# Ordinary Level Physics SOLUTIONS: *MOMENTS AND PRESSURE*

**2015 Question 12 (a) [Ordinary Level]**

**A bicycle can be steered by applying a pair of equal but opposite forces to the handlebars, which act as a lever.**

(i) **What is meant by the term *lever*?**
rigid body 3 free to rotate

(ii) **What is the name given to the turning effect of a force?**
moment//torque

(iii) **What is the name given to a pair of equal but opposite forces?**
couple

(iv) **A cyclist's hands are placed 40 cm apart on the ends of the handlebars.**
**To turn the bicycle, he applies a force of 20 N through each hand.**
**Calculate the turning effect of the force.**

$M = Fd$
$M = 0.4 \times 20 = 8$ (N m)

**2014 Question 12 (b) [Ordinary Level]**

(i) **State the unit of pressure.**
Pa / N $m^{-2}$

(ii) **Describe an experiment to demonstrate that the atmosphere exerts pressure.**
*apparatus:* glass of water and cardboard // can of water and heat source
*procedure:* place cardboard over glass and invert // boil water and put on lid
*observation/conclusion:* water remains in glass // can collapses

(iii) **State Archimedes' principle.**
The upthrust (on a body immersed in a liquid) is equal to the weight of the liquid displaced.

(iv) **What is the upthrust (buoyancy force) on the object caused by the liquid?**
3 N

(v) **Will the object float in the liquid if released?**
No

**Explain your answer.**
the upthrust is less than the weight, it is more dense, diagram shows it immersed

**2013 Question 12 (a) [Ordinary Level]**

(i) **Define pressure.**
Pressure = Force ÷ Area

(ii) **Describe an experiment to show that the atmosphere exerts pressure.**
*apparatus*: can (containing water) // can (of air) // glass of water
*procedure*: boil water in can // pump // cardboard / lid seal / invert in cold water // air out // invert
*observation/conclusion*: can crushes / collapses

(iii) **Calculate the decrease in pressure on the diver as she swims upwards.**
pressure due to water at 50 m**:** ($p = \rho gh = (10^3)(9.8)(50) =$) $4.9 \times 10^5$ Pa
pressure due to water at 20 m**:** ($p = \rho gh = (10^3)(9.8)(20) =$) $1.96 \times 10^5$ Pa
decrease in pressure due to water**:** $= 4.9 \times 10^5 - 1.96 \times 10^5 = 2.94 \times 10^5$ Pa

**2011 Question 12 (a) [Ordinary Level]**

**(i) State Boyle's law.**

(for a fixed mass of gas kept at a constant temperature) the pressure is inversely proportional to the volume // $PV = k$ (when $T$ and $m$ are fixed)

**(ii) Describe an experiment to demonstrate that the atmosphere exerts a pressure.**

*apparatus*: can (containing water) // can (of air) // glass of water
*procedure*: boil water in can // pump // cardboard / lid
seal / invert in cold water // air out // invert
*observation/conclusion*: can crushes / collapses // lid supported

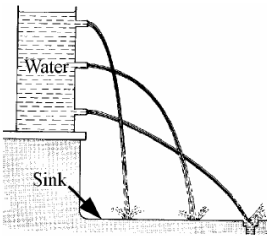
**(iii) What volume of gas will be available at the top of Mount Everest, when the gas is released from the tank?**

$P_1V_1 = P_2V_2$
$(4.2 \times 10^6)(5) = (3.0 \times 10^4)(V_2)$
$V$= 700 litres

**2009 Question 12 (a) [Ordinary Level]**

**(i) Define pressure.**

Pressure is defined as force/area.




**(ii) Describe an experiment to show that the pressure in a liquid increases with depth.**

Set up as shown.
Note that the water coming out of the hole at the bottom travels the farthest because it is under the greatest pressure.

**(iii) A diver is swimming at a depth of 5m. He then dives deeper until he reached a depth of 30 m. Calculate the increase in pressure on the diver at this new depth**

Pressure at 30 m: ($p = \rho gh = (10^3)(9.8)(30) =$) $2.94 \times 10^5$ Pa
Pressure at 5 m: ($p = \rho gh = (10^3)(9.8)(5) =$) $0.49 \times 10^5$ Pa
Increase in pressure at 30 m: $= 2.94 \times 10^5 - 0.49 \times 10^5 = 2.45 \times 10^5$ Pa
($p = \rho gh$ ; density of water = 1000 kg $m^{-3}$ ; g = 9.8 m $s^{-2}$)

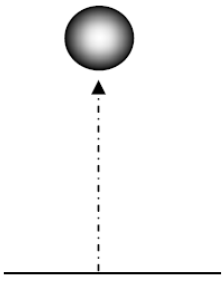
**2007 Question 12 (b) [Ordinary Level]**

**(i) Define pressure.**

Pressure = Force divided by Area.

**(ii) Describe an experiment to demonstrate that the atmosphere exerts pressure.**

Apparatus: glass of water and cardboard
Procedure: place cardboard over glass and invert
Observation/conclusion: water remains in glass



**(iii) State Boyle's law.**

Boyle's Law states that at constant temperature, the volume of a fixed mass of gas is inversely proportional to its pressure.

