

kā

fygKv

Avgiv cāZūbqZ kā DrcbaKti _vK Ges kā i`tb _vK | kā n`Q w`wZ`vcK gva`tgi e`K`Yvi j`K`K
 er Ab%N© Zi½ | wKQykā Avgv`i i`b`Z fij j`v`M | Avevi wKQykā i`b`j Avgiv wei³ nB | thgb-
 Avgiv m½xZ i`b`Z fiv`j vevm | cKZc`f m½xZ wtkl ch`e`E kā Zi½ | kā Zi½ tkvb gva`g e`ZxZ
 cēvvnZ n`Z cvti bv | GB mZ` cix`f v Kti t`Lv hıq | aiv hvK GKıU `e`wZK NıUv (Electric Bell)
 GKıU wQıch` tevZtj i`tfZi evRıv`bv nj | GB kā Aek`B tkv`bv hvte | wKšzcv`úı mıvıth` tevZtj i`
 tfZi`K evq`k`b` Kiv n`j NıUvi kā Avi tkv`bv hvte bv | gva`tgi tfZi w`tq kā cēvvnZ n`Z mgq
 j`v`M | gva`g KıMb, Zij A_er evqexq n`Z cvti | kā Zi½ı cāZdj b, cāZmiY BZ`v` n`Z cvti |
 GB BDıb`U Avgiv kā Zi½ı wıvfbav`K wbtq Avtj vPbv Kie |

cW-1

kē, kāZi I kāvĒi Zi½mgn, kā mĀvj tbi tKškj, mjh̄y kā, Acmy, mj I ˆt, mjh̄y kĀi ˆenkó |

Dīk

G cW tktl Avcib

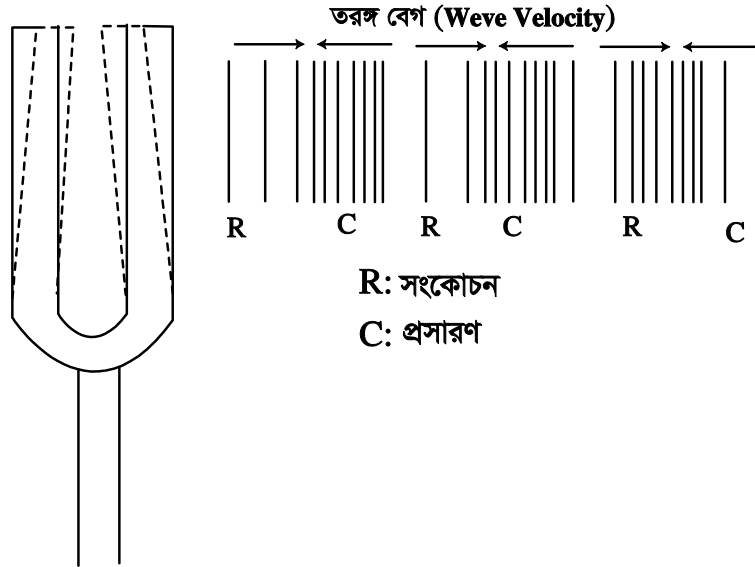
- (1) kē, kāZi I kāvĒi Zi½i msĀv ej tZ cvi tēb,
- (2) kĀi mĀvj b tKškj eˆvLˆv Ki tZ cvi tēb,
- (3) mjh̄y kā I Acmy tK Zv eYv Ki tZ cvi tēb,
- (4) mj I ˆt Gi cv_Ēˆ Ki tZ cvi tēb,
- (5) mjh̄y kĀi ˆenkóˆ ıbi fcb Ki tZ cvi tēb,

