

Zi½ I kã

fygKv

tKvb cKž ev w`i Rjvktq GKwU cv_i wbtq|c Ktj cv_i cwbZ cteki mvt_ mvt_ PZw K cmbi KYvi gta` Avtjvob mjo nq| dtj cmbi KYvi Dci bxtP I Vvbyv Kti | cmbi KYvi I Vvbyv axti axti PZw K Qwotq cto| G Ae`vtK etj tXD ev Zi½| Zi½ wwfbaaitbi nq| evZvtmI Zi½ mjo Kiv hvq| Avgiv `bw`b Rxeib th K_v ev kã`iwb Zv evZvtm mjo GK aiibi Zi½| hii tKvb kã nq ev Avgiv K_v ewj ZLb ktãi Dm ev Avgv`i KÚbyx evZvtm Avt`vj b mjo Kti | G Zi½ Avgv`i Kvib tcvotjv c`q Avt`vj b mjo Kti; dtj c`KwztZ_vtK| GtZ Kti Avgv`i gw`tq GK cKvi AbywZ mjo nq| dtj Avgiv kã`i bZ cvB| wKfite kã Zi½ Drcbenq Ges Avgiv Zv ktb_vnk Rvivi Rb` Avgv`i AibK tKŠZaj itqtQ| Zte cŭtgB Avgiv Zi½ mjoKvix KYvi MwZ Ges wwfbae aiibi Zi½i cKwZ. wbtq G BDwbU AvtjvPbv Kie|

cW - 1

chēĚ MvZ, -ú`b MvZ ev t`vj MvZ, mij Qw`Z MvZ, Zi½ MvZ |
Zi½i cKviĚ

Dġi k

G cW tġi Avcib -

- | chēĚ MvZ KvġK etj ej tZ cviġeb,
- | -ú`b MvZ ev t`vj MvZi eYġv w`tZ cviġeb,
- | mij Qw`Z MvZ KvġK etj ej tZ cviġeb,
- | Zi½ MvZi eYġv w`tZ cviġeb,
- | Zi½ KZ cKvi Zv eYġv KiġZ cviġeb|

17.1.1 t chēĚ MvZ (Periodic Motion)

tKvb MvZkxj e-zhiv` Gi MvZcġ_i tKvb w`v`ġ w`v`ġ mgq ci ci GKB w`K t_ġK AvZġg
Kġi Zvġġ Gi MvZġK chēĚ MvZ etj | D`vniY -ġġc ejv hvq, Avġġġi nvZNwġZ hiv` tmġKġŪi
Kwlv_vġK Zġe t`Lv hvġe cġZ 60 tmġKŪi ci ci tmġKġŪi Kwlv Gi MvZcġ_i tKvb w`v`ġ GKB w`K
t_ġK AvZġg KiġQ| GLvġb Nwġi tmġKġŪi Kwlv MvZ chēĚ MvZ| chēĚ MvZ mij `iġLK, eġvKvi
ev DceġvKvi nġZ cviġi |

17.1.2 t -ú`b MvZ ev t`vj MvZ (Vibratory Motion)

chēĚ MvZkxj tKvb e-z MvZ hiv` w`v`ġ mgq ci ci w`v`ġZġġx nq Zġe G aiġbi MvZġK -ú`b
MvZ ev t`vj MvZ etj | D`vniY -ġġc ejv hvq, GKwU t`vj KġK hiv` nvZ w`ġq tKvb GK w`ġK mġvġb`
tVġġ t`l qv nq Zġe t`Lv hvġe Zv w`KQġġw`Mġq Avevi w`v`ġZ w`ġK tdiZ AvmġQ Ges evi evi GKw`K
t_ġK Ab`w`ġK Avmv hvġ qv KiġQ| Giġc MvZġK -ú`b MvZ ev t`vj MvZ etj |

17.1.3 t mij Qw`Z MvZ (Simple Harmonic Motion)

hiv` chēĚ MvZm`úbæ tKvb e-zYvi MvZ mijġiLvq nq, e-zKYvi Dci w`v`ġkxj ej me`v
mġv`ve`vġbi AvġġġL w`v`ġ Kġi Ges e-z ZiY mġv`ve`vb t_ġK Gi miġYi mġvġvġZK nq Zġe Gi
MvZġK mij Qw`Z MvZ etj |

tKvb t`vj KġK hiv` AvZ Aġ tVġġ t`l qv nq Zġe t`vj ġKi MvZc_ġK GKwU mij tiLv ejv hvq| A_ġ
t`vj KwU GKwU mij `iġLK cġ_tçSYcġYK`ġġZ_vKġe| Giġc mij Qw`Z MvZ|

