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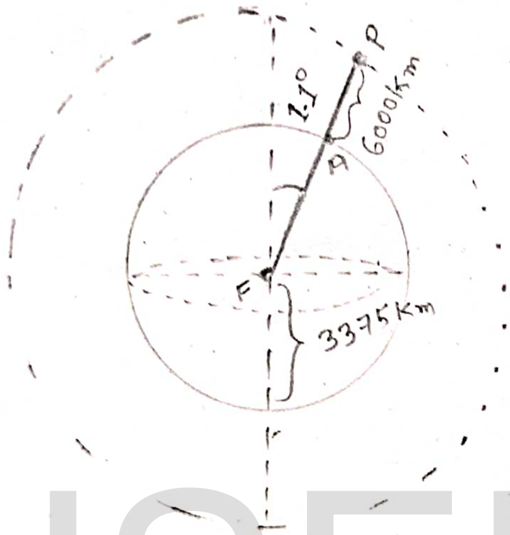
INTRODUCTION: To calculate astrodynamical data requiered for the study of this article are collected from Mars Desert Research Station and NASA insight Mars rover mission.

(i) Kinetic energy stores in phobos :—



mass of Mars, $M = 6.39 \times 10^{23}$ kg
mass of Phobos, $m = 10.6 \times 10^{15}$ kg
ecentricity of P-orbit = ·015
orbital inclination, $i = 1.1°$

Fig 1

Gravitational potential of phobos. $U_p = G\frac{Mm}{-r}$

$$= -\frac{6.67 \times 10^{-11} \times 6.39 \times 10^{23} \times 10.6 \times 10^{15}}{9375 \times 10^{3}} \text{ J}$$

$$= \frac{-452.0770362 \times 10^{24}}{9375} \text{ J}$$

$$= -\,.0482215505 \times 10^{24} \text{ J}$$

$$= -4.8 \times 10^{22} \text{ J}$$

According to the formula of energ conservation

K.E of phobos, $K.E_p = +4.8 \times 10^{22}$ J + Rotational kinetic energy (Negligible)

$$= 4.8 \times 10^{22} \text{ J} + 0$$

$$= 4.8 \times 10^{22} \text{ J} \longrightarrow (1)$$

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(ii) Conversion of Kinetic energy of phobos into seismic energy of Mars :—

At zenith, $z = 0$ at a coordinate near the equator of Mars for a homogeneous medium

Gaussian Source impact time, $\tau = 58s$ (ideal)

Assumption, $K = 10^{-4}$

∴ Siesmic Energy, $E_{sies}(\tau) = \frac{F^2 \pi^{3/2}}{2^{5/2} \tau^3 \rho} \left(\frac{1}{3\alpha^3} + \frac{2}{3\beta^3} \right)$

where, $F = 3 \times 10^{19}$

ρ = density of Mars

α = compressional speed

β = shear wave speed

it simplified as, $E_{sis}(\tau) = K \times E_{Kinetic}$

$= 10^{-4} \times 4.8 \times 10^{22}$ J [From (1)]

$= 4.8 \times 10^{18}$ J

Frequency of this siesmic Energy

$$\nu = \frac{E_{sis}}{h}$$

$$= \frac{4.8 \times 10^{18}}{6.6 \times 10^{-34}} \text{ Hz}$$

$$= 7 \times 10^{51} \text{ Hz}$$

By taking logarithem of base 10 in both side

$$\log \nu = \log(7 \times 10^{51})$$

$$= \log 7 + \log 10^{51}$$

$$= .8450 + 51$$

$$= 51.8450$$

This is the amplitude of Mars-quake in the Richter scale.

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(iii) Magnetic strength of Mars and it's convection current in the mantle :—

The magnetic strength of Mars is very weak. Hence the present convection current yield through this magnetisim is not enough to drive the tectonic plate of Mars.

