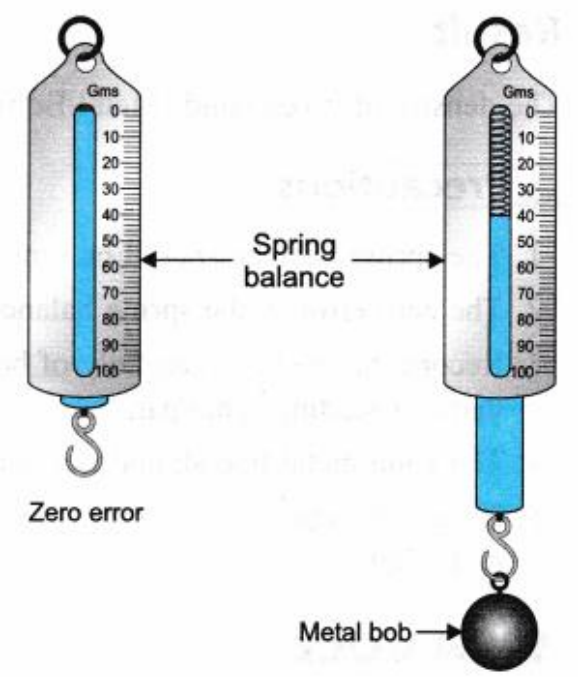
3. Weight of a body = Force on the body.
4. S.I. unit = Newton = 1 kg m/s^2
   N =1 kgf= 1 kilogram force,
   i.e g = 9.8 m/s^2
5. Weight is measured by spring balance.

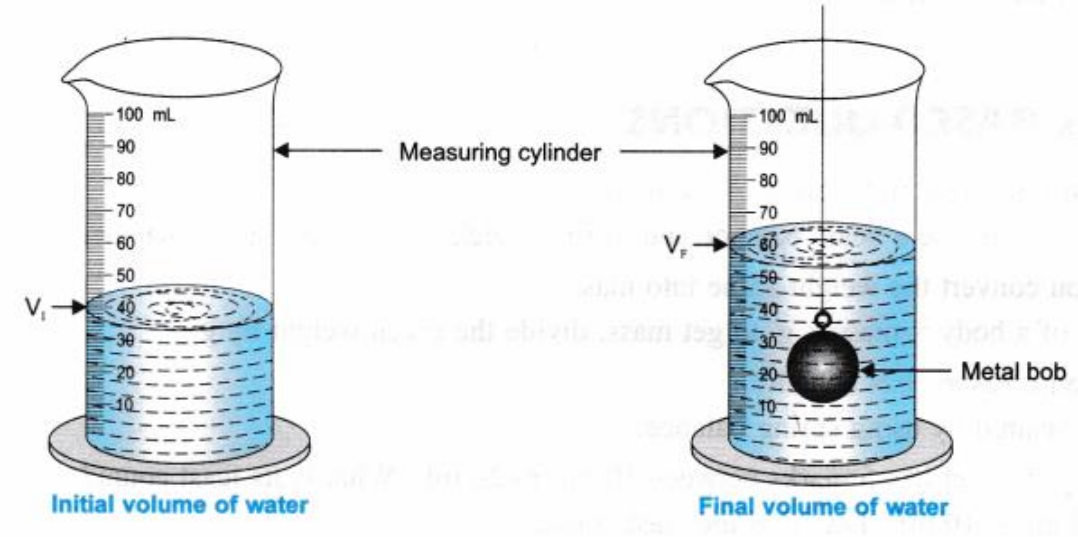
Materials Required

A spring balance, a measuring cylinder, a beaker with water, a metal bob (or anybody that is heavier than water and does not dissolve in water), a cotton string, a stand (optional).

Procedure

1. Tie a metal bob (or any solid) with the string of cotton to the hook of the spring balance. The spring balance should be checked for any error. Let the zero error be 'x'.
2. Hold the spring balance (or tie it to the stand), suspended with the metal bob in air. Measure the weight of the bob. Let its weight be 'W_F'
3. Pour the water in the measuring cylinder and record the initial volume of water, let it be ' V_1'
4. Suspend the metal bob into the measuring cylinder with water. The bob should not touch the base, nor the sides of the cylinder.
   The water level rises, measure the increased water level, let this volume be ' V_F'
5. Record all your observations in the observation table and do the calculation to find the density of a given solid metal bob.





