Name: **Index No:**

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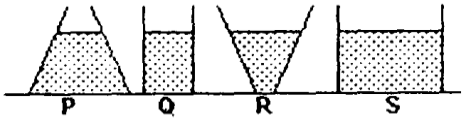
Assignment 07: Pressure

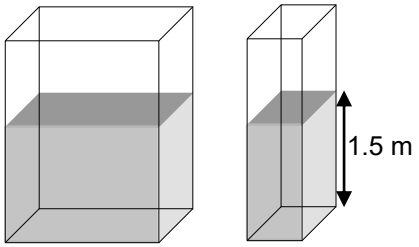
1. The diagram shows the cross-section of four vessels, **P**, **Q**, **R** and **S**, filled to the same level with water.



Which of the following statements is **true**?

A. The water in vessel **P** exerts the greatest pressure on its base.
B. The water in vessel **R** exerts the greatest pressure on its base.
C. The water in vessel **Q** exerts the greatest force on its base.
D. The water in vessel **S** exerts the greatest force on its base. (D)

2. Two cuboid containers contain oil (density = 800 kg/m^3) of equal depth. Container A has a base area of 2.0 m^2 while container B has a base area of 0.50 m^2. Take gravitational field strength, g = 10 N kg^{-1}.

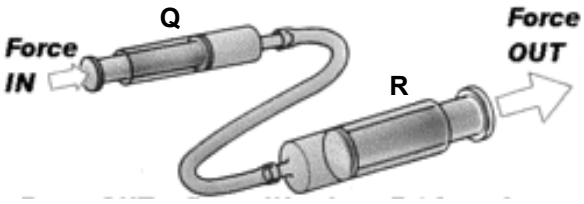


What is the pressure exerted by oil on the bases of both containers?

	container A	container B
A.	24 kPa	24 kPa
B.	12 kPa	12 kPa
C.	24 kPa	6.0 kPa
D.	12 kPa	6.0 kPa

(B)

3. The diagram shows a hydraulic system.

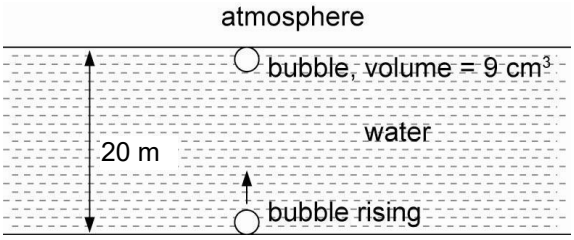


A force of 40 N is exerted on piston **Q**. The radius of piston **R** is twice the radius of piston **Q**.

What will the force exerted by the liquid on piston **R**?

A. 10 N
B. 20 N
C. 80 N
D. 160 N (D)

4. Water of depth 10 m exerts a pressure equal to atmospheric pressure. An air bubble rises to the surface of a lake which is 20 m deep. When the bubble reaches the surface, its volume is 9 cm^3.

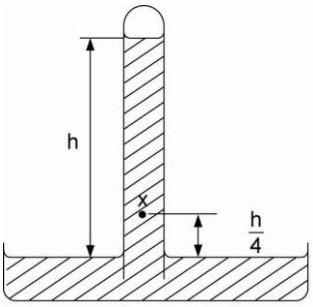


What was the volume of air bubble at the bottom of the lake?

A. 18 cm^3 B. 6 cm^3 C. 3 cm^3 D. 27 cm^3 (C)

5. When the atmospheric pressure is 100 000 Pa, the height of a mercury barometer is *h*.

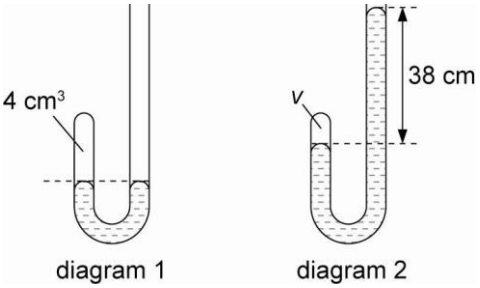
What is the pressure at *X*?



A. 75 000 Pa
B. 25 000 Pa
C. 125 000 Pa
D. 175 000 Pa

(A)

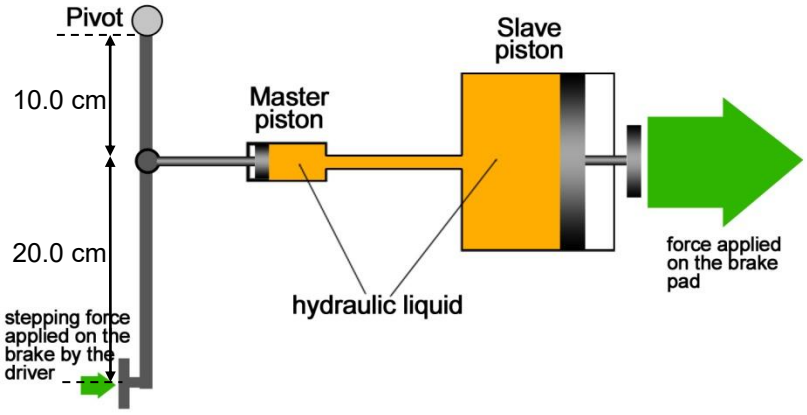
6. A J-shaped tube with 4.0 cm^3 of air trapped by mercury is shown in diagram 1. The mercury levels are the same on both sides of the tube. In diagram 2, the levels differ by 38 cm when more mercury is poured into the open end. The atmospheric pressure remains constant at 76 cm of mercury. What is the volume *V* of trapped air shown in diagram 2?