Zi½ m`úġKġ AvġġvPbvq mij Qw`Z MvZ m`úġKġ aviYv AZ`š-cġqvRbvq| w`v`ġqġ m`ġŪ Aóg
BDw`bġU w`v`w`i Z AvġġvPbv Ki v nġġQ|

17.1.4 t Zi½ MvZ

cKzi cmbtZ Avgiv hLb GKwU cv_i wbtqK Kwí ZLb Zi½ mwp nq Ges Zv PZw PK Qwotq cto| j`q` Kitj t`Lv hvte th cmbi lctii tKvb tQvU e`zthgb cvZv, BZ`wí wbr`vrb t`tKB lVvbrgv Kitq| tXdqí mvt_ mvt_ Zv`hi mti hvq br| Gi gva`tg eSv hvq Zi½ cèvtni dtj gva`tgi KYv GK`vb t`tK Ab`vrb hvqbr eis mvg`ve`vrb DVvbrgv Kti| cKZ.ctq` Zi½ cèvn gvrb nj kw³i cèvn A`r GLvrb gva`tgi KYvi bq, kw³i`vrbšit NtU| msÁv t AMñi gvb chēē Avt`vj btK Zi½ etj |

17.1.5 t Zi½i cKvitf`

Zi½ cèvtni w`tki mvtctq` gva`tgi KYv, wj i K=úbtí w`K wetePbv Kitj Zi½tK`yfvTM fVM Kiv hvq| h_v t

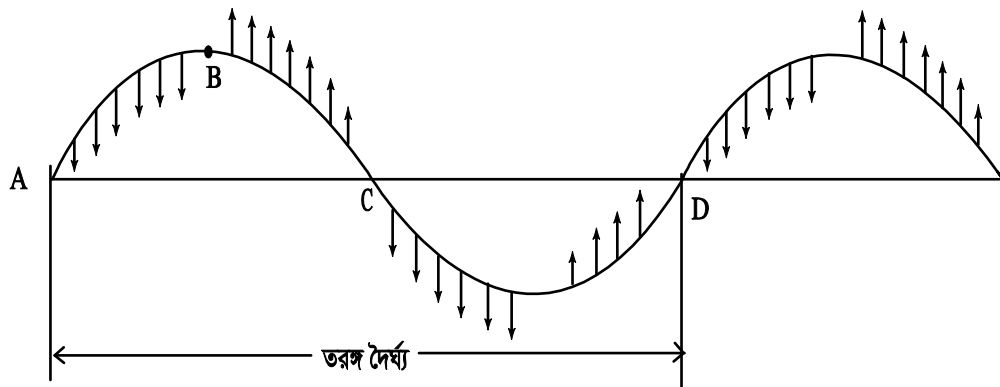
(K) Avo ev Abgō` Zi½ (Transverse Wave)

(L) j`PK ev Ab%N° Zi½ (Longitudinal Wave)

(K) Avo Zi½ : gva`tgi KYv, wj h` Zi½ cèvtni w`tki mvt_ mgtkvtY Kw=úZ ntZ`vtK Zte H Zi½tK Avo Zi½ ev Abgō` Zi½ ejv nq|

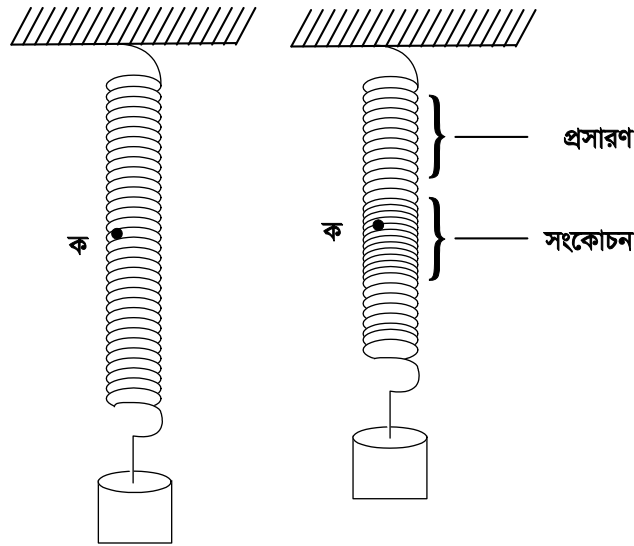
D`niY - 1 t GKwU cKzi w`i cmbtZ tQvU GK UKiv tkjv ivLv nj | tkjvi UKiv cmbtZ fvmtZ`vKte| G Ae`vq wKQy`hi cmbtZ wKj Qvtj t`Lv hvte Zi½i mwp ntqtQ Ges Zv cKzi wKbri vi w`tk AMñi nt`Q| Zi½ thw`tk AMñi nt`Q, tkjvi UKiv Zvi mvt_ j`fvte Avt`wvj Z nt`Q| tkjvi UKivi gZ cmbi KYvi MwZl GKB iKg nte| mZivs Gtq`t mō Zi½wU Avo Zi½|

