مراجعة ليلة الإمتحان

الفيزياء للثانوية

Physics

ملخص كامل للمنهج

أسئلة اختيار من متعدد ومقالية

ثانية ثانوي

ترم ثاني 2022

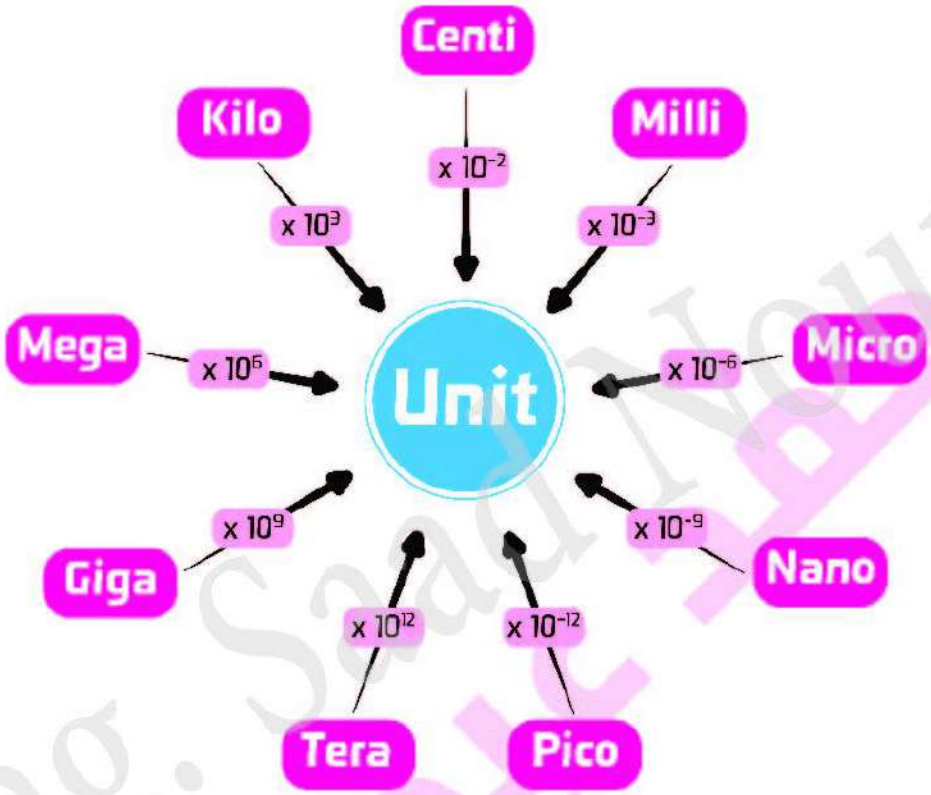
اللهم علم ينتفع به

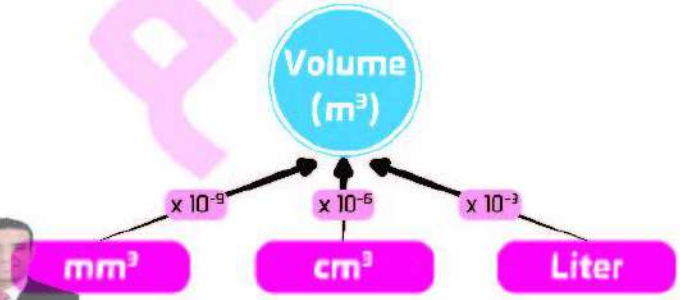
Eng Saad Nour

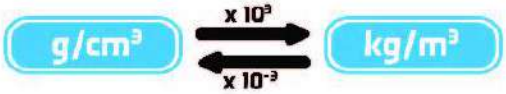
Final Revision

- Density
- Pressure
- Pressure inside a liquid
- U-shaped tube
- Barometer

Unit conversions





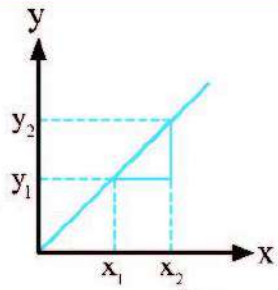


إعداد: أ. محمد عبدالسلام

Graphs

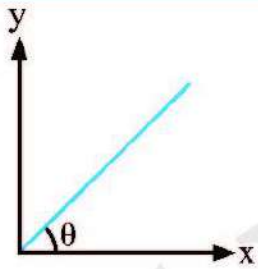
Slope of a straight line

Method 1



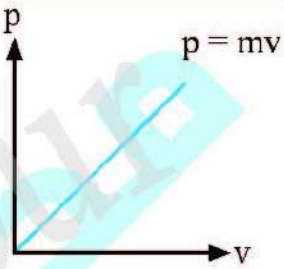
$$\text{slope} = \frac{\Delta y}{\Delta x}$$

Method 2



$$\text{slope} = \tan\theta$$

Method 3

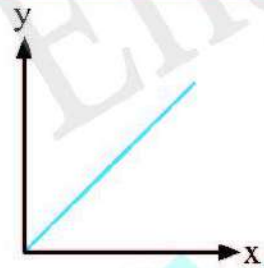


$$\text{slope} = \frac{\Delta p}{\Delta v} = m$$

Equation of a straight line

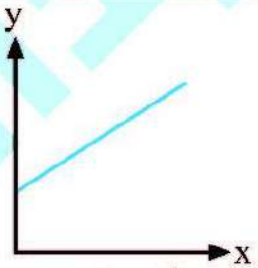
$$y = mx + b$$

b = 0



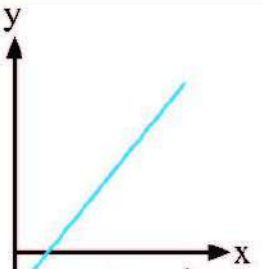
$y = mx$
slope = m
y-intercept = 0

b > 0



$y = mx + b$
slope = m
y-intercept = + b

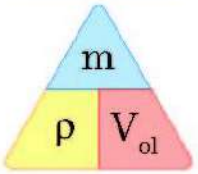
b < 0



$y = mx - b$
slope = m
y-intercept = − b

إعداد: أ. محمد عبدالسلام

Density



Dimensional formula

$ML^{-3}T^{0}$

Measuring unit

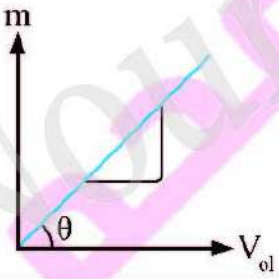
kg/m^3

Type of quantity

Scalar quantity

Graphical representation

$$Slope = \rho = \frac{\Delta m}{\Delta V_{ol}} = \tan\theta$$

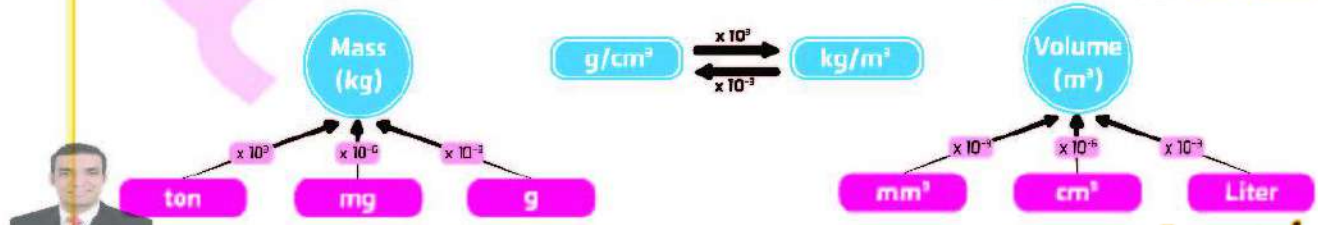


The factors affecting

1. The atomic weight of the element or the molecular weight of the compound.
   - It changes by changing the type of the material.
   - It also changes by the material purity (percentage of impurities in the substance).
2. The interatomic distances between atoms or the intermolecular spaces between molecules.
   - It changes by changing the temperature of the material.
   - It also changes by changing the pressure in the case of gases.

