Density and Pressure – 2023 June AS Physics 9702

1. June/2023/Paper_ 9702/11/No.14

Which expression for pressure is correct?

A force per unit area

B force per unit volume

C mass per unit area

D mass per unit volume

2. June/2023/Paper_ 9702/11/No.15

A ball has a mass of 0.50 kg and a volume of $1.3 \times 10^{-3}\,m^3$. The ball is floating in equilibrium on still water. The two forces that act on the ball are its weight and the upthrust due to the water.

The density of the water is $1.0 \times 10^3\,kg\,m^{-3}$.

What is the percentage of the volume of the ball above the surface of the water?

A 3.9% **B** 38% **C** 62% **D** 96%

3. June/2023/Paper_ 9702/12/No.13

Two solid cubes X and Y are made of material of the same density. Cube X has twice the mass of cube Y.

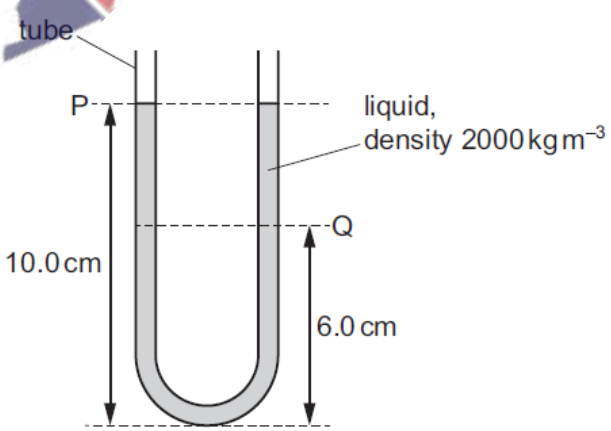
Cube X has sides of length *x*. Cube Y has sides of length *y*.

What is the ratio $\frac{x}{y}$?

A 1.26 **B** 1.41 **C** 2.00 **D** 8.00

4. June/2023/Paper_ 9702/12/No.14

A U-shaped glass tube contains liquid of density $2000\,kg\,m^{-3}$, as shown.



What is the difference in pressure due to the liquid between levels P and Q?

A 780 Pa **B** 1200 Pa **C** 1600 Pa **D** 2000 Pa

5. June/2023/Paper_ 9702/13/No.13

A volume of 1.5 m^3 of water is mixed with 0.50 m^3 of alcohol. The density of water is 1000 $kg\,m^{-3}$ and the density of alcohol is 800 $kg\,m^{-3}$.

The volume of the mixture is 2.0 m^3.

What is the density of the mixture?

A 850 $kg\,m^{-3}$ **B** 900 $kg\,m^{-3}$ **C** 940 $kg\,m^{-3}$ **D** 950 $kg\,m^{-3}$

6. June/2023/Paper_ 9702/13/No.14

An object is falling at a constant speed through a viscous liquid. F_U is the upthrust on the object due to the liquid. W_L is the weight of the liquid displaced by the object. W_O is the weight of the object.

Which equation **must** be correct?

A $F_U = W_L$

B $F_U = W_O - W_L$

C $F_U = W_O$

D $F_U = W_O + W_L$

7. June/2023/Paper_ 9702/21/No.4

A beaker in air contains a liquid. The base of the beaker is in contact with the liquid and has area A, as shown in Fig. 4.1.

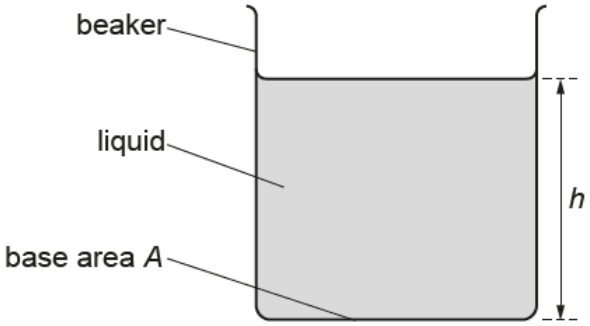


Fig. 4.1

The liquid has density ρ and fills the beaker to a depth h.

(a) By using the definitions of pressure and density, show that

$$p = \rho gh$$

where p is the pressure due to the liquid that is exerted on the base of the beaker and g is the acceleration of free fall.

[3]

(b) Suggest why the equation in **(a)** does not give the total pressure on the base of the beaker.

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..... [1]

(c) Fig. 4.2 shows the variation of the total pressure inside the liquid with depth x below the surface.

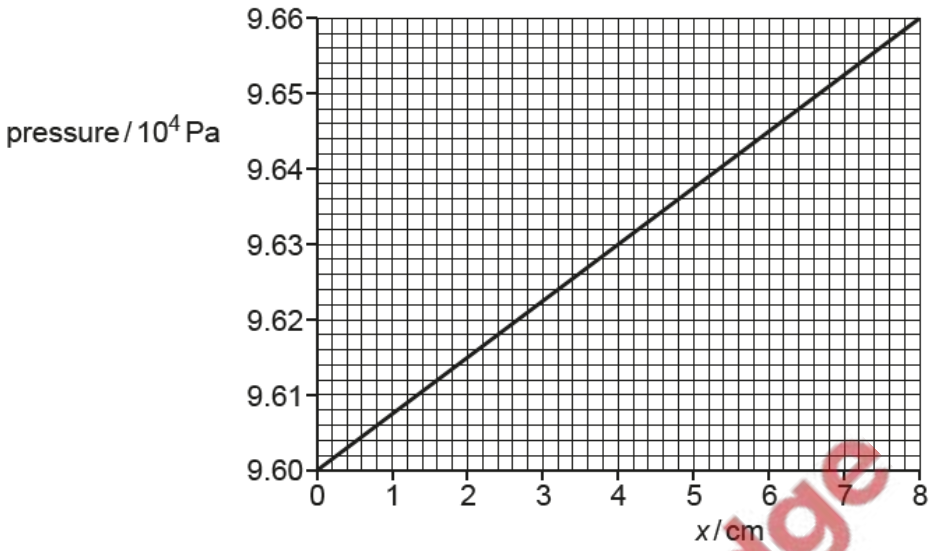

Fig. 4.2

Determine the density of the liquid.

density = ... kg m^{-3} [2]

(d) A solid cylinder is held stationary by a wire so that the base of the cylinder is level with the surface of the liquid, as shown in Fig. 4.3.

