

# Physics

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(Chapter 9) (Mechanical Properties of Solids) (Exercises)

(Class 11)

## Question 9.13:

What is the density of water at a depth where pressure is 80.0 atm, given that its density at the surface is  $1.03 \times 10^3 \text{ kg m}^{-3}$ ?

## Answer 9.13:

Let the given depth be  $h$ . Pressure at the given depth,  $p = 80.0 \text{ atm} = 80 \times 1.01 \times 10^5 \text{ Pa}$

Density of water at the surface,  $\rho_1 = 1.03 \times 10^3 \text{ kg m}^{-3}$

Let  $\rho_2$  be the density of water at the depth  $h$ , let  $V_1$  be the volume of water of mass  $m$  at the surface.

Let  $V_2$  be the volume of water of mass  $m$  at the depth  $h$  and let  $\Delta V$  be the change in volume.

$$\Delta V = V_1 - V_2$$

$$= m \left( \frac{1}{\rho_1} - \frac{1}{\rho_2} \right)$$

$$\therefore \frac{\Delta V}{V_1} = 1 - \frac{\rho_1}{\rho_2} \quad \dots(i)$$

$$\text{Bulk modulus, } B = \frac{pV_1}{\Delta V}$$

$$\frac{\Delta V}{V_1} = \frac{p}{B}$$

$$\text{Compressibility of water} = \frac{1}{B} = 45.8 \times 10^{-11} \text{ Pa}^{-1}$$

$$\therefore \frac{\Delta V}{V_1} = 80 \times 1.013 \times 10^5 \times 45.8 \times 10^{-11} = 3.71 \times 10^{-3}$$

For equations (i) and (ii), we get:

$$1 - \frac{\rho_1}{\rho_2} = 3.71 \times 10^{-3}$$

$$\rho_2 = \frac{1.03 \times 10^3}{1 - (3.71 \times 10^{-3})} = 1.034 \times 10^3 \text{ kg m}^{-3}$$

Therefore, the density of water at the given depth ( $h$ ) is  $1.034 \times 10^3 \text{ kg m}^{-3}$ .

## Question 9.14:

Compute the fractional change in volume of a glass slab, when subjected to a hydraulic pressure of 10 atm.

## Answer 9.14:

Hydraulic pressure exerted on the glass slab,  $p = 10 \text{ atm} = 10 \times 1.013 \times 10^5 \text{ Pa}$

Bulk modulus of glass,  $B = 37 \times 10^9 \text{ Nm}^{-2}$

$$\text{Bulk modulus, } B = \frac{p}{\frac{\Delta V}{V}}$$

Where,  $\frac{\Delta V}{V}$  = Fractional change in volume

$$\therefore \frac{\Delta V}{V} = \frac{p}{B} = \frac{10 \times 1.013 \times 10^5}{37 \times 10^9} = 2.73 \times 10^{-5}$$

Hence, the fractional change in the volume of the glass slab is  $2.73 \times 10^{-5}$ .

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**Mike Jess**



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