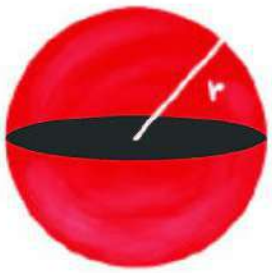
أفكار المسائل

1. أفكار **تعويض مباشر** على طول بوحدات مظبوطة.
2. أفكار بتعتمد على إن ال density **مش بتتغير بتغير** ال mass وال volume لنفس المادة. لكن لمواد مختلفة؛ ال density بتتغير directly مع ال mass و inverselyg مع ال volume.
3. أفكار **الرسومات البيانية** وهنا لازم تعرف إن ال slope بتاع $m\text{-}V_{ol}$ curve هو ال density.
4. **التحويلات** اللى ممكن تجيلك:



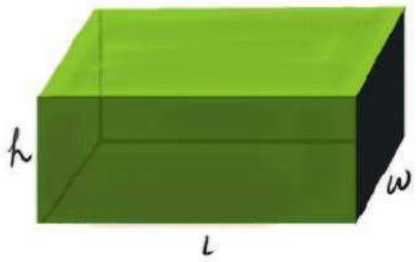
إعداد: أ. محمد عبدالسلام

5 ممكن ال volume **ميجيش بشكل مباشر:**



$V_{ol} = \frac{4}{3}\pi r^3$

$V_{ol} = \pi r^2 h$



$V_{ol} = hlw$

6 عند وضع solid object جوا أى سائل، فال solid object دا **هيزيح (displaces) جزء من السائل بيساوى حجمه.**

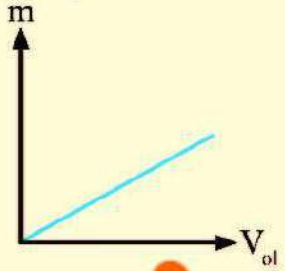
1 A rectangular block is made of clay of density of 1800 kg/m³. The block is re-shaped into one which is twice as long and half as thick. What is now the density of the clay?

a 450 kg/m³ b 900 kg/m³
c 1800 kg/m³ d 3600 kg/m³ MCQ

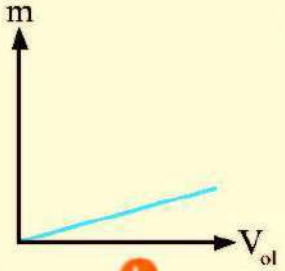
2 If the ratio between the density of scandium and the density of gallium ($\frac{\rho_{Sc}}{\rho_{Ga}}$) is approximately $\frac{1}{2}$, then the ratio between the volume of 1 kg of scandium and the volume of 4 kg of gallium, respectively is .....

a $\frac{1}{1}$ b $\frac{1}{2}$ c $\frac{1}{4}$ d $\frac{1}{8}$ MCQ

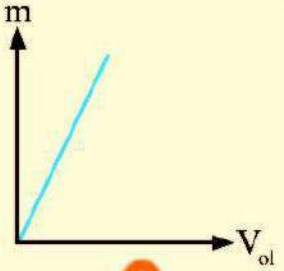
3 Each of the following graphs represents the mass-volume relation for a different material. Which of the following graphs represents the material with the greatest density?



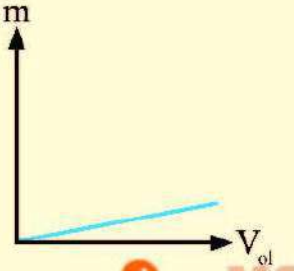
a



b

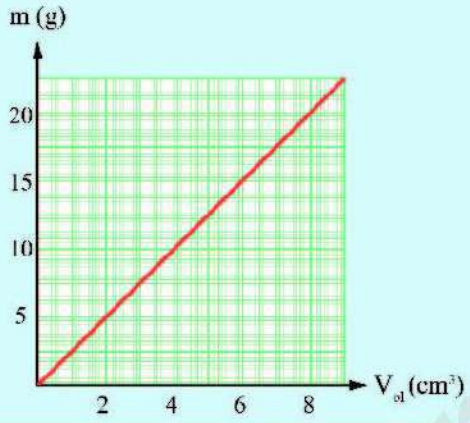


c



d MCQ

4 **The opposite graph shows the relation between mass and volume for a number of glass plates. Calculate the density of glass.**



Essay

5 **A shop-keeper places two identical blocks of cheese on a set of scales and notices that their combined mass is 240 g. Each block measures 2 cm x 5 cm x 10 cm.**

What is the density of the cheese?

a 0.42 g/cm³ **b** 0.83 g/cm³ **c** 1.2 g/cm³ **d** 2.4 g/cm³ MCQ

6 **A room is 4 m long, 2.5 m wide and 2 m high. If the density of air in the room is 1.5 kg/m³ then, the mass of the air in the room is .....**

a 10 kg **b** 20 kg **c** 30 kg **d** 40 kg MCQ

أفكار المسائل

1 A hollow body, its mass m, its external volume $(V_{ol})_{body}$ and its density ρ, if the volume of the cavity is $(V_{ol})_{cavity}$, then the density is:

$$\rho = \frac{m}{(V_{ol})_{body} - (V_{ol})_{cavity}}$$

2 **The density of the electrolytic solution in a battery:**

- **decreases** for a discharging battery
- **increases** for a charging battery

3 **Blood density decrease** indicates red blood cells concentration is decreased due to **anemia**.

4 **Urine density increase** indicates increase concentration of salts.

إعداد: أ. محمد عبدالسلام

Relative density

$$\rho_{relative} = \frac{\rho_{material}}{\rho_{water}}$$ at the same temperature

$$\rho_{relative} = \frac{m_{material}}{m_{water}}$$ the same volume at the same temperature

$$\rho_{relative} = \frac{W_{material}}{W_{water}}$$ the same volume at the same temperature

أفكار المسائل

1. The relative density is sometimes called the **specific weight** of the material.
2. The relative density **has no units** (dimensionless) because it is a ratio between two similar physical quantities.
3. The density of a material can be determined knowing its relative density:

$$\rho_{material} = \rho_{relative} \times \rho_{water}$$

4. The density of a material is **numerically equal to** its relative density when density is measured in g/cm³.
5. When mixing two or more materials that don't react together to form a homogeneous mixture, such as the solution in case of liquids or alloy in case of solid materials, then:

$$m_{mixutre} = m_1 + m_2 + \dots$$
$$\rho_{mixture}(V_{ol})_{mixutre} = \rho_1 (V_{ol})_1 + \rho_2 (V_{ol})_2 + \dots$$

القانونين دول **دايمًا** صح

إذا لم يتغير الحجم بعد الخلط

$$\rho_{mixture} = \frac{m_{mixture}}{(V_{ol})_{mixture}}$$

لو مش معاك ال masses

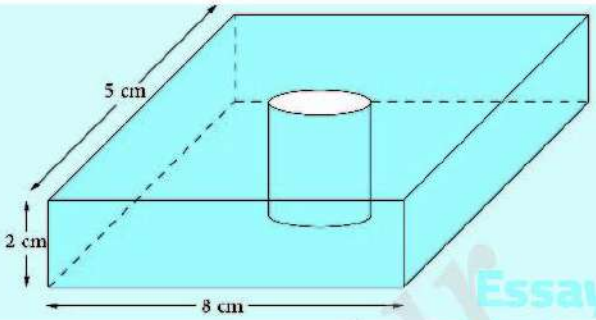
$$\rho_{mixture} = \frac{\rho_1 (V_{ol})_1 + \rho_2 (V_{ol})_2}{(V_{ol})_1 + (V_{ol})_2}$$

لو مش معاك ال volumes

$$\rho_{mixture} = \frac{m_1 + m_2}{\frac{m_1}{\rho_1} + \frac{m_1}{\rho_1}}$$

إعداد: أ. محمد عبدالسلام

7 **A cuboid of steel with a mass of 500 g and the dimensions are shown the opposite figure. It contains a cylindrical cavity of regular cross-section. If the density of the steel is 8 g/cm³, Calculate the cross-sectional area of the cavity.**



Essay

8 **How many grams of iron are required to make a hollow sphere whose inner radius is 15 cm and outer radius is 25 cm.**

(where ρ_{iron} = 7.8 g/cm³)

Essay

9 **The ratio of the density of the electrolytic solution inside a car battery after discharging the battery to its density when the battery was charged is .....**

a greater than 1 b equal to 1 c less than 1

MCQ

10 **The density of blood in anemia patients is ..... than normal blood density.**

a greater than 1 b equal to 1 c less than 1

MCQ

11 **Salt increase causes urine density to .....**

a increase b decrease c remain constant

MCQ

12 **Explain the following statements:**

(a) The type of anemia can be diagnosed by measuring the density of blood.

(b) Some diseases can be diagnosed by measuring the density of urine.

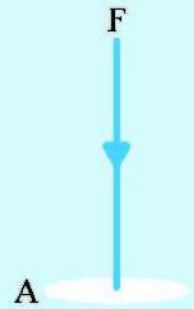
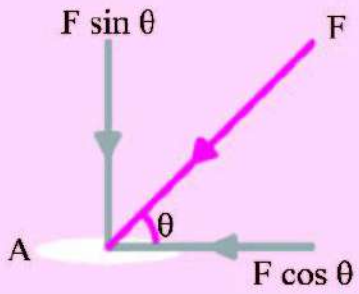
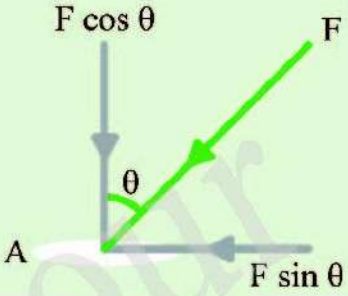
Essay

13 **Depending on the concept of density, how can you determine if the battery of a car is charged or not?**

Essay

إعداد: أ. محمد عبدالسلام

Pressure

The force is perpendicular to the surface	The force is making an angle θ with the surface	The force is making an angle θ with the normal to surface
		