Observations

WEIGHT OF THE SOLID (METAL BOB) (M)

Initial Reading of Spring balance, x	Final Reading of spring balance with Metal Bob (W_F)	Weight of the Metal Bob $W = W_F - x$
0	400	400

1. Weight of the given Metal Bob = 400N
2. Mass of the Metal Bob = 400/9.8 = 40.8 g

VOLUME OF THE SOLID (METAL BOB) (V)

Initial Volume of water in cylinder V_I (mL)	Final volume of water when Metal Bob is immersed V_F (mL)	Volume of the Metal Bob $V = V_F - V_I$
40	60	20

1. Volume of water displaced by solid (metal bob) = 20 ml.
2. Density of a solid (metal bob) = $\frac{40.8g}{20ml}$ = 2.04 g/cm^3
   1 mL of water = 1 cm^3

Result

The density of given solid (Metal Bob) is 2.04 g/cm^3

Precautions

1. The spring balance should be sensitive.
2. The zero error in the spring balance should be recorded before it is used to find the weight of solid.

3. Record the readings carefully of both spring balance and measuring cylinder by keeping the level of eye and the mark of reading same/parallel.
4. The solid/metal bob should not touch the bottom, or sides of the measuring cylinder.
5. If the zero error in spring balance is 1 N then subtract this error from the final reading of the weight of solid/ metal bob.

VIVA VOCE

Question 1:
Define density.
Answer:
Density is defined as the mass per unit volume.

Question 2:
State the S.I. unit of density.
Answer:
kg/m^3.

PRACTICAL BASED QUESTIONS

Question 1:
How do you find mass and weight of the body?
Answer:
To find mass I will use a beam balance and to find weight I will use a spring balance.

Question 2:
How can you convert the weight value into mass?
Answer:
The weight of a body = mass x g, to get mass, divide the given weight by g.

Question 3:
How can you measure 1 N weight?
Answer:
It can be measured by using spring balance.

Question 4:
A measuring cylinder has 5 marks between 10 mL to 20 mL. What is its least count?
Answer:
20 mL – 10 mL =10 mL, Let 'x; is the least count.
5 * x= 10
$x = \frac{10}{5} = 2$
Each mark is of 2 mL value.

Question 5:
The density of a solid is 2.5 g/cm3. What does it mean?
Answer:
It means that 2.5 g of solid has a volume of 1 cm^3

Question 6:
A rectangular body has dimensions x and y (/ and b). If its dimensions get doubled what will happen to its volume?
Answer:
Suppose the dimensions of a rectangular solid is 1 then
V = 1 x 1 x 1 (l x b x h taken as 1)
$V= l^3$
If it is doubled, then $V = 2^3$
V = 8 times
hence volume will increase by 8 times.

Question 7:
What is the principle of spring balance?
Answer:
The spring gets stretched due to the force exerted on it, this stretching produced is directly proportional to the stretching force.

Question 8:
State two precautions while measuring the volume in the cylinder.
Answer:

1. The measuring cylinder should be placed on a plain flat surface.
2. The lower meniscus and eye line should be parallel.

