Pressure – Experiment, Viva Voce

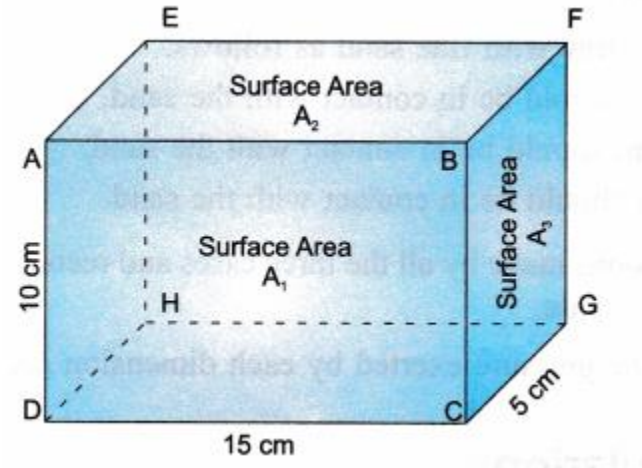
EXPERIMENT

Aim
To observe and compare the pressure exerted by a solid iron cuboid on fine sand/ wheat flour while resting on its three different faces and to calculate the pressure exerted in the three different cases.

Theory

1. **Thrust:** The net force exerted by a body in a particular direction. (Thrust = weight of body)
2. This force is perpendicular to the surface. When you stand on loose sand or lie down on the sand, the thrust acting on the surface is same, but the effects are different. Pressure increases with decrease in the area of contact. S.I. unit of Thrust is newton (N).
3. **Pressure:** The thrust acting on unit area is called pressure.
4. S.I. unit of pressure = (N m^{-2}) or pascal (Pa)
   1 Pa = 1 N/l m^2

Cuboid and its surface area
Cuboid: It is a rectangular parallelepiped whose faces are not equal in length. A solid cuboid has six faces. A pair of opposite faces are equal and have same surface area. In the given cuboid (figure)



Area of face ABCD
i. e. Surface Area = length x breadth = 15 cm x 10 cm =150 cm^2

Area of face BCGF
Surface Area A2= length x breadth = 10 cm * 5 cm = 50 cm^2

Area of face ABFE
Surface Area A3 = length x breadth = 15 cm x 5 cm = 75 cm^2

Materials Required
A solid cuboid made of iron with dimensions 5 cm x 10 cm x 15 cm, a tray with fine sand/beach sand (Tray: 10 x 20 x 30 cm), spring balance, sting and clamp stand.

A. Determination of weight of the given cuboid
Procedure

1. Tie the string to the cuboid.
2. Note the zero error of the spring balance.
3. Suspend the cuboid on the hook of the spring balance that is hung on the clamp stand.
4. Note the reading of the spring balance. If the spring balance shows the reading in newtons, record the reading shown as the weight of the cuboid.
   If the spring balance shows the reading in g, then convert the reading into newtons, as follows:
   Convert the 'g' into kg. Multiply it with (g = 9.8 m/s^2)

Observations

1. Number of divisions on spring balance between 0 to first (W_0) reading……. (n)
2. Least reading of the spring balance = $\frac{W_0}{n}$ =…….
3. Reading of spring balance suspended freely in air (zero error) = '0'
4. Weight of the Cuboid =…….. N.

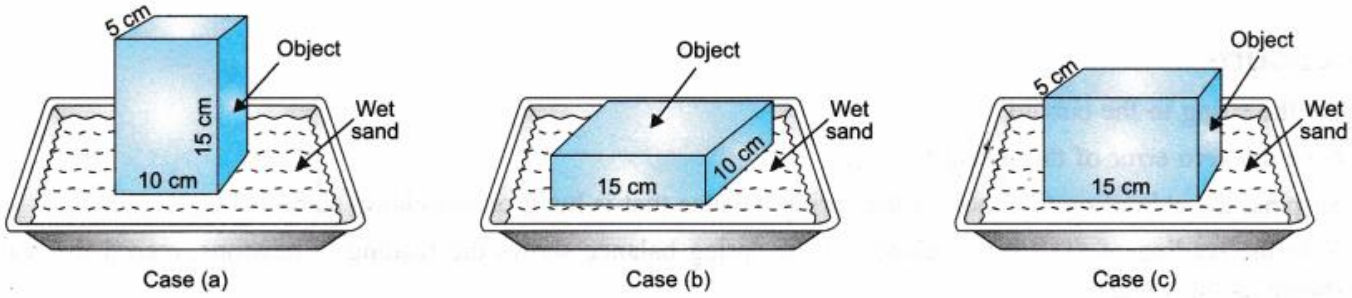
B. Determination of the pressure exerted by different faces of cuboid
Procedure