$P = \frac{F}{A}$	$P = \frac{F \sin \theta}{A}$	$P = \frac{F \cos \theta}{A}$

Dimensional formula

$ML^{-1}T^{-2}$

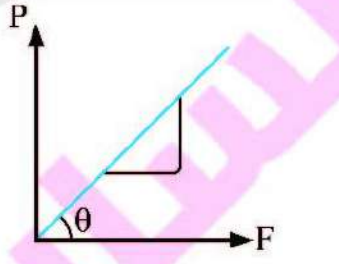
Measuring unit

Pascal (Pa) N/m^2 J/m^3 $kg.m^{-1}.s^{-2}$

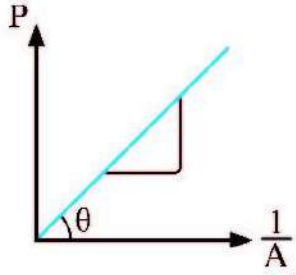
Type of quantity

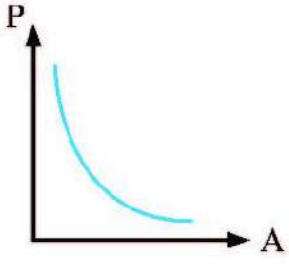
Scalar quantity

The factors affecting pressure



$$\text{Slope} = \frac{\Delta P}{\Delta F} = \tan\theta = A$$





$$\text{Slope} = \frac{\Delta p}{\Delta(\frac{1}{A})} = \tan\theta = F$$

6 When two pure substance in the solid or liquid states of different densities are mixed to form a homogeneous mixture or alloy, then:
- The value of the density of the mixture or alloy lies between the values of the densities of its components.
- When the percentage of the higher density material increases in the mixture, the density of the mixture or alloy increases.

14 The mass a calibrated flask is 25 g when empty, 75 g when filled with water, and 88 g when filled with glycerin. The relative density of glycerin is then ...

a 1.32 b 0.54 c 2.33 d 1.26 MCQ

15 A metallic alloy of mass 750 g where 60% of its mass is magnesium while the other part is copper. The density of magnesium is 1.7 g/cm³ and the density of copper is 9 g/cm³, so the relative density of the material of the alloy is approximately .....

(where ρ_{water} = 1000 kg/m³)

a 2.5 b 4.6 c 5.4 d 10.7 MCQ

16 3 liters of alcohol of density 800 kg/m³ have been mixed with 2 liters of water of density 1000 kg/m³ forming a mixture of density 900 kg/m³. Find out if there is shrinking in the total volume of the mixture and if the answer is yes, calculate the shrinking percentage. Essay

17 50 m³ of water, whose density is 1000 kg/m³, was mixed with 40 m³ of a liquid of density 800 kg/m³ where the total volume of the mixture equals the summation of the volumes of the liquids before mixing. Calculate the density of the mixture. Essay

إعداد: أ. **محمد عبدالسلام**

أفكار المسائل

1. أفكار **تعويـــض مباشر** على طول بوحدات مظبوطة.
2. أفـــكار بتعتمد على ال **Inverse** relation ما بين ال Pressure و ال Area of contact.
3. ال Force الـــلي عاملها ال object ممكن تكون its weight:

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

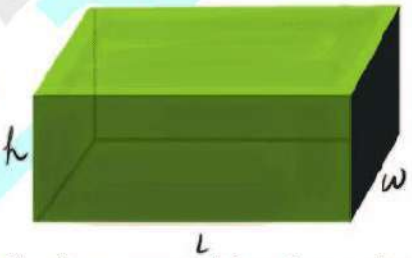
$$P = \frac{mg}{A}$$

وممكن نربط ما بين ال mass وال density:

$$P = \frac{\rho V_{ol} g}{A}$$

4. ال Surface areas ل Rectangle و Cylinder:

Surface area = πr^2



Surface area = hl or hw or lw

5. ال Weight بتـــاع عربية عندها أربع عجلات بيبقى متوزع بالتســـاوى عـــلى كل عجلة، نفس الكلام الترابيزة ورجولها والكراسى والأشـــخاص كمان.

QUIZ

18 A force of 25 N acted on a surface of area 5 cm², then the pressure acting on the surface if:

(i) The force is perpendicular to the surface equals .....

a) 4.33×10^4 N/m²
b) 5×10^5 N/m²
c) 1.7×10^5 N/m²
d) 2×10^5 N/m²

(ii) The force is making an angle of 60° with the surface equals .....

a) 4.33×10^4 N/m²
b) 5×10^5 N/m²
c) 1.7×10^5 N/m²
d) 2×10^5 N/m²

(iii) The force is making an angle of 60° with the normal to the surface equals .....

a 4.33×10^4 N/m²
b 5×10^5 N/m²
c 1.7×10^5 N/m²
d 2×10^5 N/m²

MCQ

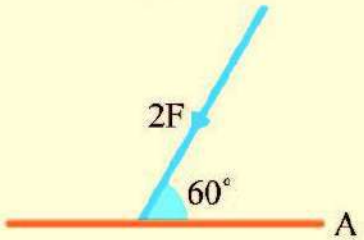
19 Four physics teachers investigate pressure. They wear identical clothes and lie on different beds of nails. The table gives the weight of each teacher and the total area of contact between the teacher and the nails. Which teacher experiences the least pressure from the nails?

	Weight of teacher (N)	Total area of contact (m²)
a	700	13
b	800	20
c	900	14
d	1000	21

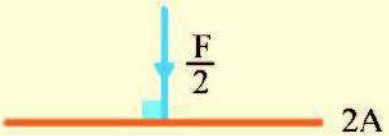
MCQ

20 The following figures represent plane surfaces of different areas, each of them is affected by a different force, so in which of them the pressure exerted on the surface is less?

a



b



c

d

MCQ

21 The pressure on the base of a cylinder containing oil with diameter 8 m is 1.5×10^3 N/m². Find the total force on the base.

a 7.5×10^4 N
b 3.01×10^5 N
c 7.5×10^5 N
d 3.01×10^6 N

MCQ

22 **A large man sits on a four-legged chair with his feet off the floor. The combined mass of the man and chair is 95 kg. If the chair legs are circular and have a radius of 0.5 cm at the bottom, what pressure does each leg exert on the floor?**

(where g = 9.8 m/s²)

a) 2.96×10^5 Pa
b) 1.19×10^7 Pa
c) 2.96×10^5 Pa
d) 1.19×10^6 Pa

MCQ

23 **A 50-kg woman wearing high-heeled shoes is invited into a home in which the kitchen has vinyl floor covering. The heel on each shoe is circular and has a radius of 0.5 cm. If the woman balances on one heel, what pressure does she exert on the floor?**

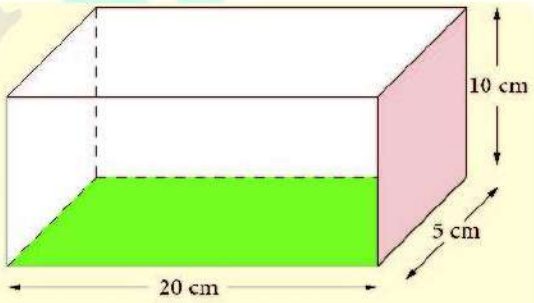
(where g = 9.8 m/s²)

a) 4.52 kPa
b) 4.52 MPa
c) 6.24 kPa
d) 6.24 MPa

MCQ

24 **The opposite figure shows a solid cuboid whose material's density is 5000 kg/m³, that is placed on a horizontal surface, then:**

(where g = 10 m/s²)



(i) The maximum pressure which can be produced by the cuboid on the surface equals ...

a) 10^2 N/m²
b) 10^3 N/m²
c) 10^4 N/m²
d) 10^6 N/m²

(ii) The minimum pressure which can be produced by the cuboid on the surface equals ....

a) 2.5×10^5 N/m²
b) 0.25×10^3 N/m²
c) 2.5×10^2 N/m²
d) 0.25 N/m²

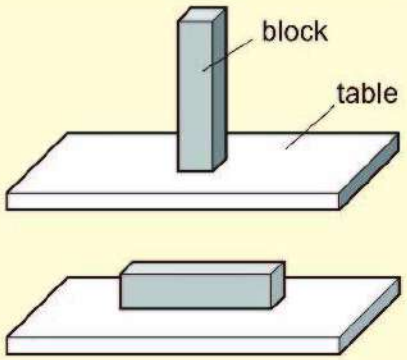
MCQ

25 **A force acts on an area to produce a pressure. Which changes produce the same pressure?**

a) Doubling the area and doubling the force.
b) Doubling the area and halving the force.
c) Doubling the area and making the force four times bigger.
d) Halving the area and doubling the force.