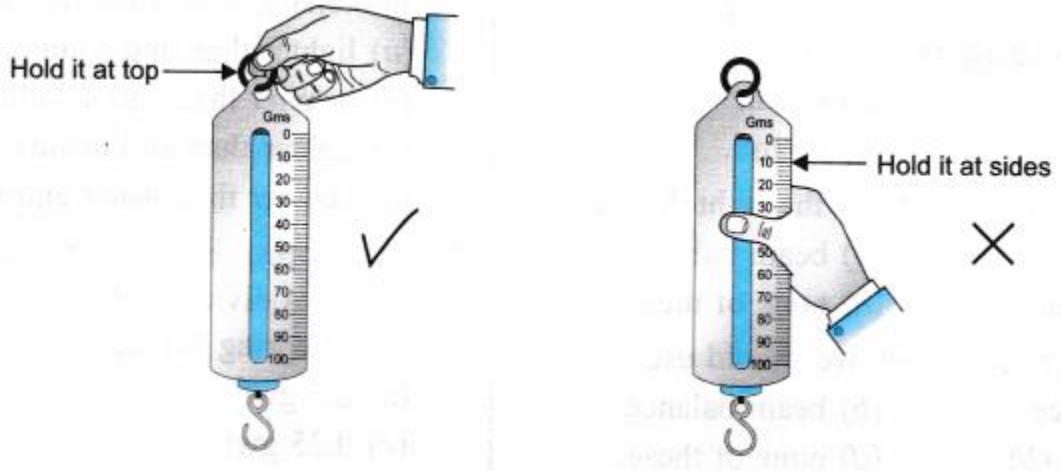
Question 9:
A spring balance has a zero error of 2 divisions and there are 10 marks between 0-10 N. Find the value of zero error.
Answer:
0-10 N has 10 divisions hence each division mark indicates 1 N. Hence, the zero error is 2 N.

Question 10:
The density of water is 1 kg/m^3 at 4° C. What will happen to its density if the temperature falls?
Answer:
With the decrease in the temperature, the density of water decreases.

Question 11:
At what temperature the density of water is maximum?
Answer:
At 4°C.

Question 12:
If you are given a choice to choose a spring balance with different least count values to do the experiment. Which one will you choose?
Answer:
I will choose the spring balance which has the minimum value of least count to get accurate readings.

Question 13:
What precautions will you take while holding the spring balance to find the weight of a body?
Answer:
The spring balance should be held only at the hook on the top end, never hold the spring balance from its sides.



NCERT LAB MANUAL QUESTIONS

Question 1:
Can you determine the density of a porous solid by using a spring balance and a measuring cylinder? Give reasons in support of your answer.
Answer:
The density of the porous solid cannot be found by using measuring cylinder and spring balance. This is because the mass of solid when immersed in water will increase instead of decreasing as it will absorb water and amount of water displaced by the porous solid will be affected.

Question 2:
How the presence of an air bubble in the liquid taken in the measuring cylinder can affect the volume of the solid?
Answer:
The air bubble in the liquid taken in the measuring cylinder for an experiment will affect the volume of the solid because the air bubble occupies some space in the liquid and this increases the volume of the liquid.

Question 3:
Density of sealing wax is 1.8 g/cm^3. Express it in kg/m^3
Answer:
Density = mass/ volume
Density of sealing wax =1.8 g/cm^3
1 g/cm^3= 1000 kg/m^3
In kg/m^3 the above density will be = 1.8 x 1000 kg/m^3 = 1800 kg/m^3

Question 4:
A metal cylinder is melted and the whole mass is cast in the shape of a cube. What happens to its density? Give reasons.
Answer:
The density in both the cases will be same because the mass remains the same and the volume of the water displaced by the metal cylinder and the cube remains the same.

Question 5:
At which temperature is the density of water maximum?
Answer:
The density of water is maximum : 4°C.

MULTIPLE CHOICE QUESTIONS (MCQs)
Questions based on Procedural and Manipulative Skills

Question 1:
To find the density 'D' of a body with mass 'M' and volume 'V', the correct formula is
(a) M = $\frac{D}{V}$
(b) D = $\frac{M}{V}$
(c) V = $\frac{D}{M}$
(d) D = M x V.

Question 2:
If W is the weight of the body, 'm' is the mass of the body and 'g' is the force of gravity acting on a body
then
(a) W = $\frac{m}{g}$

(b) W = m x $\frac{g}{2}$
(c) W = m x g
(d) W = $\frac{m}{2}$xg.

Question 3:
The S.I. unit of density is
(a) g/ cm^3
(b) kg cm^{-3}
(c) g m^{-3}
(d) kg m^{-3}.

Question 4:
To measure the mass of a body the right device is
(a) spring balance
(b) beam balance
(c) weighing machine
(d) none of these.

Question 5:
To find the weight of a body we should use
(a) spring balance
(b) beam balance
(c) both (a) and (b)
(d) none of these.

Question 6:
The density of water is maximum at temperature
(a) 0°C
(b) 100°C
(c) – 4°C
(d) 4°C.