1. On a plain table keep a tray as shown in the figure.
2. Fill in the tray with fine sand.
3. Place the solid cuboid on the tray with fine sand as follows:
   Case (a) Face 5 cm x 10 cm should be in contact with the sand.
   Case (b) Face 10 cm x 15 cm should be in contact with the sand.
   Case (c) Face 5 cm x 15 cm should be in contact with the sand.
4. Carefully observe the depressions made by all the three cases and record the maximum and the minimum depression caused by the cuboid using a scale.
5. Do the calculations to find the pressure exerted by each dimension i.e. case a, b and c.

Observation and calculations

1. The maximum depression in the sand is seen in case (a) .
2. The minimum depression in the sand is seen in case (b) .

1. The weight of the cuboid = 1 kg
2. Thrust exerted by the cuboid = (Force) = m x a
e.g. = 1 x 9.8 m/s^2 = 9.8 N
Thrust exerted by any surface of the cuboid remains the same = 9.8 N.
3. Surface area
Case (a) 5 cm x 10 cm = 50 cm2 = 5 $x10^{-3}$ m^2
Case (b) 10 cm x 15 cm = 150 cm2 = 15 $x10^{-3}$ m^2
Case (c) 5 cm x 15 cm = 75 cm2 = 75 $x10^{-4}$ m^2



Observation Table
Mass of the cuboid (m) = 1000 g = 1 kg.

Case	Surface area of contact (A_s)	Thrust (T) m × g	Pressure (Pa) = $\frac{\text{Force}}{\text{Area}} = \frac{T}{A_S}$	Measurement of depression on sand (h)
(*a*)	5×10^{-3} m^2	1 × 9.8 N = 9.8 N	1960	2 cm
(*b*)	15×10^{-3} m^2	1 × 9.8 N = 9.8 N	653.3	0.5 cm
(*c*)	75×10^{-4} m^2	1 × 9.8 N = 9.8 N	1306.07	1.5 cm

Conclusion
For any given cuboid

1. Smaller the surface area of contact, greater is the pressure exerted.
2. The pressure exerted by the body depends on the surface area that comes in contact with the sand.
3. The depression on the sand is directly proportional to the pressure exerted by the body.

Precautions

1. Carefully and gently place the cuboid on the sand.
2. The spring balance should be checked for proper range and zero error.
3. Weight of the cuboid and measuring of the height of depression on sand should be taken accurately.
4. Sand should be wet.

VIVA VOCE

Question 1:
Define thrust.
Answer:
The force acting on a body perpendicular to its surface is called thrust.

Question 2:
Give the S.I. unit of thrust.
Answer:
Newton

Question 3:
Define pressure.
Answer:
Thrust exerted per unit area is called pressure.

Question 4:
State the S.I. unit of pressure.
Answer:
Pascal (Pa).

Question 5:
What is one pascal?
Ans.
When a force of 1 N acts on a surface area of 1 m^2 then the pressure is said to be one pascal.

Question 6:
What is the blood pressure of a normal human being?
Answer:
It is 120/80 mm of mercury. The blood flows in the vessels by a pressure that it can withstand.

PRACTICAL BASED QUESTIONS

Question 1:
A body with dimensions 1 cm x 2 cm x 3 cm is placed on sand with three different surfaces. In which case the thrust exerted is more?
Answer:
The thrust exerted by the surface of dimension 1 cm x 2 cm will be more, because it has least area than 2 cm x 3 cm and 1 cm x 3 cm surfaces.

Question 2:
How are pressure, force and area related to each other?
Answer:
Pressure= $\frac{Force}{Area}$
If force increases the pressure exerted also increases. If the area decreases the pressure increases.

Question 3:
Why do nails have pointed tips?
Answer:
The pointed tip of nail reduce the surface area, so that the force exerted by it on wall while hammering result in higher pressure and fixes in the surface.

Question 4:
Give three examples where we have decreased the area to increase the pressure.
Answer:

1. knife
2. thumb pins
3. needle.

