Forces in Fluids

1) Fluid - substance that can move and change shapes without separating. It can be a liquid or a gas.

2) Force of Fluids - Caused by the mass and motion of the particles making up the fluid.

3) Pressure - Push or Force particle exert over a certain area.

4) Pressure (Calculations)

A) $P =$ ____ $F = 200\ N$ $A = 6.0\ m^2$

$$P = \frac{F}{A} = \frac{200\ N}{6.0\ m^2} = 33\ \frac{N}{m^2} = \boxed{33\ Pa}$$

B) $P = 750\ Pa$ $F =$ ____ $A = 5.00\ m^2$

$$P = \frac{F}{A} \rightarrow AP = \frac{F \cancel{A}}{\cancel{A}}$$

$$F = AP$$

$$= \left(5.00\ m^2\right)\left(750\ \frac{N}{m^2}\right) = \boxed{3800\ N}$$

C) $P = 850.\ Pa$ $F = 60.0\ N$ $A =$ ____

$$\frac{A \cancel{P}}{\cancel{P}} = \frac{F}{\cancel{A}} \frac{\cancel{A}}{P} \qquad A = \frac{F}{P} = \frac{60.0\ N}{850.\ \frac{N}{m^2}} = \left(\frac{60.0\ N}{1}\right)\left(\frac{m^2}{850.\ N}\right)$$

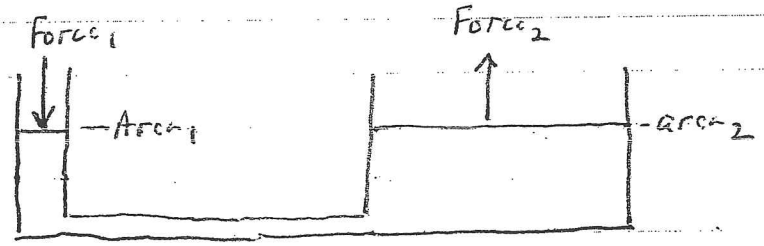
$$= \boxed{.103\ m^2}$$

5) Pressure differences – Fluids will move from areas of higher pressure to areas of lower pressure.

6) Pascal's principle – Changes in pressure at any point in an enclosed fluid at rest are transmitted undiminished to all points in the fluid and act in all directions.

7) hydraulic device – transmission of pressure equally in all directions in a liquid using two different sized pistons and cylinders.

8) Example:



$$P_1 = \frac{F_1}{A_1} \qquad P_2 = \frac{F_2}{A_2}$$

$$P_1 = P_2 \quad \therefore \frac{F_1}{A_1} = \frac{F_2}{A_2}$$

9) Hydraulic (Calculation)

How much can a hydraulic lift raise using a $.200\ m^2$ cylinder with 200 N of force applied on the fluid into a $40.00\ m^2$ cylinder?

$F_1 = 200\ N \quad A_1 = .200\ m^2 \quad A_2 = 40.00\ m^2 \quad F_2 = \_\_\_$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \quad \therefore \quad F_2 = \frac{F_1 A_2}{A_1} = \frac{(200\ N)(40.00\ m^2)}{.200\ m^2}$$

$$= \boxed{40000\ N}$$

10) Pressure and Gravity - due to the force of gravity the pressure of any fluid varies with depth.

11) Buoyancy - Upward force exerted by a fluid on objects on or within the fluid.

12) Archimedes' principle - the buoyant force on an object is equal to the weight of the fluid displaced by the object.

13) Two conditions to float

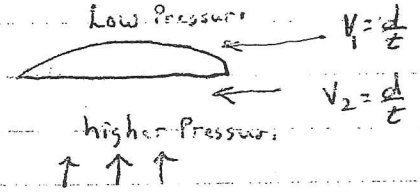
1) Object floats when it displaces a volume of fluid whose weight is equal to the object's own weight.

2) Object's density is less than the density of the fluid.

14) Bernoulli's principle - states that the pressure in a moving stream of fluid is less than the pressure in the surrounding fluid.

