

# MvZmF

ce@ZPBDubU ,uj tZ Avgiv tf±i I MvZ wbtq Avtj vPbv KtiwQ| MvZwe`vi `w kvlv| cŁtgv<sup>3</sup> kvlv nřj v wZwe`v (Kinematics) Ges wZxq kvlvU nj Pj we`v (Kinetics)| wZxq BDubtU gj-Z Avgiv mVZwe`v wbtq Avtj vPbv KtiwQ| G BDubtU Pj we`v wbtq Avj vPbv Kiv nře thLvřb \_vKte e`z Dci cŁř etj i cřvřte MvZi cwieZB Ges cŁř etj i mř½ MvZi mřúK©|

Pj we`v Avtj vPbv i i`řtZ MvZ RoZv Ges fiřeM mřúřK©avi Yv \_vKv cŁqvRb| GQovon ej I MvZ mřúřKZ mřveřx, etj i mř½ fiřeřMi mřúřK© etj i NvZ, NvZ ej , NI ř BZ`wř wbtq GB BDubtUi Avtj vPbv mřgveřx \_vKte| G Aa`řřtq ZĚřq Avtj vPbv mř½ Avgvř`i ``břw`b Rxeřb ej we`vi bmvZ I mřveř ,uj cŁqvřMi D`vni Y I MvYwZK mřgmřveřxi mřgvařb \_vKte| BDubUwřřK řh 5wU cřřřV řvM Kiv nřřřQ Zv nj

# cW 1 RoZv I ej

## Dfík

### G cvfi tktl Avicb

- 1 RoZv, fi I ej mK Zv D`iniY mn e`vL`v Ki tZ cvi teb|
- 1 tgšij K ej ,uj Dfík Ki tZ cvi teb|
- 1 tKvb tgšij K ej tKv\_vq ,i`ZcYmB avi Yv w` tZ cvi teb|
- 1 tgšij K ej cħt½ mij vg-I qvBbeM`ZĒ; Dfík Ki tZ cvi teb|

### 4.1.1 RoZv I ej

tUwetj i Dci GKwU tccvi I tqU ivLv AvtQ| GUV w`i Ae`vq AvtQ GUVtK bv mivtj GUV GKB `vfb w`i \_vKte - eQti ci eQi ati| Avevi GKwU dħej tK cv w` tq j wL gvi tj Zv Pj tZB \_vKte Ges Muzct\_ evav bv tctj \_vgtebv| cĀZ`K e`B th Ae`vq AvtQ tmB Ae`vfbZB \_vKtZ Pvg| A\_ŕ w`i e`zw`i \_vKtZ Pvg Avi Muzkxj e`zmgMuztZ Muzkxj \_vKtZ Pvg| e`ž GB Ae`v eRvq ivLvi cĀYZvtK ejv nq RoZv| e`ž w`i w`wZ \_vKvi cĀbZv nj w`wZ RoZv Avi Muzkxj e`ž Muzkxj \_vKvi cĀYZv nj Muz RoZv|

e`ž fi (mass) nt`Q Zvi RoZvi cwi gvc| Ab` K\_vq tKvb GKwU e`ž Zvi teM ev RoZvi cwi eZĒb evav t`l qvi cwi gvYB nt`Q fi| GKwU Pj gvb Lvij Mmo \_vgvfbvi tPtq GKwU gvj vgvj fWZ`Mvox \_vgvfbv KóKi bq mK? Lvij Mvovi tPtq gvj vgvj fWZ`Mvovi wgvj Z fi tekx etj B GwU NtU| fi GKwU t`j vi ivnk| Gi gvT v nj [M]; GKK mKtj vM0g mst`ŕtc kg.

%b w`b AwfÁZv t`tK Avgiv t`wL wqZ e`ž RoZvi cwi eZĒ NUtQ ev NUtbi cĀvm Pj tQ| Muzkxj e`žK w`wZkxj Kiv nt`Q Avevi w`i e`žK Muzkxj Kiv nt`Q| GKwU w`i e`žK tUtb, tVj v w` tq ev ar`v w` tq Muzkxj Kiv nt`Q Avevi KLtbr GKUv Muzkxj e`žK Dtĕv w` tK tVtj ev ar`v w` tq \_wgtq t`l qv nt`Q| GB th tKvb e`žK tVj v, ar`v t`qv A\_ev Uvbr hvi Kvi tY e`ž RoZv cwi eWZĒ nq Zvi bvg nj ej | A\_ŕ th emn`K Kvi Y e`ž w`i ev Muzkxj Ae`vi cwi eZĒ NUvq ev NUvZ Pvg ZvtK ej etj | th ej e`žK Muzkxj Kti ev Muz emotq t`q ZvtK Zj Y mĀKvix ej (accelerating force) etj | th ej Muzkxj e`žK \_wgtq t`q ev teM Kvgtq t`q ZvtK g`b mĀKvix ej (retarding force) etj | cĀZ`K etj i cĀqM w`yAvtQ| cĀqM w`y`jZ KLbl KLbl `úk`Kti ej cĀqM Kiv nq thgb GKUz AvtM tKvb e`žK tVj v ev ar`v t`qvi K\_v ejv ntquQj | tKvb e`žK tVj tZ ev ar`v w` tZ ntj ZvtK `úk`Kti tZ nq| Avevi MvQ t`tK hLb dj gwtZ cto ZLb mKšzdtj i Dci etj i `úk`vfbv, ej cW`exi tK` t`tK e`žK AvKI` Kti | GB t`ŕt` ej wL e`žK `úk`Kti bv| cĀg cKvi ej tK ejv nq `úk`ej | wZxq cKvi ej AvKI` ej | e`ž IRb (Weight) G ai tbi GKwU AvKI` ej | PŕK tj vvi UKivtK AvKI` Kti, GwU tPŠ`K ej | mvari Y AwfÁZvi Avtj tK Avgiv etj i Pvi wL `enkó` j`ŕ` Kwi, Zv nj:

(1) ej GKwU w` Kivnk ev t`f±i ivnk| Kvi Y Uvbr, tVj v ev ar`vi gva`tg ej cħŕ nq Ges G\_ tji cĀZ`KwU t`ŕt` GKwU w` K w`w` Ő AvtQ|

- (2) ej tRvovq tRvovq wuqv Kti | `w e`zci`uti i Dci wuqv Kti ev ej c0qvM Kti | GKwU e`zi`ay ej c0qvM Ki te Ab`wU wKQb Ki tebr Zv KLtbr NtU br | t`qvij GKwU grtef Qto w`b | grtef I t`qvij ci`uti i Dci ej c0qvM Ki te |
- (3) ej e`z teMi cwieZb NUvq | A\_w ej c0qvM e`z ZjY A\_ev g`b nq | GKwU MwZkij e`zK tcQb t`tK av`v w`b (ej c0qvM Ki`b), Gi teM ew` crte A\_w ZjY nte | MwZkij MvotK tcQb t`tK tUt b ai`b Gi teM nwm crte ev g`b nte |
- (4) ej e`zK wKZ.Ki tZ cwti | GKwU iveriti UKivi `B c0s`ati Uvbtj Zvi `N`efeto hvq A\_ev tgvPovtj Zvi AvKwZi cwieZb NtU | G\_wj B e`z wKwZ | j`q` Ki`b e`z fi e`z wR`^\_Y wKšzej `w e`z gta` cvi`uwi K wj\_w`lvi (interaction) dj |

### 4.1.2 tgšij K ej

c0Z`wK Rxe`b Avgiv me mgq `yitYi ej Ab`ye Kwi | Gt`i GKwU cw`exi AvKI`ej Ges AciwU nvlv Pjvi mgq cwtqi Zjvi mt`fugi NI`ej | GQvov `e`wZK tgvUtii gta` tPš`K ej, `w AvwZ e`z gta` Zvor ej, evZv`mi c0vn, cwbi c0vn RibZ ej Avgiv Dcjwä Ki tZ cwi | wKšzAvwZ `q`z` cigvYy Af`š`i I th ej wuqv Kti Zv Avgt`i w`bKU AvPš`bxq | thgb w`bDwKqv`mi gta` tc0Ub Ges w`bDw`b mgr`K GKt`i ati ti tL`tQ th ej A\_ev Btj KUb\_wj tK cigvby tKt``i Pwi w`tK w`b`w`w`b w`bq`g MwZkij ev NY`kij iv`L th ej | wAvbxiv w`etK, w`ivRgib mKj ej tK PviwU fv`tM fvM Kti tQb G\_wj v`nt`Q :

1. gnvKI`ej (gravitational force),
2. Zvor tPš`K ej (Electromagnetic force),
3. mej w`bDKwq ej (Strong Nuclear force),
4. `w`w` w`bDKwq ej (Weak Nuclear force) |

G\_wj tK e`tj tgšij K ej |

### 1. gnvKI`ej (gravitational force)

gnv`etKj c0Z`K e`zGtK Aci`K AvKI`ej Kti | c0Z tRvov e`z ev e`zYvi gta` GB AvKI`ej Zv`i f`ii `Yd`ij mgvbwZK Ges Zv`i ga`eZ`p` i`Zji e`tM`p` e`v`w`bwZK | GB ej tK ej v`nq gnvKI`ej | e`z f`ii Kvi`Y GB ej Ges Gi dj k`wZ nj I Rb | MwYwZK fiv`te e`zYv`tqi fi m<sub>1</sub>, m<sub>2</sub> Ges Zv`i tK`w`msth`MKvix`i`Z`id ntj Gt`i gta` AvKI`ej A\_w

$$gnvKI`ej F = G \cdot \frac{m_1 m_2}{d^2} \text{----- (4.1)}$$

thLw`b G gnvKI`eq a`e hvi gvb 6.670 × 10<sup>-11</sup> N·m<sup>2</sup> kg<sup>-2</sup>

GB ej Avgt`i `b w`b Rxe`b Ges e`enw`iK t`q`t` AZ`š`\_i`Z`c`Y` Gi c`fiv`teB Mh DcMh mgr`w`b`w`b Ae`v`t`b`v`K`Z` cwti Ges Gi c`fiv`teB Avgiv nvlv Pjv Ki tZ cwi |

## 2. Ziwr tPŠK ej (Electromagnetic Force)

Wj PwRZ KYv ev tPŠK avgK ci úi AvtcwJK MwZ ev w-wZtZ vKtj Zvt`i gta`Kvi AvKIŠ ev weKIŠ ej B nt`Q ZiwoZ tPŠK ej | ZiwoZ I tPŠK ej Nubofite m=úKš | cKZ.c†¶ hLb wq\_w`lqvKvix KYv,tjv MwZkxj v†K ZLbKvi GKw AwZwi<sup>3</sup> ZiwoZ ej nt`Q tPŠK ej | c`vt\_Š AvYweK Mvb, ivmivubK wewμqv Qvovl wewfbaeZiwr tPŠK NUbvi Rb` GB ej `vqx| Avgv†`i `j-RMtZ hveZxq ej (gnvKIŠ`ZixZ) GB tkYxi AŠfš | thgb NIŠ ej, `úkŠej, e`ž weKwZ.BZ`w` |

## 3. mej wDKxq ej (Strong Nuclear Force)

Avgiv Rvwb cigvYytK`a MwZ nq wDUB I tčÜb w`tq| tK>†K wDwKqym Ges KwYKv,wj†K wDKxqb etj | avvZK PwRš KwYKv,wj ci`úitK weKIŠ K†i `†i wQU†K hvlqvB `fvweK | wKšZ cigvYy tK†`a†K`xq tgšij K KYv A\_Š wDKxqb,wj GK we†kl etji Kvi†Y ci`úitii m†½ msex ntq Av†Q| ejv hvq GB ej wDwKq†mi Dcv`vb,wj†K AvU†K titL cKZ.c†¶ নিউক্লিয়াস†K `vqxZ; w`tq†Q|

Pri cKvi tgšij K etji gta` GB ej mePvB†Z kw<sup>3</sup>kvj x| Gi পল্লা LyB Kg; GKw wDwKq†mi e`vmtaŠ mgvb hvi gvb <sup>-15</sup> m Gi gZ| `iZ;ewxi m†\_ m†\_ GB ej nwm cvq| GB ej Ziwr PwKxq ej t\_†K 10<sup>2</sup> ,Y Ges gnvKIŠej t\_†K 10<sup>42</sup> ,Y kw<sup>3</sup>kvj x|

## 4. `š wDKxq ej (Weak Nuclear force)

GB ej cigvYy Af`š†`i tgšij K KwYKv,wj i gta` wμqv K†i | Gw Ziwr tPŠK etji ††q† Kg Zxe¶ GB ej wDKxq (nuclear reaction) wewμqv Rb` `vqx Ges A†bK wDwKq†m Aw`wZkxj Zvi D`we NUvq I †ZR`lqvZvi mwó K†i |

