1. a), b), e)

2. upward

3. a) greater b) greater

4. The density of sea water is greater than the density of fresh water ⇒ buoyancy is greater

5. As the fish's volume increases, the buoyancy increases, and the fish moves upward.

6. a) $F_B = \rho_{water} \cdot g \cdot V_{object} = 998\ \frac{kg}{m^3} \cdot 9.81\ \frac{N}{kg} \cdot 1.2 \cdot 10^{-3}\ m^3 = \underline{\underline{11.7\ N}}$

   b) $F_B = \rho_{alcohol} \cdot g \cdot V_{object} = 789\ \frac{kg}{m^3} \cdot 9.81\ \frac{N}{kg} \cdot 1.2 \cdot 10^{-3}\ m^3 = \underline{\underline{9.3\ N}}$

   c) The buoyant force is the same, it is only determined by the object's volume, not it's mass.

7. a) $F_B = 10.7\ N - 9.5\ N = \underline{\underline{1.2\ N}}$

   b) $V = \frac{F_A}{\rho_{Flüssigkeit} \cdot g} = \frac{1.2\ N}{1'000\ \frac{kg}{m^3} \cdot 9.81\ \frac{N}{kg}} = 0.0001223\ m^3 = \underline{\underline{122.3\ cm^3}}$

   c) $m = \frac{F_G}{g} = \frac{10.7\ N}{9.81\ \frac{N}{kg}} = \underline{\underline{1.09\ kg}}$

   d) $\rho = \frac{m}{V} = \frac{1.09\ kg}{0.0001223\ m^3} = \underline{\underline{8'917\ \frac{kg}{m^3}}}$

   e) copper

8. a) $F_A = F_G - F_{res} = 0.193\ N - 0.175\ N = 0.018\ N$

   $V_{0bject} = \frac{F_A}{\rho_{alcohol} \cdot g} = \frac{0.018\ N}{789\ \frac{kg}{m^3} \cdot 9.81\ \frac{m}{s^2}} = 0.000002326\ m^3 = \underline{\underline{2.3\ cm^3}}$

   b) $\rho_{object} = \frac{m_{object}}{V_{object}} = \frac{F_G}{g \cdot V_{object}} = \frac{0.193\ N}{9.81\ \frac{m}{s^2} \cdot 0.000002326\ m^3} = \underline{\underline{8.47 \cdot 10^3\ \frac{kg}{m^3}}}$

9. a) $F_B = \rho_{air} \cdot g \cdot V_{balloon} = 1.293\ \frac{kg}{m^3} \cdot 9.81\ \frac{m}{s^2} \cdot 0.0050\ m^3 = 0.06342\ N = \underline{\underline{63\ mN}}$

b) $F_G = F_G$ (balloon) + F_G (filling)

F_G (filling) $= m_{helium} \cdot g = \rho_{helium} \cdot V_{balloon} \cdot g = 0.179\ \frac{kg}{m^3} \cdot 0.0050\ m^3 \cdot 9.81\ \frac{m}{s^2}$

$= 0.00878\ N = 8.8\ mN$

$F_G = F_G$ (balloon) + F_G (fillung) = 30 mN + 8.8 mN = 38.8 mN = $\underline{\underline{39\ mN}}$

c) upward force = $F_B - F_G$ = 63.4 mN - 38.8 mN = $\underline{\underline{25\ mN}}$

10. $F_B = \rho_{liquid} \cdot V_{immersed} \cdot g = \rho_{liquid} \cdot V_{displaced\ liquid} \cdot g = m_{displaced\ liquid} \cdot g = F_G$ (displaced liquid)

11. sink

12. a) $F_B = \rho_{water} \cdot g \cdot V_{immersed} = 998\ \frac{kg}{m^3} \cdot 9.81\ \frac{m}{s^2} \cdot 0.000040\ m^3 = \underline{\underline{0.39\ N}}$

b) $\underline{\underline{0.39\ N}}$ (Archimedes‘ principle)

c) $\underline{\underline{0.39\ N}}$ (If an object floats, the value of the buoyant force equals the value of the gravitational force)

d) $\rho_{block} = \frac{m_{block}}{V_{block}} = \frac{F_G(block)}{g \cdot V_{block}} = \frac{0.39\ N}{9.81\ \frac{m}{s^2} \cdot 0.0000500\ m^3} = \underline{\underline{795\ \frac{kg}{m^3}}}$

13. a) The cup floats and therefore we have: $F_B = F_G$ (cup)

$\rho_{water} \cdot g \cdot V_{immersed} = m_{cup} \cdot g$

$V_{immersed} = \frac{m_{cup}}{\rho_{water}} = \frac{0.2000\ kg}{998\ \frac{kg}{m^3}} = 0.000200\ m^3 = 0.200\ dm^3 = 200\ cm^3$

$h_{immersed} = \frac{V_{immersed}}{A} = \frac{200\ cm^3}{30.0\ cm^2} = \underline{\underline{6.67\ cm}}$

b) When the cup is immersed to its rim it is just about to sink. Its total volume is immersed.

$F_A = F_G$ (cup) + F_G (sand)

$\rho_{water} \cdot g \cdot V_{cup} = m_{cup} \cdot g + m_{sand} \cdot g$

$m_{sand} = \rho_{water} \cdot V_{cup} - m_{cup} = 998\ \frac{kg}{m^3} \cdot 0.000300\ m^3 - 0.200\ kg = 0.0994\ kg = \underline{\underline{99\ g}}$