Lösungen für Arbeit, Leistung und Energie

Aufgabe 1

a. Let the area of the cucumber be A. Then the weight of the cucumber is

$$F_{grav} = (n_1 + n_2)A\rho g \tag{1}$$

where ρ is the density of the cucumber. The net bouyant force is the weight of the fluids displaced: $n_1 A(\rho_{H_2O})g + n_2 A(\rho_{ol})g$. Since the cucumber is in equilibrium, the net bouyant force equals the weight of the cucumber:

$$\begin{aligned}
(n_1 + n_2)A\rho g &= n_1 A(\rho_{H_2O})g + n_2 A(\rho_{ol})g \\
\rho &= \frac{n_1(\rho_{H_2O}) + n_2(\rho_{ol})}{n_1 + n_2} \\
n_3 &= \frac{n_1 1000 + n_2 800}{n_1 + n_2}
\end{aligned}$$

Aufgabe 2

a. Since the balloon plus cargo is floating at rest in the air, the bouyant force F_A equals its weight F_g:

$$\begin{aligned}
F_g &= F_A \\
(1890\,kg)g + V(\rho_{Heissluft})g &= V(\rho_{luft})g \\
\rho_{Heissluft} &= \rho_{luft} - \frac{1890\,kg}{V}
\end{aligned}$$

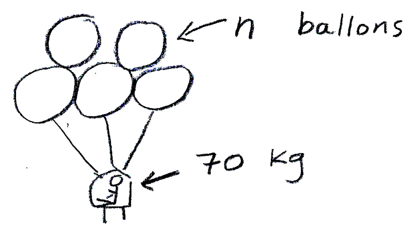
where $V = 11430\,m^3$ is the volume of the balloon. Substituting in the values gives:

$$\begin{aligned}
\rho_{Heissluft} &= \rho_{luft} - \frac{1890\,kg}{11430\,m^3} \\
\rho_{Heissluft} &= 1,0346\,\frac{kg}{m^3}
\end{aligned}$$

Aufgabe 3

a. Wenn der Backstein im Boot liegt, verdrängt das boot (zusätzlich) ein Volumen an Wasser, das dem Gewicht des backsteins entspricht. Diese Volumen ist größer als das Volumen des Blei-Backstein, da die dichte von Wasser geringer ist als de von Blei. Wenn der Backstein über Board geworfen wird, verdrängt er nur sein eigenes Volumen an Wasser. Daher sinkt der Wasserspiegel, wenn der Backstein über Board geworfen wird.

Aufgabe 4



a. Let n be the number of balloons, and V_0 be the volume of one balloon. The bouyant force must equal the total weight:

$$
\begin{aligned}
F_A &= F_g \\
nV_0(\rho_{luft})g &= (70\,kg)g + nV_0(\rho_{He})g \\
n &= \frac{70\,kg}{V_0(\rho_{luft} - \rho_{He})} \\
n &= \frac{70\,kg}{(4/3)\pi(0,3)^3 m^3 (1,29 - 0,18) kg/m^3} \\
n &\approx 558\,balloons
\end{aligned}
$$

Aufgabe 5

a. Let V_0 be the volume of the block, and ρ its density. Since the wooden block floats, the bouyant force F_A equals the blocks weight F_g:

$$
\begin{aligned}
F_A &= F_g \\
\frac{2}{3}V_0(\rho_{H_2O})g &= V_0\rho g
\end{aligned}
$$

$$\rho = \frac{2}{3}\rho_{H_2O}$$
$$\rho \approx 667\,\frac{kg}{m^3}$$

b. Applying the same equation when the block is in oil:

$$\begin{aligned}
F_A &= F_g \\
\frac{9}{10}V_0(\rho_{ol})g &= V_0\rho g \\
\rho_{ol} &= \frac{10}{9}\rho \\
\rho_{ol} &= (\frac{10}{9})(\frac{2}{3})\rho_{H_2O} \\
\rho_{ol} &= \frac{20}{27}\rho_{H_2O} \\
\rho_{ol} &\approx 741\,\frac{kg}{m^3}
\end{aligned}$$

Aufgabe 6

a. Since the raft floats, the bouyant force equals the total weight.

$$\begin{aligned}
F_A &= F_g \\
(\rho_{H_2O})(2\,m)(2\,m)xg &= \rho_{raft}(2\,m)(2\,m)(1\,m)g + (200\,kg)g \\
1000\,\frac{kg}{m^3}(4\,m^2)x &= (700\,\frac{kg}{m^3})(4\,m^3) + 200\,kg \\
x &= 0,75\,m
\end{aligned}$$

Aufgabe 7

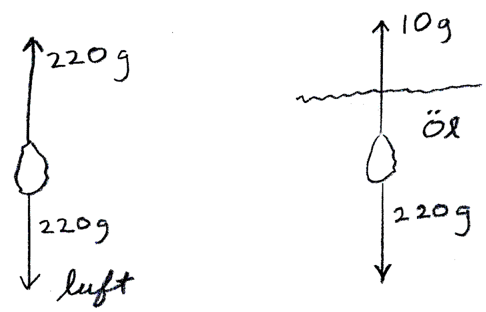
a. Let the volume of the object be V_0. The forces in the vertical direction must add to zero. The bouyant force, F_A, directed upward must equal the objects weight plus $100\,N$:

$$\begin{aligned}
F_A - F_g - 100\,N &= 0 \\
F_A &= F_g + 100\,N \\
(\rho_{H_2O})V_0 g &= (90\,kg)g + 100\,N \\
V_0 &= \frac{90(9,8)+100}{1000(9,8)} \\
V_0 &\approx 0,1\,m^3
\end{aligned}$$

The density of the object is found by dividing its mass by its volume:

$$\rho = \frac{90\,kg}{0,1\,m^3} = 900\frac{kg}{m^3} \tag{2}$$

Aufgabe 8



a. The weight of the rock is $(220\,gram)g$. Let the volume of the rock be V_0. When the rock is placed in oil, the the bouyant force F_A plus the scale reading will equal the weight of the rock.

$$\begin{aligned}
(220\,gram)g &= F_A + (10\,gram)g \\
(220\,gram)g &= V_0(\rho_{ol})g + (10\,gram)g \\
220\,gram &= V_0(\rho_{ol}) + 10\,gram \\
V_0 &= \frac{210\,gram}{0,85\,gram/cm^3} \\
V_0 &\approx 247\,cm^3
\end{aligned}$$

The density of the rock is therefore:

$$\rho_{rock} = \frac{220\,gram}{247\,cm^3} \approx 0,89\,\frac{gram}{cm^3} \tag{3}$$