D`niY 2 t GKwU Uvbr Zvi ev inki GK cōš-nvZ w`tq a`i Dci-brP Ggbfite Uvbr nj hvZ inki`ñN`P j`fvte Uvb cto| G Ae`vq nvtZi KvtQ inki KYv, wj i Uvb cwkZPKYv, wj i Dci mÁwvj Z nq Ges tkl chS`ctjiv inki lci Zv w`Z nq| G Ae`vq th tKvb GKwU KYvi w`tk j`q` ivL`tj t`Lv hvte Zv lci bxtP lVvbrgv Kitq| GUV eS`tZ cviv AwZ cōqvRbxq th, Zi½ mvg`tbi w`tk AMñi nq wKšziwki KYv, wj`i agv`l lci bxtP`úw`Z nq| Aci cōvq 17-1 wPt`tj LuPt`i mwnvth` Avo Zi½ t`Lvbr ntjv| wPt`tj Xxi (↑)wPy`θviv th tKvb gytZ`KYvi MwZ eSv`tbr nq|



wPt` 17.1 Avo Zi½

(L) jwK Zi½ : Zi½ mwóKvix gva`tgi KYv,uj hw` Zi½ cêvtni w`tki mvt_ mgvš+vj fvte mvgtb-tcQtb Avt` vj Z nq Zte H Zi½tk jwK Zi½ ev Ab%N°Zi½ etj | kâ Zi½ GKwU jwK Zi½ |



ৱপী 17.2 : w`ús eiei jwK Zi½i MwZ |

D`niY 1 t GKwU w`ús ৱপী 17-2 Gi gZ Kti Sg`tq t`qv ntj v | w`ústqi lci GKwU we`yK w`ústqi wbtPi w`tk GKwU fvix e`zevav AvtQ | Gevi fvix e`wtK mvgvb` wbtPi w`tk tUt b tQto w`tj e`w lci bxtP `jytZ `vKte Ges w`ústqi Kôj xi newfbaAsk chiqµtg mstKwPZ l cñwi Z ntZ `vKte (ৱপী 17-2) | GB mstKvPb l cñviY w`ústqi `N°eivei cêvtnZ nte | w`ústqi Dci Aew`Z K we`yZ Zi½ cêvtni w`tki mvt_ mgvš+vj fvte Avt` vj Z ntZ `vKte | mZivs w`ústqi ga` w`tq AMñi gvb G Zi½wU jwK ev Ab%N°Zi½ |

17.1.6 t Avo Zi½ l jwK Zi½i cv`R` (Distinction between Transverse waves and Longitudinal waves)

Avo Zi½	jwK Zi½
1 gva`tgi KYv,uj Zi½ cêvtni w`tki mvt_ j`fvte `úw`Z nq	1 gva`tgi KYv,uj Zi½ cêvtni w`tki mvt_ mgvš+vj fvte `úw`Z nq
2 chiqµtg Zi½ gva`tgi KYv,uj tZ PovB DZivB Drcbmq	2 chiqµtg gva`tgi KYv,uj mvgtb tcQtb `úw`Z nq
3 PovB Gi tKvb we`yntZ cvkêZP PovB Gi mgZj` we`ychS-`i-Ztk Zi½ `N°aiv nq	3 mstKvPtbi tKvb we`y t`tk cvkêZP mstKvPtbi mgZj` we`ychS-`i-Ztk Zi½ `N°aiv nq

cuVvEi gj`iqb

`be⁹PK cĀœ

m¹WK DĒti WK Pý (√) w b|

1. k¹ā m¹ú†K⁹KvbiU m¹WK?

(K) Avo Zi ½

(L) j¹PK Zi ½

(M) Avo I j¹PK Zi ½

(N) k¹ā Zi ½ bq|

2. Avo Zi ½ cĒvtni WK NtU?

(K) gva`†gi KYv, wj Zi ½ cĒvtni mg†Kv†Y DVvbigv K†i |

(L) gva`†gi KYv, wj Zi ½ cĒvtni w†K Av†`wj Z nq|

(M) gva`†gi KYv, wj Av†`-Av†`-`†i m†i hvq|

(N) gva`†gi KYv, wj eĒvKvi c†_ P†j |

3. j¹PK Zi†½i t††Ī tKvbiU NtU?

(K) gva`†gi KYv, wj Zi ½ cĒvtni mg†Kv†Y I Vvbigv K†i |

(L) gva`†gi KYv, wj Zi ½ cĒvtni w†K Av†`wj Z nq|

(M) gva`†gi KYv, wj Av†`-Av†`-`†i m†i hvq|

(N) gva`†gi KYv, wj eĒvKvi c†_ P†j |

msv†|B cĀœ

1. ch⁹eĒ MvZ Kv†K etj ?