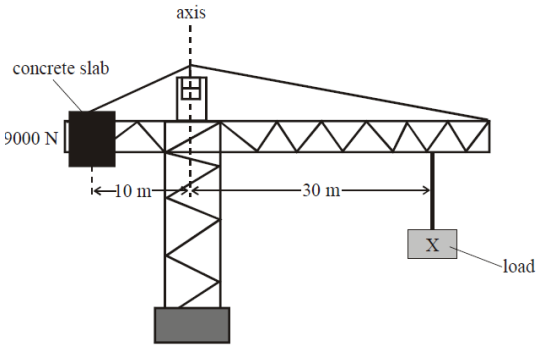
**(iv) A balloon rises through the atmosphere while the temperature remains constant. The volume of the balloon is 2 $m^3$ at ground level where the pressure is 1000 hPa. Find the volume of the balloon when it has risen to a height where the atmospheric pressure is 500 hPa.**

$(P_1V_1 = P_2V_2) \Rightarrow 1000 \times 2 = 500 \times V_2$. $\Rightarrow V_2 = (1000 \times 2)/500 = 4$ $m^3$.

**(v) What will happen to the balloon as it continues to rise?**

It will continue to expand

**2006 Question 12 (a) [Ordinary Level]**




**(i) Define the moment of a force.**
The moment of a force is equal to the force multiplied by the distance between the force and the fulcrum.

**(ii) The diagram shows a crane in equilibrium.**
**Give one condition that is necessary for the crane to be in equilibrium.**
The clockwise moments must equal the anticlockwise moments.

**(iii) What is the moment of the 9000 N concrete slab about the axis of the crane?**
Moment = F × distance = 9000 × 10 = 9000 N m.

**(iv) Calculate the value of the load marked X.**
$9000 \times 10 = 30x \quad \Rightarrow \quad x = 3000$ N.

**(v) A crane is an example of a lever. Give another example of a lever.**
Crowbar / nailbar / nutcracker / wheelbarrow / tongs / door handle etc.

**2005 Question 6 [Ordinary Level]**

**(i) Define pressure and give the unit of pressure.**
Pressure = force ÷ area. The unit of pressure is the pascal.

**(ii) Name an instrument used to measure pressure.**
The barometer.

**(iii) The earth is covered with a layer of air called the atmosphere. What holds this layer of air close to the earth?**
Gravity.

**(iv) Describe an experiment to show that the atmosphere exerts pressure.**
Apparatus: glass of water and cardboard
Procedure: place cardboard over glass and invert
Observation/conclusion: water remains in glass

**(v) The type of weather we get depends on the atmospheric pressure. Describe the kind of weather we get when the atmospheric pressure is high.**
Good weather, dry, clear skies, little wind, settled.

**(vi) The African elephant is the largest land animal.**
**An elephant weighs 40 000 N and is standing on all four feet each of area 0.2 $m^2$.**
**Calculate the pressure exerted on the ground by the elephant.**
$P = F/A \quad \Rightarrow \quad P = 40\,000/0.8 \quad \Rightarrow \quad P = 5{,}000$ Pa.

**(vii) Why would the pressure on the ground be greater if the elephant stood up on just two feet?**
The area would be smaller.

## 2003 Question 12a [Ordinary Level]

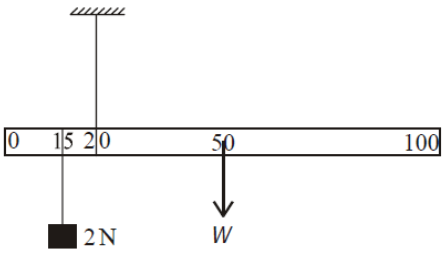
**(i)** **Define the moment of a force.**
The moment of a force = the force × perpendicular distance between the force and the fulcrum.

**(ii)** **Explain why the handle on a door is on the opposite side to the hinges of the door.**
In order to maximise the distance between the force and the fulcrum.

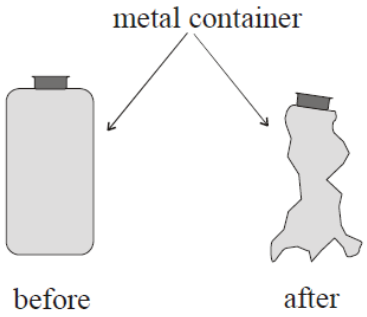
**(iii)** **A metre stick is suspended by a thread at the 20 cm mark as shown in the diagram. The weight *W* of the metre stick acts through the 50 cm mark. A weight of 2 N is placed at the 15 cm mark. Calculate the moment of the 2 N weight about the 20 cm mark.**
M = F × d = 2 × 0.05 = 0.1 N m.

**(iv)** **What is the moment of *W* about the 20 cm mark?**
M = F × d = 0.3 W N m

**(v)** **If the metre stick is in equilibrium, find the value of *W*.**
0.1 = 0.3W □ W = 0.33 N




## 2002 Question 12a [Ordinary Level]




**(i)** **What is meant by pressure? Give the unit of pressure.**
Pressure is force divided by area. The unit of pressure is the pascal.

**(ii)** **Name an instrument used to measure pressure.**
The barometer.

**(iii)** **When air is removed from the metal container shown in the diagram, it collapses. Explain why.**
The pressure outside (due to atmospheric pressure) is greater than the pressure inside.

**(iv)** **The wind exerts a horizontal force of 1000 N on a wall of area 20 $m^2$. Calculate the pressure at the wall.**
P = F/A = 1000/20 = 50 Pascals.