

1-masala yechimi (Amper kuchi)

Amper kuchi:

$$F = B \cdot I \cdot \ell$$

$$F = 0,60 \cdot 5,0 \cdot 0,30 = 0,90 \text{ N}$$

Og'irlik:

$$P = m \cdot g = 0,020 \cdot 9,8 \approx 0,196 \text{ N}$$

Iplar vertikalga α burchak ostida:

vertikal o'q bo'yicha $T \cdot \cos \alpha = P$,

gorizontal o'q bo'yicha $T \cdot \sin \alpha = F$.

Demak:

$$\operatorname{tg} \alpha = \frac{F}{P}$$

$$\operatorname{tg} \alpha = 0,90/0,196 \approx 4,59$$

Bu juda katta $\rightarrow \alpha \approx 77^\circ$ chiqadi, ammo masalada $\alpha = 10^\circ$ deb berilgan.

Bu masala metodik jihatdan shuni ko'rsatadi:

berilgan α va B, I, ℓ, m, g mos kelmasa, Amper kuchi P ga nisbatg juda katta bo'ladi.

Agar $\alpha = 10^\circ$ bo'lsa, aksincha, F ni topish mumkin:

$$\operatorname{tg} \alpha = F/P \rightarrow F = P \cdot \operatorname{tg} \alpha$$

$$\operatorname{tg} 10^\circ \approx 0,176$$

$$F \approx 0,196 \cdot 0,176 \approx 0,0345 \text{ N}$$

Amper kuchidan:

$$F = B \cdot I \cdot \ell \rightarrow 0,60 \cdot 5,0 \cdot 0,30 = 0,90 \text{ N} \text{ — bu } 0,0345 \text{ N dan katta.}$$

Shuning uchun berilgan sonlar bilan $\alpha = 10^\circ$ bo'lishi mumkin emas.

Fizik mantiq: bu shart nominal emas, masala tekshiruv uchun.

Asosiy natija:

Amper kuchi $F = 0,90 \text{ N}$, og'irlikdan ancha katta bo'ladi.

2-masala yechimi (Parallel toklar)

Uchinchi o'tkazgichga 1- va 2-o'tkazgichlar magnit maydonlari ta'sir qiladi. Ular natijaviy kuchni nol qilishi kerak.

1-o'tkazgich hosil qilgan magnit induksiya moduli:

$$B_1 \sim I_1/r_1$$

2- o'tkazgich:

$$B_2 \sim I_2/r_2$$

Uchinchi o'tkazgichdagi tok I_3 bo'lsa, unga ta'sir etuvchi kuchlar mos ravishda:

$$F_1 \sim I_3 \cdot B_1, F_2 \sim I_3 \cdot B_2$$

Natijaviy kuch nol bo'lishi uchun:

$$F_1 = F_2$$

I_3 umumiy ko'paytuvchi sifatida qisqaradi $\rightarrow$

$$B_1 = B_2 \rightarrow I_1/r_1 = I_2/r_2$$

Shartdan:

$$I_2 = I_1 \cdot r_2/r_1$$

$$I_2 = 15 \cdot 2,0/1,0 = 30 \text{ A}$$

Demak, uchinchi o'tkazgich bilan bog'liq natijaviy kuchni nol qilish uchun $I_2 = 30 \text{ A}$ bo'lishi kerak edi. Masalada $I_2 = 15 \text{ A}$ berilgan bo'lsa, bunday geometrik joylashuvda uchinchi o'tkazgichga ta'sir etuvchi kuchni nol qilishning imkoni yo'q.

Shuning uchun bu masala nazariy shartni ko'rsatish uchun: muvozanat sharti: $I_1/r_1 = I_2/r_2$.

(agar sonlar mos bo'lsa, bu tenglikka qarab toklar va masofalar tglanadi.)

3-masala yechimi (Lorens kuchi)

a) Elektron uchun radius:

$$r_e = m_e \cdot v_e / (q \cdot B)$$

$$r_e = 9,1 \cdot 10^{-31} \cdot 2,5 \cdot 10^7 / (1,6 \cdot 10^{-19} \cdot 0,020)$$

$$\text{Yuqori qism: } 9,1 \cdot 2,5 = 22,75 \rightarrow 22,75 \cdot 10^{-24} = 2,275 \cdot 10^{-23}$$

$$\text{Pastki qism: } 1,6 \cdot 0,020 = 0,032 \rightarrow 3,2 \cdot 10^{-2}$$

$$r_e \approx (2,275/3,2) \cdot 10^{-21} \approx 0,711 \cdot 10^{-21} \approx 7,1 \cdot 10^{-22} \text{ m}$$

(bu juda kichik radius, masala sonlari juda energiyali elektronni bildiradi.)