A. 1.0 cm^3
B. 2.0 cm^3
C. 2.7 cm^3
D. 6.0 cm^3

(C)

7. The diagram below shows a hydraulic brake which is used in many cars.



(a) If the driver presses down on the brake pedal with a force of 200 N, what is the magnitude of the force F applied to the master piston? [2]

Taking moments about pivot,
$F(10.0\text{ cm}) = (200\text{ N})(30.0\text{ cm})$ [1]
$F = \underline{600\text{ N}}$ [1]

(b) If the area of the master piston is only a tenth the area of the slave piston, what is the magnitude of the force applied on the brake pad? [2]

$F_m/A_m = F_s/A_s \quad \therefore (600\text{ N})/(1) = (F_s)/(10)$ [1]
Force applied on brake pad = $\underline{6000\text{ N}}$ [1]

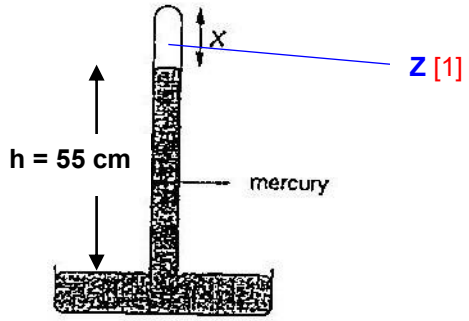
(c) The distance moved by the master piston is D_m. The distance moved by the slave piston is D_s. What is the value of D_s/D_m? [2]

$F_mD_m = F_sD_s$
$(600\text{ N})(D_m) = (6000\text{ N})(D_s)$ [1]
$D_s/D_m = 0.1$ [1]

(d) Give two ways by which the brake could be modified to increase the size of the braking force on the brake pad when 200 N force is exerted on the pedal. [2]

[Any 2 correct: 2 m]
Increase area of slave piston. / Decrease area of master piston.
Decrease distance between pivot and joint connecting master piston.
Increase distance between pivot and brake pedal.

8. A simple mercury barometer is carried to the top of a mountain, where the atmospheric pressure is less than that at its base. Take gravitational field strength, g = 10 N kg^{-1}.



(a) Calculate the atmospheric pressure, in Pa, at the top of the mountain. [2]
The density of mercury is 13 600 kg m^{-3}.

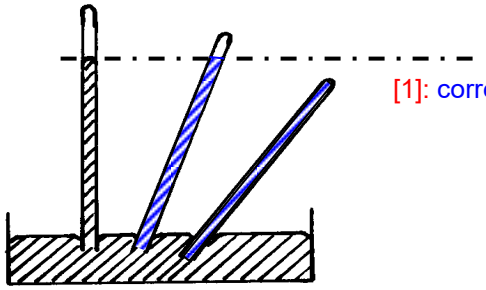
Pressure $= hpg$
$= (0.55\text{ m})(13\,600\text{ kg m}^{-3})(10\text{ N kg}^{-1})$ [1]
$= 74800\text{ Pa}$
$= \underline{75000\text{ Pa (to 2 s.f.)}}$ [1]

(b) On the above diagram, indicate with a "Z" the point where pressure is zero. [1]

(c) Explain why it is not advisable to use water to replace mercury in a barometer. [2]

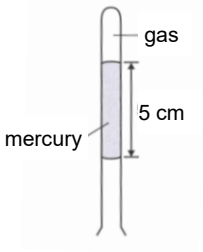
Density of water is low compared to mercury. [1]
To measure atmospheric pressure, a very long column of water is required for the barometer. This is not practical. [1]

(d) Indicate on the diagram below, the positions of the mercury level inside the tube when this barometer was tilted at two different positions. [2]



[1]: correct level in each tube

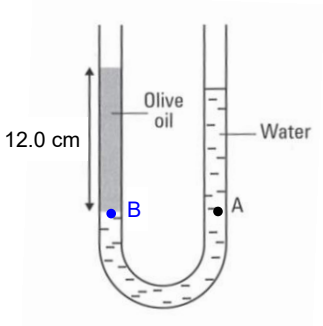
9. The diagram shows some gas trapped by some mercury in a glass tube. Calculate the pressure P of the gas, in kPa. It is given atmospheric pressure = 76 cm Hg, density of mercury = 13 600 kg m^{-3} and gravitational acceleration, g = 10 m s^{-2}. [3]



