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PAPER

# FIZIKA FANIDAGI “ERKIN TUSHISH TEZLANISHI” TUSHUNCHASINI ASTRONOMIK MAZMUNDAGI MASALALAR YORDAMIDA SHAKILLANTIRISH METODIKASI

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## Abstract

Ushbu maqolada Fizika fanidagi “Erkin tushish tezlanishi” tushunchasini astronomik mazmundagi masalalar yordamida tushuntirish metodikasi yoritilgan.

**Key words**: gravitatsion tezlanish, jism og’irligi, fanlar aro bog’lanish, nisbiy gravitatsion tezlanish, sayyora, sun’iy yo’ldosh, yer massa birligi, yer radius birligi.

## Kirish

Barcha fanlar bir biriga uzviy bo’gliq bo’lib ular bir birining tushunchalarini doim to’ldirishga harakat qiladi. Bugungi kunning o’qituvchisi ham hamma sohalarda ilg’or va o’z faniga yondosh fanlarni bilishi va bu bilimlarni mutaxassislik fanini o’quvchilarga tushuntirish jarayonida qo’llashi zarur. Fanlardagi bilimlarni o’zaro umumlarshtirilganda o’quvchi mavzularni to’laligicha tushunadi va bu ma’lumotlarni boshqa fanlar uchun ham qo’llay oladi.

Aytaylik, Komilning massasi 65 kg. Komilning Yerdagi va Oydagi shuningdek mars sayyorasidagi og’irliklari qanday bo’ladi? Ushbu savolga birinchi duch kelgan o’quvchi yerda ham oyda ham ularning og’irliklari bir xil bo’ladi deb o’ylashi tabiiy. Ma’lumki, jism og’irligi – uning massasi va joylashgan joyidagi tortishish tezlanishiga bog’liq ravishda o’zgaradi. Jismning massasi o’zgarmas bo’lsada, og’irlik har bir sayyorada turlicha bo’ladi. Chunki har bir sayyorada erkin tushish tezlanishi turlicha bo’ladi. Sababi, butun olam tortishish qonuniga ko’ra massasi M va radiusi R bo’lgan sferik sferik osmon jism sirtidagi erkin tushish tezlanishi quyidagicha aniqlanadi:

$$g = \frac{GM}{R^2} \tag{1}$$

Yer sirti uchun

$$g_y = \frac{GM_y}{R_y^2} = 9.81\,\mathrm{m/s^2} \tag{2}$$

qiymat o’rinli.

(1)ni (2) ga bo‘lsak, ixtiyoriy osmon jism sirtidagi yerga nisbatan nisbiy gravitatsion tezlanish topiladi:

$$g = g_y \cdot \frac{M}{R^2} = g_y \cdot g' \tag{3}$$

Bu yerda M yer massa birligida va R yer radius birligida ifodalanadi. $g' = \frac{M}{R^2}$-yerga nisbatan nisbiy gravitatsion tezlanishini ifodalaydi.

Osmon jismining tortishish maydonidagi ixtiyoriy masofadagi gravitatsion tezlanish

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$$g_r = \frac{GM}{r^2} \quad (4)$$

orqali ifodalanadi. (1) tenglikni hisobga olgan holda,

$$g_r = \frac{g_y}{\left(\frac{r}{R}\right)^2} \quad (5)$$

kelib chiqadi. Ushbu formuladagi r va R bir xil uzunlik birliklarida ifodalanadi.

Demak, 65 kg li massaga ega Komilning og'irligi Yer sirtida erkin tushish tezlanishi 9.81 m/s ga teng bo'lgani uchun yerda taxminan 637.5 N og'irlikka ega bo'lsa, Marsda 241N ga teng bo'ladi. Chunki, Marsda tortishish tezlanishi 3.71 m/s ga teng. oyda esa g=1.62 m/s teng va 65 kg li Komil 105 N og'irlikka ega bo'ladi. Bu kabi ma'lumotlardan ham ko'rinib turibdiki, gravitatsion tezlanish tushunchasini astronomik bilimlar yordamida o'quvchilarga tushuntirib berish muhimdir. Bu bilan o'quvchi gravitatsion tezlanish har bir sayyora uchun alohida ekanligi va u osmon jismining massasiga to'g'ri va radiusining kvadratiga teskari prororsional ekanligini tushunadi. Quyida sayyoralarning gravitatsion tezlanishlarini hisoblashga doir masalalar keltirilgan.

**1. Masala**

Yupiterdan o'rtacha $670.9 \times 10^3$ km masofada joylashgan Yupiterni ikkinchi yo'ldoshi Yevropaga berilgan gravitatsion tezlanishni toping. Yupiterning massasi yer massasidan 318 marta katta, yerning o'rtacha radiusi esa 6371 km.

