FORM 5 SPM PHYSICS SHORTHAND NOTES
Chapter 2 Pressure
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1.0 Do you Feel the Pressure?

Peer pressure = They don't like you enough

Gas/ Water pressure = They don't like you at all

Pressure, *P* is the **force, *F*** exerted per unit **area, *A***

$$P = \frac{F}{A}$$

Gas pressure: The force exerted by air molecules.

Liquid pressure: The force exerted by _______ molecules.

The SI unit for force is ___________.

The SI unit for area is ____________.

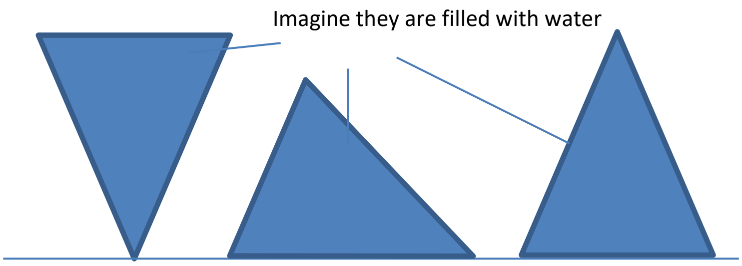
The unit for pressure is then ______________ or ________.

Give some examples for the application of pressure.

____

Which of the following orientation do you think exerts the biggest pressure on the surface? *Hint: think about the area*

____

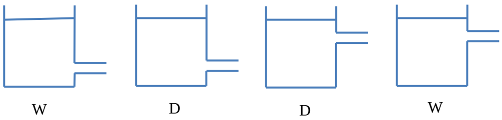


Calculate the pressure exerted on the surface for each orientation assuming the mass of the object is 100kg. The contact area for each orientation is $10cm^2$, $100cm^2$ and $1cm^2$ respectively. *Hint: Recall Chapter 1*

2.0 The Pressure Exerted by Liquids

Fluids exert pressure on the fluids below due the *weight* of the fluid. The pressure acts in all directions. The 3 factors affecting fluid pressure are the *depth* and *density* of the fluid and *acceleration due to gravity*.

Which of the following do you think will "shoot" the farthest? *Hint: Density of D < Density of W. Think logically…….*



Why?

Rewrite the pressure formula in terms of ρ, h and g.

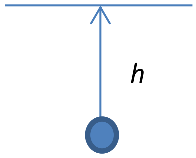
Hint 1 Write out the "original" pressure formula

Hint 2 What is the equation for weight (or force)?

Hint 3 Mass is equal to density x volume

Hint 4 Volume is equal to area x height of the fluid.

Hint 5 Assume both area are the same.



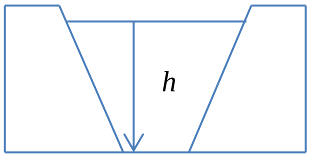
What is the pressure exerted by the water on the bubble assuming h is

a) 1m?

b) 5m?

c) 10m?

Hint: Density of water is 1000 kgm^{-3}



Calculate the depth of the water if the maximum pressure at the base of the dam is 750 kPa.

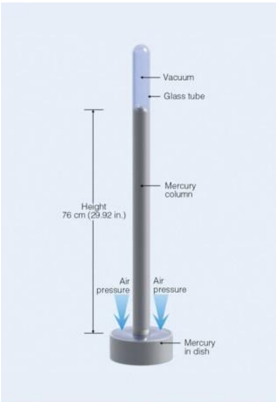
Sketch the graph of pressure vs the depth of the water. *Hint: 0 meters starts from the surface of the water.*

3.0 The Pressure Exerted by Gas

Recall the kinetic theory of gas. The theory assumes that

1) Gas particles are infinitely small and located far from each other
2) Gas molecules are in fast and continuous motion and collide with each other. Think Brownian motion.
3) This collision with each other is perfectly elastic

So gas pressure is a result of the perfectly elastic collision of gas molecules with anything. An example of pressure exerted by gas is all around you; it's called atmospheric pressure. The value of atmospheric pressure is 1 atm at sea level. When you go above sea level, this value *increases/ decreases*. When you go below sea level this value *increases/ decreases*.



A **mercury barometer** is used for measuring atmospheric pressure. Base on the height, *h* of the mercury the pressure of the atmosphere can be determined. 1 atm = 0.76 meters of Hg (760 mm Hg). Proof:

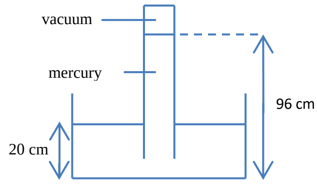
Density of mercury, ρ = 13600 kgm^{-3}
Gravitational acceleration of the earth, g = 9.82 ms^{-2}

Using $P = h\rho g$ (you can use this formula because both mercury and the atmosphere are fluids), proof that atmospheric pressure, P = 1 atm = 1.01 x 10^5 Pa.

