FIZIK MAYATNIKNING KATTA BURCHAKLAR UCHUN TEBRANISH DAVRINI TOPISH

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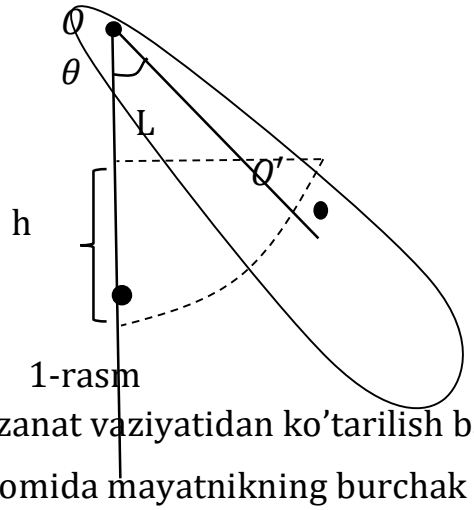
Fizik mayatnikni biror θ burchakka og'dirib qo'yib yuborsak u tabiiyki tebrana boshlaydi va biz tebranish davrini θ ni burchakni kichik burchak deb qabul qilganimizda $T = 2\pi\sqrt{\frac{I}{mgL}}$ formula orqali hisoblaymiz. Tabiiyki bu tebranish davri ifodasi katta burchaklar uchun o'rinli emas. Shuning uchun tebranish davrini θ burchakni katta qiymatlari uchun hisoblab ko'ramiz va kichik burchakka tatbiq qilamiz.

Bizga ushbu fizik mayatnik berilgan:



1-rasm

Mayatnikning muvozanat vaziyatidan ko'tarilish balandligi $h = L(1 - \cos\theta)$ ga teng, harakat davomida mayatnikning burchak tezligi esa $\omega = \frac{d\theta}{dt}$ ga teng. h va ω ni bilgan holda mayanikning potensial va kinetik energiyalarini topib olamiz.

$$E_p = mgh = mgL(1 - \cos\theta) \qquad (1)$$

$$E_k = \frac{1}{2}I\omega^2 = \frac{1}{2}I(\frac{d\theta}{dt})^2 \qquad (2)$$

Jismning to'la energiyasi potensial va kinetik energiyalari yig'indisiga teng ekanligidan E_t ifodasini (1) va (2) yordamida keltirib chiqaramiz.

$$E_t = E_p + E_k = mgL(1 - \cos\theta) + \frac{1}{2}I(\frac{d\theta}{dt})^2 \qquad (3)$$

Mayatnik maksimal $\theta_0$burchakka og'ish nuqtasida u harakatsiz bo'ladi va uning kinetik energiyasining qiymati nolga teng bo'ladi($E_k = 0$). Ushbu nuqtada faqat potensial energiyaga ega bo'ladi va potensial energiya to'la energiyani tashkil etadi, ya'ni quyidagicha:

$$E_t = E_p = mgL(1-\cos\theta_0) \qquad (4)$$

(3) va (4) to'la energiya ifodasi ekanligidan vaqt tenglamasini topib olamiz.

$$E_t = mgL(1-\cos\theta) + \frac{1}{2}I(\frac{d\theta}{dt})^2 = mgL(1-\cos\theta_0)$$

$$\frac{1}{2}I(\frac{d\theta}{dt})^2 = mgL(\cos\theta - \cos\theta_0)$$

$$dt = \sqrt{\frac{I}{2mgL}}\frac{d\theta}{\sqrt{(\cos\theta-\cos\theta_0)}} \qquad (5)$$

Vaqt tenglamasini og'ish burchagi bo'yicha 0 dan $\theta_0$gacha integrallasak bizga tebranish davrning chorak qismi kelib chiqadi. Shu orqali fizik mayatnikning tebranish davrni topib olamiz.

$$T = 4\int_0^{\theta_0} dt = 4\int_0^{\theta_0}\sqrt{\frac{I}{2mgL}}\frac{d\theta}{\sqrt{(\cos\theta-\cos\theta_0)}} \qquad (6)$$

Matematik amallarni bajarish natijasida quyidagi natijani olamiz:

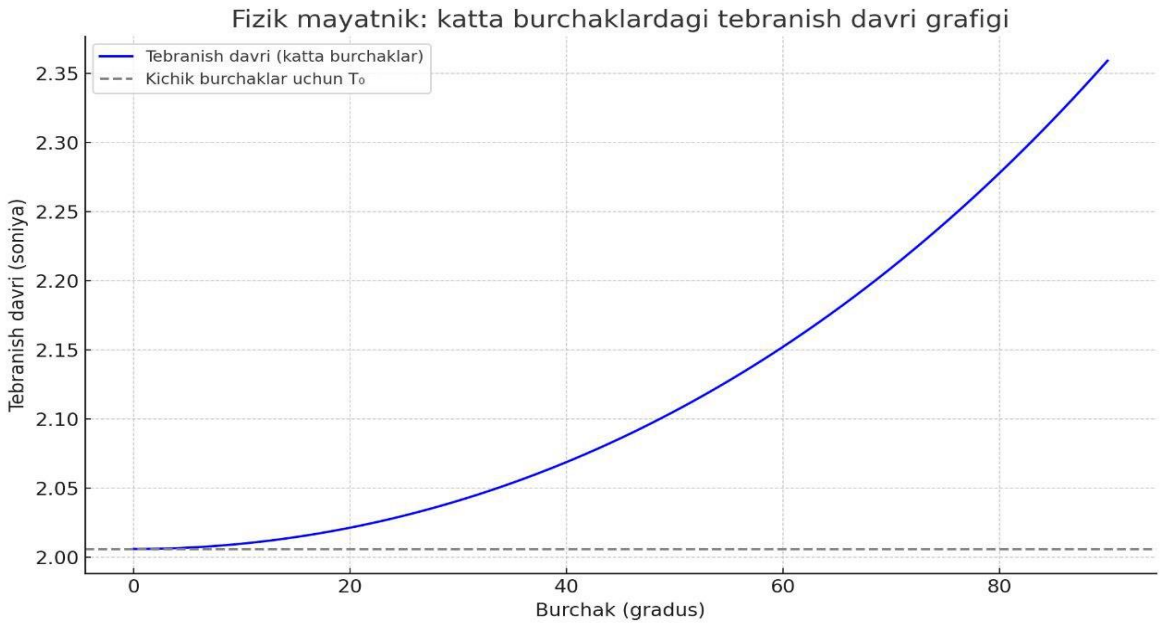
$$\int_0^{\theta_0}\frac{d\theta}{\sqrt{(\cos\theta-\cos\theta_0)}} = \frac{\pi}{\sqrt{2}}(1+\sum_{n=1}^{\infty}(\frac{(2n-1)!!}{(2n)!!})^2(\sin\frac{\theta_0}{2})^{2n}) \qquad (7)$$

(7) ifodani (6) ga keltirib qo'ysak

$$T = 2\pi\sqrt{\frac{I}{mgL}}(1+\frac{1}{4}(\sin\frac{\theta_0}{2})^2+\frac{9}{64}(\sin\frac{\theta_0}{2})^4+\frac{25}{256}(\sin\frac{\theta_0}{2})^6+\cdots) \quad (8)$$

ushbu fizik mayatnikning katta burchaklar uchun davri ifodasini hosil bo'ladi. Ushbu ifodani fizik mayatnikning umumiy burchaklar uchun tebranish davri ifodasi bo'la oladi. Sababi, kichik burchaklarda ya'ni $\theta < 12^\circ$ ushbu qiymatli burchaklarda $\sin\theta$ ning qiymati kichik($\sin\theta \approx 0$) bo'ladi va mayatnikning tebranish davri $T = 2\pi\sqrt{\frac{I}{mgL}}$ bo'ladi. Bu dastlab aytib o'tgan ifodamiz bilan bir xil. Biz mayatnik tebranish davrini hisoblashda sistemaga ideal sistema sifatida qaradik, ya'ni ishqalanish kuchlarini hisobga olmadik. Bu bizni ifodamizning real sistamalarda xatolikka ega ekanligini ko'rsatadi. Agar, ishqalanish kuchlarini hisobga olganimizda -„Nima kuzatiladi''- degan savol tug'iladi. Bu holatda to'la energiya kamayib boradi va tebranish so'nuvchi tebranishga ayladi, tebranish davri va tebranish amplitudasining qiymatlari vaqt o'tishi davomi kamayib borib, nolga teng bo'lib qoladi, ya'ni mayatnik harakatdan to'xtaydi. Biz yashayotgan materiyada ideal sistemani hosil qilib bo'lmagani uchun har qanday tebranish so'nuvchi bo'ladi.

Tebranish davri va burchak orasidagi bog'lanish grafini chizadigan bo'lsak quyidagicha bo'ladi:



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Adabiyotlar:

1. Sivuxin D.V. Obshiy kurs fiziki. I – tom Nauka” Moskva, 1977 y.
2. Zisman G.A. va Todes O.M. Kurs obshey fiziki. I – tom Moskva, 1972 y.
3. S.E.Frish va A.V.Timoreva Umumiy fizika kursi I – tom O’qituvchi 1976 y.
4. Sivuxin D.V. Obshiy kurs fiziki. I – tom Nauka” Moskva, 1977 y