Question 5:
Give three examples where we have increased the area to reduce the pressure.
Answer:

1. Wider walls of dams.
2. Broad straps of a bag.
3. Broader and more tyres in loaded trucks.

Question 6:
A cuboid of mass 5 kg and dimensions 5 x 10 x 20 cm is given, how will you place it so that

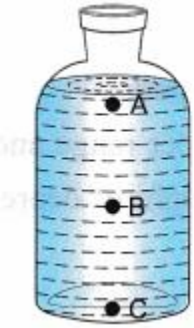
1. maximum pressure is exerted and

2. minimum pressure is exerted?

Answer:

1. To get maximum pressure minimum contact surface area should rest. i.e. 5 cm x 10 cm.
2. To get minimum pressure the maximum surface area of cuboid should be in contact.
   i. e. 10 cm x 20 cm

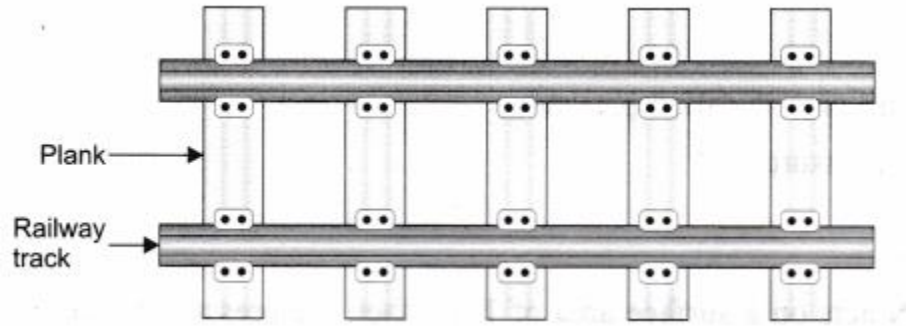
Question 7:
A bottle is filled with water it has three points A, B and C as shown in the figure, at which point the pressure exerted is maximum.



Answer:
The pressure is maximum at point C, because it has maximum depth.

Question 8:
What happens to the gases if pressure is exerted on it?
Answer:
On increasing the pressure on gases, it gets compressed.

Question 9:
Why does railway tracks have wooden planks under it?



Answer:
On the railway track, trains keep moving with pressure being exerted every time and this pressure is distributed to wider area by the planks so that the tracks do not sink into the surface.

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

Question 1:
The S.I. unit of pressure is
(a) N
(b) Nm
(c) Nm^2
(d) Pascal.

Question 2:
Pressure is defined as
(a) Volume of the body on per unit area
(b) Thrust per unit area
(c) Surface per unit area
(d) Mass per unit area.

Question 3:
The atmosphere exerts pressure on a body. This pressure depends on
(a) Surface area of the body
(b) Air column of the atmosphere
(c) Surface area of the air columns
(d) Air column and surface area of contact.

Question 4:
One pascal is equal to
(a) 1 dyne/cm^2
(b) 1 Nm
(c) 1 dyne/m^2
(d) 1 Nm^{-2}

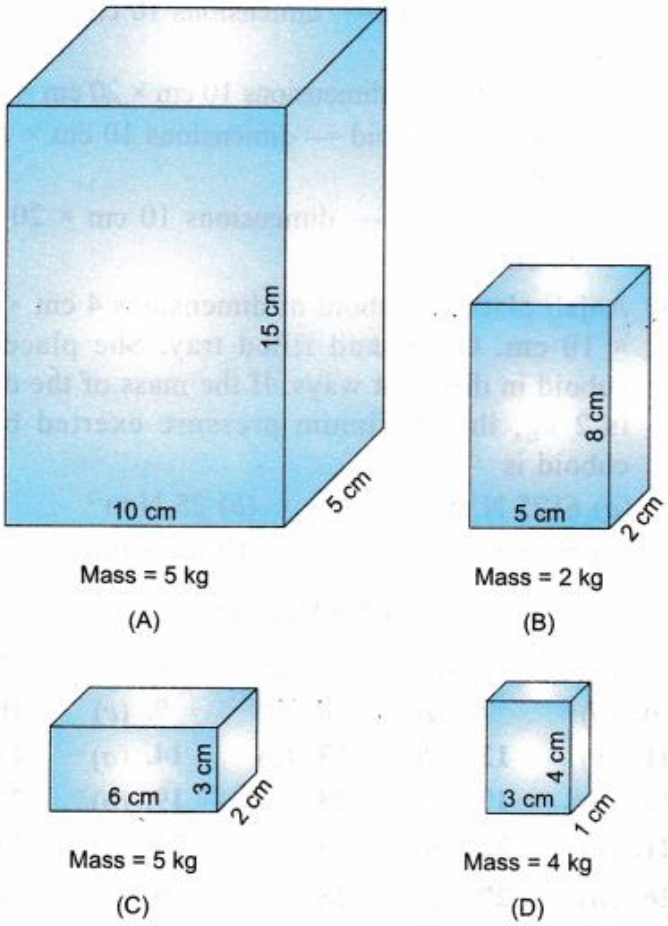
Question 5:
Pressure is inversely proportional to
(a) Volume
(b) Length
(c) Height
(d) Area.