To increase it we have to increase convection current that drive the Mars rigid tectonic plates in the planet's fluid molten mantle. When magma comes to the top of the mantle it pushes against tectonic plates. which are huge slabs of rocks where the crust rest on. It is on the top of the mantle that magma begins to drop again, but before it does so, it pushes against tectonic plates and travels almost horizontally, moving the plates in one direction on another.

From the universal data of NASA Insight Mars Mission

Magnetic strength of Mars, $H_m = \pm 1.5 \times 10^{-6} T$

Hence convection current, $I_m = H_m 2 \pi R_m$

$= 1.5 \times 10^{-6} \times \frac{44}{7} \times 3389500$

$= 22370700 0 \times 10^{-6} A$

$= 223.7 A$ —— (2)

we can utilise the seismic energy to erupt magma and it will active the dynamo of Mars by increasing convection current.

Hence $I_m \propto H_m$ —— (3)

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METHOD :- To terraform Mars we have to utilise our alternate - space technology in such a way that we can prove mathematically about how, when, why and where.

(i) Computation of Earth magnetic strength with mars magnetic strength :—

According to Universal data

Avg. Convection current of Earth, $I_E \approx 2002.3$ A

Magnetic strength of Earth, $M_E = \pm 5 \times 10^{-5}$ T

Assuming Δ (Melta) $= \dfrac{\text{Convection current}}{\text{Magnetic strength}}$

$$\Delta(\text{Earth}) = \frac{2002.3}{5 \times 10^{-5}}$$
$$= 4 \times 10^{8}$$
$$= (3+1) \times 10^{8}$$
$$= 3 \times 10^{8} + 10^{8}$$
$$= c + 10^{8} \times 1 \rightarrow (4) \quad [c = \text{speed of light}]$$

$$\Delta(\text{Mars}) = \frac{223.7}{1.5 \times 10^{-6}} \quad [\text{From } (2)]$$
$$= 1.487 \times 10^{8}$$
$$= 1.5 \times 10^{8}$$
$$= \frac{3}{2} \times 10^{8}$$
$$= \frac{3 \times 10^{8}}{2}$$
$$= \frac{c}{2} \longrightarrow (5)$$

Multiplying 3 in both side

$$3\Delta(\text{Mars}) = \frac{3c}{2}$$

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$$3\Delta(\text{Mars}) = 3 \times 1.5 \times 10^8$$

$$\Rightarrow 3\frac{I_m}{H_m} = 4.5 \times 10^8$$

$$\Rightarrow 3 I_m = \left[(3 + 1.5) \times 10^8\right] H_m$$

$$\Rightarrow 3 I_m = (3 \times 10^8 + 10^8 \times 1.5) H_m$$

$$\Rightarrow 3 I_m = (c + 10^8 \times 1.5) H_m$$

$$\Rightarrow 3\frac{I_m}{H_m} = c + 10^8 \times 1.5 \longrightarrow (6)$$

Computting the equation (4) & (6) we have

$$\frac{3^0 I_E}{H_E} = c + 10^8 \times 1$$

and

$$\frac{3^1 I_m}{H_m} = c + 10^8 \times 1.5$$

we can simplified that

$$3^K\left(\frac{I}{H}\right) = c + 10^8 \times m \longrightarrow$$

$$\Rightarrow 3^K \Delta = c + 10^8 m \longrightarrow (7)$$

where $K = \{0, 1, 2, 3 \ldots \ldots n\}$

m = mark variable

(7) is the equation of habitability in a planet having atleast two natural moonlets.