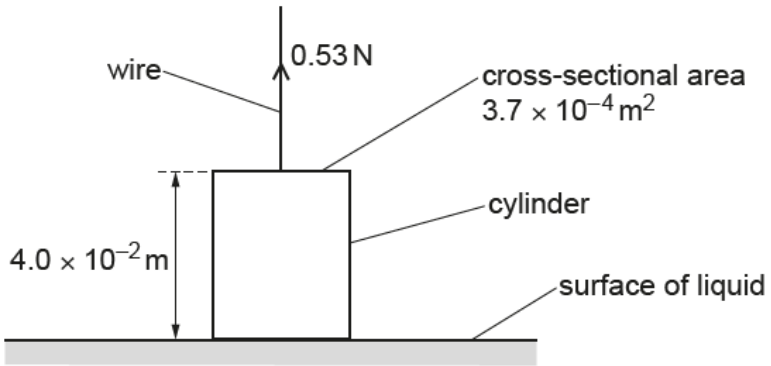

Fig. 4.3 (not to scale)

The cylinder has length $4.0 \times 10^{-2}\,m$ and cross-sectional area $3.7 \times 10^{-4}\,m^2$. The tension in the wire is 0.53 N.

The cylinder is now lowered and then held stationary by the wire so that the top of the cylinder is level with the surface of the liquid.

Calculate the new tension in the wire.

tension = ... N [2]

[Total: 8]

8. June/2023/Paper_ 9702/23/No.2

A sphere floats in equilibrium on the surface of sea water of density 1050 kg m^{-3}, as shown in Fig. 2.1.

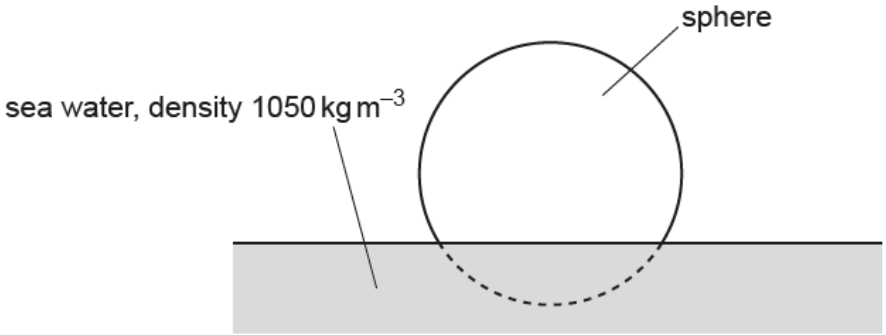

Fig. 2.1

(a) 21% of the volume of the sphere is below the surface of the water.

Calculate the density of the sphere.

density = ... kg m^{-3} [2]

(b) The sphere is now held so that its entire volume is below the surface of the water. The sphere is then released.

(i) Calculate the initial acceleration of the sphere.

acceleration = ... m s^{-2} [3]

(ii) The sphere accelerates upwards but remains entirely below the surface of the water.

State and explain what happens to the acceleration of the sphere as its velocity begins to increase.

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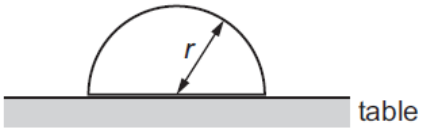
..... [3]

[Total: 8]

9. March/2023/Paper_ 9702/12/No.13

An object shaped as a hemisphere rests with its flat surface on a table. The object has radius r and density ρ.



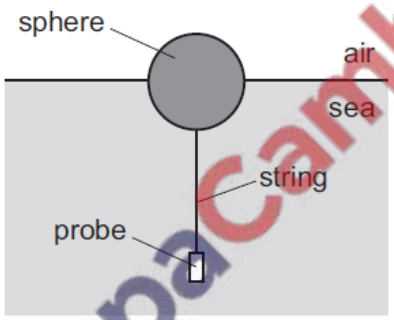
The volume of a sphere is $\frac{4}{3}\pi r^3$.

Which average pressure does the object exert on the table?

A $\frac{1}{3}\rho r^2$ **B** $\frac{1}{3}\rho r^2 g$ **C** $\frac{2}{3}\rho r$ **D** $\frac{2}{3}\rho rg$

10. March/2023/Paper_ 9702/12/No.14

A probe is used to monitor the quality of the water in the sea. The probe is suspended by a vertical string which is attached to a sphere. The stationary sphere floats in equilibrium on the surface of the sea, as shown.



The sphere has a weight of 5.00 N. The probe and string have a combined weight of 2.00 N.

The density of the seawater is $1.03 \times 10^3\,\text{kg}\,\text{m}^{-3}$. The upthrust acting on the probe and thread is negligible.

What is the volume of the sphere below the surface of the sea?

A $1.98 \times 10^{-4}\,\text{m}^3$

B $2.97 \times 10^{-4}\,\text{m}^3$

C $4.95 \times 10^{-4}\,\text{m}^3$

D $6.93 \times 10^{-4}\,\text{m}^3$