MCQ

26 **A block with flat, rectangular sides rests on a table. The block is now turned so that it rests with its largest side on the table. How has this change affected the force and the pressure exerted by the block on the table?**



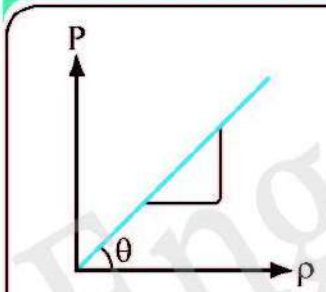
	Force	Pressure
a	Increases	Decreases
b	Remains unchanged	Decreases
c	Increases	Remains unchanged
d	Remains unchanged	Increases

MCQ

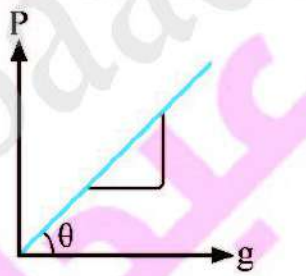
Pressure of a liquid at a point inside it

$$P = \rho h g$$

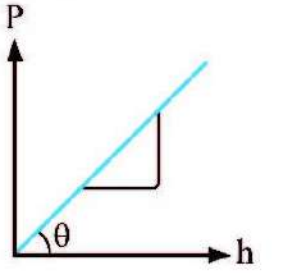
The factors affecting pressure of a liquid at a point inside it



$$\text{Slope} = \frac{\Delta P}{\Delta \rho} = \tan\theta = gh$$



$$\text{Slope} = \frac{\Delta P}{\Delta g} = \tan\theta = \rho h$$

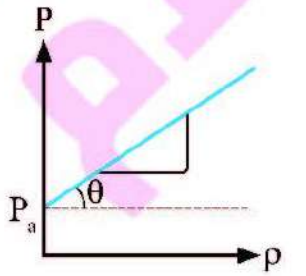


$$\text{Slope} = \frac{\Delta P}{\Delta h} = \tan\theta = \rho g$$

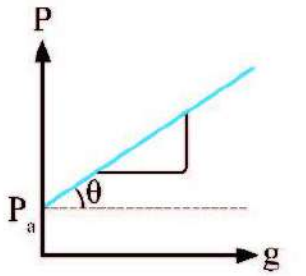
Total pressure at a point inside a liquid

$$P = P_a + \rho h g$$

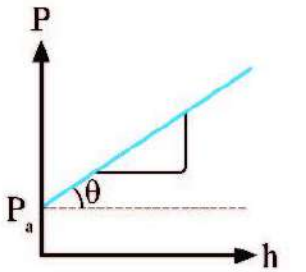
The factors affecting total pressure at a point inside a liquid



$$\text{Slope} = \frac{\Delta P}{\Delta \rho} = \tan\theta = gh$$



$$\text{Slope} = \frac{\Delta P}{\Delta g} = \tan\theta = \rho h$$



$$\text{Slope} = \frac{\Delta P}{\Delta \rho} = \tan\theta = \rho g$$

إعداد: أ. **محمد عبدالسلام**

أفكار المسائل

1. The pressure at a point inside a liquid acts **in all directions**.

2. **عشان تحسب ال Pressure difference بين نقطتين**، احسب ال Pressure بتاع السائل الموجود بين النقطتين:

$$\Delta P = \rho hg$$

3. **في ال submarine أو airplane بيكون ضغط الهواء جوا مُساوى للضغط الجوى**، وبالتالى الضغط والقوة على ال windows بيبقى:

$$\Delta P = P - P_a = P_a + \rho hg - P_a = \rho hg$$

$$\Delta F = \Delta PA = \rho hgA$$

4. **فى إطار السيارة بيكون ضغط الهواء جوا الإطار أكبر من ضغط الهواء (P_a) خارج الإطار:**

$$\Delta P = P - P_a = P_a + \rho hg - P_a = \rho hg$$

5. **عند وضع سائلين لا يمتزجان فى إناء:**

- الضغط عند نقطة على سطح السائل العلوى:

$$P = P_a$$

- الضغط عند نقطة من السائل عند السطح الفاصل:

$$P = P_a + \rho hg$$

- الضغط عند نقطة من السائل فى قاع الإناء:

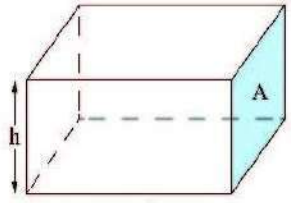
$$P = P_a + \rho_1 h_1 g + \rho_2 h_2 g$$

6. **إمتى متضيفش الضغط الجوى (P_a) وإنت بتجيب ال Total pressure؟**

- لو كان المطلوب ال Pressure due to the liquid بس.
- لو كان ال container مقفول (Closed).
- لو كان المطلوب حساب ال Pressure difference.
- فى حالة ال Submarine أو ال Airplane.

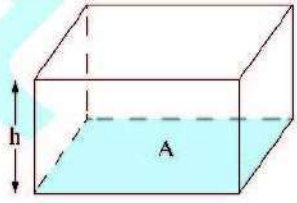
7. **القوة اللي بيأثر بيها Liquid على:**

واحد من ال Vertical faces



$$F = \rho(\frac{1}{2}h)gA$$

قاع ال Container

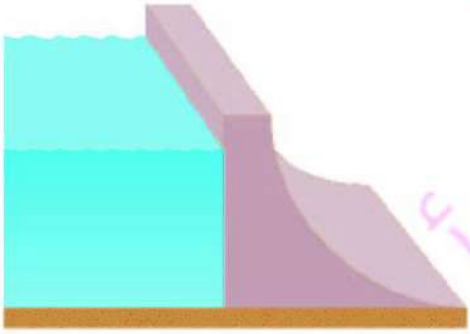


$$F = \rho hgA$$

8 **Dams must be designed to be thicker at the bottom to withstand the increasing pressure at the deeper levels.**

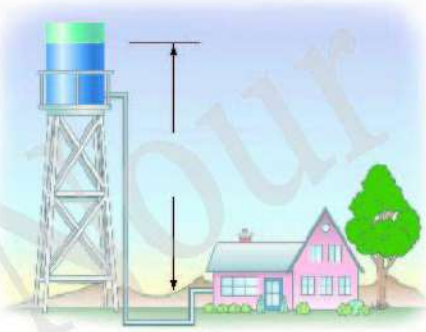
Because the pressure of water varies with depth.

$P \alpha h$



9 **Storage tanks are are placed at the highest point in town.**

Because water can reach the same height of the tanks through water pipes to high floors.



QUIZ

27 **A bowl of cross-sectional area 1000 cm², which is placed horizontally, contains salty water of density 1030 kg/m³. If the height of water inside the bowl is 1 m and the bowl surface is open to air, then:**

[where: $P_a = 1.013 \times 10^5$ Pa, $g = 10$ m/s²]

(i) The total value of pressure on the bottom of the bowl is .....

a) 2×10^3 N/m²
b) 2×10^5 N/m²
c) 9.1×10^4 N/m²
d) 1.116×10^5 N/m²

(ii) The total force acting on the bottom of the bowl equals .....

a) 2×10^5 N
b) 10^5 N
c) 2×10^4 N
d) 1.116×10^4 N

MCQ

28 **A cylindrical glass is filled with water. The pressure due to water at the bottom of the glass is P. A second cylindrical glass with twice the diameter is filled with water to the same height. The pressure due to water at the bottom of the second glass is then .....**

a) $\frac{P}{2}$
b) P
c) 2P
d) 4P

MCQ

29 **A cylindrical glass is filled with water. The magnitude of the net force at the bottom of the glass due to the weight of the water is F. A second cylindrical glass with twice the diameter is filled with water to the same height. The magnitude of the net force at the bottom of the second glass due to the weight of the water is**

a $\frac{F}{2}$ b F c 2F d 4F MCQ

30 **Dams are made thicker at the base because the ...**

a pressure acting at the base is maximum.
b pressure acting at the base is minimum.
c pressure acting at the base is the same as that at the water surface.
d pressure acting at the base is zero. MCQ

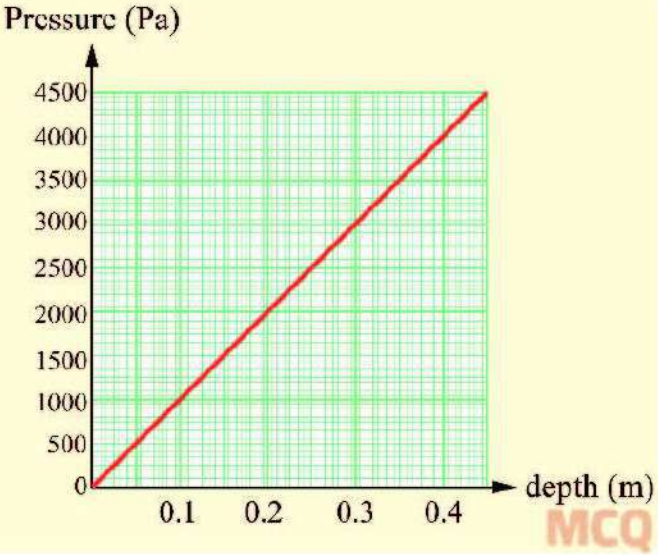
31 **The following factors affect the pressure at the bottom of a vessel except ...**

a the liquid depth in the vessel.
b the area of the vessel base.
c the density of the liquid.
d the atmospheric pressure. MCQ

32 **The graph shows how the pressure exerted by a liquid varies with depth below the surface. What is the density of the liquid?**