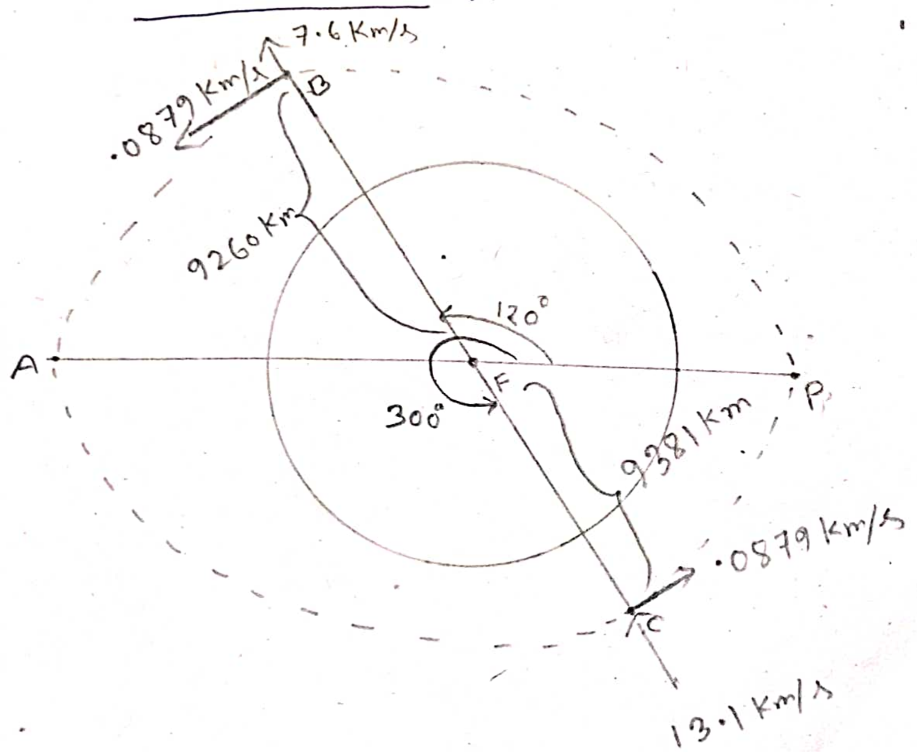
Hence the requirement of convection current to enlarge it's magnetosphere will be

$$3 I_m = 3 \times 223.7 \text{ A}$$
$$\approx 669 \text{ A}$$

It implies that we can convert 4.8×10^{22} J of Kinetic energy stores in phobos into 669 A of Convection current to erupt olympus mons and elysium mons.

(ii) Deployment of phobos while approching perigee :- To deploy phobos near the equator of mars we have to apply external force in the direction of radial component to cancel it's centrifugal force. Since Phobos is inclining at 1.1° to the equatorial plane of mars we have to calculate Delta V at an true anamaly of 300°.

(A) To find radial components at $\theta = 300^\circ$ and $\theta = 120^\circ$:—



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We have, $r_p = 9234.42\ km$ $\quad \mu = G m_p$

$r_a = 9517.58\ km$ $\quad = 6.67 \times 10^{-11} \times 10.6 \times 10^{15}$

$a = 9376\ km$ $\quad = 70.74758 \times 10^4$

$e = .0151$

$\delta = 1.1^\circ$

From the orbital equation, $\theta = 0^\circ$

$$r_p = \frac{h^2}{\mu(1 + e\cos\theta)}$$

$$\Rightarrow 9234.42 = \frac{h^2}{\mu(1 + e\cos 0^\circ)}$$

$$\Rightarrow 9234.42 = \frac{h^2}{70.7475 \times 10^4 (1 + .0151)}$$

$$\Rightarrow 9234.42 = \frac{h^2}{71.82}$$

$$\Rightarrow h^2 = 663200.58$$

$$\Rightarrow h = \sqrt{663200.58}\ km^2/s$$

$$\Rightarrow h = 814.37\ km^2/s$$

$\therefore$ At point B, $$r_B = \frac{h^2}{\mu(1 + e\cos 120^\circ)}$$

$$= \frac{(814.37)^2}{70.75 \times 10^4 (1 + .0151 \times .8141)}\ km$$

$$= \frac{(814.37)^2}{70.75 \times 10^4 \times 1.01229}\ km$$

$$= \frac{(814.37)^2}{71.6195 \times 10^4}\ km$$

$$= 9260\ km$$

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At point B, $V_\perp = \frac{h}{r_B}$

$$= \frac{814.37}{9260}$$

$$= .0879 \text{ km/s}$$

$$V_{r_B} = \frac{\mu e \sin\theta}{h}$$

$$= \frac{70.75 \times 10^4 \times .0151 \times \sin 120^\circ}{814.7} \text{ km/s}$$

