

ZvcMwZve`vi vØZxq mĤ

fygKv

Avgi v Rvnb, newfbæcKvi kw³ ci`úi ifcvšit̄hvM | A_ŕ GK cKvi kw³ Ab` cKvi kw³tZ ifcvšwZ
nĤZ cvti | wKšzhvšK kw³i thgb Zvĥc ifcvšwZ nI qvi GKUv`ŕfveK cĕbZv AvtQ, Zvc kw³i
hvšK kw³tZ ifcvšwZ nI qvi tZgb`ŕfveK cĕbZv tbB | Zvc t_ĤK hvšK KvR tctZ nĤj hšj
cŕqvRb | G hšĤK ej v nq Zvc BwÁb | Zvc t_ĤK hvšK KvR tctZ nĤj wK wK kZ`vKv cŕqvRb, ev
Avt`š KvR cvl qv hvte wK bv - G m`úĤK newfbæcÁvbx th newZ w`tqŕQb ZvB ZvcMwZve`vi vØZxq
mĤi Avtj vPbv i el q |

cW - 1

Zvc BwÄtbi hwišK `ŋZv, cZveZP I AcZveZPcŋuqv

Dtĭk

G cW tkĭI Avcib -

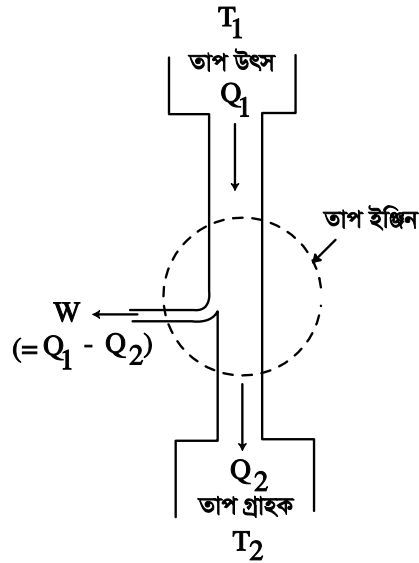
- | Zvc- BwÄtbi AcwivhAsk, ŋj ej tZ cvi teb,
- | Zvc-BwÄtbi `ŋZv ubYŋqi mĭ ej tZ cvi teb,
- | cZveZP I AcZveZPcŋuqv eYŋ I Gt`i gta` cv_R` ŋj LtZ cvi teb/

16.1.1 t Zvc BwÄtbi hwišK `ŋZv

cZ`K Zvc BwÄtbi Aek`B GKŋU D`P Zvcgvĭvi Zvc Dm (Source) vKte, hv t`K BwÄtbi Kvh` ubefĭK e`zZvc tkvY Kti hwišK KvR Kite| G QrovI v`K GKŋU ub`e Zvcgvĭvi ZvcMĭK (Sink) vKte, hv Zvc MĭY Kite|

A_ŋ Zvc BwÄtbi AcwivhAsk, ŋj ntĭv

- (1) GKŋU Kvh`ubefĭK e`z
- (2) GKŋU Zvc Dm I
- (3) GKŋU Zvc MĭK|



ŋPĭ 16-1

aiv hvK, Zvc BwÄtbi Kvh`ubefĭK e`zT1 Zvcgvĭvi Zvc Dm t`K Q1 cwi gvY Zvc MĭY Kti w cwi gvY KvR m`uv`b Kti Ges T2 Zvcgvĭvi Zvc MĭK Q2 cwi gvY Zvc eR` Kti |

$$\begin{aligned} \text{Zvc BwÄtbi `ŋZv, } \eta &= \frac{\text{KvR e`iqZ Zv`ci cwi gvY}}{\text{tkvml Z Zv`ci cwi gvY}} \\ &= \frac{Q_1 - Q_2}{Q_1} \\ &= 1 - \frac{Q_2}{Q_1} \dots \dots \dots (1) \end{aligned}$$

