

Density, pressure and pressure in liquids

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet answers

Each answer shows the equation, the substitution and the result with its unit in bold. Check that you converted units first and used $g = 9.8 \text{ N/kg}$. If your final value differs, compare each line of working with the model to find where the difference starts.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE P3, IGCSE 1.8

Problem 1 Formulas and units

1. $\rho = m \div V$.
2. $p = F \div A$.
3. $2.7 \times 1000 = \mathbf{2700 \text{ kg/m}^3}$.
4. The pascal: $\mathbf{1 \text{ Pa} = 1 \text{ N/m}^2}$.

Problem 2 Wooden plank

1. $\rho = 3.6 \div 0.0050 = \mathbf{720 \text{ kg/m}^3}$.
2. $720 < 1000$, so it **floats**.

Problem 3 Petrol tanker

1. $m = \rho \times V$.
2. $m = 740 \times 25 = \mathbf{18\,500 \text{ kg}}$.

Problem 4 Volume of mercury

1. $V = m \div \rho$.
2. $V = 0.50 \div 13\,600 = \mathbf{3.7 \times 10^{-5} \text{ m}^3}$.
3. $3.68 \times 10^{-5} \times 1\,000\,000 = \mathbf{37 \text{ cm}^3}$.

Problem 5 Float or sink?

1. **Floats:** $520 < 1000$.
2. **Sinks:** $2100 > 1000$.
3. **Floats:** $920 < 1000$.
4. **Sinks:** $1260 > 1000$.

Problem 6 Pressure of a press

1. $p = F \div A = 300 \div 0.0020 = \mathbf{150\,000 \text{ Pa}}$.

2. **150 kPa.**

Problem 7 Ore sample

1. $50.0 - 40.0 = \mathbf{10.0\text{ cm}^3}$.
2. $\rho = 84.5 \div 10.0 = \mathbf{8.45\text{ g/cm}^3}$.
3. $8.45 \times 1000 = \mathbf{8450\text{ kg/m}^3}$.

Problem 8 Steel bar

1. $V = 0.50 \times 0.040 \times 0.025 = \mathbf{5.0 \times 10^{-4}\text{ m}^3}$.
2. $m = \rho V = 7800 \times 5.0 \times 10^{-4} = \mathbf{3.9\text{ kg}}$.

Problem 9 Tractor tyres

1. $W = 4500 \times 9.8 = \mathbf{44\ 100\text{ N}}$.
2. $p = 44\ 100 \div 0.60 = \mathbf{73\ 500\text{ Pa}}$ (73.5 kPa).
3. $p = 44\ 100 \div 0.20 = \mathbf{220\ 500\text{ Pa}}$ (three times larger).

Problem 10 Drawing pin

1. $p = 20 \div 1.0 \times 10^{-4} = \mathbf{2.0 \times 10^5\text{ Pa}}$.
2. $p = 20 \div 1.0 \times 10^{-7} = \mathbf{2.0 \times 10^8\text{ Pa}}$.
3. The same force acts on a tip area 1000 times smaller, so the pressure is 1000 times greater and is enough to push into the board.

Problem 11 Rearranging $p = F \div A$

1. $A = F \div p = 800 \div 40\ 000 = \mathbf{0.020\text{ m}^2}$.
2. $F = p A = 25\ 000 \times 0.60 = \mathbf{15\ 000\text{ N}}$.

Problem 12 Water tower

1. $p = \rho g h = 1000 \times 9.8 \times 25 = \mathbf{245\ 000\text{ Pa}}$.
2. **245 kPa.**

Problem 13 Pressure-depth graph

1. **29.4 kPa.**
2. Gradient = $39.2 \div 4.0 = \mathbf{9.8\text{ kPa/m}}$.
3. Gradient = ρg , so $\rho = 9800 \div 9.8 = \mathbf{1000\text{ kg/m}^3}$.

Problem 14 Sluice gate

1. $p = 1000 \times 9.8 \times 30 = \mathbf{294\ 000\text{ Pa}}$.

2. $A = 0.50 \times 0.40 = \mathbf{0.20 \text{ m}^2}$.
3. $F = p A = 294\,000 \times 0.20 = \mathbf{58\,800 \text{ N}}$.

Problem 15 Sea and river

1. $p = 1000 \times 9.8 \times 5.0 = \mathbf{49\,000 \text{ Pa}}$.
2. $p = 1030 \times 9.8 \times 5.0 = \mathbf{50\,470 \text{ Pa}}$.
3. $50\,470 - 49\,000 = \mathbf{1470 \text{ Pa}}$.

Problem 16 Model steel boat

1. $\rho = 0.80 \div 1.2 \times 10^{-3} = \mathbf{670 \text{ kg/m}^3}$ (667).
2. $667 < 1000$, so it **floats**.
3. $V = 0.80 \div 7800 = \mathbf{1.0 \times 10^{-4} \text{ m}^3}$ (103 cm³).
4. A solid block has the density of steel, 7800 kg/m³, which is greater than that of water. The boat contains a lot of air, which lowers its average density.

Problem 17 Brass key

1. $V = 60 \div 8.9 = \mathbf{6.74 \text{ cm}^3}$.
2. $V = 40 \div 7.1 = \mathbf{5.63 \text{ cm}^3}$.
3. $\rho = 100 \div (6.74 + 5.63) = 100 \div 12.38 = \mathbf{8.1 \text{ g/cm}^3}$.
4. It is an average of the two densities, weighted by the volumes. It cannot be greater than the densest component or less than the lightest.

Problem 18 Diver at 18 m

1. $p = 1030 \times 9.8 \times 18 = 181\,692 \text{ Pa}$, so $\mathbf{1.8 \times 10^5 \text{ Pa}}$.
2. Total = 181 692 + 101 000 = 282 692, so $\mathbf{2.8 \times 10^5 \text{ Pa}}$.
3. $F = 181\,692 \times 0.015 = 2725 \text{ N}$, so $\mathbf{2.7 \times 10^3 \text{ N}}$ (about 2700 N) from the water; air inside the mask pushes back from the other side.

Problem 19 Block on its faces

1. $V = 0.50 \times 0.20 \times 0.10 = 0.010 \text{ m}^3$; $\rho = 12 \div 0.010 = \mathbf{1200 \text{ kg/m}^3}$.
2. $W = 12 \times 9.8 = \mathbf{117.6 \text{ N}}$.
3. Smallest face: $0.20 \times 0.10 = 0.020 \text{ m}^2$, $p = 117.6 \div 0.020 = \mathbf{5880 \text{ Pa}}$. Largest face: $0.50 \times 0.20 = 0.10 \text{ m}^2$, $p = 117.6 \div 0.10 = \mathbf{1176 \text{ Pa}}$.
4. The greatest pressure is on the **0.20 m × 0.10 m face** and the smallest on the **0.50 m × 0.20 m face**.

Problem 20 Submarine data

1. $\rho = p \div (g h)$: $101\,000 \div 98 = \mathbf{1031}$; $203\,000 \div 196 = \mathbf{1036}$; $303\,000 \div 294 = \mathbf{1031}$; $405\,000 \div 392 = \mathbf{1033 \text{ (kg/m}^3\text{)}}$.

2. Mean = $(1031 + 1036 + 1031 + 1033) \div 4 = \mathbf{1033 \text{ kg/m}^3}$, close to the accepted 1030 kg/m³.
3. $p = 1033 \times 9.8 \times 55 = 556\,800 \text{ Pa}$, so **about $5.6 \times 10^5 \text{ Pa}$** (557 kPa).