$$= \frac{70.75 \times 10^4 \times .0151 \times .58}{814.37} \text{ km/s}$$

$$= \frac{.6196285 \times 10^4}{814.37} \text{ km/s}$$

$$= \frac{619.6285}{814.37} \text{ km/s}$$

$$= 7.6 \text{ km/s}$$

At point C, $\theta = 300^\circ$

$$r_C = \frac{h^2}{\mu(1 + e\cos 300^\circ)}$$

$$= \frac{(814.37)^2}{70.75 \times 10^4 \{1 + .0151(-.022)\}} \text{ km}$$

$$= \frac{(814.37)^2}{70.75 \times 10^4 (1 - .0003)} \text{ km}$$

$$= \frac{(814.37)^2}{70.75 \times 10^4 \times .9997} \text{ km}$$

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$$= \frac{(814.37)^2}{70.69 \times 10^4} \text{ km}$$

$$= 9381 \text{ km}$$

$\therefore$ vertical/Transverse component, $V_{\perp} = \frac{h}{r_c}$

$$= \frac{814.37}{9381} \text{ km/s}$$

$$= .0879 \text{ km/s}$$

$\therefore$ Radial component of velocity, $\theta = 300^\circ$

$$V_{r_c} = \frac{\mu e \sin\theta}{h}$$

$$= \frac{70.75 \times 10^4 \times .0151(-.9997)}{814.37}$$

$$= \frac{-1.068 \times 10^4}{814.37} \text{ km/s}$$

$$= -.00131 \times 10^4 \text{ km/s}$$

$$= -13.1 \text{ km/s}$$

Negative component indicates that it's radial velocity towards the centre of Mars. We have to apply external force at a distance of 9381 km from the centre of Mars.

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To rotate it's plane about 1.1° phobos must has a change in velocity and that is

$$\Delta V = V_{\perp}\sqrt{2(1-\cos\delta)}$$

$$= .0879\sqrt{2(1-\cos 1.1^{\circ})} \quad km/s$$

$$= .0879\sqrt{2(1-.4598)} \quad ''$$

$$= .0879\sqrt{2 \times .5402} \quad ''$$

$$= .0879\sqrt{1.0804} \quad ''$$

$$= .0879 \times 1.04 \quad ''$$

$$= .091416$$

(B) Centripital, Contrifugal and Force of gravitational attraction at point C before collision.

we have, $r = 9381$ km

$V_{r_c} = 13.1$ km/s $= 13.1 \times 10^3$ m/s

$m_p = 10.6 \times 10^{15}$ kg

$G = 6.67 \times 10^{-11}$

$M_m = 6.39 \times 10^{23}$ kg

Before collision / enternal force

$$F_G = G.\frac{M_m m_p}{r^2}$$

$$= \frac{452.077 \times 10^{27}}{(9381 \times 10^3)^2} \quad N$$

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$$= \frac{452.077 \times 10^{18}}{88003161} N$$

