Lec. (5)
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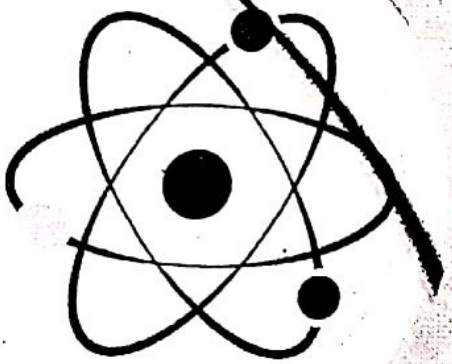
PHYSICS 1

1ST LEVEL 2020 - 2021



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ENGINEERING CAMP

SCAN FOR FACEBOOK GROUP

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CH.3: FLUIDS الموائع

* Fluid ≡ Liquid or gas (سائل أو غاز)

* Density: الكثافة

$$\rho = \frac{m}{V} \quad kg/m^3$$

حفظ

$\rho_{water} = 1000\ kg/m^3 = 1\ g/cm^3$ الماء

$\rho_{Hg} = 13600\ kg/m^3 = 13.6\ g/cm^3$ الزئبق

مكونات الفصل:

1 Fluid statics: المائع الساكن

(A) Pressure قياس الضغط

(B) Measuring Pressure

(C) Pascal's Principle مبدأ بسكال

D) Archimedes Principle مبدأ أرشميدس

2 Fluid dynamics: المائع المتحرك

(A) Flow rate معدل التدفق

(B) Continuity equation معادلة الإستمرارية

(C) Bernoulli's // معادلة برنولي

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1- Fluid statics

(A) Pressure:

76 cmHg

1 atm = 760 mmHg

1 bar = 10^5 Pascal

$$P = \frac{F}{A}$$ Pascal (Pa) N/m^2

"ضغط عمود من سائل ، ارتفاعه h"

(1) إثبات

EX: Obtain the pressure due to a liq

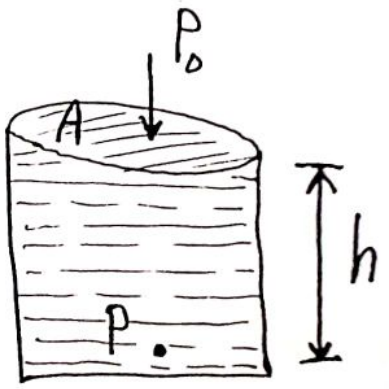
عمود column of hieght (h)

"answer"

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

$$\therefore F = mg$$

قوة السائل تمثل وزنه



$$\therefore P = \frac{mg}{A} = \frac{\rho V g}{A}$$ $[m = \rho V]$

$$\therefore P = \frac{\rho A h g}{A} = \rho g h$$ $[V = Ah]$

$$\therefore \boxed{P_{liquid} = \rho g h}$$

$$\therefore \boxed{P = P_o + \rho g h}$$

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*Note that:

(1) P --- absolute Pressure الضغط المطلق

(2) $P_o = P_a$ --- atmospheric Pressure ضغط الجوى

(3) $P_{Liquid} = \rho gh$ --- guage pressure الضغط المقاس

هو مقدار الزيادة في الضغط عن الضغط الجوى

$P_{liquid} = P - P_o$

(4) Pressure Units: وحدات الضغط

* 1 bar = 10^5 Pa حفظ

* 1 atm = 1.013×10^5 Pa حفظ

* 1 atm = 760 mm Hg = 760 torr

* 1 atm = 14.696 Psi

Psi --- Pound/in^2 يوجد

* الضغط الجوى = ضغط عمود من الزئبق طوله 760 mm

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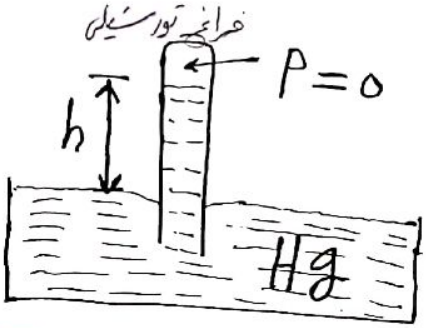
B Measuring the Pressure:

(1) Barometer: البارومتر

→ Invented by Torricelli اختراع تورشيلى

→ Is used for measuring the atmospher pressure.