18.1.1 t kē, kāZi I kāvĒi Zi½ mgn (Audible, Infrasonic & Ultrasonic Waves)

kāZi½ j tK ev Ab%N© hmsK Zi½ | tKvb w ıZˆvcK gvaˆtg tKvb eˆz Kˆutbi dtj kā Zi½ Drcbnq Ges evavcŮB bv ntj Zv PZˆFK Qıotq cto | th gvaˆtg kā Zi½ cĒvıZ nq tmB gvaˆtgi eˆZYmgn kā Zi½i cĒvıni mgsıvtj ˆjtZ ˆvtK | gvaˆg KıMb, Zij ev evqexq ntZ cvti | G ai tbi j tK ev Ab%N© hmsK Zi½i KˆúvK 20 Hz t_ tK 20,000 Hz Gi gtaˆ ˆvKtj Avgtˆi kĕtbw ˆtg kĀi AbfıZ Rbıq | AZGe j tK ev Ab%N© hmsK Zi½i KˆúvK D³ mıgvi gtaˆ ˆvKtj ZvtK kē Zi½ etj | th mKj j tK ev Ab%N© hmsK Zi½i KˆúvK 20 Hz Gi ıb tP tmme Zi½ tK kāZi (Infrasonic) Zi½ Ges th me j tK ev Ab%N© hmsK Zi½i KˆúvK 20,000 Hz Gi tekx tm me Zi½ tK kāvĒi (Ultrasonic) Zi½ ej v nq | kāZi Zi½ mvariYZ epr Dr tmi Kˆutbi dtj Drcbnq | thgb fıgK tˆıi dtj DrcbZi½ kāZi Zi½ |

18.1.2 t kā mĀvj tbi tKškj (Mechanism of Propagation of Sound)

kā Zi½ evav bv tctj Dr tmi PZˆFK Qıotq cto | kā mĀvj tbi AbˆZg cĀvb gvaˆg nj evqy Aekˆ KıMb ev Zij cˆvt_ P gaˆ ı tql kā mĀvj Z ntZ cvti | Zte kbˆ gvaˆtg kā mĀvj Z ntZ cvti bv | GKıU mj kj vKvi Kˆutbi dtj evqygvaˆg hı ˆ Avtj ııoZ nq Zte Zvi cKıZ. ıKıf? mj kj vKvi evü hLb mıgtbi ı tK AMıi nq ZLb Zv evZımtK Pırc tˆ l qvi dtj ˆıbxq fıte evqy NbZj eıx cıq Ges evqy NbxFeb ev evqy ˆıi mstKıPb axıi axıi mıgtbi ı tK GıMtq hıq | Aveıi mj kj vKvi evü hLb ıb tRi ı tK tdi Z Av tım ZLb ˆıbxq fıte evqy NbZj ıım cıq Ges evqy ZbıFeb ev cĀvı Y nq |



৷PÍ t (18.1) mij kj vKvi mrvnʰh" gva"tgi e`KYvi mstKvPb I cñviYi Øviv kā Zi½i DrcuĒ|
Gfivte `ñi evqy mstKvPb I cñviY chʰqμtg nq| mij kj vKvi evū evi evi hLb KivúZ nte Ges
Zv msj Mæ evqyñi K`úb mʷó Ki te ZLb evqyñi mstKvPb I cñviY evi evi mvgʰbi ı̄ K Gı̄Mʰtg hvte|
ı̄KQyñi tKvb e`ı̄w³ Dcw`Z `vKtj ev kā Zi½ ai½Z mʰg hš;emı̄bv `vKtj kā aiv cotē|

18.1.3 t mjhy kā Ges Acmy (Musical Sound & Noise)

Avgiv cñZı̄bqZ AʰbK aiʰbi kā i`bʰZ cvB| tKvb tKvb kā AZ`š-mı̄kñe" Avevi tKvb tKvb kā
AZ`š-kñZKı̄y hLb tKvb kā Zi½ ı̄bqı̄gZ (Regular), chʰeĒ (Periodic) Ges ı̄biı̄wı̄Obæfı̄te i`bv
hvq ZLb H kāʰK mjhy (Musical) kā ejv nq| Avevi hLb tKvb kā Zi½ Aı̄bqı̄gZ nq ZLb H
kāʰK mjnyb ev Acmy (Noise) etj |

18.1.4 t mjyl `f (Tone & Note)

mı̄vı̄vYZ GKı̄U gvĒ K`úvsKı̄wı̄kó kāʰK mjy etj | GKı̄wı̄K K`úvsKı̄wı̄kó hMcr mñi i mgvı̄vı̄tK `f
etj | Zte `ñi i gʰa" gj- mjy (Fundamental tone) Øvov Dcmı̄y (Over tone) mgʰni K`úvsK gj- mñi i
K`úvsʰKi `ı̄YZK nʰj Zv` iʰK nviʰgı̄mbKm&(Harmonics) etj | tKvb `ñi nviʰgı̄mbKı̄mi mSL`v hZ
tekr nte tmB `f ZZ kñZgı̄y nte| thgb GKı̄U nviʰgı̄mbqı̄tg ı̄wı̄fbæK`úvsʰKi AvUı̄U mjy `vKtZ
cvı̄i |

