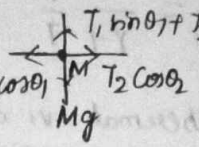
Newton Laws of Motion



1 N = 10^5 dyne

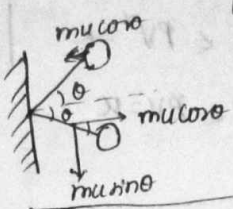
① Law of inertia

at equilibrium $\Sigma F_{net} = 0$

② Change in momentum

$\Delta p = m \Delta v = m [v_2 - v_1]$

$\Delta p = 2mu\cos\theta \uparrow$



$F = \frac{dp}{dt}$ (2nd law)

$Fdt = J$ (impulse)

if 'm' is const. $F = ma$

if 'v' is const. $F = v \frac{dm}{dt}$

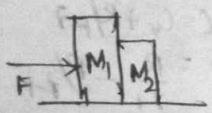
⑨ Variable force:

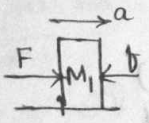
$f(t) = Ma = \int_0^t F(t)dt = \int_u^v M\,dv$

$f(x) = Mv\frac{dv}{dx} \Rightarrow \int_0^x F(x)dx = M\int_u^v v\,dv$

$a = \frac{dv}{dt} \times \frac{dx}{dx} = v\frac{dv}{dx}$

③ Contact force (pushing force):

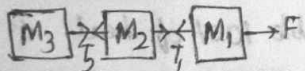




$F - f = M_1 a$ ——— $f = M_2 a$ ——— $a = \frac{F}{M_1 + M_2}$

① ②

④ Pulling force:



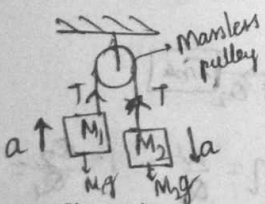
$a = \frac{F}{M_1 + M_2 + M_3}$

$T_2 = M_3 a$

$T_1 - T_2 = M_2 a$

$F - T_1 = M_1 a$

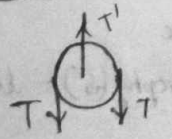
⑤ Pulleys:



$T - M_1 g = M_1 a$ ——— $M_2 g - T = M_2 a$

$a = \frac{(M_2 - M_1)g}{M_1 + M_2}$ ——— $T = \left(\frac{2M_1M_2}{M_1 + M_2}\right)g$

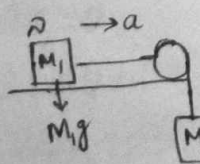
Thrust on pulley:



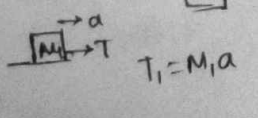
$T' = 2T$

$T' = \left(\frac{4M_1M_2}{M_1 + M_2}\right)g$

$T' = \sqrt{2}\frac{M_1M_2g}{M_1 + M_2}$

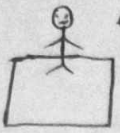


$T = \frac{M_1M_2g}{M_1 + M_2}$ ——— $a = \frac{M_2 g}{M_1 + M_2}$



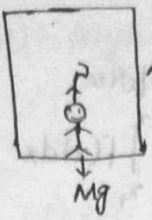
$T_1 = M_1 a$ ——— $M_2 g - T = M_2 a$

⑥ Weighing machine – It measures normal reaction of the body.



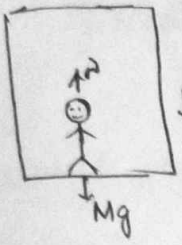
$N = Mg$

Reading $\Rightarrow \frac{N}{g} = M$



$N = M(g+a)$

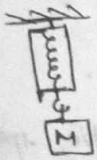
Reading $\frac{N}{g} = M(\frac{a}{g}+1)$



$M(g-a) = N$

Reading $\frac{N}{g} = M(1-\frac{a}{g})$

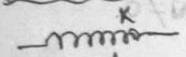
⑦ Spring balance : – It measures tension of a string attached to it.



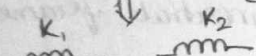
$T = Mg$

Reading $\Rightarrow T/g = M$

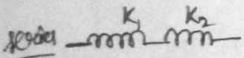
Cutting of springs & combination of springs :



$Kl = \text{const}$

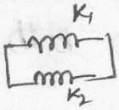


Series



$1/K_s = 1/K_1 + 1/K_2$

Parallel



$K_p = K_1 + K_2$

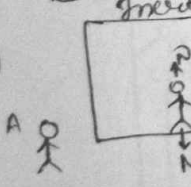
⑧ Inertial & non-inertial frame of reference :

Inertial frame of reference (A).

Non-inertial frame of reference (B).

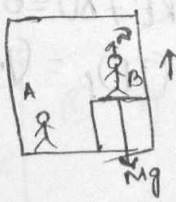
Non-inertial – an accelerating frame of reference is called non-inertial frame & rotating frame also a non-inertial frame. (A)

ⓐ



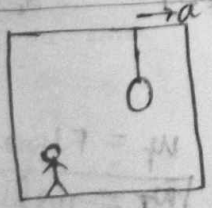
$N = M(g+a) = 10(10+2)$

$= 120N$



$N = Mg = 100N$ (pseudo force)

ⓑ

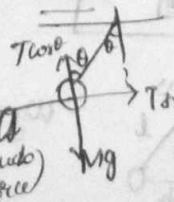


$T\sin\theta = ma$

$T\cos\theta = mg$

$\tan\theta = a/g$

FBD



$T^2\sin^2\theta + T^2\cos^2\theta = m^2a^2 + m^2g^2$

$T^2 = m^2(a^2+g^2)$

$T = \sqrt{m^2(a^2+g^2)}$