Question 7:
Four cylinders are given with different least counts. Pick the one you will choose to find the density
(a) 1 cc
(b) 0.2 cc
(c) 5 cc
(d) 0.1 cc.

Question 8:
One kgf is equal to
(a) 1 N
(b) 98 N

(c) 9.8 N
(d) 100 N.

Question 9:
The S.I. unit of mass is
(a) g
(b) kg
(c) Newtons
(d) mg.

Question 10:
The S.I. unit of weight is
(a) g
(b) kg
(c) Newton
(d) kgf.

Question 11:
The S.I. unit of volume is
(a) cc
(b) cm^3
(c) m^3
(d) $kg^{3.}$

Question 12:
In an experiment to find the density of a solid, the device by which the volume of a solid can be measured by taking water in it is
(a) beaker
(b) conical flask
(c) measuring cylinder
(d) round bottom flask.

Question 13:
The density of which of the following cannot be measured accurately using a spring balance and a measuring cylinder?
(a) A ball filled with a liquid having a leakage
(b) A block of ice at 0°C
(c) A small porous solid
(d) All of these.

Question 14:
If we want to determine the volume of a solid by immersing it in water, the solid should be
(a) lighter than and soluble in water

(b) heavier than and soluble in water
(c) lighter than and insoluble in water
(d) heavier than water and insoluble in it.

Question 15:
In a spring balance the space between 0 and 25 g marks is divided into 10 equal parts. The least count of the spring balance is
(a) 2.5 gwt
(b) 25 gwt
(c) 0.25 gwt
(d) 15 gwt.

Question 16:
To determine the density of a solid, the solid should be
(a) lighter than water
(b) heavier than water
(c) insoluble in water
(d) heavier than water and insoluble in it.

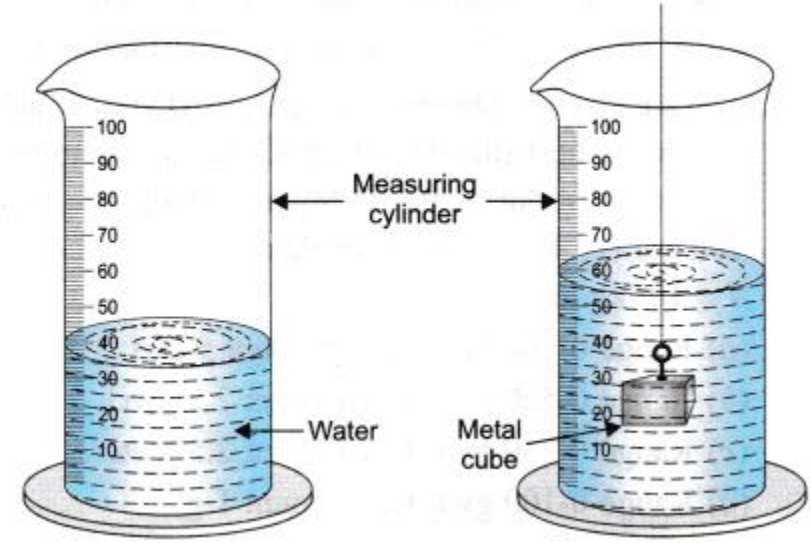
Question 17:
The relative density of water at 4°C is
(a) 1
(b) 10
(c) 1000
(d) 100.

Question 18:
While determining the density of a copper piece using a spring balance and a measuring cylinder, the following procedure is followed:
(i) Note the water level in the measuring cylinder without the copper piece.
(ii) Immerse the copper piece in water.
(iii) Note the water level in the measuring cylinder with copper piece.
(iv) Remove the copper piece from the water and immediately weigh it using a spring balance.
The wrong step in the procedure is
(a) (i)
(b) (ii)
(c) (iii)
(d) (iv)

Questions based on Observational Skills

Question 19:
The water level in a measuring cylinder, before and after immersing a metal cube in it, is