2. mij Qv` Z MvZ e`vL`v Ki`b|

3. Zi†½i cKv††f` wj L†y|

4. Avo Zi†½i GKvU tj LvPĪ A¼b K†i e`vL`v Ki`b|

17.2.4 t Zi½i Káusk (Frequency of wave) t Avgi v Rmb Káubkxj e`zGK we`y`t`K hv`v Kti Avevi GKB w`K t`K tmB we`jZ wditi Avmvi NUbvtK etj cY`Káub| cÚZ tmKtÚ gva`tgi KYv hZevi cY`Káub m`úbæKti ZvtK Zi½i Káusk etj | mnaviYZ KáuskKtK n Øviv mPZ Kiv nq|

GKwU cY`Káubibi mgq T, AZGe n msL`K cY`Káub m`úbæKtiZ KYvi mgq j vM nT

$$mÁvbhvqx nT = 1 \text{ tmKtÚ}, mZivs n = \frac{1}{T} |$$

KsáuskKti GKK mBtKj /tm: (Cycle/sec) | weÁvbx nvUR (Hertz) Gi m`ýbvt`G GKK tK nvUR (Hz) ej v nq|

Zi½i `kv t tKvb Káubkxj e`z`kv ej tZ th tKvb gytZ`H e`z`Muzi mg`K Ae`v Z`v e`KYvi mi Y, teM, ZjY BZ`w` tevSvtbv nq|

Zi½ gly t Zi½i t`f`f` t`Lv hvq, PovB ev DZivB m`p nq GKB `kvh` AmsL` KYv wgtj | tKvb Zi½i Dci Ae`Z mg` kv m`úbæKYv mgr` th Ztj Ae`vb Kti ZvtK ej v nq Zi½ gly|

17.2.5 t Zi½i teM, Káusk I `N` cvi`úvi K m`úK`

Zi½i Káusk n Ges Zi½ `N` n`j cÚZ tmKtÚ ev GKK mg`q Zi½w nλ `iZiAwZµg Ki te| wKšGKK mg`q AwZµvš` iZtK Zi½i teM etj |

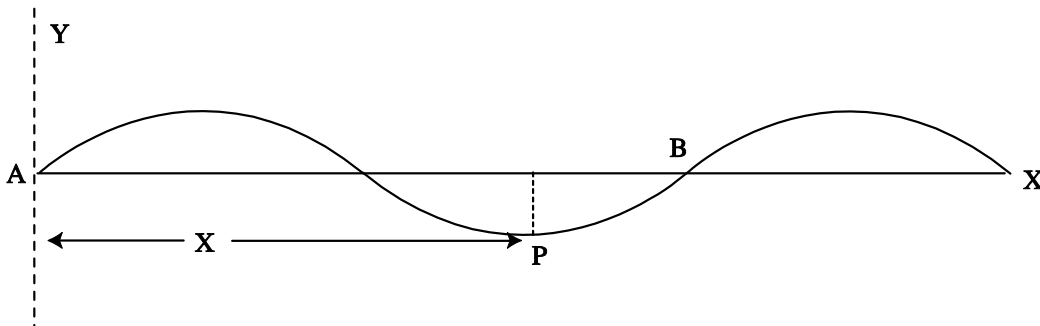
$$mZivs Zi½i teM, v = nλ$$

$$A_{teM} = Káusk \times Zi½ \text{ `N`}$$

17.2.6 t AM`v`g Zi½i Mwv`ZK c`Kv

hLb tKvb gva`tgi tfZi Avf`vj b (Disturbance) GK `i t`K Ab` `fi Zi½ ifc mgtbi w`K GKwU wv` Ø teM AM`hi nq ZLb ZvtK ej v nq AM`v`g Zi½ (Travelling waves)|

avi GKwU AM`v`g Zi½ evg w`K A we`y`t`K Wvb w`K B we`y`w`K AM`hi n`Q (wPÍ 17-4)| cÚtg evg w`K GKwU KYv Avf``v`j Z nte Ges Zvi wKQ`v`b ciB cik`Zx`Wvb w`K KYvtK Avf``v`j Z Ki te Ges Gfvt` µgk: Wvb w`K KYvmgr` Avf``v`j Z nte dtj KYv`v`j i gta` `kv cv`R` m`p nte|



wPÍ -17-4

th tKvb gytZ[⊙]A we`jZ Aew⁻Z KYvUj mvg⁻ve⁻vb t₋tK miY y Gi mgvb ntj y tK w⁻tKvYugwZi mVbB (Sine) dsktbi mrvth⁻ tj Lv hvq,