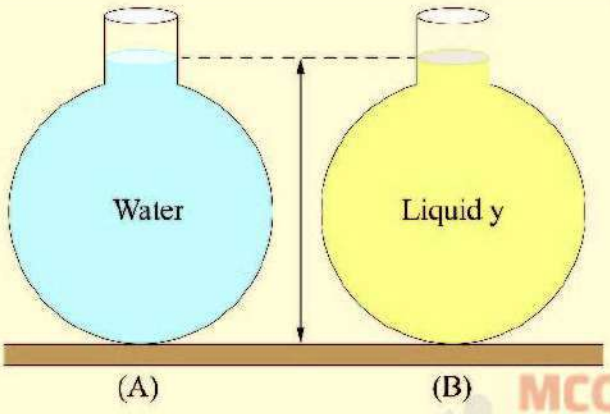
[g = 9.8 m/s²]

a 1020 kg/m³
b 760 kg/m³
c 1150 kg/m³
d 7500 kg/m³



MCQ

33 **In the opposite figure if the water pressure at the base A of the container is equal to 1.25 of the value of pressure of liquid y at the base of the container B, then the relative density of liquid y is .....**

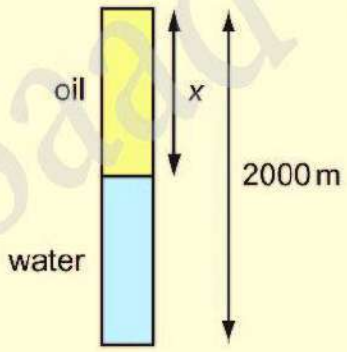


a) 0.4 b) 0.6
c) 0.8 d) 1.25

MCQ

34 **A bore-hole of depth 2000 m contains both oil and water as shown. The pressure due to the liquids at the bottom of the bore-hole is 17.5 MPa. The density of the oil is 830 kg·m^{-3} and the density of the water is 1000 kg·m^{-3}.**

[g = 9.81 m/s^2]

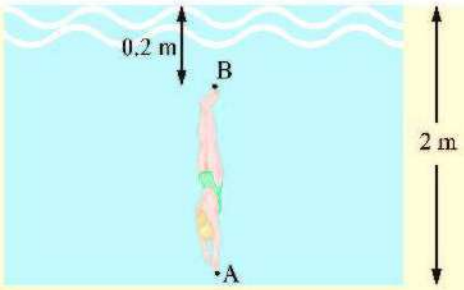


What is the depth x of the oil?

a) 907 m b) 1000 m c) 1090 m d) 1270 m

MCQ

35 **A swimmer was diving vertically downward in a river as shown in the opposite figure. If the density of the water in the river was 1000 kg/m^3, then the pressure difference between points A and B equals .....**



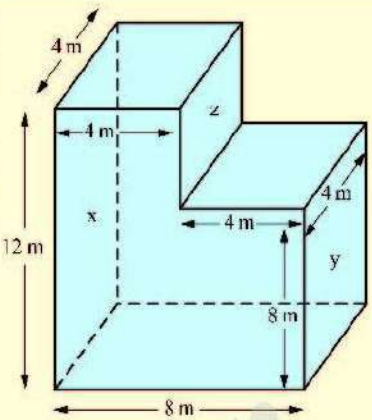
(g = 9.8 m/s^2)

a) 1.96×10^3 N/m^2 b) 13.52×10^3 N/m^2
c) 17.64×10^3 N/m^2 d) 19.6×10^3 N/m^2

MCQ

36 **The opposite figure shows a reservoir which is filled with water. If the water is exposed to the atmospheric air pressure which is 10^5 N/m², then:**

[Density of water = 1000 kg/m³, g = 10 m/s²]



(i) The total pressure on the bottom of the reservoir equals .....

a) 1.2×10^5 N/m²
b) 1.4×10^5 N/m²
c) 1.8×10^5 N/m²
d) 2.2×10^5 N/m²

(ii) The average exerted force by water on face x equals .....

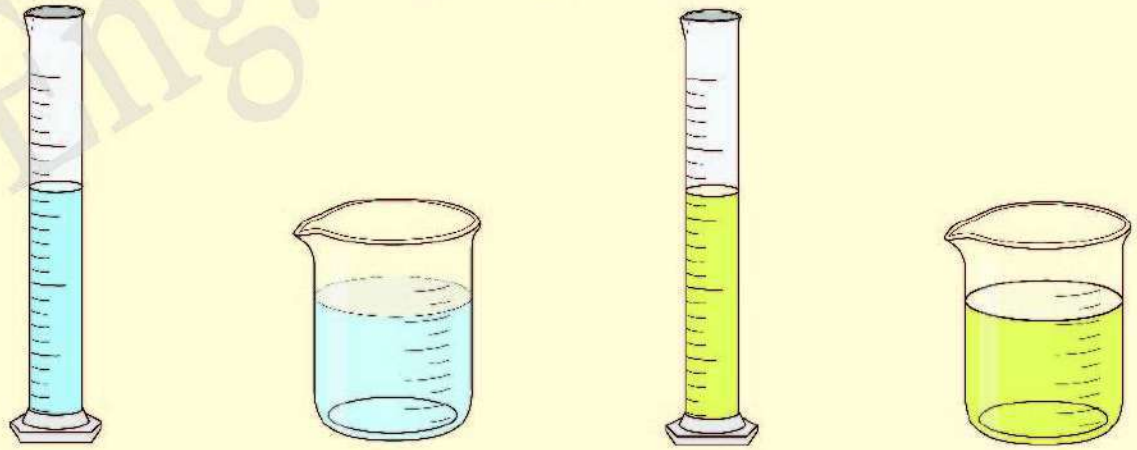
a) 5.76×10^6 N
b) 2.88×10^6 N
c) 1.92×10^6 N
d) 0.96×10^6 N

(iii) The average exerted force by water on face y equals .....

a) 1.28×10^6 N
b) 2.56×10^6 N
c) 3.2×10^6 N
d) 3.84×10^6 N

MCQ

37 **A student fills two container with water (density 1 g/cm³) and two with oil (density 0.8 g/cm³), as shown in the diagrams. In which container is the pressure on the base is the greatest?**



a) b) c) d)

MCQ

38 **When does ...?**

(a) The pressure at a point inside liquid becomes a maximum.

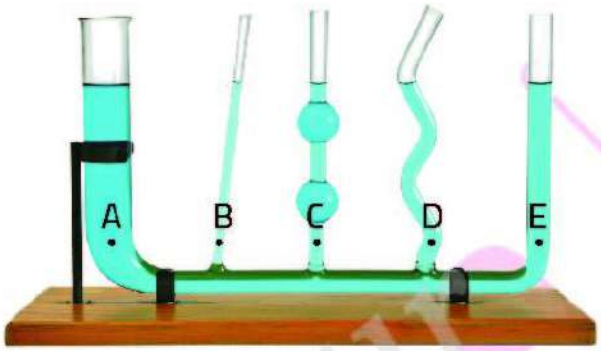
(b) The pressure difference between two points inside a liquid = zero.

Essay

Connecting vessels

$$P_A = P_B = P_C = P_D = P_E$$

$$h_A = h_B = h_C = h_D = h_E$$



QUIZ اختبر نفسك

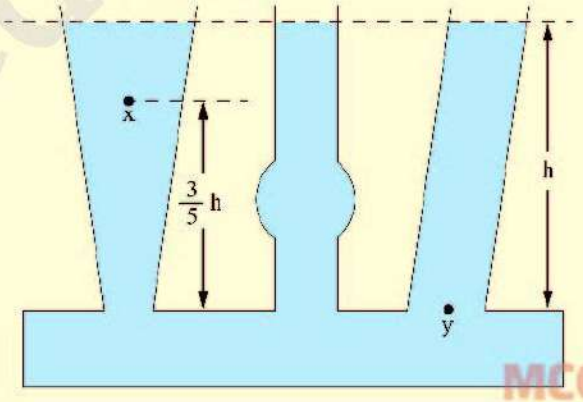
39 **The opposite figure shows a number of connected vessels that contain a liquid of density ρ. If the pressure of the liquid at point y is P, the pressure of the liquid at point x equals .....**

a $\frac{2}{3}$ P

b $\frac{1}{3}$ P

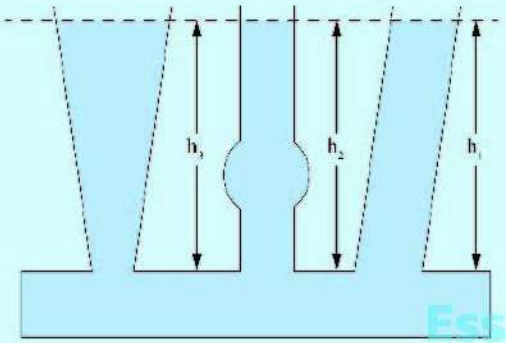
c $\frac{3}{5}$ P

d $\frac{2}{5}$ P



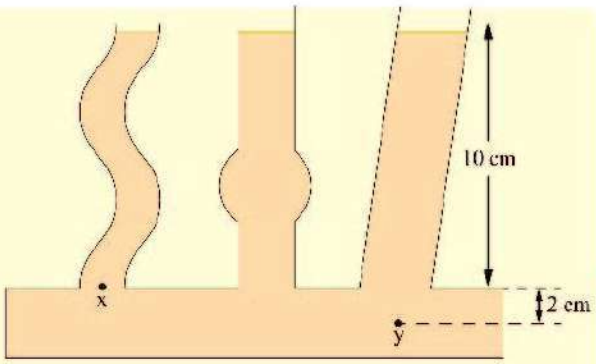
MCQ

40 **A homogeneous liquid of density ρ is put inside multiple vessels as shown in the opposite figure. If the vessels have a common base in the same horizontal level, prove that in the state of equilibrium: $h_1 = h_2 = h_3$.**