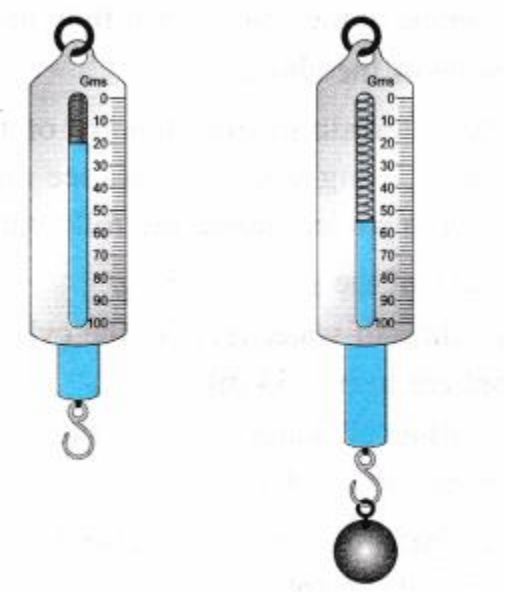
shown in the figure. The volume of the metal cube is



(a) 24 cm^3
(b) 22 cm^3
(c) 20 cm^3
(d) 18 cm^3

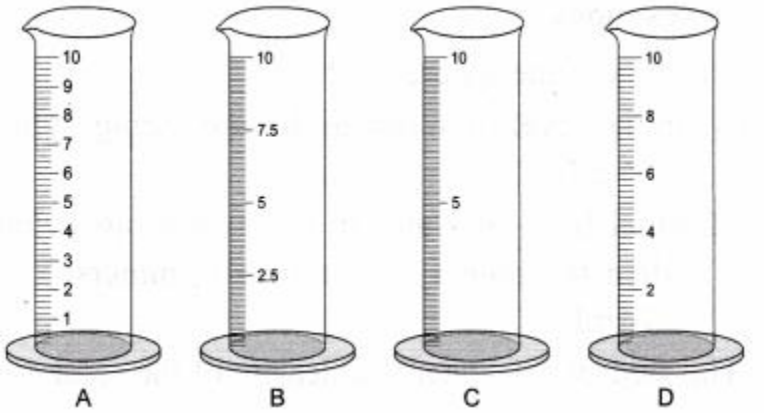
Question 20:

The spring balance shown is to measure the mass of a given solid. The mass of the solid is



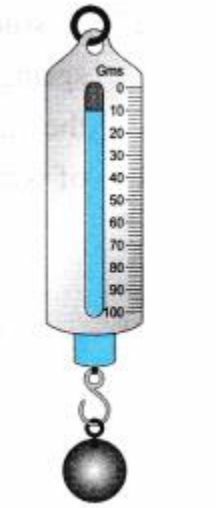
(a) 40 g
(b) 75 g
(c) 51 g
(d) 35 g

Question 21:
Four measuring cylinders with least counts are shown in figures A,B,C and D. The most suitable cylinder for determining the volume of a cube of side 1 cm is



(a) A
(b) B
(c) C
(d) D.

Question 22:
In the following figure, the zero error is



(a) 10 gwt
(b) -10 gwt
(c) 5 gwt
(d) -5 gwt.

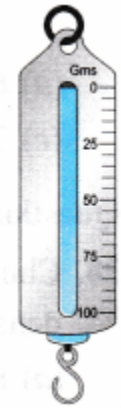
Question 23:
Four measuring cylinders with least count 2.5 ml, 1.0 ml, 0.5 and 0.2 ml are available. Which one should be preferred for finding the density of solid accurately? The one with least count
(a) 2.5 ml

(b) 1.0 ml
(c) 0.5 ml
(d) 0.2 ml.

Question 24:
The least count of the spring balance shown in the diagram is

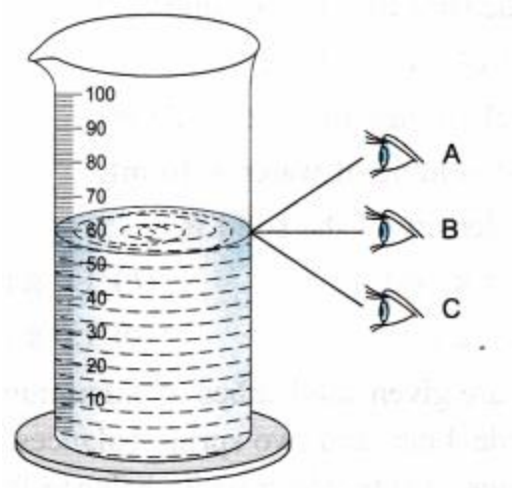
(a) 5 g
(b) 2g
(c) 1 g
(d) 0.5 g.