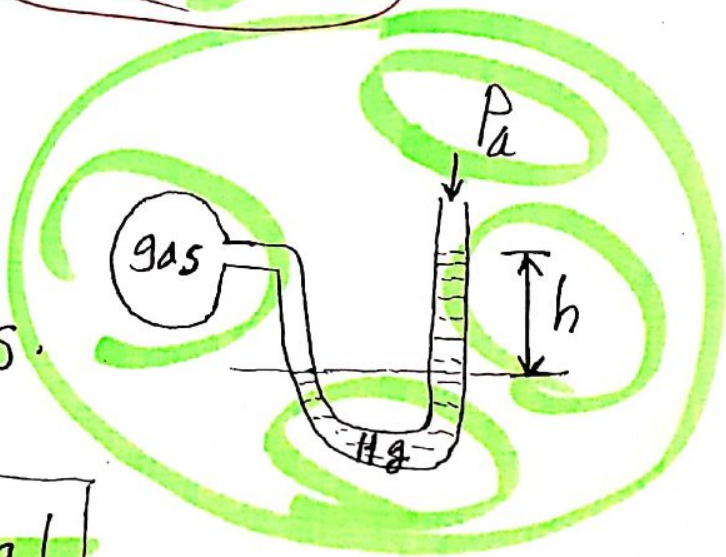


$$P_o = \rho_{Hg}\, g\, h$$

$$h = \frac{P_o}{\rho_{Hg}\, g} = \frac{1.013 \times 10^5}{13600 \times 9.8} = 0.760\ m$$

(2) Manometer: المانومتر

→ Is used to measure the pressure of a gas.



absolute pressure الضغط المطلق

$$P_{gas} = P_a + \rho g h$$

$P - P_a = \rho g h$

gauge pressure الضغط الجيارى → مقدار الزيادة او النقص عن الضغط الجوى

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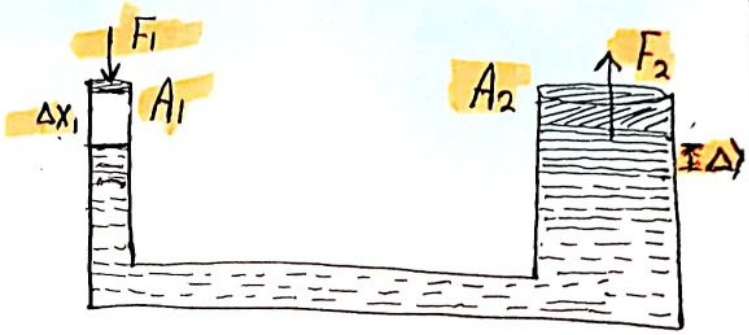
4 Pascal's Principle: قاعدة بسكال

*The pressure applied to any point of a fluid in a closed vessel وعاء مغلق is transmitted (ينتقل) to every other points.



$$P_1 = P_2$$

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

*Applications: تطبيقات قاعدة بسكال

(1) Hydraulic press. المكبس الهيدروليكي

(2) Car Lifts. رافعات السيارات

(3) Hydraulic breaks. الفرامل الهيدروليكية

(4) Hydraulic Jacks. // الرافعات

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EX.1: In a car lift used in a service station, compressed air exerts the small piston with radius 5.00cm, the Large piston has radius 15.0cm

(a) What force must the air exert to lift a car weight 13300 N?

(b) what is the pressure?

"answer"

(a) $\frac{F_1}{A_1} = \frac{F_2}{A_2}$

$\therefore F_1 = \frac{A_1 F_2}{A_2} = \frac{\pi (5\times10^{-2})^2 \times 13300}{\pi (15\times10^{-2})^2}$

$= \boxed{1.48\times10^{3}\ N}$

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(b) $p = \frac{F_1}{A_1} = \frac{1.48\times10^{3}}{\pi (5\times10^{-2})^2}$

$= \boxed{1.88\times10^{5}\ Pa}$

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EX.2: The atmospheric pressure is about 1×10^5 Pa, How Large the air inside a room exert a force in a window 40cm X 80 cm.