Essay

41 **The opposite figure shows a number of connected vessels that contains oil of density 800 kg/m³, then the ratio between the pressures of the oil at the two points x and y ($\frac{P_x}{P_y}$) is ..... (g = 10 m/s²)**



a $\frac{5}{6}$ b $\frac{6}{5}$ c $\frac{3}{2}$ d $\frac{2}{3}$

MCQ

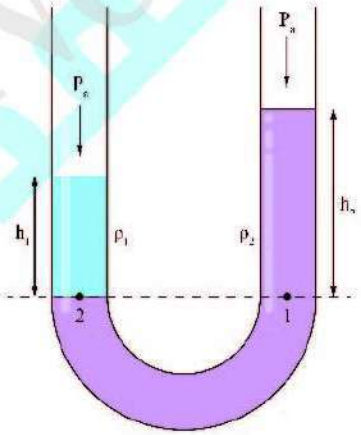
U-shaped tube

$$P_1 = P_2$$

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

$$\rho_1 h_1 = \rho_2 h_2$$

$$\frac{\rho_1}{\rho_2} = \frac{h_2}{h_1}$$

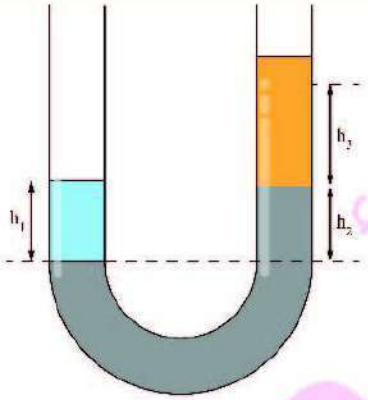


أفكار المسائل

1. At the equilibrium of the two liquids, the height of the liquid above the separating surface in the tube **is inversely proportional** to its density and consequently the level of the free surface of the less density liquid is higher than the level of the free surface of the higher density liquid.

2. The radius of the tube or the cross-sectional area of its two arms **doesn't affect** the ratio of heights of the two liquids in the two arms of the tube because according to the relation $\frac{\rho_1}{\rho_2} = \frac{h_2}{h_1}$, the ratio between the heights of the two liquids above the level of the separating surface depends only on the ratio between the densities of the two liquids which is a constant ratio.

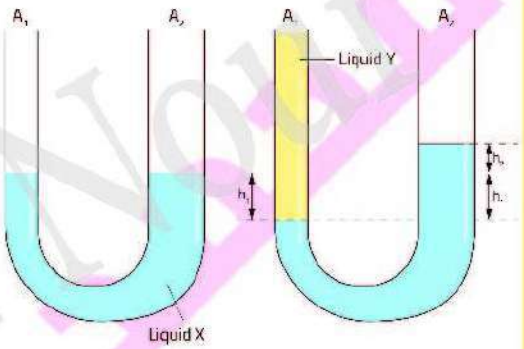
3 In the case of having two miscible liquids, they can be separated by a third liquid that is immiscible with each of them (like mercury which can separate between water and alcohol).



In case of the equilibrium of more than two liquids in a U-shaped tube:

$$\rho_1 h_1 = \rho_2 h_2 + \rho_3 h_3$$

4 When pouring an amount of liquid X in a U-shaped tube whose arms have cross-sectional areas A_1,A_2 then an amount of another liquid Y is added in one of its arms, the surface of liquid X in this arm lowers down a distance h_1 and it rises in the other arm a distance h_2 where the volume of the liquid which is displaced downward (A_1h_1) always equals the volume of the liquid which is displaced upward (A_2h_2):



$$A_1h_1 = A_2h_2$$

and the height of the liquid X in the tube above the level of the interface between the two liquids:

$$h_x = h_1 + h_2$$

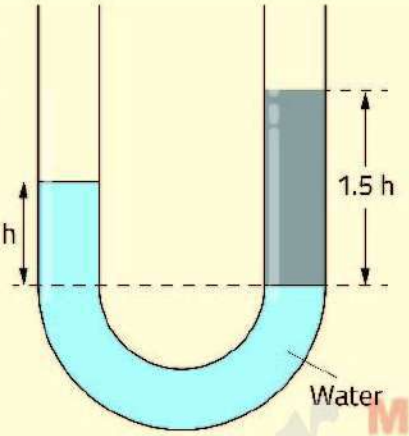
QUIZ

42 A U-shaped tube has a narrow arm of cross-sectional area of 1 cm² and a wide arm of cross-sectional area of 2 cm². The cube is partially filled with water of density 1000 kg/m³, then oil of density 800 kg/m³ is poured in the narrow arm until the height of oil column becomes 5 cm above the separating surface at equilibrium, then the height of water above the level of the separating surface is .....

a 2 cm
b 4 cm
c 5 cm
d 8 cm

MCQ

43 **The opposite figure shows a U-shaped tube containing water and another liquid in a state of equilibrium, so the relative density of this liquid equals .....**



a $\frac{3}{2}$ b $\frac{2}{3}$ c 1 d $\frac{3}{4}$

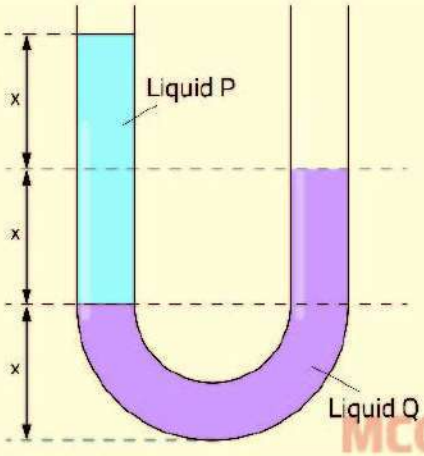
MCQ

44 **U-shaped tube of uniform cross-section whose vertical height is 50 cm, is filled to half its heights with water, then oil is poured in one of the arms until it reached the top end of the tube, if the density of oil is 750 kg/cm³ and the density of water is 1000 kg/m³ then the height of oil above the interface between the two liquids is .....**

a 2 cm b 4 cm c 5 cm d 8 cm

MCQ

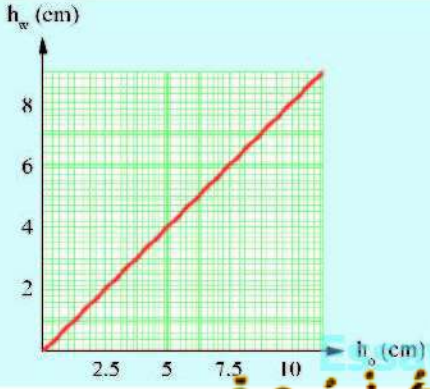
45 **The diagram shows two liquids, labeled P and Q, which do not mix. The liquids are in equilibrium in an open U-tube. What is the ratio ($\frac{\rho_P}{\rho_Q}$) is:**



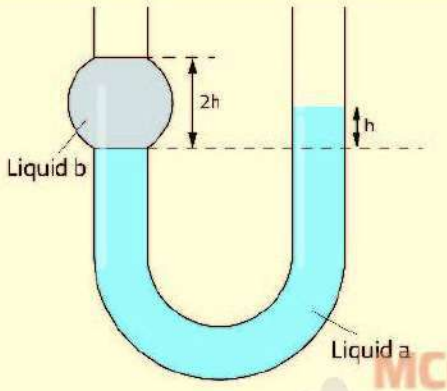
a $\frac{1}{2}$ b $\frac{2}{3}$ c $\frac{3}{2}$ d 2

MCQ

46 **U-shaped tube was containing an amount of water then oil is poured gradually in one of its arms. If the opposite graph shows the relation between the height of water (h_w) in one arm and the height of oil in the other arm (h_o) above the level of the boundary surface between the two liquids, then calculate the relative density of oil.**



47 **In the opposite figure, the ratio between the densities of the liquids ($\frac{\rho_a}{\rho_b}$) is:**

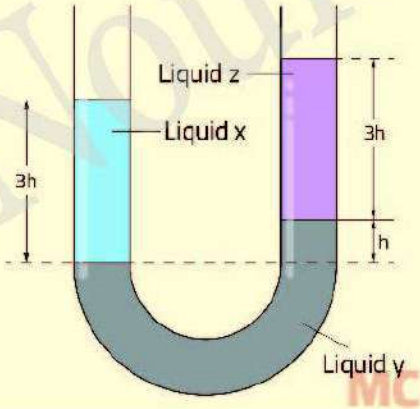


a $\frac{1}{2}$ b $\frac{1}{4}$

c $\frac{2}{1}$ d $\frac{4}{1}$

MCQ

48 **The opposite figure shows a U-shaped tube containing three liquids x, y, z, in equilibrium state, so .....**