$$y = y_m \sin \omega t \quad [\text{th tZ Z KYvUj mij Qw`Z MvZtZ i tqtQ G m⁻utK[⊙]BDwbU-8-G Avtj vPbv Kiv ntqtQ}]$$

$$\text{GLvtb } y_m = m \omega A \text{ K miY ev Zi tzi we}^{-i}$$

$$y = t \text{ mgtq mvg}^{-} \text{ve}^{-} \text{v t}_{-} \text{tK KYvi miY}$$

$$\omega = \text{KYvUj tK⁻SYK K⁻uvsk}$$

$$(M⁻AK A⁻ji \omega Gi D⁻Prib I tgmV)$$

mgq t=0 Ae⁻iq h⁻w⁻ `kv (Phase)= 0 bv⁻v⁻tK Zte mgvKi YvU⁻ `voute,

$$y = y_m \sin(\omega t - \alpha)$$

[GLvtb α (D⁻Prib Avj dv) nj `kv cv⁻R]

A I B we`jZ Aew⁻Z `v⁻ KYvi ga⁻eZ⁻ iZj Zi^{1/2} `N[⊙] λ -Gi mgvb, Giv mg⁻kv m⁻ub ϕ

λ ev GK Zi^{1/2} `tN[⊙] mgvb `iZj Rb⁻ `kv cv⁻R⁻ 2 π ev 360⁰

$$\therefore x \text{ `iZj Rb⁻ `kv cv⁻R⁻ } \frac{2\pi x}{\lambda}$$

A⁻ P we`jZ mi⁻Yi Rb⁻ mgvKi YvU⁻ nte,

$$y = y_m \sin\left(\omega t - \frac{2\pi x}{\lambda}\right)$$

$$= y_m \sin\left(2\pi n t - \frac{2\pi x}{\lambda}\right)$$

[\therefore tK⁻SYK K⁻uvsk $\omega = 2\pi n$]

$$\text{Avevi } v = n\lambda$$

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

$$\therefore y = y_m \sin\left(\frac{2\pi}{\lambda} vt - \frac{2\pi x}{\lambda}\right)$$

$$\text{ev, } y = y_m \sin \frac{2\pi}{\lambda} (vt - x) \text{ ----- (17-2)}$$

A we`jZ Aew⁻Z KYv t₋tK Aci th tKvb KYvi `jZj Rvbn⁻ vKtj th tKvb mg⁻tq KYvUj miY GB mgvKi⁻Yi mrvth⁻ vbY[⊙] Kiv hvq| GLvtb A we`jK gj⁻we`y(origin) ejv th⁻tZ cv⁻ti |

tKvb `iZj x hLb A we`j⁻tK Wvbw⁻ tK gvcv nq ZLb x tK av⁻ZK aiv nq|

m⁻Zivs av⁻ZK x A⁻ eivei AM⁻higvb Zi^{1/2} mgvKiY 17-2| GKBFite Zi^{1/2} Wvbw⁻ K t₋tK evg⁻w⁻ tK t⁻tj A⁻ FYvZK x A⁻ eivei AM⁻higvb Zi^{1/2} mgvKiY nte,

$$y = y_m \sin \frac{2\pi}{\lambda} (vt + x) \text{ ----- (17-3)}$$

weikó `y AMMvix Zi½ weciX w`K t_#K AMñi n#Q, t mgq ci gj we`y t_#K x `iZ; Zi½0tqi Rb` KYvi we`hi y₁ l y₂ -G Ae`vq Zi½ `y#K ubawj wLZ mgxKi#Yi mivvith` tj Lv hvq,

$$y_1 = y_m \sin \frac{2\pi}{\lambda} (vt - x)$$

$$y_2 = y_m \sin \frac{2\pi}{\lambda} (vt + x)$$

wgij Z nl qvi ci j wä Zi½ Y = y₁ + y₂

$$= y_m \sin \frac{2\pi}{\lambda} (vt - x) + y_m \sin \frac{2\pi}{\lambda} (vt + x)$$

$$= 2y_m \sin \frac{2\pi}{\lambda} \left(\frac{vt-x+vt+x}{2} \right) \cos \frac{2\pi}{\lambda} \left(\frac{vt-x-vt-x}{2} \right)$$

$$\left[Q \sin A + \sin B = 2 \sin \frac{A+B}{2} \cos \frac{A-B}{2} \right]$$

$$= 2y_m \sin \left(\frac{2\pi}{\lambda} vt \right) \cos \left(\frac{2\pi}{\lambda} x \right) \quad [\because \cos(-A) = \cos A]$$

$$\text{ev, } Y = 2y_m \cos \left(\frac{2\pi}{\lambda} x \right) \sin \left(\frac{2\pi}{\lambda} vt \right)$$

$$= A \sin \frac{2\pi}{\lambda} vt \dots \dots \dots (17-4)$$

$$\text{GLv#b, } 2y_m \cos \left(\frac{2\pi}{\lambda} x \right) = A \text{ aiv n#q#Q}$$