Question 6:
The apparatus required for comparing the pressure exerted by a solid iron cuboid should be
(a) Tray, sand, water, spring balance and scale.
(b) Tray, fine sand, scale, spring balance and string
(c) Tray, coarse sand, scale, spring balance and string
(d) Tray, fine wet sand, scale, spring balance and string.

Questions based on Observational Skills

Question 7:
To find the weight of the cuboid, the spring balance that one should use for accurate reading is of
(a) range 0 to 100 g and least count 1 g
(b) range of 0 to 100 g and least count 5 g
(c) range of 0 to 1000 g and least count 50 g
(d) range of 0 to 1000 g and least count 10 g.

Question 8:
Four objects of the dimensions as given below exerts pressure



(a) Block (A) exerts maximum pressure
(b) Block (B) exerts maximum pressure
(c) Block (C) exerts maximum pressure
(d) Block (D) exerts maximum pressure.

Questions based on Reporting and Interpretation Skills

A cuboid of dimensions 10 cm x 20 cm x 40 cm whose mass is given as 5 kg. (Now answer questions from 9 to 14 based on this)

Question 9:
The thrust exerted by the cuboid is
(a) 5 N
(b) 800 N
(c) 49 N
(d) 4.9 N.

Question 10:
The pressure exerted will be maximum when the surface area in contact with table is
(a) 2000 cm^2
(b) 400 cm^2
(c) 0.02 m^2
(d) 4 m^2.

Question 11:
The cuboid will exert least pressure when surface area in contact is
(a) 10 cm x 40 cm
(b) 40 cm x 20 cm
(c) 20 cm x 10 cm
(d) all of these.

Question 12:
The maximum thrust exerted by a cuboid will be
(a) when contact surface is 10 cm x 20 cm
(b) when contact surface is 20 cm x 40 cm
(c) when contact surface is 20 cm x 10 cm
(d) same in all the cases.

Question 13:
The S.I. unit of thrust is
(a) kg/m^2
(b) Pa
(c) Newton
(d) kg wt.

Question 14:
To increase the pressure exerted by a solid its surface area of contact should be
(a) least
(b) maximum
(c) both (a) and (b)
(d) none of these.

Question 15:
A body of mass 3 kg will exert thrust equal to
(a) 3 kg f
(b) 2.94 N
(c) 29.4 N
(d) 29.4 kg f.

Question 16:
What can be the maximum pressure exerted by a cuboid whose weight is ION and dimension is 10 cm x 20 cm x 30 cm?
(a) 500 Pa
(b) 50 Pa
(c) 300 Pa
(d) 30 Pa

Question 17:
In which of the following cases pressure is increased?
(a) Sharpening the pencil.
(b) Breaking the tip of needle
(c) broadening the wall of dam
(d) shoes with flat soles

Question 18:
The pressure exerted by a body depends on
(a) Area of the body
(b) Surface area of the body
(c) Volume of the body
(d) Contact area of the body.

Question 19:
Railway tracks have wooden blocks under it. These wooden blocks helps in
(a) reducing the pressure exerted on rails
(b) reducing the surface area of contact
(c) easing movement of rail
(d) rail track maintenance.

Question 20:
The pressure exerted by a body increases if the surface area of body is *'
(a) maximum
(b) least
(c) both (a) & (b)
(d) none of the above.

Question 21:
To reduce the pressure exerted by a body we can increase its
(a) Volume
(b) Area of contact
(c) Force of a body
(d) Momentum.

Question 22:
Two friends Tina & Heena visits beach. Tina wore high heels and Heena wore sports shoe. Both of them had same weight. Who is exerting less pressure on the sand?
(a) Tina
(b) Heena
(c) both (a) & (b)
(d) None

Question 23:
A body with dimensions 5 cm x 10 cm x 20 cm is placed on sand. In which case will it exert more thrust?
(a) 5 cm x 10 cm
(b) 10 cm x 20 cm
(c) 5 cm x 20 cm
(d) Same in all cases.