Pri cKvi etji পল্লা, AvtcwJK mej Zv Ges D`vniY

ej	পল্লা	AvtcwJK mej Zv (gnvKIŠej i m†c†¶)	wq_w`lqvZvi D`vniY
gnvKIŠ	Amxg	1	gnvk†b` b¶¶†, Mh, DcMh mg†ni gta` m†g`ve`v i¶v K†i
Ziwr tPŠK	Amxg	10 <sup>40</sup>	B†j ±b†K wDwKq†mi m†½ Ave× iv†L
mej নিউক্লিয়	10 <sup>-15</sup> m	10 <sup>42</sup>	wDwKq Dcv`vb,wj†K (tčÜb I wDUB†K) GKw†Z titL wDwKqym `Zix K†i
`š wDKxq	10 <sup>-6</sup> m	10 <sup>30</sup>	†ZR`lqvZvi: wDKxq fv½b, β-decay msMvb K†i

### 4.1.3 GKxfZ tŋŋ ZĚj

gnwetakj wewfbæ`z gta` AvKIŋ ej m`útk`ew`Qbreavi Yv mgrak K weÁvbx wDUB mB`k kZvãxZ  
 cū\_xi AvKIŋ etj i m½ GKxfZ Kti gnvKI`ej i mF cŏvb Ktib| wZwb cŏvY Ktib th gnwetakj  
 wewfbæ`z gta` AvKIŋ ej I cū\_xi AvKIŋ ej GKB cKwzi | Aóv`k kZvãxZ weÁvbx Rb gvBtKj  
 (1750 L;) Ges Pvj ŋ Kz`^(1785L;) h\_vu\_tg P`K I Zwor P`Rŋ AvKIŋ-weKIŋ etj i mF t`b|  
 AvI GK kZvãx cti (1870L;) tRgm KwK`g`v. I t`qj ZwoZ I tP`K cū\_qv`K GKxfZ Kti ZwoZ-  
 tP`K ZĚj (etj i) D`w`eb Ktib| Gi dtj wesk kZvãxi `i i` t`\_tKB weÁvbx`i gta` cZ`q Rtb` th,  
 ZwoZ Ges tP`K ej thgb GKB mF M`\_Z ntq`Q tZgwb gnvKI`ej tKI Gi m½ GKxfZ Kti GKw  
 gvI mF i gva`tg me cKvi ej tK cKvk Kiv hvte| cŏvY Kiv hvte th, me ej gj-Z GKB| GB  
 cŏweZ ZĚj bvg t` I qv nq GKxfZ tŋŋ ZĚj|

D`w`eb GKxfZ tŋŋ ZĚj cŏweKv`j wetakj` B aitbi etj i mUvb cvl qv wM`q`Qj | Zv nj gnvKI`ej  
 I ZwoZ-tP`K ej | mej I `ŋ` wDKxq etj i Awew`vi nI qvq weÁvbx`i GB a`vb avi Yvi cwieZ`  
 NtU Pvi cKv`i i ej th AwfbæcKwzi Zv cŏv`Yi tP`v Pj tZ `tK| G e`vcv`i weÁvbx`i gta` AM`x  
 Ges D`w`eb`th`M` fvgKv ti tL`Qb weÁvbx m`j vg, I t`qbeM`Ges গ্লাসহাও। weMZ kZvãxi IvU Gi `k`K  
 Zviv Zwor tP`K ej I `ŋ` wDKxq etj i GKxfebKZ. Zwor-`ŋ`-ZĚj cŏwe t`b| 1983 m`j  
 cix`v`j`K fvte GB ZĚj`KZ.nq| GB ZĚj m`j vg I t`qbeM`ZĚj bvtg cwi`PZ| Zwor tP`K ej Ges  
 `ŋ` wDKxq ej th AwfbæZv cŏvY Kti GB ZĚj cŏw`Z ntq`Q| wK`z`Pvi cKvi ej GKxfZ Kti  
 cŏP`v t`\_tK weÁvbx`i v`ei Z nb bvB| GB GKxfeb m`e ntj B cŏw`Z nte GKxfZ tŋŋ ZĚj|

### mvi mst`c

RoZv t c`v\_9th Ae`vq AvtQ wPi Kvj tmB Ae`vq \_vKvi cŏYZv ev ag`K RoZv etj |  
 ej t th ewn`K Kvi Y e`z RoZvi cwieZ` NUVq Zv`K ej etj | gnwetakj weivRgvb hveZxq ej tK Pvi  
 fvM fvM Kiv ntq`Q Zv nj : (1) gnvKI`ej , (2) ZwoZ tP`K ej , (3) mej wDKxq ej Ges (4)  
 `ŋ` wDKxq ej | G`w`j tK tg`w`j K ej etj |

### cvtVvEi gj`vqb

mWk DĚti i cvtk wK wPy (√) w`b|

- 1| th ewn`K Kvi Y w`i e`z K MuzKxj Kti Zv`K wK etj ?  
 (K) ej (L) RoZv  
 (M) fi (N) g`b
- 2| tKvbw etj i Rb` cŏhvR`?  
 (K) ej GKw t`\_jvi ivnk (L) e`z fiB ej  
 (M) e`z I Rb GK cKvi ej (N) RoZv GK cKvi ej |
- 3| tKvbw mef`c`v`v mej ej ?  
 (K) gnvKI`ej (L) mej wDKxq ej  
 (M) Zwor tP`K ej (N) `ŋ` wDKxq ej |

## cW -2

### MuzmĤej x

#### Dĭik

##### G cvĤVi tĭtĭ Avciĥ

- 1 ũbDUĭbi MuzmĤ, ũj eYĖv KiĭZ cviĥeb,
- 1 fiĥetMi msĀv I fiĥetMi tĭ±i iĭci eĵLĵv ĩZ cviĥeb,
- 1 ũbDUĭbi ũZxq mĤ tĭK F = ma mgxKi YĵU cĭZcĵ b KiĭZ cviĥeb,
- 1 etj i GKK I gvĭv mgxKiY ej ĭZ cviĥeb|

#### 4.2.1 ũbDUĭbi MuzmĤ

mĵi AvBRĵK ũbDUĭ Zvi Agi MĖs bĵvPvi ũj m ũĭtj vĭmĵdqv gĵvĭgĵUKĵZ (1687 mĵj cĭvĭkZ) eĵi fi, Muz I etj i gĭa mĵUkĵcb Kĭi ũZbĵU mĤ cĭKk Kĭib| GB mĤ ũZbĵU ũbDUĭbi Muz mĤ bĵtg cĵi ũPZ| mĤ, ũj nj t

**cĭg mĤ t** evĭti tĭK chĵ ej eĵĭ Aeĵvi cĵieZĖ KiĭZ evĵ bĵ Kiĭj ŵi eĵzĵPiKĵj ŵiB ũvKĭe Ges MuzKĵj eĵzĵyĵ MuzĭZ mij cĭ Pj ĭZB ũKĭe|

**ũZxq mĤ t** eĵĭ fiĥetMi cĵieZĖbi nvi Zvi Dci chĵ etj i mgvbgĵmZK Ges ej th ŵiĭK ũĵqv Kĭi eĵĭ fiĥetMi cĵieZĖI tĵmĵ ĭKB nq|

**ZZxq mĤ t** cĭZĭK ũĵqvĵB GKĵU mgvb I ŵeciĭZ cĭZĵĵqv AvĭQ|

#### 4.2.2 ũbDUĭbi cĭg mĤ

G mĤ gj-Z eĵĭ RoZĵ-agĵeeZ Kĭi Ges etj i msĀv cĭvb Kĭi| cĭg cvĭVB Avgĵv Avĭj vPbv Kĭiŵ, ŵi eĵzmeĵvB ŵi ũvKĭZ Pĵq Ges MuzKĵj eĵzmeĵvB MuzKĵj ũvKĭZ Pĵq| eĵĭ GB cĭYZĵĭK ej v nq RoZĵ| GRbĵ GB mĤĭK RoZĵi mĤI ej v nq|

mĤĵĭK Gĵĵel eĵLĵv Kiv hvq, hĵ tKvb eĵĭ Dci ej cĭqvM Kiv bĵ nq Zv nĭj Zvi Muzi cĵieZĖ ev ŵiZi cĵieZĖ nĭe bĵ Aĵ ej cĭqvM bĵ Kiĭj eĵĭ ZĵiY kbĵ nq| G tĭK Avgĵv Gĵĵe etj i msĀv ĩZ cĵi,

ŵĭth evĵĭK KivY eĵĭ ZĵiY mĵĵ Kĭi ZĵĭK ej ej v nqŵ|

AĭbK mgq gĭb nq ũbDUĭbi mĤ Avgĵĵi mĵaviY AĵfĀZvi mĵĵ AmsMuzcĵĵĵ Avmĵ DĵvniY tĵqv hvK| GKĵU Mmĵ ŵi Aeĵvq AvĭQ, Gi Dci ej cĭqvM bĵ Kiĭj GĵU ŵi ũvKĭe| ŵKĶzhLb Mvĵmĵ MuzKĵj ũvĭK ZLb ej cĭqvM bĵ Kiĭj I ŵK Mmĵmĵ MuzKĵj ũvKĭe? GLĵĭbB AmsMuz, evĵ AeĵfĀZĵq Avgĵv tĵL ŵKQĵĵĵi gĭa Mvĵmĵ tĵtg hvq| Avmĵj ŵK ZĵB? Pj Ŷ-Mmĵmĵ ej cĭqvĭMi cĵĵĭe MuzKĵj ũvĭK| GgbĵK Muz Acĵi evZĶ ivLĭZ nĭj I ej cĭqvM KiĭZ nq| eis ej cĭqvM eĵ Kiĭj B ŵKQĵĵĵi gĭa Mvĵmĵ tĵtg hvq| GLĵĭb cĭKZcĵĵ ŵK NĭU? Mmĵmĵi Dci BĵĀĭbi ej cĭqvM eĵ nĭj I Abĵ fĵĭe ej cĭqvM AeĵvZ ũvĭK| Zv nj, AĵfKĭR etj i KivĭY cĵlexi tKĵ ĵĵx Urb, ivĵi NIĵĵi dĭj NIĵ RĵbZ evĵv ev avĵv Ges evZĵĵmi evĵv| Mmĵmĵ MuzKĵj ev mgĵmĵZĶ ivLvi Rbĵ chĵ ej ŵ cĭKZcĵĵ GB AĵfKĭR ej I NIĵ ej ĭK cĭZnZ Kivi Rbĵ KivR Kĭi| mĵzĵv evĵe Rĵĭĭb ĵĵ AvciZ AĵfĀZĵq ũbDUĭbi mĤ AmsMuz AvĭQ gĭb nĭj I cĭKZ.cĵĵĭe Zv mĵVK bq|

### 4.2.3 fiŧeM

aiv hvK MvZkxj `ŋ e`zav°v tLj | av°vi ci e`z`ŋ tKvb w`ŧK hvŧe? Guv wK fiŧe wbaŋi Z nŧe? gj-Z tKvb Dcv`vbwU e`z`ŋ i av°v cieZ°MvZ wbaŋi Y Kiŧe? fi, bv teM? G cŋkŋ DEŧii Rb` fiŧeŧMi avi Yv „i”ZcYŋ Avgvŧ`i AwfÁZv t`ŧK t`uL GKB teŧM PjŧQ GiKg GKwU dŧej Avi GKwU Mvnoi gŧa` dŧej wU evav w`ŧq \_vŋŧq t`qv mnR wKšZMvnoU nvZ ev cv w`ŧq evav w`ŧq \_vŋŧbv m`e bq| Avmŧj tKvb e`z\_vŋŧZ Avgiv th cŋZeÜKZvi m`eŋb nB Zv nj H e`z`ŋ fi Ges teŧMi m`eŋj Z cŧve| Gi bvg t`qv nŧŧQ fi-teM| fiŧeM (Momentum) nŧ`Q e`z`ŋ fi l teŧMi mŧ\_ m`uŋKZ GKwU ag`ev `enkó`| e`z`ŋ fi hZ tekx nŧe GB `enkó` ZZ tRvij nŧe| Avevi fi a`e tiŧL teM hZ evovŧbv nŧe GB `enkó` ZZB tRvij nŧe| thgb GKwU eŧj U KŧeŧM (nvZw`ŧq) Qŋŧj Lŋ tekx ŋwZ bvB wKšZ`ŋ w`ŧq cŧŪ teŧM Qŋŧj Zvi cŧve AZ`š-gvivZK|

$$tKvb e`z`ŋ fiŧeM = e`z`ŋ fi \times e`z`ŋ teM$$

$$tKvb e`z`ŋ fi m l Gi teM v nŧj Zvi fiŧeM P nŧe$$

$$P = mv \text{ ----- (4.4)}$$

fiŧeM GKwU tŧ±i iwk| KviY teM GKwU tŧ±i iwk Ges GŧK t`jvi m w`ŧq „Y Kiŧj fiŧeM cvl qv hvq| fiŧeŧMi gvb