(17-4) mgxKi Ywli we`hi A = 2y_m cos $\frac{2\pi}{\lambda} x$ | mgxKi YwU mij Qw` Z MwZ w#` R K#i | wKšZ(17-4) mgxKi YwU AMMvix Zi½i mgxKi Y bq Kvi Y Gi gta` `kv tKv#Yi (vt-x) Dcw`wZ tbB A_# tKvb we`#Z KYvi `kvi cwi eZ# tbB |

m#yú` we`y (Antinodes) t mgxKi Y (17-4) 0viv th Zi½#K eSvq H Zi½i we`hi

$$A = 2y_m \cos \frac{2\pi}{\lambda} x$$

w`i Zi½i th mKj we`#Z we`hi me#K nq tm mKj we`#K m#yú` we`y etj |

$$\text{GLv#b m#e#P we`hi n#e } 2y_m \cdot hLb \cos \frac{2\pi}{\lambda} x = 1$$

$$A_# \frac{2\pi}{\lambda} x = 0, \pi, 2\pi \dots \dots \dots$$

$$\text{ev, } \frac{2\pi}{\lambda} x = n\pi \quad [hLb \ n = 0, 1, 2 \dots \dots \dots]$$

$$\therefore x = 0, \frac{\lambda}{2}, \frac{2\lambda}{2} \dots \dots \dots \frac{n\lambda}{2} \text{ BZ`w` m#yú` we`y }$$

$$y \sim \cos\left(x - Z_i \frac{\lambda}{2}\right)$$

ib`ú` e`y (Nodes) t`i Zi½i th me e`yZ e`hí kb`_v`K H mg`e`yK ib`ú` e`y e`j |

$$y \sim \cos\left(x - Z_i \frac{\lambda}{2}\right) \quad A = 2y_m \cos\left(\frac{2\pi}{\lambda} x - t\right) \quad hLb$$

$$\cos\left(\frac{2\pi}{\lambda} x\right) = 0$$

$$A \text{ } \frac{2\pi}{\lambda} x = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \dots$$

$$e\text{v}, \quad \frac{2\pi}{\lambda} x = (2n+1) \frac{\pi}{2} \quad [hLb \quad n = 0, 1, 2, \dots]$$

∴ ib`ú` e`y Ae`vb,

$$x = \frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4}, \dots \quad (2n+1) \frac{\lambda}{4}$$

$$y \sim \cos\left(x - Z_i \frac{\lambda}{2}\right) \quad | \quad AZGe \text{ c}v\text{k}v\text{c}v\text{k} \quad y \sim \cos\left(x - Z_i \frac{\lambda}{4}\right)$$

cvVvEi gj`iqb

be`K ckt mWK DĒti i cvk WK vPý (√) w b

1. Zi½i ZxeZv vKtmi Dci vbfP Kti ?

(K) Zi½i e`v`i i e`M` Dci

(L) Zi½i e`v`i i e`M` i Dci

(M) Zi½i %`N` Dci

(N) Zi½i K`úv`i Dci

msv`B cĕce

1. w`i Zi½i msÁv vj Lj|

2. w`i Zi½ vKf`te Drcb`q vP`mn e`v`v Ki`b|

3. m`y` e`y ib`ú` e`y e`v`v Ki`b|

cW - 4

Dcwi cvZtbi bwiZ, Zi½i e'wZPvi, w'f ev `Uvqgvb Zi½, w'f Zi½ MVtbi `qvš-

Df'k

G cW tkfI Avcib

- (1) Dcwi cvZtbi bwiZ wj LtZ cvi teb,
- (2) Zi½i e'wZPvi wK Zv wj LtZ cvi teb,
- (3) ktai e'wZPvi c0 kfb KBt½i cir¶v eYØv Ki½Z cvi teb,
- (4) ktai ZxeZv e'vL'v Ki½Z cvi teb|

17.4.1 t Dcwi cvZtbi bwiZ (Principle of Superposition) t tKvb gva'tg GKw Zi½ c'vwnZ ntj Gi c'vite gva'tgi KYv, wj i mvg've'v nZ miY NtU Ges KYv, wj `u'w`Z nZ _vtK| wKšZtKvb gva'tg hLb `B ev ZtZmaK Zi½ m'Avij Z nq ZLb tKvb we'`jZ gva'tgi KYvi j wä miY c0Z'Kw Zi½ c_wK c_wKfite H we'`jZ gva'tgi KYvi th miY mw0 Kti Zvt i t±i mgw0i mgvb nq| GtK Dcwi cvZtbi bwiZ etj | we'Avbx Ugvm Bqvs Dcwi cvZb bwiZi c0Z'R|

aiv hvK, GKw Zi½ c'vtni dtj tKvb we'`jZ gva'tgi KYvi miY y_1 | hMcrfite w0Zxq Zi½ c'vtni dtj GKB we'`jZ gva'tgi KYvi miY y_2 |