Question 24:
The application of "decrease the area to increase the pressure" is seen in
(a) knife
(b) straps of bag
(c) both (a) & (b)
(d) none.

Question 25:
The application of "increase the area to reduce pressure" is seen in
(a) needle
(b) thumb pin
(c) wider walls of dam
(d) knife.

Question 26:
A cuboid of mass 2 kg and dimensions 3 cm x 10 cm x 15 cm is given. How will you place the cuboid so that minimum pressure is exerted on sand?
(a) 3 cm x 10 cm
(b) 10 cm x 15 cm
(c) 3 cm x 15 cm
(d) All of the above.

Question 27:
In the above set-up, how will you place the cuboid so that maximum pressure is exerted on sand?
(a) 3 cm x 10 cm
(b) 10 cm x 15 cm
(c) 3 cm x 15 cm
(d) All of the above.

Question 28:
If the density of a cuboid is 10 g/cm^3 and g = 10 m/s^2 and the dimension is 4 cm x 8 cm x 10 cm, the weight of the cuboid and the maximum pressure exerted by it is
(a) 0.1 N; 3.125 N/m^2
(b) 320 N, 3.125 N/m^2
(c) 100 N; 1 N m^{-2}
(d) 32 N, 10000 N m^{-2}.

Question 29:
Which of the following cuboid will exert the maximum pressure on the sand?
(a) Wooden cuboid — dimensions 10 cm x 20 cm x 30 cm
(b) Iron cuboid — dimensions 10 cm x 20 cm x 30 cm
(c) aluminum cuboid — dimensions 10 cm x 20 cm x 30 cm
(d) Plastic cuboid — dimensions 10 cm x 20 cm x 30 cm

Question 30:
Anjali placed a cuboid of dimensions 4 cm x 8 cm x 10 cm. On a sand filled tray. She placed the cuboid in different ways. If the mass of the cuboid is 2 kg, the maximum pressure exerted by the cuboid is
(a) 6125 N m^{-2}
(b) 25 N m^{-2}
(c) 50 N m^{-2}
(d) 65 N m^{-2}.

SCORING KEY WITH EXPLANATION

1. (d) Pascal (Pa) is the S.I. unit of Pressure.
2. (b) P = $\frac{F}{A}$.

3. (d) The force exerted by air on the body and the contact area of the force.
4. (d) 1P= 1N/1m^2, as P = $\frac{F}{A}$.
5. (d) Pressure is inversely proportional to the area, less the area more is the pressure.
6. (d) The procedure and the material requirements.
7. (a) Devices having maximum range with lowest least count gives less errors.
8. (d) P = $\frac{F}{A}$, 4 x$\frac{9.08}{0.03}$ is the maximum.
9. (c) F = m x g, 5 x 9.8 = 49N.
10. (c) Pressure is inversely proportional to the area, less the area more is the pressure.
11. (b) Pressure is inversely proportional to the area, less the area more is the pressure.
12. (d) Thrust is the force exerted by a body which is m x g.
13. (c) The S.I. unit is fixed for thrust i.e., Newton.
14. (a) Pressure is inversely proportional to the area, less the area more is the pressure.
15. (c) F = m x g, 3 x 9.8 = 29.4N.
16. (a) Pressure = $\frac{Force}{Area}$, $\frac{10}{0.02}$ = 500 Pa.
17. (a) Sharpened pencil has reduced area.
18. (d) P = $\frac{F}{A}$, the area here means the contact area.
19. (a) The planks are wide enough to distribute the pressure on wider area.
20. (b) Pressure is inversely proportional to the area, less the area more is the pressure.
21. (b) Pressure is inversely proportional to the area, less the area of contact more is the pressure.
22. (b) Flat shoes distribute the force. Thrust to more area of contact thereby reducing the pressure exerted.
23. (d) Thmst is the force exerted by a body which is m x g.
24. (a) In knife the sharpening reduces the contact area thereby increasing the pressure exerted by it.
25. (c) In dams the water column exerts more pressure at the bottom hence the base walls are thicker.
26. (b) Use more contact area.
27. (a) Use less contact area.
28. (d) M = D x V ,W = M x g, and pressure = $\frac{Thrust}{Area}$.
29. (b) The density of iron is the maximum among the given materials, hence it will exert maximum thrust.
30. (a) Using the least contact surface area, P = $\frac{F}{A}$,
    F = m x g.