hv` Q2 = 0 nq Zvntĭj $\eta = 1$ nq|

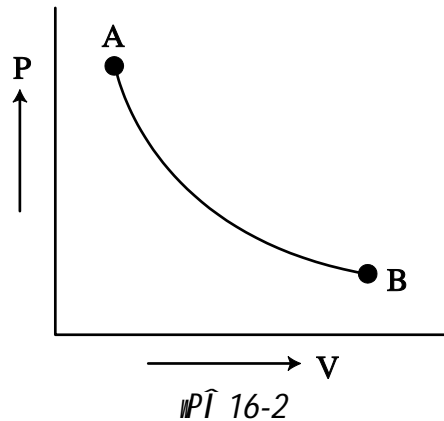
Gi A_©vovq GB th, BwÁb Zvc Drm t_#K th Zvc MhY K#i Zvi meUKB Kv#R cwiYZ nq| tKvb Zvc eirZ nq bvl wKŠzveÁvix Kv#b#A#bK M#elYv K#i GB wmv#š-Av#mb th, Zvc#K m#úY#f#c Kv#R ifcviš# Kiv m#e bq| A_# BwÁ#bi `¶Zv KLB 100% n#Z cv#i bvl

16.1.2 t cZ`veZ# AcZ`veZ#c#uqv

cZ`veZ# c#uqv t th c#uqv weci#Zg#x n#q cZ`veZ# Ki#Z cv#i A_# m#úMv#x c#uqv Kvh#be#K e`#i cZ`-# h#` c#v`Mv#x c#uqv cZ`-#i m#_ me#Zv#v#e w#t# hvq, Z#e Zv#K cZ`veZ#c#uqv ej#v nq|

tj LwP#T#i m#v#h` e`vL`v

aiv hvK, tKvb Kvh#be#K e`# Av# I P#vš-Ae`v tj LwP#T#i h_v#t#g A I B w#`y m#v#h` c#KvK Kiv n#j#v| A t_#K B-#Z t#Z e`# q cwi#vY Zvc MhY K#i I w cwi#vY KvR m#úv`b K#i | G c#uqv#K m#úMv#x c#uqv e#j |



e`# h#` GKB cwi#e#K B Ae`v t_#K A Ae`v#q cZ`veZ# K#i, ZLb Zv#K c#v`Mv#x c#uqv ej#v nq|

c#v`Mv#x c#uqv h#` q cwi#vY Zvc eR# K#i I w cwi#vY KvR e`# Dci m#úv# Z nq, Zv#t# mgM# c#uqv# n#e cZ`veZ#|

cZ`veZ#c#uqv kZ#

tKvb c#uqv cZ`veZ#n#Z cv#i h#`

- (1) c#uqv L# ax#i ax#i m#úv# Z nq| Ges
- (2) AcPqg#-K dj #w# h#` m#úY#v#e tiva Kiv hvq|
- (3) cZ`veZ#c#uqv t#¶#T# GKw# e`-v #M tj LwP#T#i th c#_ GKw# w#v`# Ae`v t_#K Ab` Ab` GKw# w#v`# Ae`v#q t#š#Q, c#uqv#K weci#Zg#x Ki#j wK#mB GKB c#Z w#Z#q Ae`v t_#Z c#_g Ae`v#q cZ`veZ# Ki#e|

cZ`veZ#c#uqv D`v#iY

- (1) w#b h# w#j Úv#i g#a` tKvb M`v#t#K h#` m#gv# c#uqv ax#i ax#i m#b#v#Z Kiv nq, w#b M`v#t#i Dci KvR m#úv`b K#i |
Ave#i ax#i ax#i M`v#m Øv#v mgcwi#vY KvR m#úv# Z n#j M`v#m c#_w#K Ae`v#q w#t# Av#t#e| AZGe G#¶#T# mgM#c#uqv# cZ`veZ#|

(2) eid wbr̄θ cwigrY Zvc tkvly Kti cmbtZ cwiyZ nq| Averi H cmb GKB cwigrY Zvc eRθ
 Kiti eid ifcšwi Z nte| AZGe G cūqv cĹveZf

AcĹveZf cūqv

th cūqv wecixZgylx nq cĹveZθ Kitz cti bv ZvK AcĹveZf cūqv ej v nq|
 mkj ctkwZK cūqvB AcĹveZf