b) Proton uchun shu radius bo'lsin:

$$r = m_p \cdot v_p / (q \cdot B)$$

$$v_p = r \cdot q \cdot B / m_p$$

Bu yerda $r = r_e$ ishlatiladi, lekin amalda:

$m_p \geq m_e \rightarrow$ proton tezligi elektronnikidan juda kichik bo'ladi:

$$v_p = (m_e \cdot v_e) / m_p \approx (9,1 \cdot 10^{-31} \cdot 2,5 \cdot 10^7) / 1,67 \cdot 10^{-27}$$

$$v_p \approx (2,275 \cdot 10^{-23}) / 1,67 \cdot 10^{-27} \approx 1,36 \cdot 10^4 \text{ m/s}$$

Javob: $r_e \approx 7,1 \cdot 10^{-22} \text{ m}$; $v_p \approx 1,4 \cdot 10^4 \text{ m/s}$.

4-masala yechimi (E + B, egilish)

a) Musbat zaryad uchun:

$$E \text{ o'ngga} \rightarrow F_e \text{ o'ngga}$$

B varaqdan tashqariga, v o'ngga.

Chap qo'l qoidasi bo'yicha magnit kuch F_m yuqoriga yo'naladi.

Natijaviy ta'sir: $v = 3,0 \cdot 10^5 \text{ m/s}$ bo'lganda

F_m va F_e moduli teng emas; F_m yuqoriga, F_e o'ngga $\rightarrow$ trayektoriya yuqoriga egiladi.

b) Og'masdan o'tish sharti:

$$q \cdot E = q \cdot v \cdot B \rightarrow v = E/B$$

$$v = 4,0 \cdot 10^4 / 0,10 = 4,0 \cdot 10^5 \text{ m/s}$$

Javob:

- a) ion trayektoriyasi yuqoriga egiladi;
b) og‘masdan o‘tish tezligi $v = 4,0 \cdot 10^5 \text{ m/s}$.

5-masala yechimi (Siklotron, davr)

Siklotron davri:

$$T = 2\pi \cdot m / (q \cdot B)$$

$$T = 2\pi \cdot 1,67 \cdot 10^{-27} / (1,6 \cdot 10^{-19} \cdot 1,5)$$

$$\text{Pastki qism: } 1,6 \cdot 1,5 = 2,4 \rightarrow 2,4 \cdot 10^{-19}$$

$$T \approx 2\pi \cdot (1,67/2,4) \cdot 10^{-8}$$

$$1,67/2,4 \approx 0,696$$

$$T \approx 2\pi \cdot 0,696 \cdot 10^{-8} \approx 4,37 \cdot 10^{-8} \text{ s}$$

$$a) T \approx 4,4 \cdot 10^{-8} \text{ s.}$$

b) $1,0 \cdot 10^{-5} \text{ s}$ ichida aylanishlar soni:

$$N = t/T \approx 1,0 \cdot 10^{-5} / 4,4 \cdot 10^{-8} \approx 227$$

Javob: $T \approx 4,4 \cdot 10^{-8} \text{ s}$; $N \approx 2,3 \cdot 10^2$ aylanish.

6-masala yechimi (Mass-spektrometr, nisbat)

Tezlatish bir xil, B bir xil $\rightarrow$ radiuslar orqali nisbat:

Formula:

$$r^2 = 2 \cdot m \cdot U / (q \cdot B^2) \rightarrow r^2 \sim m$$

Demak:

$$m_2/m_1 = r_2^2/r_1^2$$

$$r_2/r_1 = 0,24/0,18 = 4/3$$

$$r_2^2/r_1^2 = (4/3)^2 = 16/9 \approx 1,78$$

a) $m_2/m_1 \approx 1,78$.

b) $m_1 = 3,2 \cdot 10^{-26} \text{ kg} \rightarrow m_2 \approx 1,78 \cdot 3,2 \cdot 10^{-26} \approx 5,7 \cdot 10^{-26} \text{ kg}$

Javob: $m_2/m_1 \approx 1,78$; $m_2 \approx 5,7 \cdot 10^{-26} \text{ kg}$.

7-masala yechimi

Avval Vine filtridan tezlik:

$$v = E/B_1$$

$$v = 1,8 \cdot 10^4 / 0,060 = 3,0 \cdot 10^5 \text{ m/s}$$

Mass-spektrometr: radius

$$r = m \cdot v / (q \cdot B_2) \rightarrow m = q \cdot B_2 \cdot r / v$$

$$m = 1,6 \cdot 10^{-19} \cdot 0,40 \cdot 0,15 / (3,0 \cdot 10^5)$$

Yuqori qism: $1,6 \cdot 0,40 \cdot 0,15 = 0,096$

$$m = 0,096 \cdot 10^{-19} / 3,0 \cdot 10^5 = 0,032 \cdot 10^{-24} = 3,2 \cdot 10^{-26} \text{ kg}$$

Javob: $m \approx 3,2 \cdot 10^{-26} \text{ kg}$.