18.1.5 t mjhy ktāi `enkó" (Characteristics of Musical Sound)

mjhy ktāi cñı̄vZ: ı̄Zbı̄U `enkó" `vʰK, h_v (1) Zı̄eZv (Intensity) (2) Zı̄ı̄gı̄v (Pitch) | (3) `ı̄Y
(Quality)|

cvtVĚi gj`vqb

(K) `be`P̄K cĕkĕt mĭWK DĚti i cvĕk vĭK v̄y (v) v̄b

1. kĕ` kĀ Zi t̄zi K`úvsK nĕ?

(1) 20 Hz t̄tK 20,000 Hz	
(2) 2000 Hz t̄tK 20,000 Hz	
(3) 20 Hz t̄tK 200 Hz	
(4) 50 Hz t̄tK 50,000 Hz	

2. tKvb gva`tg kĀ Zi ½ cĕvvnZ nĕZ cvĕi br?

(1) Kĭvb gva`tg	(2) Zij gva`tg
(3) evqygva`tg	(4) kb` gva`tg

3. kĀ tKvb ai t̄bi Zi ½?

(1) Avo Zi ½	(2) j v̄K Zi ½
(3) Avo I j v̄K Zi t̄zi v̄gkY	(4) tKvb Zi ½ bq

4. mĭyh̄ kĀ v̄K ai t̄bi Zi ½?

(1) AchĕĚ	(2) v̄ekij v̄e`hi mn
(3) chĕĚ	(4) v̄e`hi nxb

5. mĭyh̄ kt̄ai `eikó KqĭU?

(1) GKĭU	(2) `v̄
(3) v̄ZbiU	(4) Pvi v̄U

(L) msĭv̄B cĕkĕ

1. kĀ mĀvj t̄bi tKŠkj eYĖv Ki`b|
2. mĭ I `t̄i i msÁv v̄`b|
3. mĭyh̄ kt̄ai v̄ZbiU `eikó` v̄K v̄K?

$j \times mi Y, Y = y_1 + y_2$

$$= y_m \sin 2\pi n_1 t + y_m \sin 2\pi n_2 t$$

$$= y_m [\sin 2\pi n_1 t + \sin 2\pi n_2 t]$$

$$= 2y_m [\sin \frac{2\pi n_1 t + 2\pi n_2 t}{2} \cos \frac{2\pi n_1 t - 2\pi n_2 t}{2}]$$

[$\because \sin A + \sin B = 2 \sin \frac{A+B}{2} \cos \frac{A-B}{2}$]

$$= 2y_m \sin 2\pi \left(\frac{n_1+n_2}{2} \right) t \cos 2\pi \left(\frac{n_1-n_2}{2} \right) t$$

$$= Y_m \sin 2\pi \left(\frac{n_1+n_2}{2} \right) t$$

$$= Y_m \sin 2\pi n t$$

GLi#b, $\left[Y_m = 2y_m \cos 2\pi \left(\frac{n_1 - n_2}{2} \right) t \right], n = \left(\frac{n_1+n_2}{2} \right) t$ ----- (18-1)

f`Lv hv#`Q j wä Zi½ mij`ú#`Z MwZm#úbeZi½ hvi we`#

$Y_m = 2y_m \cos 2\pi \left(\frac{n_1-n_2}{2} \right) t$ Ges

$K#úvsK n = \frac{n_1+n_2}{2}$

we`# Y_m Gi mSL`mZ gvb mte#P n#e hLb, $\cos 2\pi \left(\frac{n_1-n_2}{2} \right) t = \pm 1$

eV, $2\pi \left(\frac{n_1-n_2}{2} \right) t = 0, \pi, 2\pi, \dots, m\pi$

eV, $t = 0, \frac{1}{n_1 - n_2}, \frac{2}{n_1 - n_2}, \dots, \frac{m}{n_1 - n_2}$

AZGe`# c#j k# tkıvı ga`eZ#mgq $\frac{1}{n_1 - n_2}$ sec.