D`niY

(1) wfbeZvcgr̄vi `w e`K ci`ūti ms`ūtk̄ivLtj D`P Zvcgr̄vi e`zt`K wbeZvcgr̄vi e`Z
 Zvc mĀwj Z nte| wKšzKLbB wbeZvcgr̄vi e`zt`K Zvc D`PZvcgr̄vi e`Z mĀwj Z nte bv|
 AZGe, G cūqv AcĹveZf

(2) NIŷi dtj Zvc Drcbenq| wKšzGB ZvcK cgr̄vq KtR ifcšwi Z Kiv hvq bv| mZivs NIŷ
 GKw AcĹveZf cūqv|

16.1.3 t cĹveZf AcĹveZf cūqv gta` cv`R`

cĹveZf cūqv	AcĹveZf cūqv
1 th cūqv wecixZgylx nq cĹveZθ Kitz cti Ges m`Mvgr̄ I cōv`Mvgr̄ cūqv cĹ `fi Zvc I KvRi djvdj mgvb I wecixZ nq, tm cūqvK cĹveZf cūqv ej v nq	1 th cūqv wecixZgylx nq cĹveZθ Kitz cti bv, ZvK AcĹveZf cūqv ej v nq
2 Gw `Z:ōZ`cūqv bq	2 Gw `Z:ūZ`cūqv
3 KivwefnK e`zcō`wK Ae`vq wdti Avtm	3 KivwefnK e`zcō`wK Ae`vq wdti AvmtZ cti bv

mvi mst`c

cĹveZf cūqv t th cūqv cwicvKp tkvb iKg cwieZθ bv Nułq cteP cūqv wecixZgylx nq
 GKB c` Aw` Ae`vq cĹveZθ Kitz cti, ZvK cĹveZf cūqv etj |

AcĹveZf cūqv t th cūqv wecixZgylx nq cĹveZθ Kitz cti bv, ZvK AcĹveZf cūqv etj |
 Zvc BwĀb t th htšj mvinth` ZvcK hmsK kw³tZ ifcšwi Z Kiv hvq, ZvK Zvc BwĀb etj |

Zvc BwĀbi `ŷZv t hw` tkvb Zvc BwĀb Q₁ Zvc tkvly Kti w KvR m`ur`b Kti I Q₂ Zvc eRθ

$$Kti, Zvtj hmsK `ŷZv, \eta = \frac{w}{Q_1} = \frac{Q_1 - Q_2}{Q_1}$$

$$kZKiv wmvte, \eta = \frac{Q_1 - Q_2}{Q_1} \times 100\%$$

ც`ლ`ე`ი` გ`-`ი`ბ

K. მ`მ`K D`E`t`i`i` ც`ლ`ე`ი` K (√) `P`y` w` b`|

1| ც`ლ`ე`i`ve`Z`P`c`l`u`q`v` t`K`v`b`w` N`t`U`?

(K) მ`ა`g`M`i`g`x` I` c`d`v` `M`i`g`x` c`l`u`q`v` m`a`u`w`i` Z` e`i`n`:` `K`v`R` m`g`v`b`|

(L) t`k`v`w`l` Z` Z`i`c` e`i`R`Z` Z`i`t`c`i` w`_`Y`

(M) t`k`v`w`l` Z` Z`i`c` e`i`R`Z` Z`i`t`c`i` m`g`v`b` b`q`|

(N) მ`ა`g`M`i`g`x` c`l`u`q`v` m`a`u`b`a`K`v`R` c`d`v` `M`i`g`x` c`l`u`q`v` m`a`u`w`i` Z` K`v`t`R`i` w`_`Y`|

2| N`I`P`Y` D`r`c`b`e`Z`i`c` t`K`v`b` c`l`u`q`v`i` A`a`x`b`?