G Ae'vq gva'tgi tKvb KYvi j wä miY,
 $Y = y_1 + y_2$, [Zi½0q GKB w' tK c'vwnZ ntj]
 $Y = y_1 - y_2$, [Zi½0q we'ci xZg'x ntj]
 $A_{\text{f}} Y = y_1 \pm y_2$

w'f c'kzi i c'vbtZ GKB mgtq KvQvKwQ `w' wj Qgtj t'Lv hvte th c'vbi th we'`jZ `w' tXDtqi Pev GKB w'K t' tK Gtm wgvj Z nq tmLvbt Zi½i Pevi D'PZv Atc¶vKZ. te0 hvq| Avevi th we'`jZ `w' LuR GKB w'K t' tK Gtm wgvj Z nq tmLvbt Zi½i LdRi Mfvi Zv te0 hvq|

17.4.2 t Zi½i e`wZPvi (Interference of waves)

Bev ZtZmaK Zi½i DcwicvZtbi dtj th Ae`vi mwp nq ZvtK Zi½i e`wZPvi etj | D`miY`tfc awi, mgvb K`úvsk l mgvb we`vim`úbre`w Zi½ gva`tgi tKvb we`jz t`wz h`vµtg x₁ l x₂ `iZj AwZµg Kti | Gt`i miY h`vµtg y₁ l y₂ | G Ae`vq Zi½ wZK w`wµj wLZ mgxKiY Øviv cKvk Kiv Ptj

$$y_1 = y_m \sin \frac{2\pi}{\lambda} (vt - x_1)$$

$$y_2 = y_m \sin \frac{2\pi}{\lambda} (vt - x_2)$$

GLv`b, $y_m = Zi½i we`w,$

$\lambda = Zi½ \text{ `N}^\ominus,$

$v = Zi½i teM|$

Zi½ `wi DcwicvZtbi dtj H we`jz miY Y ntj

$$Y = y_1 + y_2$$

$$= y_m \sin \frac{2\pi}{\lambda} (vt - x_1) + y_m \sin \frac{2\pi}{\lambda} (vt - x_2)$$

$$= y_m \left[\sin \frac{2\pi}{\lambda} (vt - x_1) + \sin \frac{2\pi}{\lambda} (vt - x_2) \right]$$

$$= 2y_m \sin \frac{2\pi}{\lambda} \left(\frac{vt - x_1 + vt - x_2}{2} \right) \cos \frac{2\pi}{\lambda} \left(\frac{vt - x_1 - vt - x_2}{2} \right)$$

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

$$= 2y_m \cos \frac{\pi}{\lambda} (x_2 - x_1) \sin \frac{2\pi}{\lambda} \left(vt - \frac{x_1 + x_2}{2} \right)$$

$$= Y_m \sin \frac{2\pi}{\lambda} \left(vt - \frac{x_1 + x_2}{2} \right)$$

GLv`b $Y_m = 2y_m \cos \frac{\pi}{\lambda} (x_2 - x_1)$

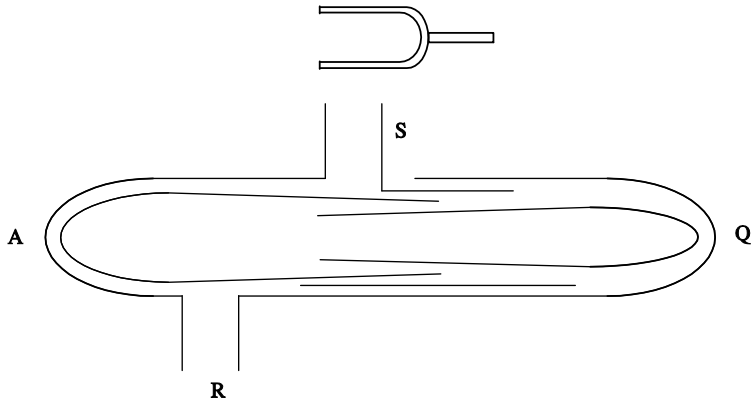
$$A_w Y = Y_m \sin \frac{2\pi}{\lambda} \left(vt - \frac{x_1 + x_2}{2} \right) \text{ ----- (17-6)}$$