$$P = mv \text{ ----- (4.5)}$$

gvŧv t fiŧeŧMi gvŧv nj, fŧii gvŧv \times teŧMi gvŧv

$$A_{ŋ} [P] = MLT^{-1}$$

GKK t fi teŧMi GKK nj, fŧii GKK \times teŧMi GKK

$$A_{ŋ} \text{ kg ms}^{-1}$$

### 4.2.4 wDUŧbi wZxq mŧ

GKwU fvix Ges AciwU nij Kv `ŋ w`i e`z`ŋ mgvb teM mŋó KiŧZ fvix e`z`ŧZ Awak ej cŋqM KiŧZ nq| Avevi GKB fŧii `ŋ w`i e`z`ŋ gŧa` GKwUŧK tekx `Z MvZkxj KiŧZ ev ZjiY tekx mŋó KiŧZ nŧj tekx ej cŋqM KiŧZ nq| A\_{ŋ} teM a`e \_vKŧj ej fŧii mgvŋvZK nŧe Avi fi a`e \_vKŧj ej teŧMi cwiezŧbi nŧii mgvŋvZK nŧe| GwUB wDUŧbi wZxq MvZmŧi cŋZcv` w`elq| aiv hvK tKvb e`z`ŋ fi m, fiŧeM P Ges t mgŧq cŧŋŋ ej F| Zvntj

$$F \propto \frac{dP}{dt}$$

$$\text{ev, } F \propto \frac{d}{dt} mv$$

$$\text{ev, } F \propto \frac{mdv}{dt} [hLb fi w`i _vŧK]$$

$$\text{ev, } F \propto ma [GLvŧb a nj ZjiY]$$

$$\text{ev, } F \propto kma \text{ ----- (4.6)}$$

GLvŧb k GKwU mgvŋvZK a`eK| Gi gvb iwk „ij i GKK ōviv wbaŋi Y Kiv nq|

Gm. AvB c×wZŧZ eŧj i GKK wDUŧbi msÁv Ggbfvŧe t`qv nq thb k = 1 nq| hLb m = 1 kg

$$a = 1 \text{ ms}^{-2}$$

ZLb F = 1ubDUB ai tj (4.6) mgxKi tY k=1 nq |  
th cwigrY ej 1 kg f tii e - z Dci uquv Kti 1 ms<sup>-2</sup> Zji Y mup Kti ZvtK 1N ej etj |  
mZivs 1N = 1 kg ms<sup>-2</sup>

AZGe mgxKi Y 4.6 Gi cwienZz ifc nte

F = ma ----- (4.7)

4.7 mgxKi tY m a e, ZvB ubDUtbi m f tK Gfite msAvqZ Kiv hvq OtKvb e - z Zji Y e - z Dci ch y  
etj i mgvbxwZK | 0

GKwaK ej e - z Dci ch y ntj ,

Σ F = ma ----- (4.8)

Σ uPy Øviv GLvtb GKwaK etj i thvMdj ev j ux eSvtbv ntqtQ |

hLb Σ F = 0 ZLb a = 0; ubDUtbi GB m f t tK ZvB Gfite etj i msAv t`qv hvq |

ej t hv tKvb e - z Zji Y mup Kti ZvB ej | tKvb e - z Dci ch y etj i w KB nte Zji tYi w K |  
etj i GKK t ubDUB GtK mst q t c N Øviv cKvk Kiv nq |  
etj i gvTv t etj i gvTv nte fi I Zji tYi gvTvi , Ydj |

A\_# [ F ] = [ MLT<sup>-2</sup> ]

### NvZej

KLbl KLbl Ggb nq th L y mgv b mg tqi Rb tekx ej cØqvM Kiv nq | thgb u tKU tLj vi mgq  
GKwU e vU etj i Dci Aí mg tqi Rb cØU ej cØqvM Kti | aiv hvK e vU KZR.ch y ej F u tKU  
ej u i fi t e M i cw i e Z Ø Nuvq | hLb ej u e vU i ms u t k u t K ZLb e vU KZR.etj i Dci ch y ej ,  
u tKU ej u i Dci ch y Ab v b ej t tK A t b K tekx |

L y m m g Z mg tqi Rb cØU ej ch y ntj ZvtK NvZ ej etj | A t b K mgq GB NvZ etj i gv b GZ eo  
nq th Gi uquvKvj L y Kg ntj I Gi uquv `wØMØn` nq A\_# Gi c fve m y u o fite j q l Kiv hvq | th  
Aí mgq e v c x NvZej ch y nq t m B mgq Ab v b etj i c fve D t c q l v Kiv nq | Kvi Y Ab v b ej t Kvb  
Zvrch e y c fve c Ø k Ø Kti b v | G m K j t q t A v giv t Kej NvZ ej B w e t e P b v Kwi |

aiv hvK tKvb e - z Dci F ej t mg t q uquv Kij Ges Gi fi t e M H mg t q P; Zv ntj Avgiv ubDUtbi

uØZxq MvZm y t tK w j L t Z cw i F = dP / dt

ev, dP = F dt

GB mgxKi tYi mgvKj b Kti cvB

ΔP = p<sub>f</sub> - p<sub>i</sub> = ∫<sub>t<sub>i</sub></sub><sup>t<sub>f</sub></sup> F dt [GLvtb, i = Initial, f = final mgq eSvtZ e eüZ ntqtQ |]

GB mgxKi tYi Wvb cv tki i v k B nj NvZ etj i NvZi cwigrY;



$$G\text{t}K J \text{ w } \text{t}q \text{ c}K\text{v}k \text{ Kiv} \text{ n}q \text{ A}_{\text{P}} J = \int_{t_i}^{t_f} \vec{F} dt = \Delta \mathbf{P} \text{ ----- (4.9)}$$

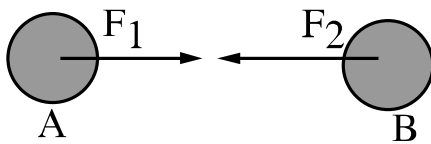
$$\text{ev, mst} \text{ } \text{t}c \text{ ej} \text{ v} \text{ h}vq \text{ } \mathbf{J} = m\mathbf{v}_f - m\mathbf{v}_i \text{ ----- (4.10)}$$

NvZetj i gvT v Ges fi tetMi gvT v GKB A<sub>P</sub> MLT<sup>-1</sup> | Gi GKK w bDUB-tm tK U (NS) |

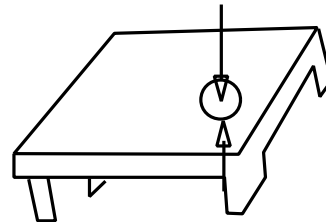
### 4.2.5 t w bDU tbi ZZxq mF

w bDU tbi MwZi ZZxq mF n t"Q, 00c0Z"K w w qv iB GKwU mgvb I w ecixZ c0Zw w qv Av tQ" | w bDU tbi c0g I w bZxq mF GKwU gvT e z m u u K Z | Aci c t q | ZZxq mF w w e z m i t m u u K Z | w w qv Ges c0Zw w qv ej t Z GLv t b w w e t j i K v ej v n t q t Q | aiv hvK A Ges B w w e z (w P T 4.1) A e w B Gi Dci F<sub>1</sub> ej c0q v M K t i | B e w A Gi Dci F<sub>2</sub> ej c0q v M K t i | w bDU tbi ZZxq mF v b y w t i

$$\mathbf{F}_1 = -\mathbf{F}_2 \text{ ----- (4.11)}$$



w P T : 4.1



w P T : 4.2

ej 0 t q i g v b mgvb w K S z w ecix Z g l x | G w w e t j i g t a " th t K v b GKwU t K w w qv Ges Ab w U t K c0Zw w qv ej v n q | w w qv Ges c0Zw w qv me mgq B w w w f b a e z Dci c h y n q | w w qv I c0Zw w qv mgvb Ges w ecix Z g l x Z v B G t i th w M d j k b n t e |

w w qv I c0Zw w qv mgvb n t j I G w w e j GKwU e z Dci w w qv K t i b v | w w w f b a e z Dci w w qv K t i , d t j e z q w ecix Z MwZ j v f K t i | th g b - Av t i v n x t b S K v t t K j v d w t q Z x t i b v g t j t b S K v i Dci th ej c h y n q Z v t Z t b S K v t c Q t b h v q | t b S K v Av t i v n x i Dci th ej c0q v M K t i Z v t Z Av t i v n x m v g t b G w M t q h v q |

### cw mst q c

c0g mF : ev B t i i t t K c h y ej e z Ae v i c w i e Z B K i t Z e v a " b v K i t j w i e z w i B v K t e Ges MwZ k x j e z m l y g MwZ t Z m i j c t P j t Z B v K t e |

w bZxq mF : e z fi tetMi c w i e Z B i n v i Z v i Dci c h y e t j i mgvb g w w Z K Ges ej th w t K w w qv K t i e z fi tetMi c w i e Z B t m w t K B N t U |

ZZxq mF : c0Z"K w w qv i GKwU mgvb I w ecixZ c0Zw w qv Av t Q |

$$e z fi tetM \mathbf{P} = f_i (m) \times t e M (v)$$

$$Z j Y w b Y q i m g x K i Y \mathbf{F} = ma$$

**MwvZK mgm'vej x**

**D`niY -1**

50 kg f`ii GKwU e`z Dci 60 N ej c0qM Ki`j ZiY KZ nte?

**mgvab :**

GLv`b fi, m = 50 kg

ej, F = 60N

ZiY, a = ?

*Avgiv Rwb, F = ma*

$$\begin{aligned}
\text{ev, } a &= \frac{F}{m} \\
&= \frac{60N}{5kg} \\
&= 12 \text{ ms}^{-2}
\end{aligned}$$

*D`Ei t 12 ms<sup>-2</sup>*

**D`niY -2**

20 kg f`ii GKwU w`i e`z Dci 60N ej 4sec mqv Ki`j tkl teM KZ?

**mgvab t GLv`b t`l qv Av`Q**

fi, m = 20 kg

ej, F = 60N

Aw`teM, u = 0 ms<sup>-1</sup>

mgq, t = 4 sec

tkl teM, v = ?

*Avgiv Rwb, ZiY a ntj*

F = ma ----- (i)

Ges v = u + at -----(ii)

*mgvKiY `m t`K a Acmvib Ki`j cvB*

$$F = m \frac{(v-u)}{t}$$

$$\therefore 60N = \frac{20 \text{ kg} (v-0)}{4 \text{ sec}}$$

$$\text{ev, } v = \frac{60N \times 4 \text{ S}}{20 \text{ kg}}$$

$$= \frac{60 \text{ kg ms}^{-2} \times 4 \text{ S}}{20 \text{ kg}}$$

$$= 12 \text{ms}^{-1}$$

*D`Ei t 12ms<sup>-1</sup>*

**D`niY -3**

MvQ t`K GKwU 1 kg f`ii bvi`Kj tmvRv wbtP cotQ| evZv`mi evav Dct`qv Ki`j KZ etj bvi`Kj wU gvwUtZ AvNvZ Ki`te?

[GLv`b  $g = 9.8 \text{ ms}^{-2}$  ]

mgvavb t` l qv Av`Q fi,  $m = 1 \text{ kg}$

ZjY,  $g = 9.8 \text{ ms}^{-2}$

ej,  $F = ?$

Avgiv Rmb,  $F = ma = 1\text{kg} \cdot 9.8 \text{ ms}^{-2}$

$= 9.8 \text{ kg ms}^{-2}$

$= 9.8 \text{ N}$

D`Ei t 9.8 N

**cv`Vv`Ei gj`vqb**

m`wK D`E`ii cv`k w`K w`p`y (v) w`b|

1| ej c`qvm bv Ki`j e`z ZjY kb` nq; GUv w`bDU`bi tKvb m`f`i w`f`baifc?

(K) MvZi c`g m`f`

(L) MvZi w`Zxq m`f`

(M) MvZi ZZxq m`f`

(N) tKvbw`b bq|

2| fi`teM ej tZ hv e`svq

(K) fi l te`Mi mgw`

(L) fvi`x e`z teM

(M) MvZkxj e`z fi

(N) fi l te`Mi ,Ydj |

3| etj i gv`v mgxKiY tKvbw`b?

(K)  $[F] = \text{MLT}^{-2}$

(L)  $[F] = [\text{MLT}^{-2}]$

(M)  $F = [\text{MLT}^{-2}]$

(N)  $F = \text{MLT}^{-2}$

4| GKwU 5Kg f`ii tMjvi teM  $50 \text{ ms}^{-1}$  Gi fi`teM KZ n`te?