Aveı j wä Zi#i ZıeZı me#ante hLb, $\cos 2\pi \left(\frac{n_1-n_2}{2} \right) t = 0$

eV, $2\pi \left(\frac{n_1-n_2}{2} \right) t = \frac{\pi}{2}, \frac{3\pi}{2}, \dots, (2n+1) \frac{\pi}{2}$

eV, $t = \frac{1}{2(n_1 - n_2)}, \frac{3}{2(n_1 - n_2)}, \dots, \frac{2m+1}{2(n_1 - n_2)}$

AZGe`# w:k#i ga`eZ#mgq $\frac{1}{n_1 - n_2}$ sec.

cW 3

Uvbn Zvfi i Káub, Uvbn Zvfi Avo Ziťzi teM

Dťik`

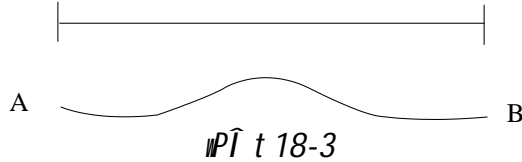
GB cW tkťl Avcib -

- 1 Uvbn Zvfi i Káub m`úťK`RvbťZ cvi`teb,
- 1 Uvbn Zvfi Avo Ziťzi teM mKťmi Dci wbfPkxj RvbťZ cvi`teb|

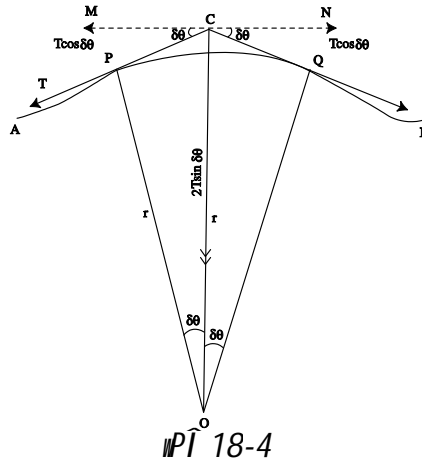
18.3.1 t Uvbn Zvfi i Káub (Vibration of stretched string)

mlyg `ťN` Ges řž`cťť`Q` weikó GKwU ZviťK Uvb Kťi `gŃš-Avex Kiv nj | G Ae`řq ZviťK Uvbn Zvi etj | Uvbn Zvfi `ťN` mřť_j řřvte g`yAvNvZ Kij Avo Káub (Transverse vibration) Drcbrenq ev ejv Pťj Avo Ziťzi mřp nq| Avo ZiťzU `B cŃšť wťK AMňi nťq cŃš-nťZ cŃZdij Z nťe| AvcuZZ I cŃZdij Z Ziťzq w`i Ziťzi mřp Kiťe Ges ZviU eŃřb KivúZ nťZ vKťe|

18.3.2 t Uvbn Zvfi Avo Ziťzi teM (Velocity of transverse wave in a stretched string) : awi `řđ w`i we`y gťa` mlyg cťť`Q` weikó GKwU Zvi Uvb Ae`řq AvťQ| ZviU Uvb T



G Ae`řq Zvfi g`yAvNvZ Kivq Avo Ziťzi mřp nťqťQ Ges AB H Avo Ziťzi GKwU Ask| Avo ZiťzU evg t`ťK Wvb wťK AMňi nť`Q| AB Gi AwZ řž`Ask PQ| PĪ 18-4 G PQ tK tevSvi mřřavi Rb` eo Kťi t`Lvťbv nťqťQ| PQ řž`AskUťK etĚi gZ Kíbv Kiv hřq| CP Ges CQ tK `úkŘ aiv Pťj | mřZivs CP I CQ eivei Uvb T mřřvkvxj PĪ vbfřvqx $\angle COP = \angle COQ = \delta\theta$. CP eivei mřřvkvxj T Uvťbi উল্লস Dcvsk $T\sin\delta\theta$ I AbřřřgK Dcvsk $T\cos\theta$ h_vřřg CO I CM ti Lv eivei mřřvkvxj |



