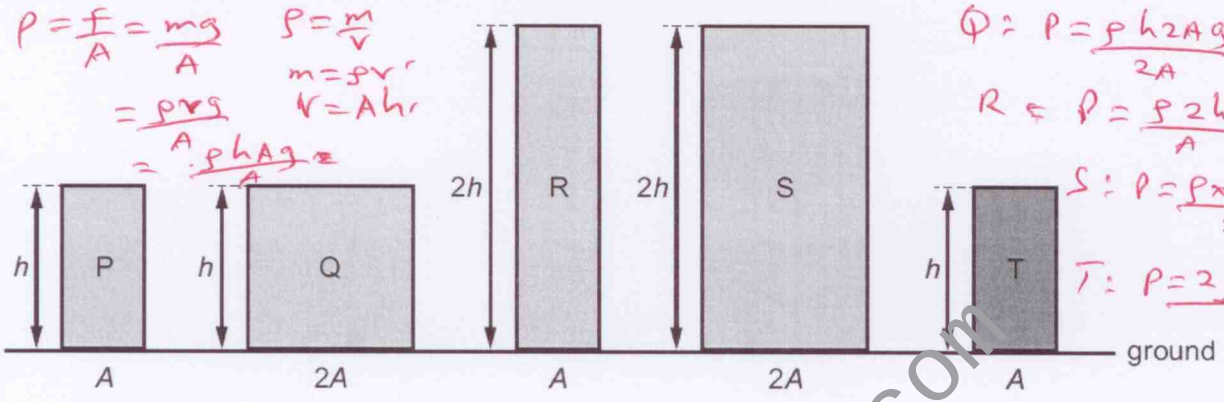
Density and Pressure - 2018

1. 9702/11/M/J/18/No.11

Blocks P, Q, R and S are made from material of the same density. Block T is made from a material of twice the density of the material of the other blocks.

The cross-sectional area and height of each of the blocks are shown.



Which two blocks exert the same pressure on the ground?

A P and T **B** Q and R **C** Q and S **D** S and T

2. 9702/11/M/J/18/No.13

Liquids X and Y are stored in large open tanks. Liquid X has a density of 800 kg m^{-3} and liquid Y has a density of 1200 kg m^{-3}.

At which depths are the pressures equal?

	depth in liquid X / m	depth in liquid Y / m
A	8	20
B	10	15
C	15	10
D	20	8

3. 9702/12/M/J/18/No.10

The density of water is 1.0 g cm^{-3} and the density of glycerine is 1.3 g cm^{-3}.

Water is added to a measuring cylinder containing 40 cm^3 of glycerine so that the density of the mixture is 1.1 g cm^{-3}. Assume that the mixing process does not change the total volume of the liquid.

What is the volume of water added?

A 40 cm^3 B 44 cm^3 C 52 cm^3 D 80 cm^3 ✓

$\rho = \frac{m}{V}$.

$m_g = 1.3 \times 40 = 52$ g.

$m_w = 1.0 \times V_w$

$1.1 = \frac{m_w + m_g}{V_w + V_g}$.

$1.1 = \frac{1.0 \times V_w + m_g}{V_w + 40}$

$1.1(V_w + 40) = V_w + m_g$

$1.1V_w + 40 = V_w + m_g$

$1.1V_w + 40 = V_w + 52$.

$1.1V_w - V_w = 52 - 44$

$0.1V = 8$

$V = 80$ cm^3

4. 9702/12/M/J/18/No.12

A cylindrical block of wood has cross-sectional area A and weight W. It is totally immersed in water with its axis vertical. The block experiences pressures p_t and p_b at its top and bottom surfaces respectively.

$f = p \times A$

Which expression is equal to the upthrust on the block?

A ✓ $(p_b - p_t)$

B $(p_b - p_t)A$

C $(p_b - p_t)A - W$

D $(p_b - p_t)A + W$

Upthrust $= f_b - f_t$.