(K) ც`ლ`ე`i`ve`Z`P`c`l`u`q`v`

(L) A`c`l`e`i`ve`Z`P`c`l`u`q`v`

(M) m`t`g`v`o` c`l`u`q`v`i`

(N) i`f`x`Z`i`c`x`q` c`l`u`q`v`i`

3| Z`i`c` D`r`m` t`_`t`K` Q₁ `c`w`i` g`v`Y` Z`i`c` t`k`v`l`Y` K`t`i` M`i`n`t`K` Q₂ Z`i`c` e`R`b` K`i`t`j` B`w`A`t`b`i` `q`|Z`v` K`Z` n`t`e`?

(K) $\eta = 1 + \frac{Q_2}{Q_1}$

(L) $\eta = 1 - \frac{Q_2}{Q_1}$

(M) $\eta = 1 + \frac{Q_1}{Q_2}$

(N) $\eta = 1 - \frac{Q_1}{Q_2}$

4| G`K`w`l` Z`i`c` B`w`A`b` Z`i`c`-D`r`m` t`_`t`K` 1000J` Z`i`c` M`i`Y` K`t`i` M`i`n`t`K` 700J` Z`i`c` e`R`b` K`t`i` | B`w`A`t`b`i` `q`|Z`v` K`Z`?

K) 25%

L) 30%

M) 35%

N) 40%

L. m`S`u`q`B` c`l`e`

1| ც`ლ`ე`i`ve`Z`P`c`l`u`q`v` I` A`c`l`e`i`ve`Z`P`c`l`u`q`v`i` g`t`a` `c`l`_`R` `e`Y`b`v`i` K`i`"b`|

2| ც`ლ`ე`i`ve`Z`P` I` A`c`l`e`i`ve`Z`P`c`l`u`q`v`i` K`t`q`K`w`l` D` `v`n`i`Y` D`t`a`x` K`i`"b`|

(3) D'P ZvcaviY ¶gZv wëkó GKuU kvZj e`zB Zvc MñK wñtme KvR Kti | Zvc MñK u bæ Zvcgñvq (T₂ K) ivLv nq|

$$A_{\text{P}} T_1 \gg T_2$$

(4) D m'úY©Zvc Aš+K Ki GKuU Avmb| Zvc Drm I ZvcMñK D'P ZvcaviY ¶gZv wëkó; ZvB Zvtci Av`vb cövtbi dtj Gf`i Zvcgñvi cwi eZB nq bv|

16.2.3 t Kvfb Pµ

Kvfb BwÄtb KvfbefñK e`zDr m t`tk Zvc MñY Kti `ñ cñviY (GKuU mtgvò I Ab`uU ifxZvcxq) Ges `ñ msbgb (GKuU mtgvò I Ab`uU ifxZvcxq) Gi gva`tg Zvtci wKQyAsk Kvfb ifcvišwi Z Kti I Aewkó Zvc MñtK eR© Kti cö`wgK Ae`vq wdñi Avtm| G KvfbPµtK Kvfb Pµ etj |

wb`RK wPñ A wë`yKvfbefñK e`z cö`wgK Ae`v ešvq| GLv AB tiLv T₁ Zvcgñvq mtgvò cñviY wb`R Kti Ges G cñviYi Rb` m'úw Z KvR, w₁ = AA₁B₁B t¶ñdj | BC ifxZvcxq cñviY wb`R Kti Ges G chñq Kvfbri cwi gvY, w₂ = BB₁C₁C t¶ñdj | CD tiLv T₂ Zvcgñvq mtgvò msbgb ešvq| C t`tk D tZ thñZ Kvfbri cwi gvY

$$w_3 = CC_1D_1D \text{ t¶ñdj i mgvb|}$$

DA ifxZvcxq msbgb Kvfbri cwi gvY w₄ =

$$DD_1A_1A \text{ t¶ñdj |}$$

AZGe, KvfbefñK e`zñvi m'úw Z tgvU KvR,

$$W = w_1 + w_2 - w_3 - w_4 = ABCD \text{ t¶ñdj |}$$

A`P KvfbPwÄtb KvfbefñK e`zGKuU cY¶m m'úv`b Kti cö`wgK Ae`vq wdñi Avtm| KvfbefñK e`zKZR.m'úw Z wbu KvR wb`R wPñ AwZ ABCDA Pµi t¶ñdj i mgvb|

