Problem 2.

Let's calculate the quantities of natrium atoms (n_1) and chlorine atoms (n_2) embedded in a single NaCl unit crystal cell (Fig.2).

One atom of natrium occupies the middle of the cell and it entirely belongs to the cell. 12 atoms of natrium hold the edges of a large cube and they belong to three more cells so as 1/4 part of each belongs to the first cell. Thus we have

$n_1 = 1+12\cdot 1/4 = 4$ atoms of natrium per unit cell.

In one cell there are 6 atoms of chlorine placed on the side of the cube and 8 placed in the vertices. Each atom from a side belongs to another cell and the atom in the vertex - to seven others. Then for one cell we have

$n_2 = 6\cdot 1/2 + 8\cdot 1/8 = 4$ atoms of chlorine.

Thus 4 atoms of natriun and 4 atoms of chlorine belong to one unit cell of NaCl crystal.

The mass m of such a cell is equal

$$m = 4(m_{rNa} + m_{rCl})\ \text{(amu)},$$

where m_{rNa} and m_{rCl} are relative atomic masses of natrium and clorine. Since the mass of hydrogen atom m_H is approximately equal to one atomic mass unit: $m_H = 1.008$ amu ≈ 1 amu then the mass of an unit cell of NaCl is

$$m = 4(m_{rNa} + m_{rCl})\, m_H\ .$$

On the other hand, it is equal $m = \rho a^3$, hence

$$m_H = \frac{\rho a^3}{4(m_{rNa} + m_{rCl})} \approx 1.67\cdot 10^{-27}\ \text{kg}\ .$$