Question 25:
In the following diagram the least count is



(a) 2 gwt
(b) -2 gwt
(c) 5 gwt
(d) -5 gwt.

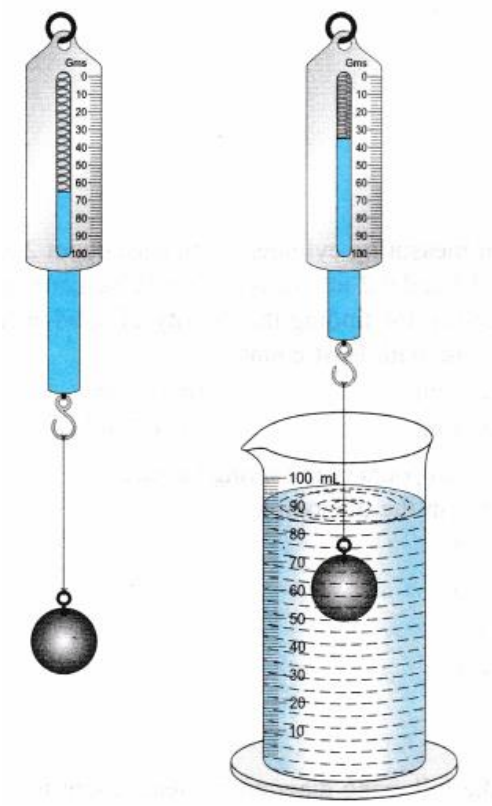
Question 26:
Three students A, B and C noted the water level reading in the measuring cylinder as shown in figure. The correct way of taking reading is of



(a) A & C
(b) Only B
(c) Only C
(d) A & B

Question 27:

A student notes down the observations in the two spring balances and the measuring cylinder shown in the figure. From the given observations, the volume of water displaced by the solid is



(a) 64 cc
(b) 36 cc

(c) 30 cc
(d) 100 cc.

Questions based on Reporting and Interpretation Skills

Question 28:
Choose the solid that can be used to determine the density by dipping in water
(a) rubber ball
(b) cork
(c) eraser
(d) metal bob.

Question 29:
A student recorded the following observations to find the density of a given solid
mass of the solid = 24 g
Initial volume of water = 25 mL
Final volume of water = 40 mL
The density of the solid is
(a) 16 kg/m^3
(b) 1.6 g/m^3
(c) 16 g/m^3
(d) 1.6 g/cm^3

Question 30:
You are given solid cubes of aluminium and iron each of side 4 cm, and two spring balances. Balance A has a range of 0 to 250 g while balance B has a range of 10 to 1000 g. The performed option for precise mass measurement would be to use the balance
(a) A for both
(b) B for both
(c) A for aluminium cube and B for iron cube
(d) A for iron cube and balance B for aluminium.

Question 31:
You are given a sphere of radius 2 cm. If you are asked to select a best suited spring balance to determine its weight, then out of the following which one would you prefer? The sphere is made of an alloy of density 7 x 103 kg m^{-3}
(a) Range 0-1000 gwt, least count 5 gwt.
(b) Range 0-500 gwt, least count 2.5 gwt.
(c) Range 0-250 gwt, least count 2.5 gwt.
(d) Range 0-100 gwt, least count 1 gwt.

Question 32:
In an experiment when an object is immersed in water, the volume of the displaced water gives
(a) mass of the object immersed
(b) weight of the object immersed
(c) volume of the object when fully immersed in water
(d) none of the above.

Question 33:
While determining the density of the material of a sphere, using a spring balance and a measuring cylinder, a student noted the following readings
(i) mass of the sphere = 81 g
(ii) reading of water level in the cylinder without the sphere in it = 54 mL
(iii) reading of water level in the cylinder with the sphere in it = 63 mL
On the basis of these observations, the density of the material of the sphere is
(a) 1500 kg/m^3
(b) 6000 kg/m^3
(c) 7000 kg/m^3
(d) 9000 kg/m^3.