GB PµtK Kvfb Pµ ejv nq|

cñZ Pµ hñ BwÄb Zvc Drm t`tk Q₁ cwi gvY Zvc MñY Kti Ges Zvc MñtK Q₂ cwi gvY Zvc eR© Kti Zvtj BwÄbi `¶Zv,

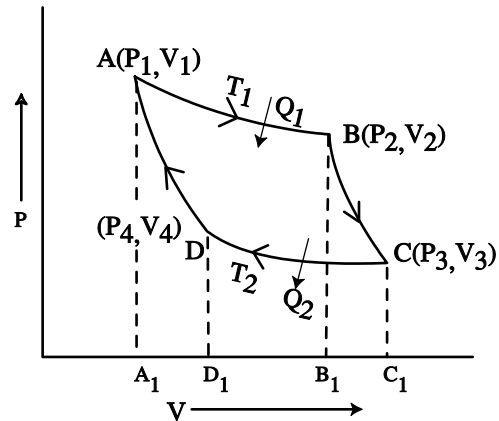
$$\eta = \frac{Q_1 - Q_2}{Q_2} = 1 - \frac{Q_2}{Q_1} ,$$

BwÄb ðvi MpxZ ev eñRZ Zvc, Q BwÄbi ms`útk`vKv Zvc Drñi Zvcgñv T Gi mgvbgñvZK|

$$A_{\text{P}} \frac{Q}{T} = a^e \text{ mSL`v,}$$

$$\therefore \frac{Q_1}{T_1} = \frac{Q_2}{T_2}$$

mZivs KvfbPwÄbi t¶ñdj t`Lvbn hvq th,



wPñ 16-5

$$\frac{Q_2}{Q_1} = \frac{T_2}{T_1}$$

$$\therefore \text{Kvfb}^\circ\text{Bw}^\circ\text{Abi} \text{ `} \eta = 1 - \frac{T_2}{T_1} = \frac{T_1 - T_2}{T_1}$$

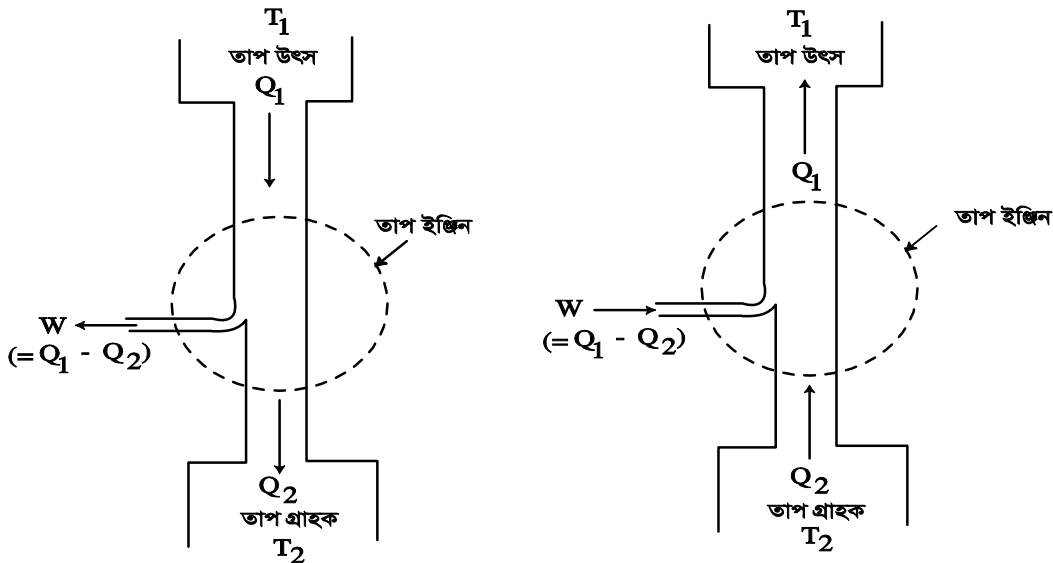
$$\text{kZKiv} \text{ inmvte}, \eta = \frac{T_1 - T_2}{T_1} \times 100\%$$

tKvb ev`e Bw`Abi `Zvi Kvfb` c`weZ Av`k Bw`Abi `Zvi tPtq tek nZ cti br| Kvfb` Pμ GKwU cZ`veZPμ|