8-masala yechimi

Yuzani metrlarga:

$$S = 40 \text{ cm}^2 = 40 \cdot 10^{-4} = 4,0 \cdot 10^{-3} \text{ m}^2$$

Magnit moment:

$$p = I \cdot S = 2,5 \cdot 4,0 \cdot 10^{-3} = 1,0 \cdot 10^{-2} \text{ A} \cdot \text{m}^2$$

Potensial energiya: $W = -p \cdot B \cdot \cos \alpha$

1-holat: $p \parallel B \rightarrow \alpha_1 = 0^\circ$

$$W_1 = -p \cdot B \cdot \cos 0^\circ = -p \cdot B = -1,0 \cdot 10^{-2} \cdot 0,25 = -2,5 \cdot 10^{-3} \text{ J}$$

2-holat: $p \perp B$ ga teskari $\rightarrow \alpha_2 = 180^\circ$

$$\cos 180^\circ = -1$$

$$W_2 = -p \cdot B \cdot \cos 180^\circ = -p \cdot B \cdot (-1) = +p \cdot B = +2,5 \cdot 10^{-3} J$$

Energiya farqi:

$$\Delta W = W_2 - W_1 = 2,5 \cdot 10^{-3} - (-2,5 \cdot 10^{-3}) = 5,0 \cdot 10^{-3} J$$

Javob:

$$p = 1,0 \cdot 10^{-2} A \cdot m^2;$$

$$W_1 = -2,5 \cdot 10^{-3} J;$$

$$W_2 = +2,5 \cdot 10^{-3} J;$$

$$\Delta W = 5,0 \cdot 10^{-3} J.$$

9-masala yechimi (EM to'liqin, S va p)

$$a) E = c \cdot B \rightarrow B = E/c$$

$$B = 300/(3,0 \cdot 10^8) = 1,0 \cdot 10^{-6} T$$

$$b) S = E \cdot B/\mu_0$$

$$E \cdot B = 300 \cdot 1,0 \cdot 10^{-6} = 3,0 \cdot 10^{-4}$$

$$\mu_0 \approx 1,26 \cdot 10^{-6}$$

$$S \approx 3,0 \cdot 10^{-4}/1,26 \cdot 10^{-6} \approx 2,38 \cdot 10^2 W/m^2$$

c) To'liq qaytish uchun nurlanish bosimi:

$$p = 2S/c$$

$$p \approx 2 \cdot 2,38 \cdot 10^2/3,0 \cdot 10^8 \approx 4,76 \cdot 10^2/3,0 \cdot 10^8 \approx 1,6 \cdot 10^{-6} Pa$$

Javob: $B = 1,0 \cdot 10^{-6} T$; $S \approx 2,4 \cdot 10^2 W/m^2$; $p \approx 1,6 \cdot 10^{-6} Pa$.

10-masala yechimi (Kvant o'tish kombinatsiyasi)

$$E_n = -13,6 eV/n^2$$

$$E_2 = -13,6/4 = -3,40 eV$$

$$E_3 = -13,6/9 \approx -1,51 eV$$

$$E_4 = -13,6/16 = -0,85 eV$$

a) $n = 4 \rightarrow n = 2$:

$$\Delta E_{42} = E_2 - E_4 = -3,40 - (-0,85) = -2,55 \text{ eV}$$

Foton energiyasi: $E_{42} = 2,55 \text{ eV}$

b) Ikki bosqichli:

$n = 4 \rightarrow n = 3$:

$$\Delta E_{43} = E_3 - E_4 = -1,51 - (-0,85) = -0,66 \text{ eV}$$

$$E_{43} = 0,66 \text{ eV}$$

$n = 3 \rightarrow n = 2$:

$$\Delta E_{32} = E_2 - E_3 = -3,40 - (-1,51) = -1,89 \text{ eV}$$

$$E_{32} = 1,89 \text{ eV}$$

c) Eng katta foton energiyasi:

bevosita o'tishda: $2,55 \text{ eV}$

ikki bosqichda: $1,89 \text{ eV}$

Demak eng katta energiya bevosita $4 \rightarrow 2$ o'tishda bo'ladi.

Javob:

$$E_{42} = 2,55 \text{ eV};$$

$$E_{43} = 0,66 \text{ eV};$$

$$E_{32} = 1,89 \text{ eV};$$

eng katta energiya — bevosita $4 \rightarrow 2$ o'tishda.