① (a) Submerged volume $= \frac{1}{2}\left(\frac{4}{3}\pi r^3\right) = \frac{1}{2}\left(\frac{4}{3}\pi \cdot (9.0\,cm)^3\right) = 1527\,cm^3$

$= 1.527 \times 10^{-3}\,m^3$

Buoyancy force = weight of displaced fluid

$= \rho V g = (0.800 \times 10^3\,kg/m^3)(1.527 \times 10^{-3}\,m^3)(9.8\,\frac{N}{kg})$

$= 11.97\,N$ = weight of sphere

mass of sphere $= \frac{11.97\,N}{9.8\,N/kg} = 1.22\,kg$

(b) Volume of material $= \frac{4}{3}\pi r_1^3 - \frac{4}{3}\pi r_2^3$

$= \frac{4}{3}\pi\left[(9.0\,cm)^3 - (8.0\,cm)^3\right] = 909\,cm^3$

$= 0.909 \times 10^{-3}\,m^3$

$\rho = \frac{m}{V} = \frac{1.22\,kg}{0.909 \times 10^{-3}\,m^3} = 1.34 \times 10^3\,kg/m^3$

② (a) Volume of wood $= \frac{m}{\rho} = \frac{3.67\,kg}{600\,kg/m^3} = 6.12 \times 10^{-3}\,m^3$

Buoyant force = wt of block + wt of lead

$(1.00 \times 10^3\,kg/m^3)(0.9)(6.12 \times 10^{-3}\,m^3)g = (3.67\,kg + m_{lead})g$

$m_{lead} = 1.84\,kg.$

(b) Buoyant force = wt of block + wt of lead

$(1.00 \times 10^3\,kg/m^3)\left[(0.9)(6.12 \times 10^{-3}\,m^3) + \frac{m_{lead}}{\rho_{lead}}\right]g = (3.67\,kg + m_{lead})g$

$5.51 + 0.0885\,m_{lead} = 3.67 + m_{lead}$

$m_{lead} = 2.02\,kg$

(3) (a) $v_1 A_1 = v_2 A_2$

$$v_2 = \frac{v_1 A_1}{A_2} = \left(5.0\,\frac{m}{s}\right)\frac{4.0\,cm^2}{8.0\,cm^2} = 2.5\,m/s$$

(b) $P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$

$$P_2 = P_1 + \frac{1}{2}\rho(v_1^2 - v_2^2) + \rho g(y_1 - y_2)$$

$$= 1.5\times10^5\,Pa + \frac{1}{2}\left(1.00\times10^3\,\frac{kg}{m^3}\right)\left(\left(5.0\,\frac{m}{s}\right)^2 - \left(2.5\,\frac{m}{s}\right)^2\right)$$

$$+ \left(1.00\times10^3\,\frac{kg}{m^3}\right)\left(9.8\,\frac{N}{kg}\right)(10.0\,m)$$

$$= 2.57\times10^5\,Pa$$

(4) $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$

Compared with still air ($v_2 = 0$): $P_2 - P_1 = \frac{1}{2}\rho v_1^2$

$$= \frac{1}{2}\left(1.23\,\frac{kg}{m^3}\right)\left(30.0\,\frac{m}{s}\right)^2$$

$$= 554\,Pa = F/A$$

$$F = PA = (554\,Pa)(4.0\,m \times 5.0\,m) = 1.11\times10^4\,N$$