(K) 250N

(L)  $10 \text{ kg ms}^{-1}$

(M) 10 N

(N)  $250 \text{ kg ms}^{-1}$

## cW 3

### fi̇tėMi msi̇ŋŋY

#### Dṫi̇k

##### G cWVi tk̇I Avċib-

- | fi̇tėM msi̇ŋŋYi mḞ eYöV̇ I ėv̇L̇v̇ ẇ ṫZ ċvi̇tėb,
- | ėv̇ṫK̇i̇ v̇j̇ Qv̇ṫj̇ ṫK̇ḃ ṫċQ̇ṫḃ av̇ö̇v̇ ṫq̇ Żvi̇ ṀẇẎẇŻK̇ ėv̇L̇v̇ ẇ ṫZ ċvi̇tėb ,
- | i̇ṫK̇U̇ ẇK̇ḟi̇tė Ṗṫj̇ Żvi̇ ṀẇẎẇŻK̇ av̇i̇Ẏv̇ ẇ ṫZ ċvi̇tėb,
- | fi̇tėṀi̇ msi̇ŋŋYi̇ mḞ ċö̇q̇u̇Ṁ K̇ṫi̇ ẇeẇḟbȧṀẇẎẇŻK̇ ṁgṁvi̇ ṁġv̇av̇ḃ Ki̇ṫŻ ċvi̇tėb|

#### 4.3.1 fi̇tėṀi̇ msi̇ŋŋẎ mḞ

ẇḃDU̇ṫbi̇ ṀẇŻi̇ ċö̇ġ ṁḞnj̇, ėż Ḋci̇ ej̇ ċḣṡẏ ḃv̇ ṅṫj̇ ẇi̇ ėżẇi̇ v̇ṫK̇ Geṡ ṀẇŻK̇ẋj̇ ėżṁġṫėṀ ṀẇŻK̇ẋj̇ v̇ṫK̇| Ȧv̇ŋ̇ ṫK̇v̇ḃ ṀẇŻK̇ẋj̇ ėż Ḋci̇ ċḣṡẏ ṫġv̇U̇ ej̇ ḣẇ k̇ḃ ṅq̇ Żv̇ṅṫj̇ ėẇ ṁij̇ ċṫ\_ ṁġ v̇ẇŻṫŻ Ṗj̇ ṫŻ v̇ṫK̇ Ȧv̇ŋ̇ Gi̇ ṫėṀ ȧė v̇ṫK̇| ṁġṫq̇i̇ ṁv̇ṫċṫŋ̇ ṫėṀ v̇ ḣẇ ȧė ṅq̇ Żv̇ ṅṫj̇ fi̇tėṀ Ṗ = ṁv̇ ṁġṫq̇i̇ ṁv̇ṫċṫŋ̇ Ȧċẇi̇eẇŻ v̇ṫK̇ K̇v̇i̇Ẏ ėż fi̇ ṁ ȧė|

Żv̇ṅṫj̇ Ȧḃḟi̇tė ej̇v̇ ḣv̇q̇| ṫK̇v̇ḃ ėż Ḋci̇ ċḣṡẏ ej̇ k̇ḃ ṅṫj̇ ėẇi̇ fi̇tėṀ Ṗ Ȧċẇi̇eẇŻ v̇ṫK̇ ev̇ ṁsi̇ẇŋŋŻ v̇ṫK̇| Ȧv̇i̇ İ ĠK̇ẇȧK̇ v̇ċk̇ ḟi̇tė ej̇v̇ ḣv̇q̇, ĠK̇ẇȧK̇ ėżṁġḃṫġ ṀẇŻ ṫK̇v̇ḃ ėėv̇i̇ (System) Ḋci̇ ḣẇ ċḣṡẏ ṫġv̇U̇ eẇṅK̇ ej̇ k̇ḃ ṅq̇ Żv̇ ṅṫj̇ ṁġṫq̇i̇ ṁv̇ṫċṫŋ̇ ėėẇi̇ ṫġv̇U̇ fi̇tėṀ Ṗ ċẇi̇eẇŻ ṅq̇ ḃv̇| Ȧv̇ŋ̇ ḣL̇ḃ ṫK̇v̇ḃ ėėv̇i̇ Ḋci̇ ċḣṡẏ ḃẇ eẇṅK̇ ej̇ k̇ḃ ṅq̇, ŻL̇ḃ ėėẇi̇ ṫġv̇U̇ fi̇tėṀ ṁsi̇ẇŋŋŻ v̇ṫK̇ Ġu̇J̇Ḃ fi̇tėṀi̇ msi̇ŋŋẎ ṁḞ|

ȧiv̇ ḣv̇K̇, ĠK̇ẇi̇ ėėv̇q̇ ṁ<sub>1</sub> | ṁ<sub>2</sub> ḟṫi̇ v̇ẇ ėż u̇<sub>1</sub> Geṡ u̇<sub>2</sub> ṫėṀ ṀẇŻK̇ẋj̇ v̇K̇v̇ Ȧėv̇q̇ Żv̇ṫi̇ ġṫȧ ṁṡṄi̇ŋ̇j̇ ḋṫj̇ Żv̇ṫi̇ ṫėṀ ċẇi̇eẇŻ ṅṫq̇ ḣv̇µ̇ṫġ v̇<sub>1</sub> Geṡ v̇<sub>2</sub> nj̇ | Ġṫŋ̇ŋ̇ ċḣṡẏ eẇṅK̇ ṫK̇v̇ḃ ej̇ ḃv̇ v̇K̇v̇q̇ fi̇tėṀi̇ msi̇ŋŋẎ ṁḞv̇ḃẏṅṫi̇ ṁṡṄi̇ŋ̇ Ȧv̇ṫṀi̇ ṫġv̇U̇ fi̇tėṀ = ṁṡṄi̇ŋ̇ ċṫi̇ ṫġv̇U̇ fi̇tėṀ|

ṁṡṄi̇ŋ̇ Ȧv̇ṫṀi̇ ṫġv̇U̇ fi̇tėṀ,  $P_i = m_1 \mathbf{u}_1 + m_2 \mathbf{u}_2$

ṁṡṄi̇ŋ̇ ċṫi̇ ṫġv̇U̇ fi̇tėṀ,  $P_f = m_1 \mathbf{v}_1 + m_2 \mathbf{v}_2$

fi̇tėṀi̇ msi̇ŋŋẎ ṁḞv̇ḃẏṅṫi̇  $P_i = P_f$  ----- (4.12)

ev̇,  $m_1 \mathbf{u}_1 + m_2 \mathbf{u}_2 = m_1 \mathbf{v}_1 + m_2 \mathbf{v}_2$  ----- (4.13)

ḣẇ ṫq̇i̇ ȦẇȧK̇ ėż ġṫȧ ṁṡṄi̇ŋ̇q̇ ẇK̇ṡżḃu̇ ċḣṡẏ eẇṅK̇ ej̇ k̇ḃ ṅq̇ Żv̇ṅṫj̇ İ ĠḂ ḃẇi̇Ż ċö̇ḣv̇Ṙ ṅtė|

Ȧv̇ŋ̇  $\sum \mu = a^e K$

ṫḣṫṅŻżfi̇tėṀ Ṗ ĠK̇ẇi̇ ṫḟ±i̇ i̇v̇ẇk̇, ṁżi̇v̇ṡ Ṗ ṁsi̇ẇŋŋŻ ṅl̇q̇v̇i̇ Ȧv̇ŋ̇ Gi̇ ġv̇ḃ İ ẇK̇ Ḋḟq̇Ḃ Ȧċẇi̇eẇŻ v̇ṫK̇v̇| ṁġṀö̇ ėėv̇i̇ fi̇tėṀ ṁsi̇ẇŋŋŻ ev̇ Ȧċẇi̇eẇŻ v̇ṫK̇ṫj̇ İ Gi̇ ȦṡṀŻ Ḋċi̇sk̇ ev̇ ŻṠi̇ ėżṫj̇v̇i̇ fi̇tėṀ ẇK̇ṡżċẇi̇eẇŻ ṅṫŻ ċṫi̇| Ȧv̇ŋ̇ ėėv̇i̇ Ȧḟṡi̇ẋẎ ej̇ ṁġṙ ėżṫj̇v̇i̇ fi̇tėṀ ŻṠi̇ḟi̇tė ċẇi̇eẇŻ Ki̇ṫŻ ċṫi̇| ẇK̇ṡżȦḟṡi̇ẋẎ ej̇ ėėẇi̇ ṫġv̇U̇ fi̇tėṀi̇ ṫK̇v̇ḃ ċẇi̇eẇŻ ṄU̇v̇ṫŻ ċṫi̇ ḃv̇|

ṫK̇v̇ḃ ĠK̇ẇi̇ ẇeẇQ̇ḃæ̇ ėėv̇i̇ Ȧẇi̇ İ ṫk̇l̇ Ȧėv̇i̇ ġṫȧ ṁȧú̇K̇ v̇ċṫḃi̇ ṫŋ̇ŋ̇ fi̇tėṀi̇ msi̇ŋŋẎ ṁḞ ẇėṫk̇l̇ ḟi̇tė ḊċṫḣṀẋ|

### 4.3.2 fiɛM msiŋŋi D`niY

#### (1) e`ŋKi cōv MvZ

e`ŋ w`tq ŋij Qŋtj th gŋtZ`ŋij mvgŋbi w`ŋK QŋU hvq w`K tmB gŋtZ`e`ŋ kavix tcŋtbi w`ŋK ar`v  
Abŋe Kŋib GwU Avmŋj fiɛM msiŋŋi D`niY `ŋvŋŋ

aiv hvK, ŋij i fiɛM = p<sub>1</sub>

e`ŋKi fiɛM = p<sub>2</sub>

ŋij Qŋevi AvŋM e`ŋ I ŋij Dfŋqi teM o mŋZivs tŋvU fiɛM = 0

ŋij Qŋevi cŋi tŋvU fiɛM nte, p<sub>1</sub> + p<sub>2</sub>

fiɛtŋMi w`bZ`Zvi m`Ā Abŋvŋi

$$p_1 + p_2 = 0$$

$$\text{ev, } p_1 = -p_2 \text{ ----- (4.13)}$$

mŋZivs e`ŋKi fiɛM Ges ŋij i fiɛM mgvb w`KŋecixZgŋx| G KvŋŋYB e`ŋKwU tcŋtbi ar`v t`q  
ev MvZcŋŋ nq| Avmŋj Avgiv e`ŋKi cōv ar`vi MvZteM w`bYŋqi tPŋv Kw |

aiv hvK, ŋij i fi = m,

ŋij i teM = v

e`ŋKi fi = M

e`ŋKi teM = v

$$(4.13) \text{ bs mgxKiY t`ŋK } p_1 = -p_2$$

$$\text{ev, } |mv| = |-MV|$$

$$\text{ev, } mv = MV$$

$$\text{ev, } v = \frac{m}{M} V \text{ ----- (4.14)}$$

#### (2) tbŋKvi cōv MvZ

fvmgvb tbŋKv t`ŋK tKvb Avŋvnx jvd w`ŋj tbŋKwU w`ecixZ w`ŋK mŋi hvq| jvd t`qvi cŋe`ŋtŋvU  
fiɛM kb` w`Qj | jvd t`qvi cŋi l tŋvU fiɛM kb` nte| A`ŋ tbŋKvi fiɛM l Avŋvnx i fiɛM  
mgvb w`KŋecixZgŋx nte| tbŋKvi fi tekx etj teM Kg nq, ZvB j`ŋi` Kiv hvq tQvU w`w`z tbŋKv  
t`ŋK Avŋvnx jvd t`q coŋj tbŋKvi cōv MvZ mŋúo nq, w`Kŋz tbŋKv eo nŋj tbŋKvi cōv MvZ AŋbK  
mgq tPŋtLB cŋo bv|

#### (3) iŋKŋUi MvZ

iŋKŋUi MvZ fiɛM msiŋŋi D`niY| RvUj Zv cwiŋvi Kivi Rb` Avgiv aŋi w`b`Q iŋKŋUwU  
AvfKŋiP Avl Zvgŋŋ gnvKŋb` MvZkŋj | iŋKŋUi cōv fŋvŋMi GKwU w`ŋKl w`Q`w`ŋtq Rŋj vbx M`vm w`bMŋ  
nq| GB w`bMŋ M`vŋmi GKwU fiɛM `vŋK| fiɛM msiŋŋiZ `vKvi KvŋŋY iŋKU w`ecixZ w`ŋK MvZcŋŋ  
nq| M`vm hLb GKwU w`b`ŋ nŋŋi w`bMŋ nŋZ `vŋK ZLb M`vŋmi MvZi w`ecixZ w`ŋK iŋKŋUwU GKwU w`i  
ej jvŋf Kŋi | GB ej ŋK etj ar`v (Thrust)|