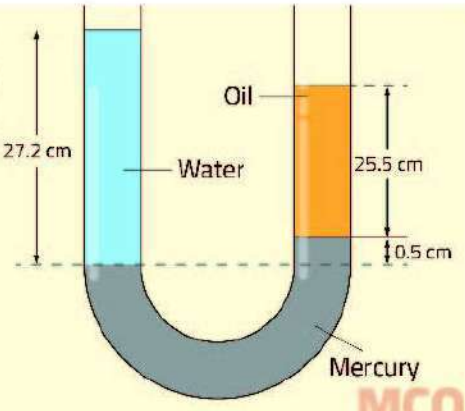


a $\rho_x = \rho_y + \rho_z$ b $\rho_x = 3\rho_y + \rho_z$

c $\rho_x = \rho_y + 3\rho_z$ d $\rho_x = \frac{1}{3}\rho_y + \rho_z$

MCQ

49 **In the opposite figure, a U-shaped tube of uniform cross-section contains three liquids in a state of equilibrium. If the relative density of mercury is 13.6, then the relative density of oil is .....**



a 0.6 b 0.8

c 0.85 d 1.25

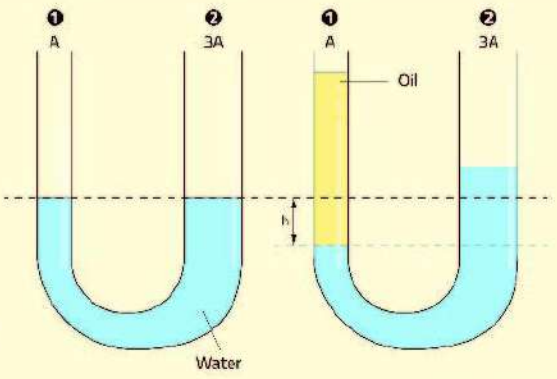
MCQ

50 **U-shaped tube of height 60 cm is placed vertically and the cross-sectional area of one of its arms is double that of the other. It is filled until half its height with water then oil of density 600 kg/m³ is poured in the narrow arm until it reached the top end of the tube, then the height of water above the level of the interface between the liquids is .....** [where: ρ_{water} = 1000 kg/m³]

a 10 cm b 11.25 cm c 12.86 cm d 30 cm

MCQ

51 **In the opposite figure a U-shaped tube contains an amount of water. If an amount of oil is poured in the arm (1) and the level of water surface is lowered down a distance h, the height of water above the level of interface between the two liquids becomes .....**



a $\frac{1}{3}$ h **b** $\frac{4}{3}$ h

c 3h **d** h

MCQ

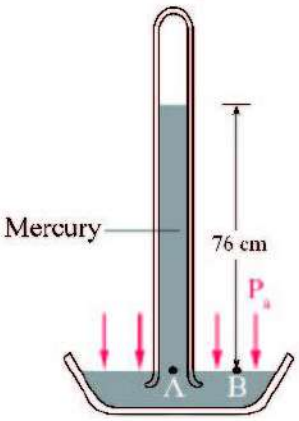
Mercury Barometer

Uses of the mercury barometer

1 Measuring the atmospheric pressure

$$\therefore P_A = P_B = P_a$$

$$\therefore P_a = \rho_{Hg} g h_{Hg}$$



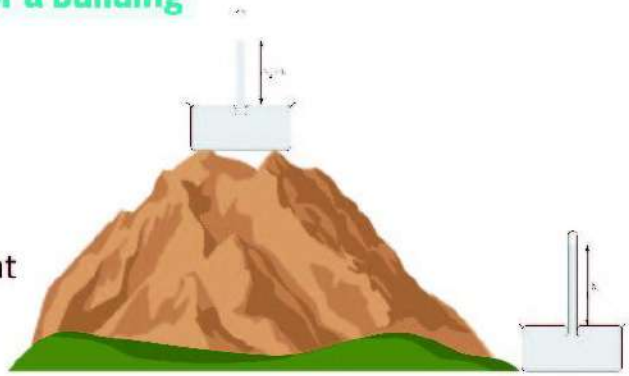
2 Determining the height of a mountain or a building

$$\Delta P_{Hg} = \Delta P_{air}$$

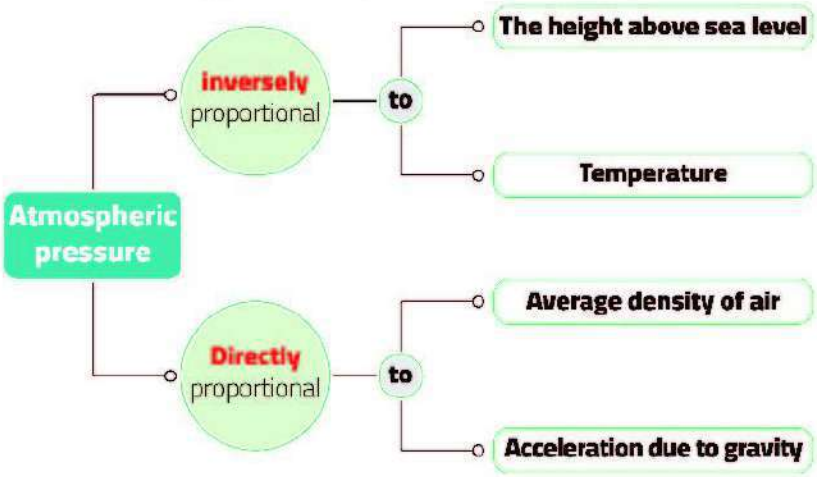
$$\rho_{IIg} g \Delta h_{IIg} = \rho_{air} g h_{mountain}$$

$$\rho_{IIg} g (h_1 - h_2) = \rho_{air} g h_{mountain}$$

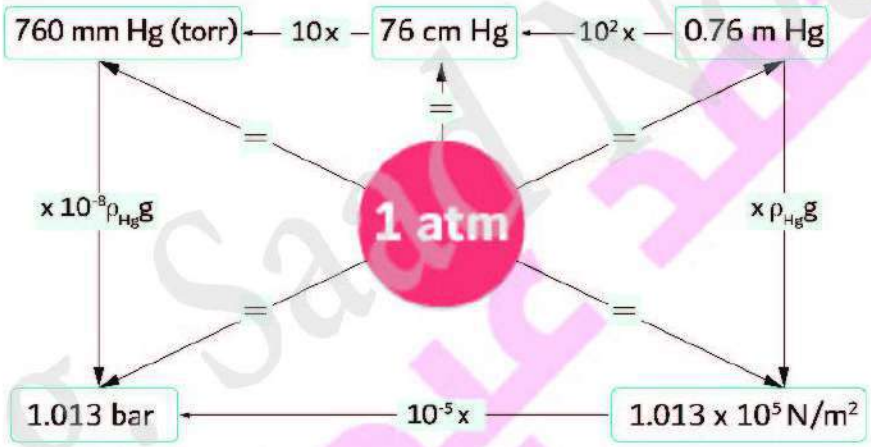
By knowing the average density of air, the height of the mountain can be determined.



إعداد: أ. محمد عبدالسلام



Measuring units of atmospheric pressure



$$\text{Pressure in required unit} = \frac{\text{The quantity to be converted} \times \text{Atmospheric pressure in required unit}}{\text{Atmospheric pressure in the original unit}}$$

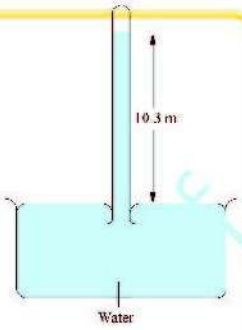
أفكار المسائل

1 Mercury is commonly used in barometers for the following reasons:

1. The high density of mercury, so the height of its column can be suitable for using a tube of reasonable length (less than one meter) for measuring the atmospheric pressure.
2. The resulted vapor quantity from mercury is very small that can be neglected, so that Torricellian vacuum becomes evacuated except from a small amount of mercury whose pressure is negligible in normal temperatures, hence the approximately zero pressure in Torricellian vacuum doesn't affect the reading of the barometer.
3. Adhesive forces between the mercury molecules and that of the glass are very weak so it doesn't adhere to the glass.
4. It can be easily seen through the glass tube due to its silver color.

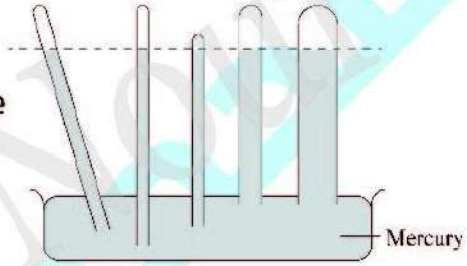
Water is not used in barometers because:

1. The density of water is much less than that of mercury, so the height of water column that has a pressure equal to the atmospheric pressure is 10.3 m.
2. Water evaporates in a much more amount than mercury at normal temperatures, so the resulted pressure due to water vapor in the tube can't be neglected which affects the barometer reading.