$= p_b A - p_t A$

$= (p_b - p_t) A$

5. 9702/13/M/J/18/No.11

A rectangular block of lead of density 1.13×10^4 kg m^{-3} has sides of length 12.0 cm, 15.0 cm and 10.0 cm.

What is the maximum pressure the block can exert when resting on a table?

A 1.13 kPa B 1.70 kPa C 11.1 kPa D ✓ 16.6 kPa

max. Pressure when standing on smaller area.

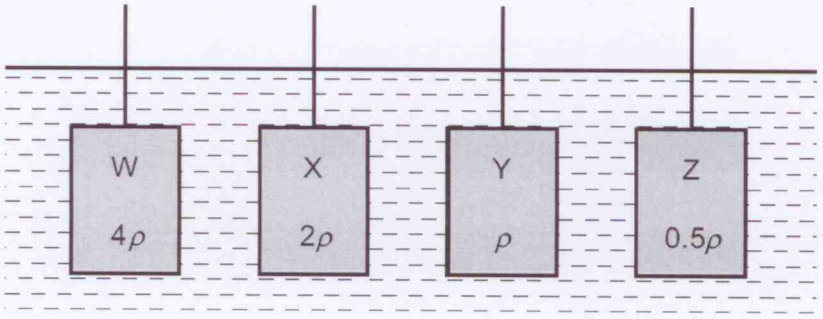
$P = \frac{F}{A} = \frac{\rho V g}{A} = \frac{1.13 \times 10^4 \times (0.12 \times 0.15 \times 0.10) \times 9.81}{0.12 \times 0.10}$

$= 16,627.95$ Pa

$= 16.6$ kPa

6. 9702/13/M/J/18/No.10

Four cuboids with identical lengths, breadths and heights are immersed in water. The cuboids are held at the same depth and in identical orientations by vertical rods, as shown.



Water has density ρ.
Cuboid W is made of material of density 4ρ.
Cuboid X is made of material of density 2ρ.
Cuboid Y is made of material of density ρ.
Cuboid Z is made of material of density 0.5ρ.

Which statement is correct?

A The upthrust of the water on each of the cuboids is the same.

B The upthrust of the water on W is twice the upthrust of the water on X.

C The upthrust of the water on X is twice the upthrust of the water on W.

D The upthrust of the water on Y is zero.

7. 9702/13/M/J/18/No.13

Full-fat milk is made up of fat-free milk mixed with fat.

A volume of $1.000 \times 10^{-3}\,m^3$ of full-fat milk has a mass of 1.035 kg. It contains 4.00% fat by volume.

The density of fat-free milk is $1.040 \times 10^3\,kg\,m^{-3}$.

What is the density of fat?

A $1.25 \times 10^2\,kg\,m^{-3}$

B $9.15 \times 10^2\,kg\,m^{-3}$

C $9.28 \times 10^2\,kg\,m^{-3}$

D $1.16 \times 10^3\,kg\,m^{-3}$

$V_{fat} = \frac{1.0\times10^{-3}\times4}{100} = 0.00004\,m^3$

$\rho_{full\,fat} = \frac{m_{free} + m_{fat}}{V_{free} + V_{fat}}$

$\rho_{full\,fat} = \frac{1.035}{1.0\times10^{-3}} = 1035\,kg\,m^{-3}$

$V_{free} = 1.0\times10^{-3} - 4.0\times10^{-5}$
$= 9.6\times10^{-4}\,m^3$

$m_{free} = \rho_{free} \times V_{free}$
$= 1.040\times10^3 \times 9.6\times10^{-4}$
$= 0.9984\,kg$

$1035 = \frac{0.9984 + m_{fat}}{9.6\times10^{-4} + 4\times10^{-5}}$

$1035 \times 0.001 = 0.9984 + m_{free}$

$m_{fat} = 1.035 - 0.9984$
$= 0.0366$

$\rho_{fat} = \frac{m_{fat}}{V_{fat}}$
$= \frac{0.0366}{0.00004}$
$= 915\,kg\,m^{-3}$
$= 9.15\times10^2\,kg\,m^{-3}$