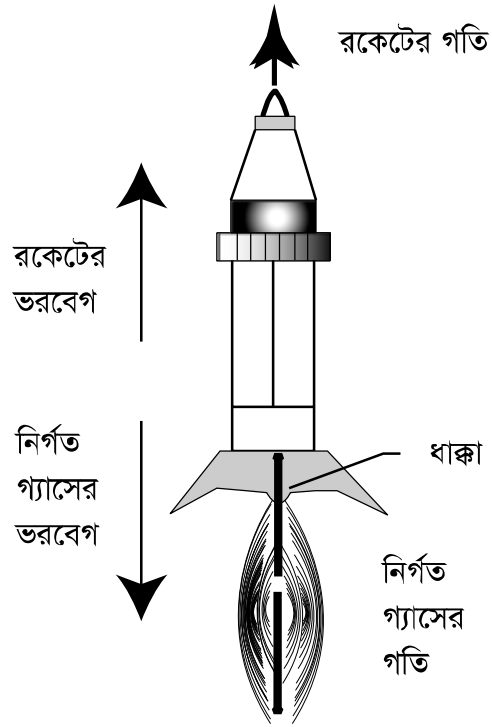
e"üZ Ryj vbx i fi Ges ubMz M'v'fmi  
teM i A'c'K i'f'c GB av'v'K c'K'v'k  
Kivi Rb' Av'g'iv GK'u'U mg'x'Ki'Y c'Z'c'v'b  
Ki'Z'c'v'i |

ubMz M'v'fmi fi Δm, teM v ai'tj  
fi'te'tMi c'v'ie'Z'P ΔP = (Δm)v

ubMz M'v'fmi fi'te'tMi GB c'v'ie'Z'P  
i't'K'u'U'i fi'te'tMi c'v'ie'Z'P'i mg'v'b |  
m'ec'ix'Z n't'e' | t'K'v'b e'z' fi'te'tMi  
c'v'ie'Z'P'i n'v'i Z'v'i D'c'i c'h'y' N'v'Z e't'j'i  
mg'v'b |

$$m'z'iv's \frac{\Delta P}{t} = F$$

$$e'v', F = \frac{(\Delta m)v}{t} \text{ ----- (4.15)}$$



পট 4.3

GL'v't'b F = i't'K'u'U'i D'c'i av'v',  $\left(\frac{\Delta m}{t}\right)$  Ryj vbx e'env'i i n'v'i Ges v i't'K'u'U'i Ryj vbx ubMz'v' teM |

### 4.3.3 M'u'v'v'Z'K mg'm'v'ej'x

#### D'v'i'Y' 1

40 kg Ges 60kg f't'i i 'v'v' e'z'c'i 'u'i m'ec'ix'Z w' t'K h'v'v'v't'g 10 ms<sup>-1</sup> Ges 12 ms<sup>-1</sup> te'M h'v'l q'v'i  
c't' GK A'c'i't'K av'v' t'q' | av'v'i c'i e'z' v'v' GK't' h'y' t' t'K KZ te'M P'j te'?

mg'v'v'b :

t' l'q'v' Av't'Q, c'v'g e'z' fi m<sub>1</sub> = 40 kg

v'v'Z'x'q e'z' fi m<sub>2</sub> = 60 kg

c'v'g e'z' Av'v' te'M u<sub>1</sub> = 10 ms<sup>-1</sup>

v'v'Z'x'q e'z' Av'v' te'M u<sub>2</sub> = -12 ms<sup>-1</sup>

mg'v'v' Z n'l q'v'i c'i Z'v't' i D'f't'q'i te'M GKB n't'e, g't'b K'v'i GB te'M v<sub>f</sub>.

[a'iv h'v'K c'v'g e'z' M'u'Z'i w' K ab'v'Z'K]

Av'g'iv R'v'b,

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v_f$$

$$\text{ev, } 40 \text{ kg} \times 10 \text{ ms}^{-1} + 60 \text{ kg} \times (-12 \text{ ms}^{-1}) = (40 \text{ Kg} + 60 \text{ Kg}) V_f$$

$$\text{ev, } (100 \text{ Kg}) V_f = (400 - 720) \text{ Kg ms}^{-1}$$

$$\text{ev, } V_f = \frac{-320}{100} \text{ ms}^{-1}$$

$$= -3.20 \text{ ms}^{-1}$$

$$\text{te}tMi \text{ gvb} = 3.20 \text{ ms}^{-1}$$

Ges Muzi w`K nte c`l`g e`z` Muzi wecixZ w`tK|

### D`niY 2

w`i cnbi Dci fvmgvb GKwU 1000 kg f`ii tbsKv t`tK 60 kg f`ii GKRB Av`ivnx Zxti j vndtq  
coj | jvtdi teM 20 ms<sup>-1</sup> ntj tbsKvi c`v` Muz KZ?

mgvavb

$$t`lqv \text{ Av}tQ, \quad \text{tbsKvi } fi, M = 1000 \text{ kg}$$

$$tjvKwU \text{ fi, } m = 60 \text{ kg}$$

$$jvtdi \text{ teM, } v = 20 \text{ ms}^{-1}$$

$$\text{tbsKvi c`v` teM, } v = ?$$

Avgiv Rwb jvtdi gytZ`bSKv I tjvKwU fi teM mgvb I wecixZ|

AZGe, MV = mv

$$(1000 \text{ kg})V = 60 \text{ kg} \times 20 \text{ ms}^{-1}$$

$$\text{ev, } V = \frac{60 \times 20}{1000} \text{ ms}^{-1}$$

$$= 1.2 \text{ ms}^{-1}$$

D`Ei t 1.2 ms<sup>-1</sup>

### D`niY 3

6 kg I 4 kg f`ii `w` tMvj K GKB mij ti Lvq wecixZ w`K t`tK Pjv Ae`vq GtK AcitK av`v w`j |  
av`vi c`teZv`i teM h`vμtg 5 ms<sup>-1</sup> (D`Ei w`tK) Ges 2 ms<sup>-1</sup> (`w`tb w`tK) w`j | av`vi ci 2q  
e`w` 2.5 ms<sup>-1</sup> teM w`c`Qtq tMj, 1g e`w`i teM KZ nte Ges tKvb w`tK hvte ?

**mgvavb**

$$ar^{\circ}vi\ c\check{t}e\ D\check{E}i\ w\ \check{t}K\ c\check{U}g\ tMj\ \check{t}Ki\ fi\ \check{t}eM = 6\ kg \times 5\ ms^{-1}$$

$$= 30\ kg\ ms^{-1}$$

$$\check{w}\check{r}\check{b}\ w\ \check{t}K\ w\check{Z}xq\ tMj\ \check{t}Ki\ fi\ \check{t}eM = (4 \times 2)\ kg\ ms^{-1}$$

$$= 8\ kg\ ms^{-1}$$

$$ar^{\circ}vi\ c\check{t}i,\ w\check{Z}xq\ e^{-\check{z}}\ fi\ \check{t}eM\ (D\check{E}i\ w\ \check{t}K) = (4 \times 2.5)\ kg\ ms^{-1}$$

$$= 10\ kg\ ms^{-1}$$

$$awi,\ c\check{U}g\ e^{-\check{z}}\ teM = v$$

$$c\check{U}g\ e^{-\check{z}}\ fi\ \check{t}eM\ (D\check{E}i\ w\ \check{t}K) = 6 \times v\ kg\ ms^{-1}$$

$$ar^{\circ}vi\ c\check{t}e\check{p}\ tgvU\ fi\ \check{t}eM = ar^{\circ}vi\ c\check{t}i\ tgvU\ fi\ \check{t}eM$$

D\check{E}i\ w\ \check{t}K\ fi\ \check{t}eM\ \check{t}K\ abvZ\ \check{t}K\ ai\ \check{t}j\ c\check{v}B

$$30\ kg\ ms^{-1} + (-8\ kg\ ms^{-1}) = 6\ kg\ v\ ms^{-1} + 10\ kg\ ms^{-1}$$

$$ev,\ 6v\ kg = (30-8-10)\ kg\ ms^{-1}$$

$$ev,\ v = \frac{12}{6}\ ms^{-1}$$

$$ev,\ v = 2\ ms^{-1}$$

th\ \check{t}n\ Z\check{z}\ abvZ\ \check{t}K\ AZGe\ Gi\ w\ \check{t}K\ D\check{E}i\ w\ \check{t}K

D\check{E}i\ t\ 2\ ms^{-1}\ D\check{E}i\ w\ \check{t}K\ |

**mvi\ \check{v}sk**

$$fi\ \check{t}eM = fi \times teM; fi\ \check{t}eM\ GK\check{u}\ t\check{f}\ \pm\ i\ i\check{v}\check{t}\check{K}\ |$$

fi\ \check{t}eM\ msi\ \check{r}\check{b}\ m\check{f} : hLb\ \check{t}K\check{v}\ e\ \check{e}\ \check{v}\ i\ Dci\ c\check{h}\ \check{y}\ b\check{x}\ U\ ewn\ \check{K}\ ej\ kb\ \check{v}\ nq\ ZLb\ e\ \check{e}\ \check{v}\ \check{u}\ i\ tgvU\ fi\ \check{t}eM\ msi\ \check{r}\check{b}\ \check{Z}\ \check{v}\ \check{t}\check{K}\ G\check{u}\ B\ fi\ \check{t}e\ \check{t}\check{M}\ i\ msi\ \check{r}\check{b}\ m\check{f}\ |

\check{t}K\check{v}\ e\ \check{e}\ \check{v}\ fi\ \check{t}e\ \check{t}\check{M}\ i\ c\check{w}\ i\ e\ Z\ \check{f}\ bi\ n\check{v}\ i\ Z\check{v}\ i\ Dci\ c\check{h}\ \check{y}\ N\check{v}\ Z\ e\ \check{t}\check{J}\ i\ mg\check{v}\ | i\ \check{t}\check{K}\ \check{t}\check{U}\ i\ M\check{u}\ Z\ i\ R\check{b}\ \check{v}\ i\ \check{t}\check{K}\ U\ B\check{w}\ \check{A}\ \check{t}\check{b}\ i

$$ar^{\circ}v\ F,\ R\check{y}\ j\ v\ b\ x\ i\ e\ \check{e}\ n\check{v}\ \check{t}\check{I}\ i\ n\check{v}\ i\ \frac{\Delta m}{t}\ Ges\ R\check{y}\ j\ v\ b\ x\ i\ w\ b\ M\ \check{e}\ teM\ \check{v}\ n\check{t}\check{J}\ F = \frac{(\Delta m)v}{t}$$



**cúVvĚi gj`vqb**

**mWk DĚti i cŭk Wk vPý (√) w`b|**

1/ e`e`vi fi teM msi 7Y mĤi minvĥ` e`vL`v Kiv hvq bv ubĥPi tKvb cĭμqvuU?

- (K) „wj Qgtj e`Ĥ tcQtb av`v t`q
- (L) „vqv Ae`vq wi Kkv t\_ĤK j vvdĥq cotj wi Kkv tcQtb QĥU hvq
- (M) Pj Š-Mvox nVvr teK Klĥj hvĤx mvgtbi w`ĤK SĤK cto
- (N) iĥKĥUi Mwzi KviY

2/ tKvb e`ĥ fi teĥMi cwieZĥbi nvi KZ?

- (K) e`ĥ Dci cĥĥ NvZ etj i mgvb
- (L) e`ĥ m=ŷ Mwzi I fĥi „Ydtj i mgvb
- (M) e`ĥ cĥv` Mwzi mgvb
- (N) e`ĥ m=ŷ teM I cĥv teĥMi wĥqvMdj |

3/ GKwU iĥKĥUi NvZej 50000 N Gi fi 50 kg nĥj ZiY KZ?

- (K)  $5 \times 10^5 \text{ ms}^{-2}$
- (L)  $10^3 \text{ ms}^{-2}$
- (M)  $25 \times 10^3 \text{ ms}^{-2}$
- (N)  $25 \times 10^5 \text{ ms}^{-2}$

# cW 4

## eTj i fvimvg

### DtIk

#### GB cW tkTl Avclb

- 1. weifbæTj i gta fvimvg tf±i wPtIi mrvvth cKvk KitZ cviTeB|
- 1. wj ej, wZbuU eTj i mvg've-vi MvYwZK mgxKiY cWZcr`b KitZ cviTeB|
- 1. wZbuU mgvšij eTj i mvg've-vi kZ`vL'v KitZ cviTeB|
- 1. `bw`b RxeTb eTj i mvg've-vi `pvš-DtKx KitZ cviTeB|

#### 4.1.1 t fvimvg

e-ž Dci eTj i jwä kb" ntj wK nq? e-ž tel a'e nq| teTmi gvTbi ev wTKi tKvb cwi eZB nq bv| e-ž Dci hLb eTj i jwä kb" nq ZLb e-ž th Ae-v ZvTK ejv nq fvimvg| hw` e-zv`i Ae-vq \_vTK Zv ntj ZvTK ejv nq w-wZmvg| Avi hw` e-znij tiLvq mg`wZtZ PjtZ \_vTK Zvntj ZvTK ejv nq MZxq mvg| fvimvg ARB KitZ ntj e-wi Dci jw` ej`i b" ntZ nTe| e-ž Dci ej wlvq Ktibv Ggb Ae-v ev`te mæe bq| tKej gvT gnvkTb` thLvTb tKvb Mb bTtIi AvKI v bvb Ggb RvqMvq Kibv Kiv thtZ cviTi| mvari Yfvte tKvb e`e-vq AtbK, tjv ej wlvq Kti eTj i jwä kb" ntj B fvimvg AvRZ nq|