$$= .005137054 \times 10^{18} N$$

$$= 5.1 \times 10^{15} N$$

$$F_{c.f.} = \frac{m_p v_r^2}{r}$$

$$= \frac{10.6 \times 10^{15} \times (13.1 \times 10^3)^2}{9381 \times 10^3} N$$

$$= \frac{10.6 \times 10^{15} \times 171.61 \times 10^6}{9381 \times 10^3} N$$

$$= \frac{1819.066 \times 10^{18}}{9381} N$$

$$= .193909604 \times 10^{18} N$$

$$= 1.9 \times 10^{17} N$$

Required external force,

$$F_{external} = \frac{F_{cf}}{F_G}$$

$$= \frac{1.9 \times 10^{17}}{5.1 \times 10^{15}} N$$

$$= .37 \times 10^2 N$$

$$= 37 N$$

Hence the external force must be greater than 37 N to deploy phobos

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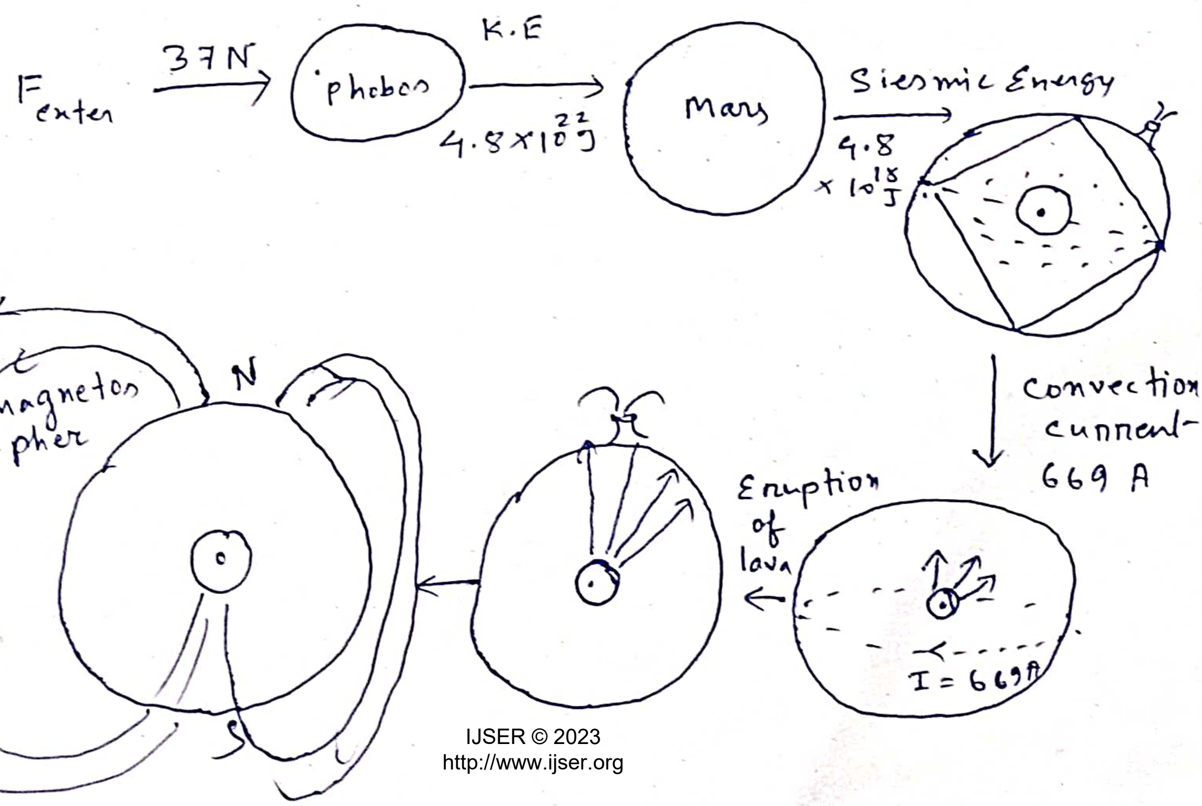
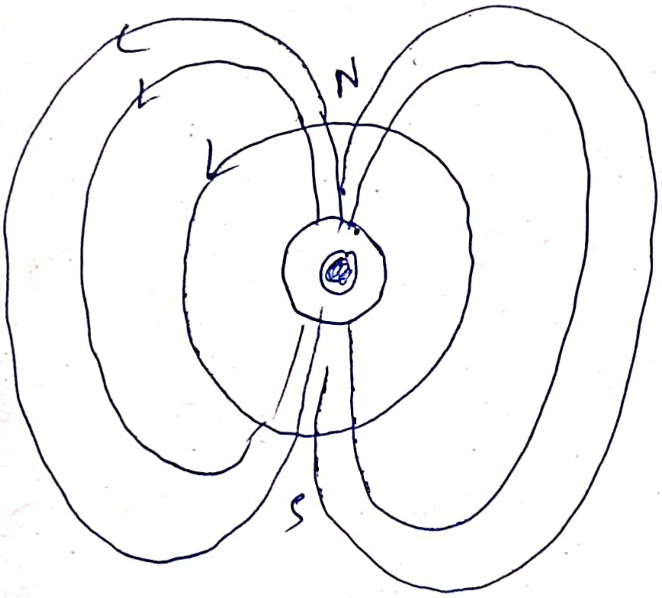
RESULT :-

To deploy phobos near the equator of Mars to produce a convention current of 669 A, we have to apply an external force greater than 37 N at a true anamaly of 300°.

