A-Level Physics: **w25 11**

Question 16 (Answer: **B**)

- Upthrust equals the weight of fluid displaced, so ρ is the density of the water, not the wood.
- Only the submerged part displaces anything, so V is the volume below the surface.
- The wood's density decides how deep it floats, but it does not appear in this formula.

A-Level Physics: **w25 12**

Question 15 (Answer: **C**)

- Density is m/V, so it rises when the mass rises or the volume falls.
- Increasing the mass while decreasing the volume does both, so the density must increase.
- B moves both the wrong way; with A and D the result depends on which change is larger.

Question 16 (Answer: **A**)

- Upthrust is $\rho g V$, and both the density and the volume are unchanged, so it simply follows g.
- $U_M/U_E = g_M/g_E = 3.7/9.81 = 0.38$.
- C is the same ratio the other way up, $9.81/3.7 = 2.7$.

A-Level Physics: **w25 14**

Question 12 (Answer: **C**)

- "Just fully submerged" puts the top of the sphere level with the liquid surface.
- Its lowest point is therefore a depth $2r$ below the surface.
- $p = P_A + \rho g(2r)$ – the air pressure plus the weight of the liquid column above.

A-Level Physics: **w25 21**

2(a)(i)	(normal) force per (unit cross-sectional) area
2(a)(ii)	(due to difference in depth there is a) difference in pressure between top and bottom (of ball)
	(due to pressure difference, upwards) force on bottom of ball is greater (than downwards force on top of ball, so resultant force is upwards)
2(b)(i)	arrow vertically downwards labelled 'weight'
	arrow vertically upwards labelled 'upthrust'
	arrow vertically upwards labelled '(viscous) drag'
2(b)(ii)	SI base units of D: kg m s^{-2}
	base units of η: kg m s^{-2} / (m × m s^{-1}) = kg m^{-1} s^{-1}
2(c)(i)	upthrust = 920 × (4 / 3) × π × $(4.2 \times 10^{-3})^3$ × 9.81 = 2.8×10^{-3} (N)
2(c)(ii)	weight = drag + upthrust
	($2.4 \times 10^{-3} \times 9.81$) = ($2.8 \times 10^{-3}$) + ($6\pi \times 4.7 \times 4.2 \times 10^{-3} \times v$)
	v = 0.056 m s^{-1}

A-Level Physics: **s25 11**

Question 14 (Answer: **A**)

- In water the upthrust is $25.0 - 10.0 = 15.0$ N.
- Upthrust is proportional to the liquid's density, so it becomes $15.0 \times 1.10 = 16.5$ N.
- The meter then reads $25.0 - 16.5 = 8.5$ N.

Question 16 (Answer: **C**)

- The pressure due to the water is $\rho g h$, so it is proportional to the depth.
- Doubling the depth from 130 m to 260 m doubles it, to $2p$.
- The difference between the two depths is $2p - p = p$.

A-Level Physics: **s25 12**

Question 14 (Answer: **D**)

- Fully submerged, the block feels an upthrust $\rho g V$ upwards.
- The string holds it down, so the three forces balance: $\rho g V = mg + T$.
- $T = \rho g V - mg$, which is positive precisely because the block would otherwise float.

A-Level Physics: **s25 13**

Question 13 (Answer: **D**)

- Density is defined as mass per unit volume, $\rho = m/V$.
- "Per unit volume" makes it a ratio, so the value does not depend on the units chosen.
- A and C tie the definition to one particular volume instead.

A-Level Physics: **s25 14**

Question 13 (Answer: **A**)

- Floating means weight equals upthrust: $\rho_i A H g = \rho_w A (H - h) g$.
- The cross-sectional area cancels, leaving $H - h = (\rho_i/\rho_w) H$.
- So $h = H\,(1 - \rho_i/\rho_w)$.

A-Level Physics: **m25 12**

Question 10 (Answer: **A**)

- Fully submerged, the upthrust is $\rho_{\text{liquid}} g V$ and the weight is $\rho_{\text{object}} g V$ – the same V.
- The ratio is therefore just $\rho_{\text{liquid}}/\rho_{\text{object}}$; the volume cancels entirely.
- Doubling the liquid's density doubles it, while B changes nothing and C halves it.

1(a)	mass per unit volume
1(b)(i)	density $= 0.243 / (0.0541 \times 0.1109 \times 0.0162)$
	$= 2500\ \mathrm{kg\,m^{-3}}$
1(b)(ii)	$(0.001 / 0.243)$ **or** $(0.01 / 5.41)$ **or** $(0.01 / 11.09)$ **or** $(0.01 / 1.62)$
	$(\Delta\rho / \rho) = (\Delta m / m) + (\Delta x / x) + (\Delta y / y) + (\Delta z / z)$ $= (0.001 / 0.243) + (0.01 / 5.41) + (0.01 / 11.09) + (0.01 / 1.62)$ $(= 0.013)$
	percentage uncertainty in ρ $= 0.013 \times 100$ $= 1.3\%$ (allow 1 s.f. answer of 1%)
1(c)	zero error (on calipers / balance) **or** incorrect calibration (of calipers / balance)