$P_{gas} + P_{mercury} = P_{atm}$
P + 5 cm Hg = 76 cm Hg
P = 71 cm Hg [1]

P = (0.71 m)(13 600 kg m^{-3})(10 m s^{-2}) [1]
= 97 kPa (to 2 s.f.) [1]

10. A U-tube with 30.0 cm of water is set up vertically and 12.0 cm of olive oil is poured carefully into the left-hand limb of the tube as shown in the diagram. It is observed that water will be pushed up in the other limb. The density of water and olive oil are 1.00 x 10^3 kg m^{-3} and 9.20 x 10^2 kg m^{-3} respectively.



(a) Mark on the diagram a point B which has the same pressure as point A. [1]

(b) What is the length of the water column above point A? [2]

$P_A = P_B$
$(h)(1.00 \times 10^3 \text{ kg m}^{-3})g + P_{atm} = (12.0 \text{ cm})(9.20 \times 10^2 \text{ kg m}^{-3})g + P_{atm}$ [1]

h = 11.04 = 11.0 cm (to 3 s.f.) [1]

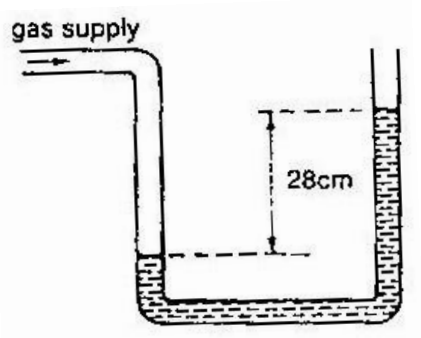
(c) A further 6.0 cm of olive oil is added into the left-hand limb. How much further will the water level rise in the right limb? [3]

pressure change caused by olive oil = (height change of water)ρg

$h_o \rho_o g = h_w \rho_w g$
(6.0 cm)(9.20 x 10^2 kg m^{-3}) = h_w (1.00 x 10^3 kg m^{-3}) [1]
h_w = 5.52 cm [1]

For a height change of water = 5.52 cm, the water in the left limb moves down by 2.76 cm and the water in the right limb rises by 2.76 cm. [Accept 2.8 cm] [1]

11. The diagram shows a water manometer connected to a gas supply. The difference in height between the two levels is 28 cm.



(a) What would be the difference in height between the two water levels if the diameter of the right-hand tube were double that of the left-hand tube? [1]

28 cm (difference in height would be the same) [1]

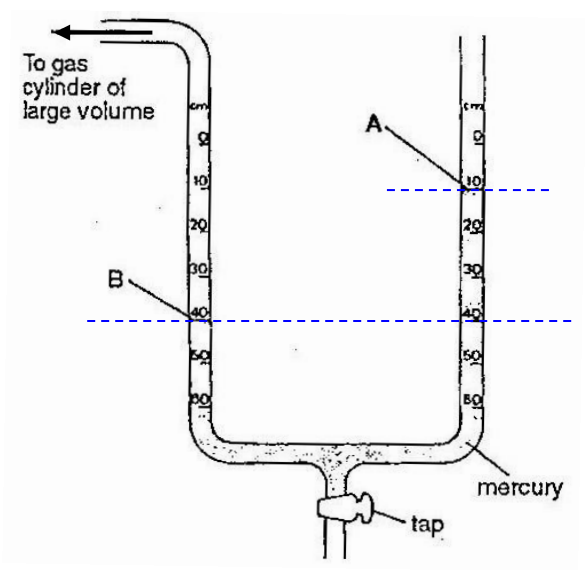
(b) If mercury were used instead of water, what would be the difference in the height between the levels? Take density of the mercury to be 14 times that of water. [2]

$h_1\rho_1 = h_2\rho_2$
$28\ (\rho_1) = h_2\ (14\ \rho_1)$ [1]
$h_2 = \underline{2.0\text{ cm}}$ [1]

(c) Give one reason why an astronaut on the moon could not use this manometer for measuring the pressure of his oxygen supply. [1]

There is no atmospheric air in space to make comparison. [1]

12. The diagram shows a U-tube manometer connected to a gas cylinder of large volume. The atmospheric pressure is 76 cm Hg.



(a) (i) What is the pressure at point **A** in the right-hand tube? 76 cm Hg [1]

(ii) What is the pressure at point **B** in the left-hand tube? 106 cm Hg [1]

(b) The tap is opened and mercury runs out until the level in the left-hand tube drops to the 60 cm mark.

(i) Assuming that the pressure in the gas cylinder remains constant, what is the new position of the level in the right-hand tube? 30 cm [1]

(ii) Explain how you arrived at your answer. [1]

Pressure **difference** (keyword) between gas in cylinder and atmosphere is constant at 30 cm Hg, thus constant height of Hg.