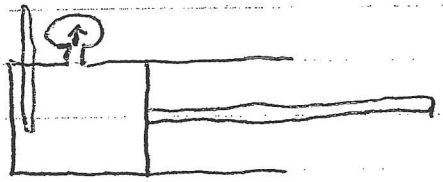
15) lift - Upward force on a wing created by the shape of the wing.

Example:



16) Boyle's Law - Volume of a dry gas is inversely proportional to the pressure when the temperature is constant.

17) Boyle's Law (Calculation) - $\frac{V_1}{V_2} = \frac{P_2}{P_1}$ or $P_1V_1 = P_2V_2$



$V_1 = 1L$ $V_2 = 2L$

$P_1 = 1\ Pa$ $P_2 = \_\_\_$

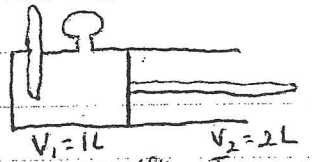
$P_1V_1 = P_2V_2$ $\therefore P_2 = \frac{P_1V_1}{V_2}$

$= \frac{(1\ Pa)(1L)}{2L}$

$= \boxed{.5\ Pa}$

18) Charles' Law - Volume of a dry gas is directly proportional to the temperature (°K) when the pressure is constant.

19) Charles' law (Calculation)



$V_1 = 1L$ $V_2 = 2L$

$T_1 = 273.15°K$ $T_2 = \_\_\_$

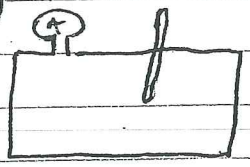
$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\therefore T_2 = \frac{V_2T_1}{V_1} = \frac{(2L)(273.15°K)}{1L}$

$= \boxed{546.3°K}$

64 (d)

20) Gay-Lussac's Law- Pressure of a gas is directly proportional to the temperature (°K) when the volume is constant.

21) Gay-Lussac's Law (Calculation)



$P_1 = 1\ Pa \quad P_2 = \_\_\_$

$T_1 = 273.15°K \quad T_2 = 546.3°K$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad \therefore P_2 = \frac{P_1 T_2}{T_1}$$

$$= \frac{(1\ Pa)(546.3°K)}{273.15°K}$$

$$= 2\ Pa$$

22) Combination Gas Law Formula

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Example #1

$P_1 = 2\ Pa \quad V_1 = 6.0L \quad T_1 = 20.0°C = 293°K \quad P_2 = 4\ Pa \quad V_2 = \_\_\_ \quad T_2 = 40.0°C = 313°K$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \qquad \frac{T_2 P_1 V_1}{P_2 T_1} = \frac{\cancel{P_2} V_2}{\cancel{T_2}} \frac{\cancel{T_2}}{\cancel{P_2}}$$

$$V_2 = \frac{T_2 P_1 V_1}{P_2 T_1} = \frac{(313°K)(2\ Pa)(6.0L)}{(4\ Pa)(293°K)}$$

$$= \boxed{3\ L}$$

22) Example #2

$P_1 = 7.00\,Pa$ $V_1 = 5.00L$ $T_1 = 20.0^\circ C = 293\,^\circ K$ $P_2 = \_\_\_$ $V_2 = 7.00L$ $T_2 = 30.0^\circ C = 303\,^\circ K$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \qquad P_2 = \frac{P_1V_1T_2}{T_1V_2}$$

$$= \frac{(7.00\,Pa)(5.00L)(303\,^\circ K)}{(293\,^\circ K)(7.00L)}$$

$$= \boxed{5.17\,Pa}$$

Problems

1) How much pressure is produced when 400. N of force are applied to $20.0\,m^2$ of surface?

2) How much force is needed to produce $200\,Pa$ of pressure on $5.50\,m^2$ of area?

3) How much force is needed to lift a 20,000 N object using a $.250\,cm^2$ cylinder and $250.\,cm^2$ cylinder in a hydraulic system?

4) How much pressure is produced with a gas with a volume of 6.00L and 3.00 Pa changed to a volume of 10.0L?

5) What is the volume of a gas at 25.0°C changed from a volume of 9.00L at 100.°C?