From above you can see that, when pressure increases the height of the mercury *increases/ decreases*. Likewise when the pressure decreases the height of the mercury *increases/ decreases*.

A mercury barometer is hard to carry around (and potentially hazardous to your health!). A **manometer** is more practical for day to day measurement of gas pressure.

Let's say this Hg barometer is placed in a room.



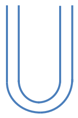
Based on this reading, calculate

1) The atmospheric pressure in the room in both mm Hg and Pa.

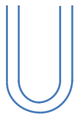
2) The pressure at point A.

3) The pressure at point B.

When both arms are not connected to anything



When one arm is connected to a gas supply and the gas pressure > atmospheric pressure



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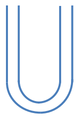
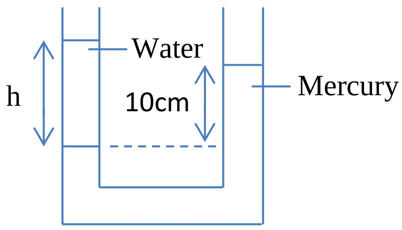


There are several steps in order to find pressure using a manometer.

Step 1 Draw equal pressure lines. Remember the pressure is only the same for same fluids.
Step 2 Draw arrows showing the direction of force caused by the weight of the Fluids on the equal pressure lines.
Step 3 Write the relevant equations down.
Step 4 Solve the problem

Try the problem below using the steps above:



The manometer consists of water and mercury. You are asked to find *h*.

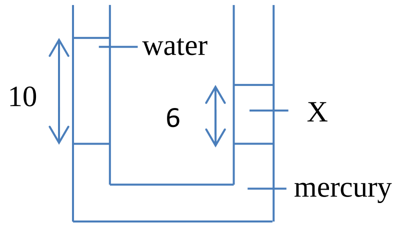
Step 1 Draw equal pressure lines. *Hint: It's obvious this time.*

Step 2 Draw arrows showing the direction of force caused by the weight of the fluids. *Hint: Both arms are exposed to the atmosphere*

Step 3 Write the relevant equations down. *Hint:* $P = h\rho g$

Step 4 Solve the problem

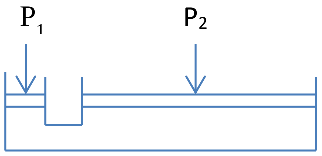
This time around *Liquid X* is poured into the right arm. Find the density of *X*.



4.0 Pascal's Principle

The pressure applied to an *enclosed* liquid is transmitted *equally* to every part of the liquid.

eg. Hydraulic systems



In simpler terms, what Pascal meant was $P_1 = P_2$. But recall that $P = \frac{F}{A}$. Hence we can rewrite the above as

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

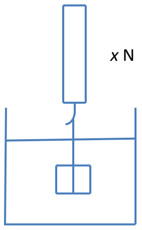
5.0 Archimedes Principle

He said that when an object is *completely* or *partially* immersed in a fluid, it experiences a *buoyant* force *equal* to the *weight* of the fluid displaced.

Buoyant force is a reaction force caused by fluids. Remember when you sit on a chair the chair is pushing back on you as you are pushing on the chair. The same goes here; the fluid is pushing back on you as much as you push them! Meaning if you put one foot in the water the water is only going to push that foot. On the other hand if you put your whole self in it, the water is going to push all of you. *Hint: Think sitting half on a chair and half using your legs to support you!*

$$Buoyant\ force = Actual\ weight - Apparent\ weight$$

E.g.

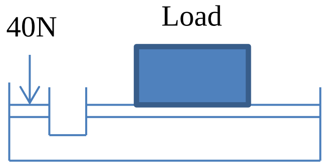


Find x given that the volume of the block is 200cm^3. *Hint: The density of water is 1000kgm^{-3}. Also note how the block is submerged in the water.*

An object will **float** in the water (not on top of it!) if the *buoyant force* matches the *weight of the object*. An object will ________ if the weight of the object is greater than the buoyant force. An object will float on the water if the buoyant force is ________ than the weight of the object.

Can you design a submarine that will float IN water (not sinking or rising)?
Density of mild steel = 7850 kg/m^3
Density of sea water = 1027 kg/m^3
Hint: Assume that the submarine is a closed cylinder.

Find the force exerted by the right piston on the Load.



If a force of 40N is applied to the left piston. *Hint: Know which direction the force is acting on.*

6.0 Bernoulli's Principle

This principle states that when the speed of a fluid is high, the pressure is low. When the speed of the fluid is low, the pressure is high.

Pressure consists of two components; static and dynamic. Static pressure is the pressure of fluid when it is not moving. Dynamic pressure is the pressure of the fluid when it is moving.

$$P_T = P_S + P_D$$

As you can see from the above equation, when dynamic pressure, P_D goes up static pressure, P_S goes down and vice versa.