Berilgan:

r=$670.9 \times 10^3$ km

$M_{yup} = 318\,M_{yer}$

$R_{yer} = 6371$ km

Toppish kerak: $g_r$ =?

Yechilishi. Kerakli tezlanish (4) va (5) formulalar bo'yicha qidirilganda

$$g_r = g \cdot \frac{R^2}{r^2} \quad (6)$$

$$g = g_{yer} \cdot \frac{M}{r^2} \quad (7)$$

Bu yerda g yupiter sirtidagi erkin tushish tezlanishi, R yupiterning radiusi, r yo'ldoshgacha bo'lgan masofa, $g\_r$ yupiterning yo'ldoshga bergan gravitatsion tezlanishi $g_{yer} = 981\,cm/s^2$ yerdagi erkin tushish tezlanishi ifodalaydi.

Keyin yo'ldoshga berilgan gravitatsion tezlanish yer sirtidagi erkin tushish tezlanishi bilan bog'liqligi r yer radiusida ifodalanadi $g_r = g_{yer} \cdot \frac{M}{r^2}$

Bundan tashqari r yer radiuslarida, M massasi esa yer massalarida, ya'ni, (2) formulada bo'lgani kabi bir xil o'lchov birliklarda ifodalanadi.

Yerning o'rtacha radiusi $R_{yer} = 6371$ km bo'lganligi sababli, kerakli tortishish tezlanishi

$g_r = \frac{981 \cdot 318}{\left(\frac{670.9 \times 10^3}{6371}\right)^2} = 28.1\,cm/s^2$

Javob: $g_r = 28.1\,cm/s^2$

2. Mars va Venera sayyoralarida, shuningdek Serera astroidida tortishish (erkin tushish) tezlanishini aniqlang. Yer massalari va radiusi bilan taqqoslaganda: Marsda - 0.107 va 0.533, Venerada- 0.815 va 0.950, Sererida-$28.9 \times 10^{-5}$ va 0,0784

| Berilgan: | Yechimi: |
|---|---|
| $M_m$=0.107 $M_{yer}$<br>$M_v$=0.815 $M_{yer}$<br>$M_s$=$28.9*10^{-5}M_{yer}$<br>$R_m$=0.533$R_{yer}$<br>$R_v$=0.950 $R_{yer}$<br>$R_s$=0,0 784 $R_{yer}$ | Mars uchun erkin tushish tezlanishi $g_m = G\frac{M_m}{R_m^2}$ ni Yerning erkin tushish tezlanishiga $g_y = G\frac{M_y}{R_y^2}$bo'lsak, $g_m = g_y\frac{M_m}{R_m^2}\cdot\frac{R_y^2}{M_y}$ hosil bo'ladi. Bu yerda $\frac{M_m}{M_y}$ -yer massasiga nisbatan sayyoraning taqqoslangan massasi bo'lib uni M, $\frac{R_m}{R_y}$ - yer radiusiga nisbatan osmon jismini radiusini esa R deb olsak, $g_m = g_y\frac{M_1}{(R_1)^2}$ kabi bo'ladi. Ushbu formulani qolgan sayyoralar uchun ham qo'llasak bo'ladi. $g_v = g_y\frac{M_2}{(R_2)^2}$ va $g_s = g_y\frac{M_3}{(R_3)^2}$ kabi bo'ladi. |
| Topish kerak:<br>$g_m$-$g_y$-$g_s$-? | |

Hisoblash:

$g_m = g_y \cdot \frac{M_1}{R_1^2} = \frac{9.81 \cdot 0.107}{(0.533)^2} = 3.70\,m/s^2$

$g_v = g_y \cdot \frac{M_2}{R_2^2} = \frac{9.81 \cdot 0.815}{(0.950)^2} = 8.86\,m/s^2$,

$g_s = g_y \cdot \frac{M_3}{R_3^2} = \frac{9.81 \cdot (28.9 \times 10^{-5})}{(0.0784)^2} = 0.46\,m/s^2$

Javob: $g_m = 3.70\,m/s^2$, $g_v = 8.86\,m/s^2$, $g_s = 0.46\,m/s^2$

3. Oyning massasi 81.3ga va diametri esa yerdan 3.67 marta kichik. Kosmonavtlarning vazni oy sirtida yerga qaraganda necha marta kichik bo'ladi.

| Berilgan: | Yechimi: | Hisoblash: |
|---|---|---|
| $M_{oy}$=81.3 $M_{yer}$<br>$D_{oy} = 3.67D_{yer}$ | $g_{oy} = G\frac{M_{oy}}{R_{oy}^2}$ ni<br>$g_y = G\frac{M_y}{R_y^2}$ga bo'lamiz. | $n = \frac{g_{oy}}{g_y} = \frac{M_{oy}}{M_y}\cdot\frac{R_y^2}{R_{oy}^2} = \frac{81.3}{3.67^2} = 6$ |
| Topish kerak: n=? | $n = \frac{g_{oy}}{g_y} = \frac{M_{oy}}{M_y}\cdot\frac{R_y^2}{R_{oy}^2}$ | Javob: n=6 marta |

