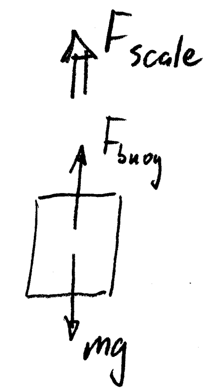
Problem F2 Solution UE Fall '07



Archimedes' Principle. $F_{buoy} = \rho_{fluid}\, g\, V_{object}$

a) Cube in air. $\rho_{fluid} = \rho_{air} = 1.22\ kg/m^3$

$F_{buoy} = \rho_{air} \cdot V \cdot g = 1.22\ kg/m^2 \cdot 1\ m^3 \cdot 9.8\ m/s^2 = 11.96\ N$

$mg = \rho_f \cdot V \cdot g = 20\ kg/m^3 \cdot 1\ m^3 \cdot 9.8\ m/s^2 = 196\ N$

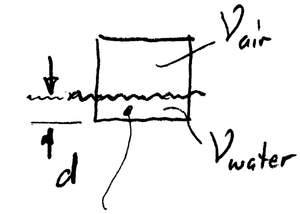
$\boxed{F_{scale} = mg - F_{buoy} = 196\ N - 11.96\ N = 184.0\ N}$

b) Cube in water. $\rho_{fluid} = \rho_{water} = 1000\ kg/m^3$

$F_{buoy} = \rho_{water}\, V \cdot g = 1000\ kg/m^3 \cdot 1\ m^3 \cdot 9.8\ m/s^2 = 9800\ N$

$\boxed{F_{scale} = mg - F_{buoy} = 196\ N - 9800\ N = -9604\ N}$ (scale pushes down)

c) Cube is now two volumes: $V = V_{air} + V_{water} = 1\ m^3$



Net force is $F = mg - (F_{buoy})_{air} - (F_{buoy})_{water} = 0$

$(F_{buoy})_{air} = \rho_{air} V_{air}\, g = \rho_{air}(V - V_{water})\, g$

$(F_{buoy})_{water} = \rho_{water} V_{water}\, g$

$F = mg - \rho_{air} V g - (\rho_{water} - \rho_{air}) V_{water}\, g = 0 \rightarrow V_{water} = \dfrac{mg - \rho_{air} V g}{(\rho_{water} - \rho_{air})\, g}$

$V_{water} = 0.0188\ m^3 = d \cdot 1\ m^2 \rightarrow \boxed{d = 0.0188\ m = 1.88\ cm}$