KviY : Kvfb`Bw`Abi (1) c`uqv, ij AZ`š-axi axi msNwUZ nq| (2) AcPq gj-K dj mgr m`úYfite tiva Kiv nq|

th`nZzKvfb` Pμ cZ`vMvgx, th`nZzKvfb` Bw`Abi ecixZgix cZ`veZB Kti ingvqKi`c KvR Ki`Z cti| hLb ingvqK inmvte KvR Ki`te ZLb ub`eZvcgvi`vi Zvc M`nK t`K Zvc tkvY Kti D`PZvcgvi`vi Drtm eR`B Ki`te| GRb` Kvfb`e`nK e`z Dci ewn: `KvR Ki`Z nte|

A`r hLb ingvqK inmvte KvR Kti ZLb T₂ Zvcgvi`vi Zvc M`nK t`K Q₂ cwi gvY Zvc M`Y Kti h`jLi Dci wKQyein: `KvR m`úv`b Kiv nq Ges T₁ Zvcgvi`vq Q₁ cwi gvY Zvc Drtm eR`B Kiv nq|



uPÎ 16-6 Zvc Bw`Abi I ingvqK

16.2.5 t GbUic (Entropy) t mtgvò c`uqvq thgb Zvcgvi`v w`i `vK, ifxZvcxq c`uqvqI wKQy GKUv w`i `vK| ifxZvcxq c`uqvq e`z th Zvcxq ag`v`i `vK, Zv`K GbUic etj |

hiv` w`i Zvcgvi`v T tZ tKvb e`e`v GK Ae`v t`K Ab` Ae`vq hiv` qvi mgq aQ cwi gvY Zvc tkvY ev eR`B Kti, Zvntj GbUici cwi eZB

$$ds = \frac{dQ}{T} \text{-----} (1)$$

hiv` Zvcgvi`v w`i br `vK A`ev tKvb epr cwi eZB t`j`Î GbUici cwi eZB

$$S_B - S_A = \int_A^B \frac{dQ}{T}$$

GLv#b, $S_A = c_{\text{v}} \ln K A e^{-vq} GbUlc$

$S_B = P\text{ov}\check{S} - A e^{-vq} GbUlc$

e'e-v Zvc tkvIY Kitj GbUlc epx cvq Ges Zvc eR0 Kitj GbUlc nvm cvq|

ifxZvcxq c#uqvri t#t#T, dQ = 0

AZGe, ifxZvcxq c#uqvq GbUlcici cwi eZ0, ds = 0 A_# GbUlc s a'e_v#K|

D`niY

1| GKwU Kv#b#Bw#b#bi Zvc Dr#mi Zvcgv#v 400K Ges M#n#Ki Zvcgv#v 300K n#j Bw#b#bi `#Zv KZ?

Avgiv Rmb, Kv#b#Bw#b#bi `#Zv,

$$\eta = \frac{T_1 - T_2}{T_1}$$

GLv#b, $T_1 = 400K$

$T_2 = 300K$

$$\therefore \eta = \frac{400-300}{400} \times 100\% = \frac{100}{400} \times 100\% = \frac{1}{4} \times 100\% = 25\%$$

D#i t 25%

2| GKwU Kv#b#Bw#b#bi Zvc Dr#mi Zvcgv#v 327⁰C Ges ZvcM#n#Ki Zvcgv#v 127⁰C n#j Bw#b#bi `#Zv KZ?