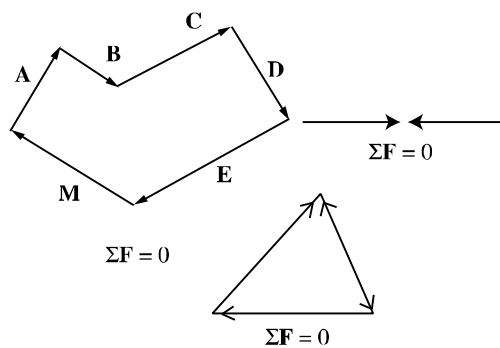
avi, tKvb e-ž Dci wlvqKxj mKj ej B GKwU we`Tz wlvqKxj | wbdUtbi wZxq mF t`TK cvB,

$$F = ma$$

AtbK, wj ej GK mvt\_ wlvq Kitj  $\Sigma F = ma$

tKvb KYv fvimvg Ae-vq \_vKte hw` Gi Dci wlvqKxj mKj eTj i tf±i mgwä kb" nq| A-w hw`  $\Sigma F = 0$  nq| Zvntj ej, tjvi tf±i wPt GKwU ex eUfR nTe| wZbuU ej ntj wTfR nTe| wj ej ntj ejBq mgvb l GKB tiLvq wecixZgla nTe (wPt 4.4)| tKvb tf±i kb" ntZ cviTi tKej hLb Gi cWZwU j`Dcvsk kb" nq| mZivs  $\Sigma F = 0$  mgxKiYwU wZbuU mgxKiYi mgZj`

$$\Sigma F_x = 0, \Sigma F_y = 0, \Sigma F_z = 0$$

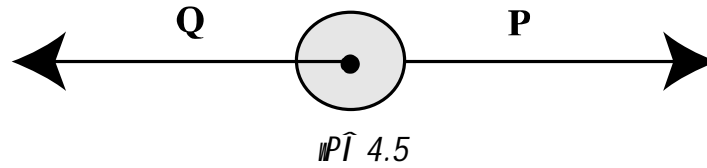


wPt 4.4

mZivs tKvb e-zw` mvg've-vq \_vTK Ges Gi Dci wlvqKxj GKwU e`ZxZ evKx ej, tjv Rvbn \_vTK, Zvntj tmB AA'vZ ej wU wbyQ Kiv hvq| wbtP KtqKwU weTKl mvg've-vi mgxKiY cWZcr`b Kiv nj |

**(K) `w etj i fvimg`**

GKwU we`jZ wqvkxj `w mgvrbtbi ej hw` ci`úi wecixZgkx nq Zte Giv mvg` cZôv Kti | wPÎ 4.5 G aitbi `w ej P I Q t`Lvrbv ntqtQ|  
wPÎ P = - Q



ev,  $P + Q = 0$

A\_ŕ Σ F = 0

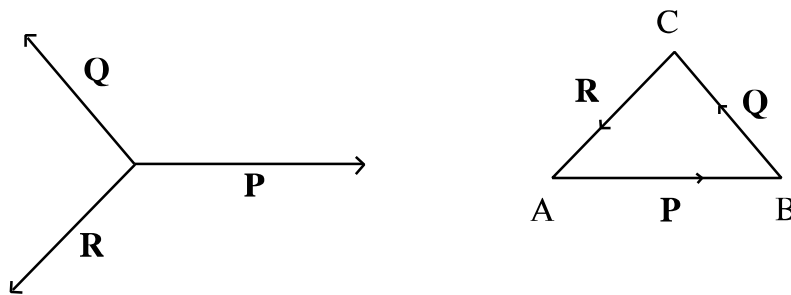
mZivs ej ōq mvg` cZôv Kti |

GKwU iwki `B cš-ati `Bb tjuvK hw` mgvb etj iwkuUtk ubtRi w`tk Uvrb Zvntj ej ōtqi fvimg`i KvitY iwkuU w`i`vK | A\_ŕ fvimg` Ae`vq`vK |

**(L) wZbuU Amgvš+vj etj i fvimg`**

wZbuU Amgvš+vj ej tk mvg` cZôv Kitz ntj Zvt`i`K Aek`B mgZj xq ntZ nte, GKB we`jZ wfbce wfbcew` tk KvR Kite Ges tf±i w`fR m` tgb Pj te | tf±i w`fR m` nj t GKwU we`jZ wqvkxj wZbuU ej tk hw` tkvb w`fRi wZbuU evû ōviv GKB μtg ubt`RZ Kiv hvq Zv ntj ej ōq mvg` cZôv Kite |

wPÎ 4.6 -G wZbuU ej P, Q, R; Giv o we`jZ wqviZ | ej wj tk ABC w`fRi wZbuU evû ōviv mPZ Kiv hvq |



wPÎ : 4.6

GLvrb,

$P + Q = - R$

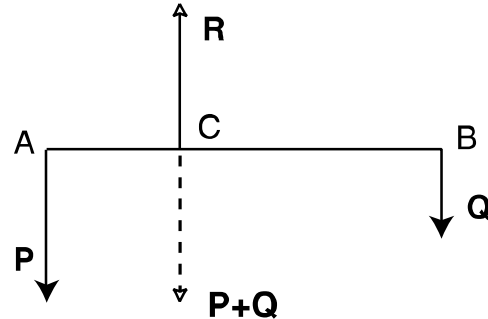
$P + Q + R = 0$

mZivs ej wZbuU mvg` cZôv Kti |

**(M) wZbuU mgvš+vj etj i mvg**

wZbuU mgvš+vj etj i mvg cÖZÖv nZ cvti hwi ej,ij mgZj xq nq, GKU ej Ab" w etj i j wäi mgvb I wecixZgÿx nq Ges cÖZ"KU ej Ab" ej Øtqi ga"eZP` iZji mgvbZvZK nq|

¶PÎ 4.7 G aiZbi mvg" cÖZÖvKvix wZbuU ej P, Q, R t`Ltvb nj | ej,tjv mvg've`vq AvtQ| ZvB ej,tjv th Ztj Aew`Z tmB Ztj th tKvb we`y mvtçt¶ ej,tjvi åvgKki exRMwYvZK mgwó kb" nte| C we`y mvtçt¶ åvgK



¶PÎ 4.7

P. AC - Q. BC + R. 0 = 0

ev, P. AC = Q. BC

ev,  $\frac{P}{BC} = \frac{Q}{AC}$

GKBfite t`Ltvb hvq  $\frac{Q}{AC} = \frac{R}{AB}$

∴  $\frac{P}{BC} = \frac{Q}{AC} = \frac{R}{AB}$  ----- 4.17

tdivi I qjv Kvta GKU `Ü (evK) wbtq `B cÖš-fvi ivtL| `B fvi Ges `tÜi gvSvms `vrb Kvta i cÖZvµqv ej-G wZbuU mgvš+vj etj i mvg" cÖZÖv Kti |  
 `wD পাত্রে wbtq I Rb Kivi mgqI wZbuU mgvš+vj etj i mvg" cÖZwZ nq| ej wZbuU n"Q evULvivi I Rb, e`Z I Rb Ges wbr³ `Ü ev avitKi DaYgÿx Uvb|

**mvi vsk**

e`Z Dci etj i j wä kb" ntj fvi mvg" mµó nq| wZbuU mgvš+vj etj i mvg" cÖZÖv Kiti Gt` i cÖZ"KU ej Ab" ej Øtqi ga"eZP` iZji mgvbZvZK | GKU we`yZ µqvkvxj wZbuU ej tK hwi tKvb GKU wI fZRI wZbuU evÜ Øviv GKB µtg wbt`R Kiv hvq Zv ntj ej Tq mvg" cÖZÖv Kiti | wZtbi Awak etj i tf±i ¶PÎ eüfR ntj ej,tjv mvg've`v mµó Kiti |

**cúVvĚi gj`vqb**

**mĚK DĚti ĚK Pý (√) ŵ b**

1/ fvi mvg" ej tZ ĚK eSvq?

(K) e`zr`i \_vKv

(L) e`z Dci etj i j Ěä kb" nI qv

(M) e`z MZkxj \_vKv

(N) e`z MZnxbZv

2/ ĚZbĚU Amgvštj etj i fvi mvg" KLb nq hLb --

(K) P + Q + R = 0

(L) P + Q = R

(M) P - Q - R = 0

(N) -P - Q + R = 0

3/ ĚZbĚU mgvštj etj i mvg" nI qvi kZ<sup>q</sup>KvĚU ?

(K) ej , Ěj mgZj xq

(L) GKĚU ej Ab`Ěi j Ěäi mgyb I ĚcixZ

(M) cĚZ`K ej Ab` ej tqi ga`eZ<sup>p</sup>` tZj mgyb<sup>q</sup>mZK

(N) Dcti i me , Ěj |

# cW 5 NI

## Dik

### G cvVi tkI AvciB

- 1 NI ej K Zv eVLv KiZ cvi teB,
- 1 wefbaCKvi NI etj i msAv I D`vniY w`tZ cvi teB,
- 1 NI ej Kfite w`Zve`v I MuztK cFmeZ Kti Zv ej tZ cvi teB Ges G m`uKq mnR  
mgm`vej xi mgraib KiZ cvi teB|

### 4.5.1 NI

tLjvi grtV GKwU grteP Mnotq w`tj hZ `xi hite mtgtUi tgtStZ grtePwU Mnotq w`tj Zvi tPtq  
AtbK tekx `xi hite| gmb tgtSi Dci w`tq tnU hvl qv t`tK Agmb wctPi iv`vq nvUv mnR| bZb  
Rzv t`tK cjtbr Rzv cti Pj tZ m`ear|

G mtei KviY K?

Avgiv Rmb e`zj AvciZ `wtZ hZB gmb gtb trvK bv tKb cKZ.c`te tKvb e`zZj B m`uY`gmb  
bq| cOZ`KwU Zj B Kg tekx DPybPydtj hLb GKwU e`zAci e`z Dci w`tq Pjvi tPov Kti ZLb  
e`z`di DEybPyLvb`\_tjv ci`uti i mrt\_ AvtK hvq| dtj Muz evav cOB nq ev NI m`o nq| Avevi  
e`z`di `ukZtj i AYytjv ci`uti K AvKI Kti | Gi dtj I Zj Otqi gta`i Muz evav cOB nq|  
Gme ej hvt i Oviv Muz evav cOB nq ZvtK NI ej etj | KvRB ejv hvq : `w e`zci`uti i  
ms`utk`\_tK hw` GtKi Dci w`tq AciwU Pj tZ tPov Kti Zv ntj e`Otqi `uk`Ztj GB Muzi  
wei`tx th evav m`o nq ZvtK NI etj | Avi GB evav RmbZ ej tK ejv nq NI ej |

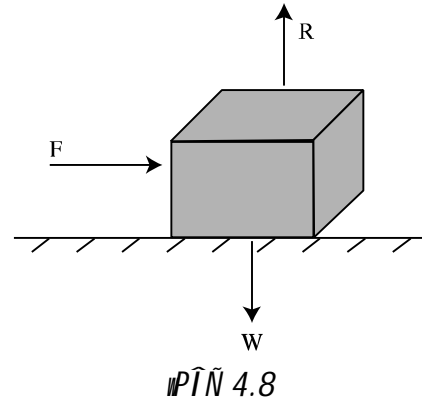
NI ej tK tgrUv`w 4 fvtM fivM Kiv ntqtQ

- 1| w`wZ NI (Static Friction)
- 2| MZxq NI (Kinetic Friction)
- 3| AveZNI (Rolling Friction)
- 4| c`vrx NI (Fluid Friction)

### w`wZ NI

aiv hvK GKwU tUwetj i Dci GKwU KvVi ব্লক AvtQ (wP 4.8) | e`wji I Rb Lvov wbtPi w`tK KvR  
Kti tQ | tUwetj i Zj e`w`tK mgvb ej Oviv Dctii w`tK tVj tQ | Guv wDUtbi ZZxq m`A Abvvti  
eVLv Kiv hvq | ব্লকটির I RbRmbZ wbgg`lx w`uqv ej w Ges tUwetj i Da`g`lx cOZ`w`uqv ej R mgvb  
nl qvq ব্লকটি mvg`ve`vq ev w`wZ Ae`vq AvtQ |

GLb ব্লকটির Dci চক; t`tK F চিগvY ej ctqM Kiv nj | aiv hvK e`ধি w`Zve`vi চিেZB nj bv | GB ej মগvb` emotq F<sub>1</sub> Kiv nj ZvtZI e`ঋ w`Zve`v AcচিেZ` \_vKj | Gfite GKUZGKUZKti emotq μgk F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub> ej c`qM KtiI GKB dj cvlqv tMj | ঋKšZF<sub>5</sub> t`tK ej মগvb` evotj B ব্লকটি tUetj i Dci w`tq MuzKxj nj | Avgiv ejtZ cwi F<sub>1</sub>, F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub> BZ`w` gvtbi ej c`qM Kiv mtEjI ব্লকটি MuzKxj bv nlqvi Kvi Y NI` ej |