"answer"

$$F = PA = (1 \times 10^5) \times (40 \times 10^{-2} \times 80 \times 10^{-2})$$

$$= \boxed{3.2 \times 10^4 \, N}$$

EX.3: Find the pressure at depth 76 cm in still (a) water $\rho_w = 1 \, g/cm^3$

(b) Mercury $\rho_{Hg} = 13.6 \, g/cm$

"answer"

إجابة الكتاب بيهمل الضغط الجوى

(a) $P = \rho_w g h = 1000 \times 9.81 \times 0.76$

$$= \boxed{7450 \, Pa}$$

(b) $P = \rho_{Hg} g h = 13600 \times 9.81 \times 0.76$

$$= \boxed{1.01 \times 10^5 \simeq 1 \, atm}$$

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خزان
EX.4: A reservoir dam holds $8\ km^3$ lake behind it, the Lake is 12 m deep.

(a) What is the water pressure at the base of the dam?

(b) at 3m down the Lake surface?

"answer.

(a) $P = \rho_w g h = 10^3 \times 9.81 \times 12 = \boxed{118 \times 10^3\ Pa}$

(b) $P = \rho_w g h = 10^3 \times 9.81 \times 3 = \boxed{29 \times 10^3\ Pa}$

EX.5: Vertical tube has 2 cm of oil ($\rho = 0.8\ g/cm^3$), floating on 8 cm of water, What is the pressure at the bottom of the tube?

"answer.

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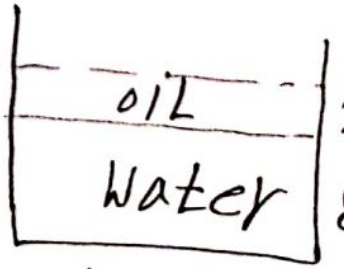
$P_t = P_{oil} + P_{water}$

$= \rho_1 g h_1 + \rho_2 g h_2$

$= (800 \times 9.81 \times 0.02) + (10^3 \times 9.81 \times 0.08)$

$= \boxed{940\ Pa}$



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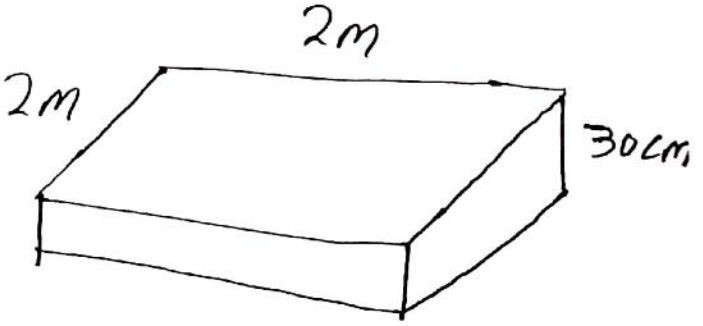
EX: From Lecture

The mattress of water bed is 2m Long by 2m wide and 30cm deep.

(a) Find the weight of water?

(b) Find the Pressure of the water bed on the floor

"answer"



(a) $W = mg$

$W = \rho_w V g$

$= 10^3 \times (2 \times 2 \times 0.30) \times 9.81$

$= \boxed{11772\ N}$

(b) $P = \frac{F}{A} = \frac{11772}{2 \times 2}$

$= \boxed{2943\ Pa}$

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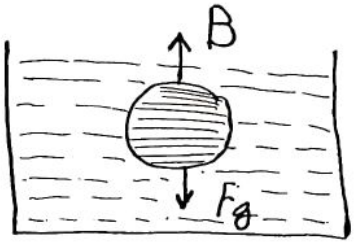
D Archimedes' Principle:

تعريف

* The buoyant force (قوة الطفو) on a object always equals the weight of the fluid displaced by the obje

B → Buoyant Force



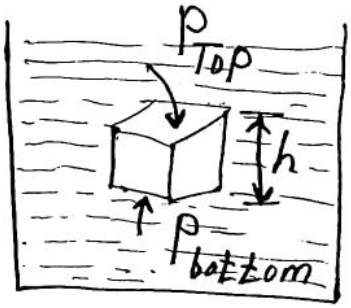
* قوة الطفو المؤثرة على الجسم تساوى وزن السائل المزاح.

$$B = (P_{bot.} - P_{Top})A$$

$$= \rho_F g h A$$

$$= \rho_F V g \qquad [V = Ah]$$

$$= m_F g \qquad [m = \rho V]$$



$$\therefore \boxed{B = W_{Fluid}}$$

(displaced) الـ : الـ

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EX.1: a solid aluminum cylinder wit $\rho = 2700\ kg/m^3$ has a measured mass 67g in air and 45g when immersed (مغمورة كلياً) in a Liquid. Find the density of the Liquid.

answer.

$F_B = W_{in\text{-}air} - W_{in\text{-}Liquid}$ قوة الطفو

$= (67\times10^{-3}\times9.81) - (45\times10^{-3}\times9.81)$

$= 0.21582\ N$

$F_B = W_{displaced} = m_L g$

$\therefore F_B = \rho_L V g$, $V = \frac{m}{\rho} = \frac{67\times10^{-3}}{2700} = 2.48\times$

$\therefore \rho_L = \frac{F_B}{V g} = \frac{0.21582}{2.48\times10^{-5}\times9.81}$

$= \boxed{886.6\ kg/m^3}$

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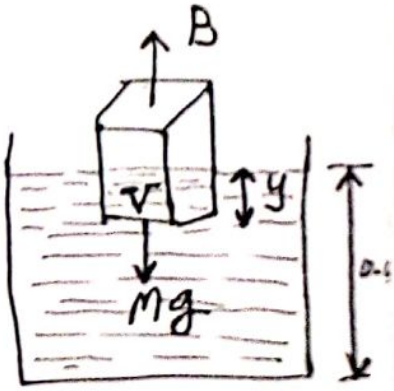
Ex·2: A 60kg rectangular box open at top has bas dimensions 1m by 0.8m and depth 0.5m.

(a) How deep will it sink in fresh water?

(b) What weight of ballast (ثقل) will cause it to sink to depth of 30 cm?

answer.

(a) F_B = weight of displaced water
= weight of the box



$m_{water}\ g = m_{box}\ g$

$\rho_w [V] = m_{box}$

$\rho_w [y \times 1m \times 0.8m] = m_{box}$

$\therefore y = \frac{60}{1000 \times 1 \times 0.8} = \boxed{0.075m}$

(b) $y = 30\ cm = 0.3m$:

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$\rho_w [y \times 1m \times 0.8m] = m_{box} + m_{ballast}$

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$$\therefore m_{ballast} = \rho_w [V \times 1 \times 0.8] - m_{box}$$

$$= 10^3 [0.3 \times 0.8] - 60$$

$$= \boxed{180 kg}$$

Lec. 2

EX.3: a person purchase (اشترى) a "gold" crown, its weight in air is 7.84N, and when immersed in water the scale read 6.86N, is the crown made of pure gold?

$\rho_{gold} = 19.3 \times 10^3 \ kg/m^3$

"answer"

$$F_B = 7.84 - 6.86 = 0.98 N$$

$$F_B = W_L = m_L g = \rho_L V g$$

$$\therefore V_{crown} = \frac{F_B}{\rho_L g} = \frac{0.98}{1000 \times 9.81} = 10^{-4} m^3$$

$$\therefore F_{air} = mg = \rho_{crown} V_c g$$

$$\therefore \rho_{crown} = \frac{7.84}{10^{-4} \times 9.81} = 7.99 \times 10^3 \neq 19.3 \times 10^3$$

Not pure or hollow ← مفرغ

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