Question 34:
While determining the density of the material of a metallic sphere using a spring balance and a measuring cylinder, a student noted the following observations
(i) Mass of the sphere = 72 g
(ii) Initial level of water in the measuring cylinder = 65 mL
(iii) Final level of water in the measuring cylinder when the object is completely immersed in it = 74 ml.
The student calculated the density of the solid as
(a) 2000 kg m^{-3}
(b) 9000 kg m^{-3}
(c) 8000 kg m^{-3}
(d) 6000 kg m^{-3}

Question 35:
The amount of heat energy lost by a hot body in a given time depends on
(a) the area of its surface
(b) the temperature of its surface
(c) the nature of the surface
(d) all of the above.

Question 36:
The liquid having the highest density among the following is
(a) Mercury
(b) Water

(c) Alcohol
(d) Sea Water.

SCORING KEY WITH EXPLANATION

1. (b) It is the relationship between D, M and V.
2. (c) W = mg, is how the weight of the body calculated.
3. (d) D = $\frac{M}{V}$, S.I. unit of M = kg and V = m^3
4. (b) Mass is the quantity of matter, it is measured best by beam balance.
5. (a) The mass is acted by gravitational force hence spring balance measures the weight of the body.
6. (d) The water is heavier at 4°C, unique property of water.
7. (d) Smaller the least count better are the results.
8. (c) kg is kilogram force, which means mass x g = 9.8 N.
9. (b) kg is the S.I. unit of mass.
10. (c) Weight = m x g, the value is given in Newton, S.I. unit of weight.
11. (c) It is the SI unit of volume.
12. (c) Measuring cylinder measures the liquid.
13. (d) The solid that is non-porous, denser than water, insoluble and is stable can be used to determine its density using water.
14. (d) The solid that is non-porous, denser than water, insoluble and is stable can be used to determine its density using water.
15. (a) 2.5 x 10 = 25.
16. (d) The solid that is non-porous, denser than water, insoluble and is stable can be used to determine its density using water.
17. (a) The relative density is compared with the density of water.
18. (d) The step (iv) is not required.
19. (c) 60 – 40 = 20.
20. (d) The spring balance is showing the zero error and hence the reading shown in error is subtracted from the final reading (55 – 20 = 35).
21. (a) Cylinder A shows the graduated scale with lowest range.
22. (a) The reading on the spring balance when suspended freely in the air.
23. (d)Smaller the least count, better and more accurate are the results.
24. (b)Between 0 to 20 there are 10 markings hence each marking measure 2g.
25. (c)Between 0 to 25 there are 5 markings hence each marking measure 5g.
26. (b)To avoid parallax error, the eye level and water level should align parallel.
27. (c)The volume of solid (in cc) has the same magnitude as its loss in weight (in grams) in water. 65 – 35 = 30 cc
28. (d)Heavier body that can dip in water and displace water can be used to find the density by using water.
29. (d)D = $\frac{M}{V}$, D = $\frac{24}{15}$ = 1.6 g/cm^3
30. (c)Aluminium is lighter and iron is denser metal.
31. (c)The dimension of sphere is very small.
    volume of sphere = $\frac{4}{3}\pi r^3 = \frac{4}{3} X \frac{22}{3} X 0.22 m^3$ =3.55×10^{-3} m^3
    Density = 7x 10^{-3} kg m^{-3}

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

So, mass = density x volume

= (7x 10^{-3} kg m^{-3}) x (3.35 x 10^{-5} kg m^{-3}) = 0.235 kg = 235 g

Range 0 – 250 g wt, least count 2.5 g wt is used.

32. (c)As per the Archimedes' principle.
33. (d)D = M/V, D = $\frac{81}{9}$ = 9000 kg/m^3

When taken in S.I units.

34. (c)D = M/V, D = $\frac{72}{9}$= 8000 kg/m^3When taken in S.I units.
35. (d)These are the factors on which the loss of heat by a body depends.
36. (a)The density of mercury is 13590, which is the highest among the given liquids.