AbiutK CQ eivei umqvkj ej T. GB etji উল্লস Dcisk Tsinδθ ibtPi w`tk CO eivei Ges
 AbfugK Dcisk Tcosδθ CNeivei umqvkj | CM I CN eivei umqvkj ej mgvb I necixZgkx
 nlqvg ci`uitK bnKP Kti t`q| AZGe KvhRix ej 2Tsinδθ Ges Bnv CO eivei umqvkj |

Zvtii GKK`tn^q fi m ntj PQ Astki fi m × r × 2δθ

[∴ PQ Pivci e`imva^o_r, ZvB PQ Pivci`N^o_rδθ]

$$\begin{aligned} \text{CO eivei tk>`gkx ej} &= mr(2\delta\theta) \times \frac{v^2}{r} \\ &= 2mv^2 \delta\theta \end{aligned}$$

GLv^{tb} v teM Zi ½ O tk>`neko Piv eivei Muzkij |

$$\therefore 2T\sin\delta\theta = 2m\delta\theta v^2$$

$$\text{ev, } 2T\delta\theta = 2mv^2 \delta\theta$$

[∴ δθ AwZ^qz^aetj sinδθ δθ]

$$\text{ev, } v^2 = \frac{T}{m}$$

$$\text{ev, } v = \sqrt{\frac{T}{m}} \dots \dots \dots (18-2)$$

teM = K^{av}sk × Zi ½ % N^o

$$\text{ev, } v = n\lambda$$

GLb m^{av}Y^oZi^u P mSL`K eFvst^k wef³ ntq K^{av} DrcbæKij GtKKu^u eFvst^{ki} `N^o $\frac{1}{p}$, GLv^{tb}

l = Zvtii`N^o cZi^u eFvsk Aa^oZi ½ `N^oib^t`R Kti |

$$\therefore \frac{l}{p} = \frac{\lambda}{2}$$

$$\text{ev, } \lambda = \frac{2l}{p}$$

$$\therefore v = n\lambda \text{ ntZ cvB,}$$

$$\text{ev, } v = n \cdot \frac{2l}{p}$$

$$\text{ev, } \sqrt{\frac{T}{m}} = n \cdot \frac{2l}{p} \quad \left[18.2 \text{ ntZ } v = \sqrt{\frac{T}{m}} \right]$$

$$\text{ev, } n = \frac{p}{2l} \sqrt{\frac{T}{m}}$$

$$\text{ev, } n = \frac{l}{\lambda} \sqrt{\frac{T}{m}} \dots \dots \dots (18-3)$$

$$A_{\text{f}} \text{ K}^{\text{av}}\text{sk} = \frac{l}{Zi \frac{1}{2} \% N^o} \sqrt{\frac{Zvtii \text{ Uvb}}{Zvtii \text{ GKK} \% \text{tn}^q \text{ fi}}}$$

D`niY t t`l qv AvtQ, Zv`ii `N^ol = 25 cm = 0.25 m

Uvb T = 10kg × g = 10kg × 9.8 m sec⁻²

Zv`ii GKK `N^o fi m = 9.8 × 10⁻³ kg/m

Rvbn AvtQ,

$$n = \frac{1}{2l} \sqrt{\frac{T}{m}}$$

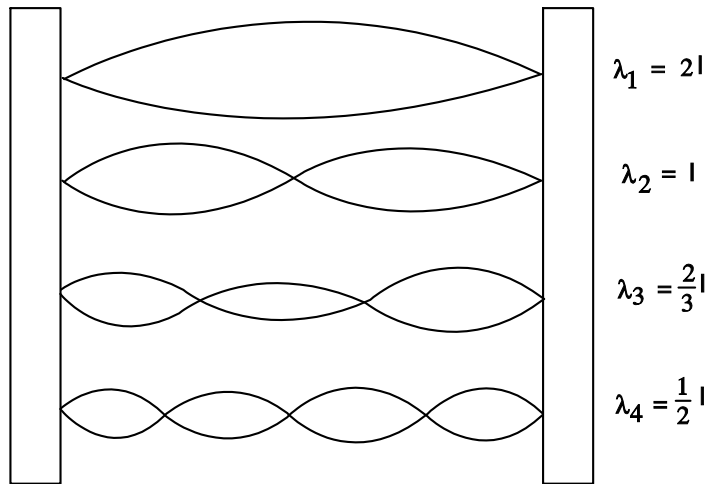
$$= \frac{1}{2 \times .25} \sqrt{\frac{10 \times 9.8}{9.8 \times 10^{-3}}}$$

$$= 200 \text{ Hz}$$

18.3.3 t Uvb Zv`i vevfbai`bi K`ub (Different modes of vibration of stretched string)