The height of the mercury column in the barometer tube doesn't depend on:

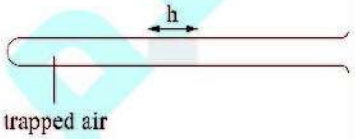
1. The length of the tube.
2. The volume of Torricellian vacuum.
3. The length of the submerged part of the tube under the mercury surface.
4. The cross-sectional area of the barometric tube.
5. The inclination angle of the tube.



As long as the vertical height of the tube above the open surface of mercury is larger than the atmospheric pressure in the unit of cm Hg.

The **Torricellian vacuum** disappears in the barometric tube when the vertical height of the tube from the open surface of mercury is less than or equal to 76 cm or the value of atmospheric pressure (in cm Hg) at the place of measurement and in this case the height of the mercury column doesn't represent the magnitude of the atmospheric pressure.

When putting a thread of mercury of length h in a capillary tube of uniform cross-section, where a certain air volume is trapped in the tube, then if the tube is:

Horizontally oriented	Vertically oriented and its open is upward	Vertically oriented and its open is downward
		
$P = P_a$	$P = P_a - h$	$P = P_a + h$

QUIZ

52 When does ...?

(a) Torricellian vacuum disappear in the barometric tube?

(b) The height of mercury in the barometric tube become not representing the atmospheric pressure. Essay

53 If the pressure of an enclosed gas is 152 cm Hg, then its pressure in the bar equals ...

a 1.013 b 2.026 c 3.039 d 4.052 MCQ

54 If the pressure at a point inside a liquid is 1000 torr, then this pressure in pascal equals .....

a 1.013×10^5 b 1.13×10^5

c 1.33×10^5 d 1.93×10^5 MCQ

55 If the pressure of an enclosed gas is 152 cm Hg, then its pressure in the bar equals .....

a 1.013 b 2.026 c 3.039 d 4.052 MCQ

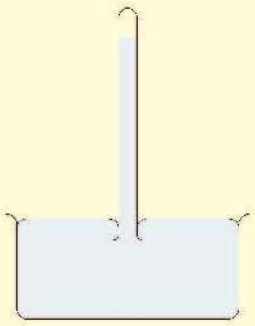
56 If the pressure at a point inside a liquid is 1000 torr, then this pressure in pascal equals .....

a 1.013×10^5 b 1.13×10^5

c 1.33×10^5 d 1.93×10^5 MCQ

57 The opposite figure shows the reading of a mercury barometer at the top of a mountain. If the barometer is transferred to the bottom of the mountain, then the level of the mercury surface .....

Sol

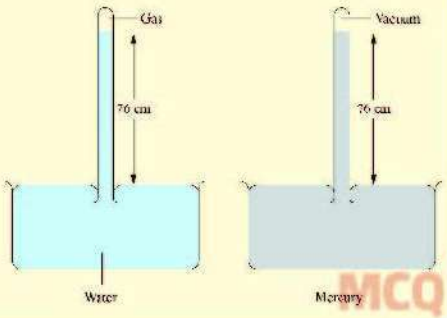


	In the barometer basin	In the barometer tube
a	increases	increases
b	decreases	decreases
c	increases	decreases
d	decreases	increases

MCQ

58 **The opposite figure shows two barometers, mercury barometer and water barometer, which are placed in the same room. If the tube of the water barometer contains an amount of a gas, then the pressure of this gas equals .....**

(where: $\rho_{mercury}$ = 13600 kg/m³, ρ_{water} = 13600 kg/m³, and g = 9.8 m/s²)



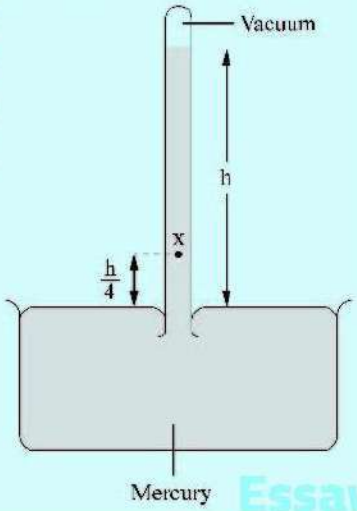
MCQ

59 **Consider that a mercury barometer is placed at a well-sealed room that is evacuated gradually using a vacuum pump, then the Torriciellian space inside the barometer tube .....**

a increases
b decreases but does not vanish
c does not change
d decreases till it vanishes

MCQ

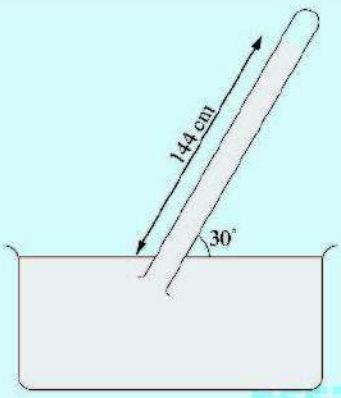
60 **The opposite figure shows a mercury barometer. If the height of the mercury column inside in the barometer equals h when the atmospheric pressure equals 1.01 x 10⁵ N/m², the value of pressure at point x equals ....**



Essay

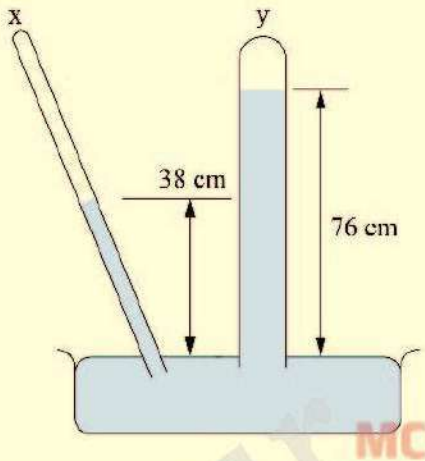
1 **The opposite figure shows a mercury barometer measuring barometer measuring atmospheric pressure. If the tube of the barometer is inclined to the horizontal by 30°, then the measured atmospheric pressure equals .....**

(where: $\rho_{mercury}$ = 13600 kg/m³ and g = 9.8 m/s²)



Essay

61 **The opposite figure shows a mercury barometer with two tubes x , y of cross-sectional area 1 cm², 2 cm² respectively. It is found that the height of mercury on the tube x is less than its height in the tube y because the tube x is .....**

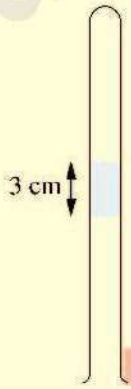


a greater in length
b less in thickness
c inclined
d containing air

MCQ

62 **The opposite figure shows a thread of mercury that traps an amount of air in a capillary tube, then the pressure of the contained air in the tube equals .....**

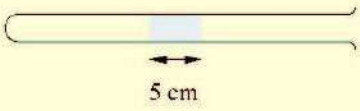
(where the atmospheric pressure = 76 cm Hg)



a 73 cm Hg
b 75 cm Hg
c 76 cm Hg
d 79 cm Hg

MCQ

63 **The opposite figure shows a thread of mercury that traps an amount of air in a capillary tube under pressure of 75 cm Hg, if the tube is turned to be vertical and its open end becomes upward, then the pressure of the contained air in the tube becomes .....**

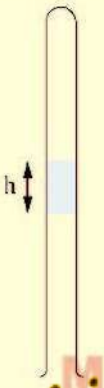


a 70 cm Hg
b 75 cm Hg
c 80 cm Hg
d 81 cm Hg

MCQ

64 **In the opposite figure a capillary tube of uniform cross-sectional area contains a thread of mercury which traps an amount of air at pressure of 68 cm Hg, so the length of mercury thread (h) is .....**

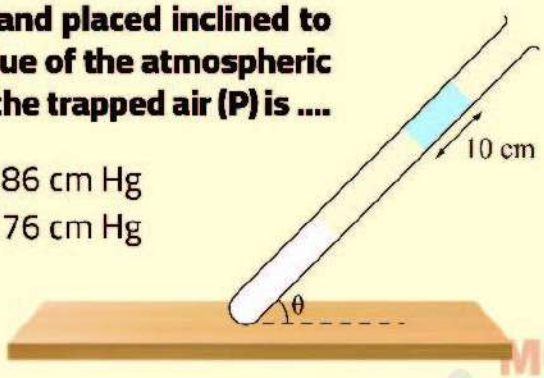
(where: the atmospheric pressure = 75 cm Hg)



a 5 cm
b 7 cm
c 9 cm
d 12 cm

MCQ

65 **The opposite figure represents a capillary tube of uniform cross-sectional area contains a mercury thread and placed inclined to a horizontal surface by an angle . If the value of the atmospheric pressure is 76 cm Hg, then the pressure of the trapped air (P) is ....**



a greater than 86 cm Hg
b less than 86 cm Hg
c equal to 86 cm Hg
d less than 76 cm Hg

MCQ

66 **What happens in each of the following cases:**

(a) Transferring a barometer from the surface of Earth to the peak of a mountain concerning its reading when assuming unchanged temperature?

(b) Climbing with a barometer to the top of a mountain concerning the size of Torriciellian vacuum in the barometric tube?

Essay