Abstract :

1. The aim of the experiment is : to find the density of a metal and then to find the spaces between atoms in the metal given.

2. The method used is : measuring the length , width , thickness and mass of the metal with vernier caliber , micrometer and a balance scale .

3. The main result is :

   $$\rho = 6.8 \pm 0.03 gm/cm^3$$

   spacing between atoms (a) = 2.302 A^o

Theory :

We find the density of the metal with the equation :

$$\rho = \frac{Mass}{Volume} = \frac{M}{V}$$

and with our rectangular shaped metal of thickness T, length L and width W , then Volume V = L×W×T .

To find the error in the density , we calculate the uncertainty in ρ .

$$\frac{\Delta\rho}{\rho} = \frac{\Delta M}{M} + \frac{\Delta V}{V}$$

but V = L × W × T
so that the uncertainty in V will be :

$$\frac{\Delta V}{V} = \frac{\Delta L}{L} + \frac{\Delta T}{T} + \frac{\Delta W}{W}$$

Then we ca find the approximate expression for the distance between atoms in the metal given.

The total number of atoms (N) in the material = $nN_A = \frac{M}{A_W} N_A$

Where (n) is the number of moles , N_A is Avogadro's number = 6.02 × 10^{23} and A_W is the atomic mass of the material .

We assume that each atom is contained inside a box of volume a^3. Then the volume V is : $V = N \times a^3$.

$$a^3 = \frac{V}{N} = \frac{V}{\frac{M}{A_W} N_A} = \frac{VA_W}{MN_A} = \frac{A_W}{\frac{M}{V} N_A} = \frac{A_W}{\rho \times N_A}$$

so $a = \sqrt[3]{\frac{A_W}{\rho \times N_A}}$

Procedure :

a) We obtained a metal block , caliper , micrometer and balance scale .
b) We measured the length L and the width W with the use of vernier caliper . We repeated the measurement five times each time from a different place .
c) We measured the thickness with the use of the micrometer and also we repeated the measurement five times from different places .
d) Finally we used a balance scale to measure the mass of the block .

Data :

Table of the data in the exp.

M = 30.06 ± 0.05 g						**average**
Length L (cm)	5.220	5.240	5.225	5.235	5.230	5.230
Width W (cm)	1.925	1.920	1.925	1.925	1.915	1.922
Thickness T (cm)	0.442	0.438	0.441	0.411	0.411	0.4406

Calculations :

$\overline{L}$ = 5.230 cm $\overline{T}$ = 0.4406 cm $\overline{W}$ = 1.922 cm

σ_s (L) = 7.9 × 10^{-3} cm σ_s (T) = 1.51× 10^{-3} cm σ_s (W) = 4.47 × 10^{-3} cm

ΔL = 0.004 cm   ΔT = 0.0007 cm   ΔW = 0.002 cm

V = 4.43 cm^3

$$\rho = \frac{M}{V} = \frac{30.06}{4.43} = 6.80 gm/cm^3$$

$$\frac{\Delta V}{V} = \frac{\Delta L}{L} + \frac{\Delta W}{W} + \frac{\Delta T}{T} = \frac{0.004}{5.23} + \frac{0.002}{1.922} + \frac{0.0007}{0.4406} = 3.39 \times 10^{-3}$$

$$\frac{\Delta M}{M} = \frac{0.05}{30.06} = 1.66 \times 10^{-3}$$

$$\frac{\Delta \rho}{\rho} = \frac{\Delta M}{M} + \frac{\Delta V}{V} = 5.06 \times 10^{-3}$$

$$\Delta \rho = 0.03 gm/cm^3$$

$$\rho = 6.80 \pm 0.03 gm/cm^3$$

Returning to appendix e we assume the metal to be cast iron

$$a = \sqrt[3]{\frac{A_W}{\rho \times N_A}} = \sqrt[3]{\frac{55.84}{7.6 \times 6.02 \times 10^{23}}} = 2.302 \times 10^{-8} \text{ cm} = 2.302 \ A^o$$

Results and Conclusion:

$\rho = 6.8 \pm 0.03 gm/cm^3$

a (spacing) = 2.302 A^o

The result of density here is different from the number shown in the appendix e and that result is related to a problem with the balance scale , and that for after we had calibrated the balance scale and after that it was used by other students and was moved from its place without enogh careful. For the the time wasn't enough we couldn't check the balance scale carefully so we used it with this situation and this caused the error that happened . And another reason is that also for the time wasn't enough we couldn't redo our measurement . And for that our measure was 30.06 .

If we revised that result and made a simple change we would put the mass to be 33.66 gm to make the denity be the right measure as is it in appendix e .
So that we could correct this systematic error by adding 3.1 gm for mass and continue the calculation .