Avgiv Rmb, Kv#b#Bw#b#bi `#Zv,

$$\eta = \frac{T_1 - T_2}{T_1} \times 100\%$$

GLv#b, $T_1 = 327+273 = 600K$

$T_2 = 127+273 = 400K$

$$\therefore \eta = \frac{600-400}{600} \times 100\% = \frac{200}{600} \times 100\% = \frac{1}{3} \times 100\% = \frac{1}{3} \times 100\% = 33.33\%$$

D#i t 33.33%

3| GKwU Kv#b#Bw#b#bi 500K Zvcgv#v Zvc Drm t_#K 1200J Zvc M#Y K#i Ges Zvc M#n#K 600J Zvc eR0 K#i | Zvc M#n#Ki Zvcgv#v I Bw#b#bi `#Zv #bY# Ki`b|

Avgiv Rmb, $\eta = \frac{Q_1 - Q_2}{Q_1}$

GLv#b, $Q_1 = 1200J, Q_2 = 600J, T_1 = 500k, T_2 = ?, \eta = ?$

$$\therefore \eta = \frac{1200-600}{1200} \times 100\% = \frac{600}{1200} \times 100\% = \frac{1}{2} \times 100\% = \frac{1}{2} \times 100\% = 50\%$$

Avevi, Kv̄bBwÁtbi t̄t̄, $\frac{Q_2}{Q_1} = \frac{T_2}{T_1}$

ev, $\frac{600}{1200} = \frac{T_2}{500}$

ev, $\frac{1}{2} = \frac{T_2}{500}$

ev, $T_2 = \frac{500}{2} = 250K$

DĒi t 250K, 50%

4| GKw BwÁb 2000J Zvc M̄Y K̄i | 1500J Zvc eR̄ K̄i | BwÁbU ōv̄v Kv̄Ri c̄v̄gY | BwÁtbi
`̄Zv̄ v̄Ȳ K̄i`b|

Av̄ḡv̄ R̄w̄b, $\eta = \frac{Q_1 - Q_2}{Q_1} \times 100\% \dots \dots \dots (1)$

Ges w = $Q_1 - Q_2 \dots \dots \dots (2)$

GLv̄b, $Q_1 = 2000J$

$Q_2 = 1500J$

AZGe, (1) bs mḡK̄i Y t̄t̄K̄ t̄j Lv̄ hv̄q,

$\eta = \frac{2000-1500}{2000} \times 100\% = \frac{500}{2000} \times 100\% = \frac{1}{4} \times 100\% = \frac{1}{4} \times 100\% = 25\%$

(2) bs mḡK̄i Y t̄t̄K̄ t̄j Lv̄ hv̄q,

w = 2000-1500 = 500J

DĒi t 500J; 25%

mvi m̄t̄c̄

Kv̄b c̄L̄veZ̄BwÁtbi `̄Zv̄ t̄ hv̄ Kv̄b BwÁb T_1 Zvcgv̄vi Zvc Drm t̄t̄K̄ Q_1 Zvc tkv̄l Y K̄i
 T_2 Zvcgv̄vi Zvc M̄t̄K̄ Q_2 Zvc eR̄ K̄i Ges w Kv̄R m̄v̄v̄`b K̄i, Zv̄t̄j `̄Zv̄,

$\eta = \frac{w}{Q_1} = \frac{Q_1 - Q_2}{Q_1} = \frac{T_1 - T_2}{T_1}$

ev, $\eta = \frac{Q_1 - Q_2}{Q_1} \times 100\%$

ev, $\eta = \frac{T_1 - T_2}{T_1} \times 100\%$

ZvcM̄Zve`vi v̄Zv̄q m̄t̄

- 2/ GKıU Kıtb®BıÄtbi `¶Zı 50% | hı Zıv MñtKi Zıvııv 227⁰ C nq, Zıv Drımi Zıvııv KZ nte?
- 3/ GKıU Kıtb®BıÄtbi Zıv Drm I Zıv MñtKi Zıvııv h_vııg 127⁰ C I 227⁰ C | BıÄb Zıv Drm t_tK 4000J Zıv tkvIY Kti | BıÄb 0ııv m=úıı Z KıtRi cıııııY KZ nte?
- 4/ GKıU Kıtb®BıÄtbi Zıv Drm I Zıv-MñtKi Zıvııv h_vııg 227⁰ C I 102⁰ C | hı BıÄb cöz Pıı 252 × 10⁴ J Zıv MñY Kti Zııııı
 (K) BıÄtbi `¶Zı, (L) cöz Pıı KıtRi cıııııY I (M) ııRZ Zııııı cıııııY ıııııı Ki "b|