পট্টন 4.8

hLb F Gi gvb GKUw ubw` ঠ মগvq tcSvq ZLub gvI ব্লকটি MuzKxj nte | th মগvq tcSvtj ঋtK Muzi m`Avi nlqvi Dcμg nte tmB মগvq e`ঋtqi Avtci`K MuztK eva `vbKvix NI` etj i gvb মেঠাক nte | NI` etj i GB gvbtK মগvmsK gvb ev মগvmsK (Limiting) NI` etj | hZ`b chS-ব্লকটি w`i \_vtK A-ঋ ব্লক I tUetj i gta` tKvb Avtci`K Muz bv \_vtK ZLb e`ঋtqi gta` th NI` ej KivR Kti ZvtK w`wZ NI` etj | w`wZ NI`Yi gvb kb` t`tK মগvmsK gvb chS-ntZ cvti |

**MZxq NI`**

`ধি `ukZj hLb Avtci`K MuztZ \_vtK, ZLb Zvt`i gta` th NI` ej μqv Kti Zv MZxq NI` | tqtSi Dci w`tq gvtEj Mmotq w`tj Zv axti axti t`tg hvq | Guw MZxq NI`Yi KvitY | GB NI` ej PjtZ `i` Kivi gytZ` ev Zvi ce`chS-`th NI` ej Zvi tPtq Kg |

**AveZ`NI`**

hLb GKUw Zj Aci GKUw Ztj i Dci w`tq Mmotq hvq ZLb Muzi মেi`t`x th ej μqv Kti ZvtK AveZ`NI` etj | thgb PvKvi NI`, tqtSi Dci gvtEj i Mmotq Pjvi NI` I ej teqmis Gi NI` | tqtSi Dci w`tq GKUv ev` tUtB wbtZ ntj hZ Kó nq Zvi wbtP `ধি PvKv ev tivvi j vM`tq w`tj NI` Kg nq etj tUtB wbtZ Kó Kg nq |

**c`vnx NI`**

hLb tKvb Zij ev evqexq c`vt`P Muzct` tKvb w`i e`zivLv nq ev tKvb e`#K Zij ev evqexq c`vt`P gvS w`tq MuzKxj ntZ nq ZLb Dftqi gta` NI` Drcb`enq | GB aibtI NI`tK c`vnx NI` etj | c`vbi ga` w`tq tbSKv ev RvrvR Pjv, evZvtmi ga` w`tq Pjvi mgq Avgvt`i kixti Ztj i mtb evZvtmi eva G`tjv c`vnx NI` | tKvb tKvb t`t` c`vnx NI` AZ`š-Kg nq | gva`gti NbZ; w`wZ `vcKZvi mv`\_ mv`\_ c`vnx NI`I চিেZ` nq |

**4.5.2 NI` , YisK**

`ধি e`ঋ ci`úti `ukZtj NI` ej Ges Avfj`K c`Zμqv mgbv`vMZK nq | Gt`i AbgvZtK ej v nq NI` , bvsK | w`wZNI`, MZxq NI` Ges AveZ`NI`Yi t`t` Avj v`v Avj v`v NI` , YisK মে`gvb |

w̄wZ NIΨ, YvsK : w̄w e-zci-úti ms-útk-vKtj w̄wZ NIΨyi m̄xgwišK gvb F<sub>s</sub> I Awfj w̄K cōZwμqv R ntj

$$w̄wZ NIΨ, YvsK \mu_s = \frac{F_s}{R} \text{-----} (4.20)$$

MZxq NIΨ, YvsK t tKvb e-zhLb Aci GKwU e-z Dci w̄tq w̄i teM Pj tZ -vtK ZLb Awfj w̄K cōZwμqv R I MZxq NIΨ ej F<sub>k</sub> ntj

$$MZxq NIΨ, YvsK \mu_k = \frac{F_k}{R} \text{-----} (4.21)$$

AveZ<sup>Q</sup>NIΨ, YvsK t GKwU e-zAci e-z Dci w̄tq MwoTq Pj vi mgq hw̄ Awfj w̄K cōZwμqv R Ges AveZ<sup>Q</sup>NIΨ ej F<sub>r</sub> nq Zvntj

$$AveZ<sup>Q</sup>NIΨ, YvsK, \mu_r = \frac{F_r}{R} \text{-----} (4.22)$$

### NIΨ tKvY

m̄xgwišK NIΨyi t<sup>Q</sup>t<sup>Q</sup> Awfj w̄K cōZwμqv R I NIΨ ej F<sub>s</sub> tK msthvRZ Kti th jwä ej cvl qv hvq ZvtK j ä cōZwμqv etj | j ä cōZwμqv Awfj w̄K cōZwμqv i mvt\_ th tKvY DrcbæKti ZvtK NIΨ tKvY etj | 4.9 w̄t<sup>Q</sup> m̄xgwišK NIΨ, F<sub>s</sub> I Awfj w̄K cōZwμqv, R tK msthvRb Kti j ä cōZwμqv s cvl qv tMj | GB j ä cōZwμqv s I Awfj w̄K cōZwμqv R Gi ga-eZ<sup>Q</sup>tKvY θ<sub>f</sub> nt<sup>Q</sup> NIΨ tKvY |

$$GLv\#b R = S \cos \theta_f$$

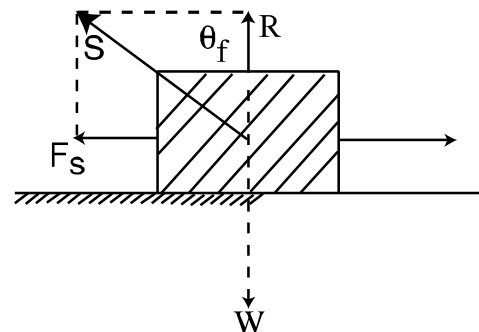
$$F_s = S \sin \theta_f$$

Avgiv Rvmb w̄wZ NIΨ, bvsK,

$$\mu_s = \frac{F_s}{R} = \frac{S \sin \theta_f}{S \cos \theta_f} = \tan \theta_f$$

$$\therefore \mu_s = \tan \theta_f$$

$$ev, \theta_f = \tan^{-1} \mu_s \text{-----} (4.23)$$



w̄t<sup>Q</sup> 4.9

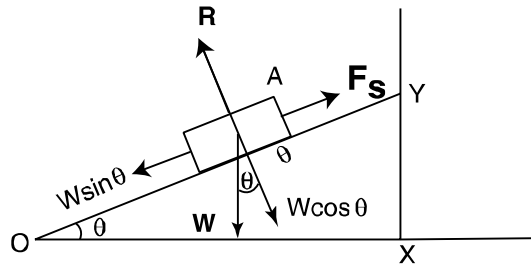
A\_# NIΨ tKvYi U-vb\#R>U NIΨ, Yvs\#Ki mgvb |

### w̄wZ tKvY

Avgiv AwfÁZv t\_#K t\_wL Avb\#wK Ztj -wncZ tKvb e-zw-wZkxj -vtK | Zj wUtK Ab\#wgtKi mvt\_ ax\#i ax\#i tnj vtZ -vKtj I e-w GKwU wv-w-# m̄xqv chS-w-i -vtK | Ab\#wK I Ztj i gta-tKvYi gvb Kg ntj w-wZkxj Zv eRvq -vtK | tKvb Zj Ab\#wgtKi mvt\_ bly-Zg th tKvY DrcbæKti j AvbZ Ztj i Dci -tKvb e-zMwZkxj nI qvi Dcμg nq tmB tKvY\#K H Ztj e-w\#i w-wZ tKvY etj | th tKvY Ztj i AvbwZ w-wZ tKvY chS-ntj H Ztj i Dci e-zw-i -vKte | AvbwZ w-wZ tKvY AwZμg Kti tMj e-w\#i MwZkxj nte |



¶PÎ 4.10 -G A ब्लकटि 0Y AvbZ Ztj i Dci emv`bv AvtQ| Avb`vugK tiLvi mvt\_ 0Y Ztj i AvbZ tKvY B`QvgZ cwieZ` Kiv hvq| रूतKi IRb w I NI` ej F<sub>s</sub> | GLb 0Y Ztj i AvbWZ evovtZ evovtZ hLb 0 tKvY Avbv nj ZLb A ब्लकटि MvZKxj nI qvi Dcµg nj | GB mvgv`SK Ae`vq Avgiv vj LtZ cwi



¶PÎÑ4.10

$$R = W \cos \theta$$

$$\text{Ges } F_s = W \sin \theta$$

$$\therefore \text{NI` } \mu_s = \frac{F_s}{R} = \frac{W \sin \theta}{W \cos \theta} = \tan \theta$$

$$\therefore \theta = \tan^{-1} \mu_s \text{ ----- (4.25)}$$

A\_¶ w`wZ tKvYi U`vb`R`U NI` , YvstKi mgvb|

$$\text{mgvKi Y 4.23 Ges 4.24 t`tK cvB } \theta_f = \theta \text{ -----(4.25)}$$

A\_¶, NI` tKvY Ges w`wZ tKvY ci `úi mgvb| NI` tKvY Ges w`wZ tKvYi gvB mgvb ntj I `w tKvY GKB tKvY bq| w`wZ tKvY tKej AvbZ Ztj i tej vtZB c`hvR` wKszNI` tKvY mgZj I AvbZ Zj Dfq Ztj i tej vtZB c`hvR`| ¶PÎ 4.10 G ∠YOX = θ

$$\text{Ges } \frac{YX}{OX} = \tan \theta$$

tKvb e`z AvbZ Ztj MvZKxj Zvi t¶tÎ 0Y, 0X cwi gvc Kti Avgiv cix¶v gj-K frte NI` , Yvsk μ<sub>s</sub> tei KiZ cwi |

### 4.5.3 NI`Yi m`ejx

`w Ztj i w`wZ NI` I MZxq NI` KZ, tjv m` tgtb P tj | Gt` i tK NI`Yi m` etj | m`, wj wbtP D`v` Kiv nj |

### w`wZ NI`Yi m`ejx

- 1) NI` ej me`v MvZi wei`tx wµqv Kti |
- 2) mvgv`SK NI` Avfj w`K c`Zwµqv mgvb`vZK|
- 3) tKvb wv` 0 Avfj w`K c`Zwµqv Rb, NI`vsk `úkZtj i c`KvZi Dci wbfP Kti, `úkZtj i t¶tÎ dtj i Dci bq|

### MZxq NIŲi mĤej x

- 1) MZxq NIŲ ej Awfj wK cĀZġµqvī mgvbgwZK |
- 2) MZxq NIŲ ej ūkZtj i tġĪdtj i Dci wbfŲ Kti br | wbfŲ Kti Zj Ųtqi Dcv`vb, AvKwZ. I Ae`vi Dci |
- 3) MZxq NIŲ ej MwiZi weciXZ w`tK µµqv Kti |

### 4.5.4 NIŲi DcĤhwMIZv

NIŲ Avgt`i RxeĤb mġeav I Amġeav Dfqb mġŲ Kti | NIŲi cĤve Avgt`i ``bw`b RxeĤb „i“ZcYŲ, Avmġ Avgiv NIŲi mġeav/Amġeav Ges NIŲ KgtĤbri Dcvq „wġ AvĤj vPbv Kwi |

### NIŲi mġeav

NIŲ \_vKvi dtj Avgiv nvUv Pjv KitZ cwi, nvZ w`tq tKvb wKQyaitZ cwi, teK Kti Mvox \_vgĤZ cwi | NIŲi Rb` iv`vq Mmo PjĤZ cvti, t`qvĤj gB j vMĤbv hvq, w`qvĤj vBĤqi Kmw Ryj vb hvq Ges Kj Kvi Lvbi PvKv NĤj | G aitbi AtbK wKQŲ mġe nq NIŲi cĤve | KvĤRB eSĤZ cviĤQb NIŲ br \_vKĤj Avgt`i KZUv Amġeavi mġŲxb nĤZ nZ |

### NIŲi Amġeav

NIŲ MwiZĤK evav t`q mZivS Mwi eRvq ivLvi Rb` A\_Ų NIŲ RwbZ evav AwZµg Kivi Rb` kw<sup>3</sup> e`q KitZ nq | NIŲ th kw<sup>3</sup> e`q KitZ nq, Zv ZĤc ifcivS Mwi Z nq | GĤZ kw<sup>3</sup> i AcPq nq, MwiZ KĤg hvq | NIŲi dtj tgwĤbi hšysk, Avgt`i RZvi Zj v Ųq nq, AtbK mgq hšysĤk Av „b atĤ hvq |