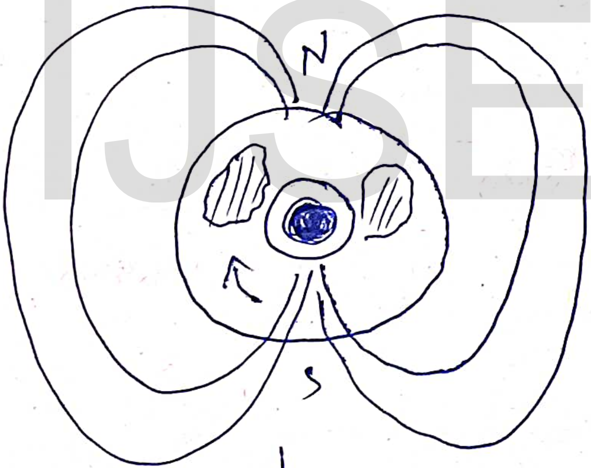
In our space industry we already acquire the technology to apply this minimum external energy during D.A.R.T mission.

Here is our project diagram of energy conversion



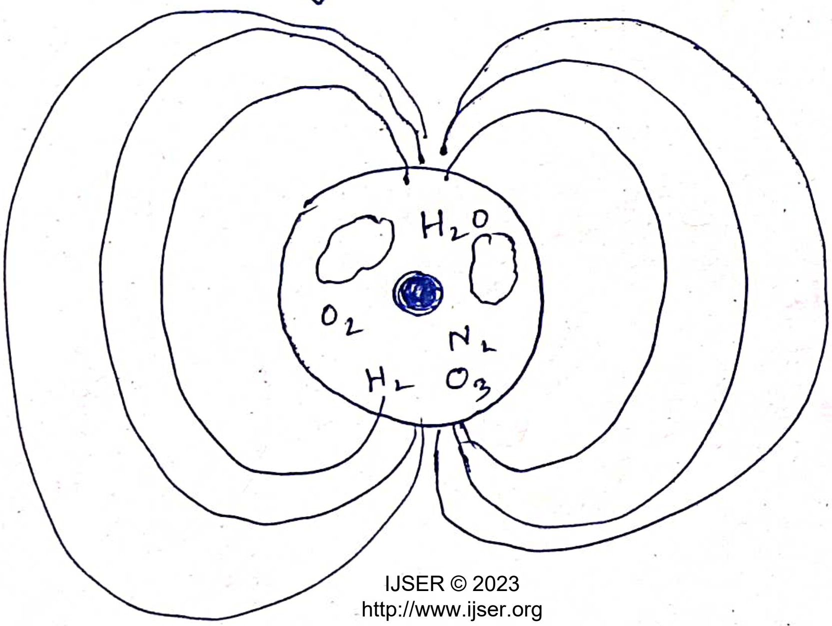


Terra formation process



Tectonic movement

creation of aqua, air, atmosphere.



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Baby Mars with Deimos.

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KEYWORD

Asaph Hall, insight Mar Rover, air-aqua-atmosphere, Elon musk variation, orbital mechanics and utilities, MDRS Deploy phobos.

CONCLUSION :- The importance of this paper is to sustain humanity on Mars before the age of asteroids, global warming and coronal mass ejection from our sun. After the deployment of phobos with the interest of current space companies like spacx, skyroot, Dhruv Deimos will continue it's binary relation with Mars like our Earth-moon system.

— x — x —

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