(2) Zi½`w GKB t`Lv eivei miY NUvte|

(3) Zi½`w c_cv`R` $\frac{\lambda}{2}$ Gi tRvo`wYwZK n`j Mvbgj-K e`wZPvi Ges c_cv`R` $\frac{\lambda}{2}$ Gi w`tRvo`wYwZK n`j aYsmvZK e`wZPvi n`te|

17.4.4 t k`ai e`wZPvi c`k`b K`ai ci`v

wP` 17.5 tZ K`ai ci`v h`m`v t`Lv n`j v`w avZe d`v bj Ggbf`te evK`v Av`Q h`tZ tkv`v U Gi gZ t`Lv Ges GK`w bj Aciv`i t`Z`i c`ek Ki`Z ci`i |



wP` t 17-8 K`ai h`i

s g`v w` t`q m`y k`j v`K`v m`v`th` k`a Drcb`K`v n`q| s g`v w` t`q k`a Zi½` c`ek K`i` v`v`M f`vM n`t`q P I Q ev` w` t`q Mgb K`i` R eiv`g`v w` t`q tei n`q| Q ev`t`K` W`v`b A`_ev ev`t`q m`v` t`q w`f`³ Zi½`t`q`i c_cv`R` n`l ev (2n+1)λ K`i`v h`v`q| h`Lb c_cv`R` n`l n`q ZLb eiv`g`v A`_v` R Gi K`i`Q t`R`v`i k`a t`k`v`v h`v`q| Avevi Q ev` m`v` t`q c_cv`R` (2n+1)λ Ki`j t`K`v`b k`a t`k`v`v h`v`q`v

[GL`v`b n = 0,1,2]

Gf`v`te k`ai e`wZPvi t`Lv n` m`e`|

17.4.5 t Zi½`i Z`e`Z`v

Zi½`i Z`e`Z`v Zi½`i w`-v`i e`M`P` mgv`b`v`w`ZK| k`a Zi½`i t`v`v`i P`v`ci w`-v`i m`i`Y`i w`-v`i mgv`b`v`w`ZK| GRb` k`a Zi½`i t`v`v`i Z`e`Z`v g`j-Z: k`a Zi½`i th` P`v`c m`v` K`i` t`m`B P`v`ci D`ci w`b`f`k`j | th` w`-v`i k`a ev` Zi½`i Drcb`e n`t`Q Z`e`Z`v t`m`B w`-v`i t`K` t`k`v`v`i` i`Z`j e`M`P` e`v`-v`b`v`w`ZK n`q|

cvtVvEi gj`iqb

be⁹K ckt mWK DEti WK Pý (v) w b

1. GKwU Uvbn Zvti w`i Zi½ Drcbanevi KviY WK?

- (K) Wcj vi çµqv (L) e`wZPvi
- (M) tekx K^çúvsK (N) Kg K^çúvsK |

2. MVbgj-K e`wZPvi ntj Zi½ `wji `kv cv_R` KZ nq ?

- (K) 0 (L) $\frac{\pi}{2}$ (M) $\frac{3\pi}{2}$ (N) $\frac{5\pi}{2}$

msvMjB cktce

1. Zi½i e`wZPvi nl qvi kZ⁹K?

2. $y = 0.4 \sin 0.1 x \cos 32t$ mgxKiYwU w`i Zi½ cKvk Kti | GLvfb x Ges y ugUvti Ges t tmKtU t`l qv AvtQ | th `wji Zi½i Dcwi cvZtbi dtj w`i Zi½ mjo nq Zvt`i we`hi KZ?

(K) iPbvj-K cktce

- 1. Avo Zi½ I j^wK Zi½i eY⁹v w`b | mij Qw`Z MwZ KvK etj ? GKwU AMMvgx Zi½i mgxKiY wj tL Zi½i teM, K^çúvsK I `tN⁹ m^çúK⁹ei Ki`b |
- 2. Dcwi cvZtbi bnwZ e`vL`v Ki`b | Zi½i e`wZPvtii MmYwZK cKvk tei Ki`b Ges jwä Zi½i mte⁹P I me⁹ç⁹me`hi kZ⁹ei Ki`b | ktai e`wZPvi t`LvZ KBt⁹i cix⁹vi eY⁹v w`b |

(L) MwYwZK mgm`v

- 1. GKwU Zi½tK w^çij wLZfvte tj Lv hvq, $Y = 5 \sin 2(vt + x)$, Zi½i we`hi I Zi½ `N⁹KZ?
- 2. 220 Hz K^çúvsK weikó GKwU mjy kvvkv nZ Drcbækā 10 tmKtU 3000 m c_ AwZµg Kti | Zi½ `N⁹KZ?
- 3. `wji mjy kvvkv K^çúvsK 256 Hz I 512 Hz Zvt`i Zi½ %tN⁹ Zj⁹bn Ki`b |