`B c`š-AvUKv`bn Ae`vq GKvU Uvbn Zv`ii gvSLv`b AvNvZ Kitj `B c`š-ib`ú` ve`yI gvSLv`b m`yú` ve`yDr`cbante| G Ae`vq $l = \frac{\lambda}{2}$ (vPÎ 18.5)

$$n_1 = \frac{1}{\lambda_1} \sqrt{\frac{T}{m}} = \frac{1}{2l} \sqrt{\frac{T}{m}} \dots \dots \dots (18-4)$$



vPÎ t 18-5

tKvb GK c`š-t`k GK PZz`k `fi Zv`iU`k AvNvZ Kitj `B c`š-ib`ú` ve`yQvovI ga`Lv`b AvI GKvU ib`ú` ve`yDr`cbante| G Ae`vq, $l = \lambda_2$

$$n_2 = \frac{1}{\lambda_2} \sqrt{\frac{T}{m}} = \frac{2}{2l} \sqrt{\frac{T}{m}} = 2n_1 \dots \dots \dots (18-5)$$

G t`v`v K`úvsk gj- K`úvstKi v0, Y|

GKBfite vZb e`vst`k ev Pvi e`vst`k ev AvI tekx fivM vef³ Kfi Zv`iK Kiv`úZ Kiv hvq| tm Ae`vq h`v`vtg $n_3 = 3n_1, n_4 = 4n_1 \dots \dots \dots$ BZ`v` |

D`niY 1

GKw Zv`ii fi 3gm Ges `N^o 60cm | Zv`ii KZ etj Uvbr ntj Gi Avo K`ub Drcbæ1g Dcm`ji K`úvK n`e 200 Hz?

mgvab t`q AvtQ, Zv`ii `N^o l = 60cm = 0.6m

Zv`ii fi, 3gm = 0.003 kg

$$\begin{aligned} \therefore \text{Zv`ii GKK `N^o fi, } m &= \frac{0.003}{0.6} = 5 \times 10^{-3} \text{ kg m}^{-1} \\ &= .5 \times 10^{-2} \text{ kg m}^{-1} \end{aligned}$$

1g Dcm`ji K`úvK, n₂ = 200 Hz

Zv`ii Uvb T aiv hvK |

$$m\hat{f}gtZ, n_2 = \frac{1}{l} \sqrt{\frac{T}{m}}$$

$$n_2^2 = \frac{1}{l^2} \cdot \frac{T}{m} \quad [eM\text{K}ti]$$

$$T = n_2^2 l^2 m$$

$$\begin{aligned} &= (200)^2 \times (0.6)^2 \times 0.5 \times 10^{-2} \\ &= 72 \text{ N.} \end{aligned}$$

mvi mst`c

Uvbr Zv`ii K`ub t Uvbr Zv`ii g`yAvNvZ Kitj Avo Zi½ m`p nq | Uvbr Zv`ii `Bcš-`pfrte AvUKv`bv `vKtj `B cš-t`K Zi½ cšZdij Z ntq w`i Zi½ m`p nq | Uvbr Zv`ii GK j`g loop, `B j`g, wZb j`g BZ`w` ntZ cv`i | G Ae`vq Zi½ %N^oh`vµtg 2l, l, $\frac{2}{3}$ l; thLv`b l Zv`ii `N^onte |

cv`Vv`Ei gj`vqb

(K) `be`pK c`kæ

m`WK D`E`ti w`K w`p`y (√) w`b

1. Uvbr Zv`ii g`yAvNvZ Kitj w`K Zi½ Drcbæng?

(1) j`w`K Zi½

(2) Avo Zi½

(3) Z`vor P`yK`xq Zi½

(4) t`Kvb Zi½ m`p ÷ nq bv |

(L) msu`B D`E`ti w`b

1 | Uvbr Zv`ii w`i Zi½ w`Kfv`te Drcbæng?