4. Agar Yer va Marsning massasi o'zgarmagan holda diametlari ikki va uch kattalashsa, ularning sirtida erkin tushish tezlanishi qanday bo'ladi? Mars haqida ma'lumot olish uchun 1-masalaga qarang.

| Berilgan: | Yechimi: |
|---|---|
| $M_m$=0.107 $M_{yer}$<br>$R_m$=0.533$R_{yer}$ | $\frac{M_m}{M_y}$=0.107 ga teng bo'lib, uni M deb olsak, $\frac{R_m}{R_y}$ ni **R** deb olsak,birinchi holda yerning radiusini o'zgarmas deb olib marsning radiusini 2 va 3 marta kattalashtirsak, $R_1 = \frac{R_{m1}}{R_y} = 0.533 \cdot 2 = 1.066$; $R_2 = \frac{R_{m2}}{R_y}$ =0.533· 3 = 1.599; Ikkinchi holda mars sayyorasining radiusini o'zgarmas qoldirib yer sayyorasining radiusini 2 va 3 marta oshirsak, $R_3 = \frac{R_m}{R_{y1}} = \frac{0.53}{2}$=0.2665; $R_4 = \frac{R_m}{R_{y2}} = \frac{0.53}{3} = 0.17766$ $g_{m1} = g_y\frac{M}{(R_1)^2}$; $g_{m2} = g_y\frac{M}{(R_2)^2}$; $g_{y1} = g_y\frac{M}{(R_3)^2}$; $g_{y2} = g_y\frac{M}{(R_4)^2}$ kabi bo'ladi. |
| Topish kerak:<br>$g_{m1}$-$g_{y1}$-$g_{m2}$- $g_{y2}$-? | |

Hisoblash:

$g_{m1} = g_y \cdot \frac{M}{R_1^2} = \frac{9.81 \cdot 0.107}{(1.066)^2} = 0.93\,m/s^2$ ;

$g_{m2} = g_y \cdot \frac{M}{R_2^2} = \frac{9.81 \cdot 0.107}{(1.599)^2} = 0.41\,m/s^2$ ;

$g_{y1} = g_y \cdot \frac{M}{R_3^2} = \frac{9.81 \cdot 0.107}{(0.2665)^2} = 1.09\,m/s^2$ ;

$g_{y2} = g_y \cdot \frac{M}{R_4^2} = \frac{9.81 \cdot 0.107}{(0.17766)^2} = 2.45\,m/s^2$

Javob: 2.45 m/s$^2$, 1.09 m/s$^2$, 0.93 m/s$^2$, 0.41 m/s$^2$

5. 1975 yilning 14-aprelida Orbitaga chiqarilgan va yer yuzasidan 636 km dan 40660km gacha bo'lgan balandlikda yerni aylanib chiqadigan "Molniya-3" sun'iy yo'ldoshining gravitatsion tezlanishi qanday chegaralarda o'zgaradi? Yerning radiusi 6370 km.

| Berilgan: | Yechimi: |
|---|---|
| $R_{yer}$=6370 km<br>$h_1$=636 km<br>$h_2$=40660 km | $g_{m1} = \frac{g_y}{(\frac{r_1}{R})^2}$ $g_{m2} = \frac{g_y}{(\frac{r_2}{R})^2}$<br>bu yerda $r_1=R_{yer}+h_1$ va $r_2=R_{yer}+h_2$<br>$n = \frac{g_{m1}}{g_{m2}}$ |
| Topish kerak:<br>$g_{m1}, g_{m2} va\ n = ?$ | |

Hisoblash:

$g_{m1} = \frac{g_y}{\left(\frac{r_1}{R}\right)^2} = \frac{9.81}{\left(\frac{7006}{6370}\right)^2} = 8.11$ m/s$^2$

$g_{m2} = \frac{9.81}{\left(\frac{47030}{6370}\right)^2} = 0.18$ m/s$^2$

$n = \frac{g_{m1}}{g_{m2}} = \frac{8.11}{0.18} = 45$

Javob: 0.18 m/s$^2$ dan 8.11 m/s$^2$ gacha (45 marta ortgan)

Yuqoridagi masalalarni ishlash davomida o'quvchilar astronomik hodisalarni, gravitatsion tezlanish, og'irlik kuchi, butun olam tortishish kuchi kabi tushunchalarni ham tushunib boradi va fanlarning bir biriga bog'liq ekanligini anglaydi.

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