### NIŲ Kġevi Dcvq

NIŲ Avgt`i Amġeav ev ŲwZ Kitj I NIŲi cĤqvRbxqZv AZ`š-A\_Ųn | NIŲnxb vek | MwiZnxb | Rxeb I MwiZnxb | ZvB NIŲ eRvq ivLĤZ nĤj NIŲĤK wġqšĤb ivLĤZ nĤe | NIŲ KgtĤbri Rb` ūk<sup>3</sup>Ztj i gmbZv evovĤZ nĤe hvĤZ DPYbxPyLvŲ „wġ ci`úi AvUKvĤbri mġeav KĤg hvq | Ų ūk<sup>3</sup>Ztj i gĤa` wġŲQj Kvix`è` (tZj, cvDWi, MŲR) e`envi KitZ nĤe | MZxq NIŲ t\_ĤK AveZ<sup>3</sup>NIŲ Kg | GRb` NyŲkxj PvKvi gĤa` NIŲ KgtĤbri Rb` ej teqmivS ev ŲzĤ teqmivS e`envi KitZ nĤe |

### mvi vsk

NIŲ t`wġ e`zci`úti i ms`útk<sup>3</sup>ĤK hw` GĤKi Dci w`tq AciwU PjĤZ tPóv Kti Zv nĤj e`Ųtqi ūk<sup>3</sup>Ztj GB MwiZi wei`tx GKwU evavi DrcwĤ nq | GB evavĤK NIŲ etj |

NIŲ cĤvbZ 4 cĤvi : w`wZ NIŲ, MZxq NIŲ, AveZ<sup>3</sup>NIŲ I cĤvnx NIŲ

NIŲ „YusK t mġwivS<sup>3</sup> NIŲ etj i gvb I Awfj w`cĤZġµqv etj i gĤbri AbgvZĤK NIŲ „YusK etj |

mġwivS<sup>3</sup> w`wZ NIŲ ej t ci`úi ms`útk<sup>3</sup>\_vKv`wġ w`i e`zĤ gĤa` th w`wZ NIŲ ej Drcbæng Zvi mġeav<sup>3</sup> gvbĤK mġwivS<sup>3</sup> w`wZ NIŲ etj |

### 4.5.5 MmVvZK mgm`vej x

D`niY 1 t tKvb e`w<sup>3</sup> 2N I Rb weikó GKwU eB`B nvtZ tPtC ti tLqOb hvZ eBwU bv cto hvq| hw` cŁZ`K nvtZi Zvj j`b`bZg ej 5N nq Zte eB Ges nvtZi gta` NI`Y , YvstKi gub wBY` Ki`b|

mgvavb t t`I qv AvtQ nvtZi Dci Pvc = j`wä cŁZw`uqv R = 2 × 5 N  
[ cŁZnvtZ 5N Kti 2 nvtZ ]

eBwU i Rb = NI`Y ej = F<sub>s</sub> = 2N

$$AZGe NI`Y , Yvsk \mu_s = \frac{F_s}{R} = \frac{2N}{2 \times 5N} = 0.2$$

D`niY 2 t 250 N I Rb weikó GKwU ev` tK tqtSi Dci w`tq tUtb wbtZ nte| tqtS I evt` i gta` w`wZ NI`Y , Yvsk Ges MZxq NI`Y , Yvsk h`v`m`tg 0.42 Ges 0.40 ntj (i) ev` wU bvovtZ KZ ej cŁqvm Ki tZ nte? (ii) ev` wU tK mPj i vL tZ ntj Kgc t`q] KZ ej cŁqvm Ki tZ nte ?

mgvavb t t`qv AvtQ ev` wU j`w`K cŁZw`uqv ej R = evt` i I Rb = 250N

tqtS I evt` i w`wZ NI`Y , Yvsk  $\mu_s = 0.42$

tqtS I evt` i MZxq NI`Y , Yvsk  $\mu_f = 0.40$

1) ev` wU bvovtZ ch`y` ej A`f` m`xg`m`šK NI`Y ej F<sub>s</sub> wBY` Ki tZ nte|

2) ev` wU MvZk`j i vL tZ ch`y` ej A`f` MZxq NI`Y ej F<sub>k</sub> wBY` Ki tZ nte|

$$1) \text{ Argiv Rwb } \mu_s = \frac{F_s}{R}$$

$$\text{ev, } F_s = \mu_s R = 0.42 \times 250N = 105 N$$

$$2) \text{ Argiv Rwb } \mu_f = \frac{F_k}{R}$$

$$\text{ev, } F_k = \mu_f R = 0.40 \times 250N = 100 N$$

### Povš-gj`vqb t Ablyj bx

be`P K ckat mWk DEti i cvtk Wk Pý (√) w b |

1/ `W e`zci`úti i ms`útk`\_tk hW GtKi Dci w`tq AciuW Pj tZ tPón Kti Zv ntj e`zdtqi  
`úk`Ztj GB Muzi wei`tx th evav mWó nq ZvtK Wk etj ?

- (K) w`WZ NI`
- (L) c`vnx NI`
- (M) MZxq NI`
- (N) AveZ`NI`

2/ iv`vq t`tg \_vKv tgvUi Mvovi Pvkv tKvb aitbi NI` mWó Kti ?

- (K) MZxq NI`
- (L) w`WZ NI`
- (M) AveZ`NI`
- (N) c`vnx NI`

3/ tKvbW NI`Yi mF bq ?

- (K) NI` ej me`v Muzi wei`tx Wqv Kti |
- (L) NI` `úk`Ztj i t`T`dtj i Dci wbf` Kti |
- (M) mgvWŠK NI` Avfj W`K c`Z`Wqv mgvbgvWZK
- (N) MZxq NI` Avfj W`K c`Z`Wqv mgvbgvWZK

4/ e`z RoZv ej tZ evŠ-

- (K) w`i e`z w`i \_vKvi c`bZv
- (L) Muzkxj e`z Muzkxj \_vKvi c`bZv
- (M) K I L DfqWUB
- (N) Muzkxj e`z teM

5/ tKvbW mef`c`v``ej ej ?

- (K) gnvKI`ej
- (L) mej w`bDKxq ej
- (M) `ej w`bDKxq ej
- (N) Z`w`or tPŠ`Kxq ej

6/ tKvbW etj i `enkó` bq?

- (K) ej GKW w`K i`vk
- (L) ej tRvovq tRvovq KvR Kti
- (M) ej e`z`K weKZ.Ki tZ cvti bv
- (N) ej e`z` teMi cwi eZ` NUvq |

7/ Muzkxj iKtUi NvZej KZ?

- (K) iKtUi fi teMi cwi eZ`bi nvti mgvb
- (L) iKtUi teMi mgvb
- (M) iKtUi Da`v`lx teMi mgvb
- (N) iKtUi Rjv vx e`envti i nvti mgvb |

**L. msuŋB DĚi cĕke**

- 1/ RoZv ũK? KZ cĕvi I ũK ũK?
- 2/ etj i `ewkó" ũK ũK?
- 3/ cĕwZtZ KZ cĕvi tgšij K ej weivRgub? ũK ũK?
- 4/ Ziur `ŋp ej ũK?
- 5/ gnvKI ˚ej ũK?
- 6/ Ziur tPšK ej ũK?
- 7/ ũbDUtbi MwiZi cĕg mFĭU weez Ki"b|
- 8/ ũbDUtbi MwiZi ũZxq mFĭU Dšax Ki"b|
- 9/ fiŋem KvŋK etj ?
- 10/ fiŋetMi gvĭv ũK? GKk ũK?
- 11/ NvZ ej etjZ ũK etjSb?
- 12/ etj i NvZ etjZ ũK etjSb?
- 13/ fiŋetMi msi ŋY weva weez Ki"b?
- 14/ NI ˚ KvŋK etj ?

**M. vek` DĚi cĕke**

- 1/ RoZv ũK? RoZv KZ cĕvi I ũK ũK? cĕZ`K cĕvŋi i msÁv I ũZbũ Kŋi D`vniY ũ`b|
- 2/ tgšij K ej KZ cĕvi I ũK ũK? cĕZ`K cĕvi etj i msuŋB cwiPq ũ`b?
- 3/ weivfbœcĕvi tgšij K etj i पञ्जा I AvŋcŋŋK mej Zv mn D`vniY ũ`b|
- 4/ ũbDUtbi MwiZmFĭ, ũj eYŋv I e`vL`v Ki"b|
- 5/ ũbDUtbi MwiZi ũZxq mFĭ eYŋv Ki"b| Gi thšv`KZv e`vL`v Ki"b Ges F = ma mgvKiYũ cĕZcv`b Ki"b|
- 6/ fiŋem ũK? fiŋetMi ũbZ`Zvi mFĭU eYŋv I e`vL`v Ki"b|
- 7/ iŋKU ũKfiŋe Pŋj e`vL`v Ki"b Ges iŋKŋUi Dci av`vi i ũkgyj v ũbYŋ Ki"b|
- 8/ tŋ±i ũPŋĭi mŋvŋh" etj i mŋg`ve`v e`vL`v Ki"b|
- 9/ etj i firimŋ" etjZ ũK etjSb? ũZbũ mgvšŋvj I Amgvšŋvj etj i mŋg" cĕZŋvi kZŋK ũK?
- 10/ NI ˚ ej etjZ ũK etjSb? e`vL`v Ki"b| NI ˚ KZ cĕvi I ũK ũK?
- 11/ NI ˚ ej ũKfiŋe MwiZŋK cŋweZ Kŋi Zv Avŋj vPbv Ki"b|
- 12/ NI ˚, YisK ũK, NI ˚ tKvY Ges NI ˚, YisŋKi gŋa" m`úK`cĕZŋv Ki"b|
- 13/ NI ˚ tKvY Ges ũ`ũZ tKvŋYi gŋa" m`úK`cĕZŋv Ki"b|
- 14/ NI ˚Yi mŋeav I Amŋeav Avŋj vPbv Ki"b|

**N. MwYvZK mgmiv**

- 1/ GKwU ej 4 kg fi wekó GKwU w<sup>-1</sup> e<sup>-z</sup> Dci w<sub>μqv</sub> Kti | Gi dtj e<sup>-w</sup> 6 tm#KtU 30 m/s teM c0B nq| etj i gvb KZ?
- 2/ 60 N ej 30kg fti GKwU e<sup>-z</sup> Dci 1 min w<sub>μqv</sub> Kti | e<sup>-w</sup> te#Mi cwieZ0 KZ nte?
- 3/ 5 kg I 3 kg fti e<sup>-z</sup> GKB mij tiLv eivei wKšwecixZ w<sup>-1</sup> K Pjv Ae<sup>-vq</sup> GtK AcitK av<sup>o</sup>v w<sup>-1</sup> | av<sup>o</sup>vi cte<sup>o</sup>Zv<sup>-1</sup> i teM h<sub>vμtg</sub> 10 ms<sup>-1</sup> (DEiw<sup>-1</sup> K) Ges 5 ms<sup>-1</sup> (w<sup>-1</sup> Y w<sup>-1</sup> K) w<sub>Qj</sub> | av<sup>o</sup>vi ci e<sup>-z</sup> q mshy<sup>o</sup> Ae<sup>-vq</sup> KZ te#M Pj te?
- 4/ 0.5 kg fti GKwU dtej 20 ms<sup>-1</sup> te#M MwZkxj <sub>vKv</sub> Ae<sup>-vq</sup> j w<sub>w</sub> (kick) gviv nj | Gi dtj dtej w<sub>U</sub> GKB w<sup>-1</sup> K 40 ms<sup>-1</sup> teM c0B nj | cv KZR.chy<sup>o</sup> etj i NvZ KZ?
- 5/ 40 kg Ges 60 kg fti e<sup>-z</sup> ci<sup>-ui</sup> wecixZ w<sup>-1</sup> K h<sub>vμtg</sub> 8 ms<sup>-1</sup> Ges 2 ms<sup>-1</sup> te#M hvl qvi c<sub>t</sub> GK AcitK av<sup>o</sup>v w<sup>-1</sup> | av<sup>o</sup>vi ci e<sup>-z</sup> w<sub>U</sub> GKt<sup>-1</sup> hy<sup>o</sup> t<sup>-1</sup> K KZ te#M Pj te?
- 6/ 400N IRtbi GKwU Kv<sup>-1</sup>vi štKi Dci Avb<sub>fug</sub> K f<sup>-1</sup>te 160N ej c0qvM Kitj GwU Pjvi Dcμg nq| t<sub>g</sub>S I Kv<sup>-1</sup>vi štKi ga<sup>-e</sup>Z<sup>o</sup>NI<sup>o</sup> , YrsK w<sub>Y</sub>q Ki<sup>-b</sup>|
- 7/ 1.5 kg fti GKwU eB tUtej i Dci Av<sup>-1</sup>Q| tUtej i Zj eivei KZ etj Uvb<sub>tj</sub> eBwU Pjv<sup>-1</sup> i<sup>-1</sup> Ki te? (tUtej I eBtqi g<sup>-1</sup>ta<sup>-1</sup> NI<sup>o</sup> , YrsK 0.2)
- 8/ GKwU Kv<sup>-1</sup>vi Z<sup>-3</sup>vi Dci Aew<sup>-Z</sup> GKwU BtUi w<sup>-1</sup> Z tKvY 40<sup>o</sup> | BU I Z<sup>-3</sup>vi ga<sup>-1</sup> w<sup>-1</sup> Z NI<sup>o</sup> , YrsK KZ?