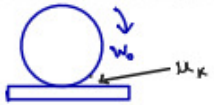
QUES 07:-

A disc of radius R is rotating with an angular speed ω_0 about a horizontal axis. It is placed on a horizontal table. The coefficient of kinetic friction is μ_k.

(a) What was the velocity of its centre of mass before being brought in contact with the table?
(b) What happens to the linear velocity of a point on its rim when placed in contact with the table?
(c) What happens to the linear speed of the centre of mass when disc is placed in contact with the table?
(d) Which force is responsible for the effects in (b) and (c).
(e) What condition should be satisfied for rolling to begin?
(f) Calculate the time taken for the rolling to begin.

⇒ Solution (a)]



$(velocity)_{initial} = 0$

initially ball is only rotating and not translating.

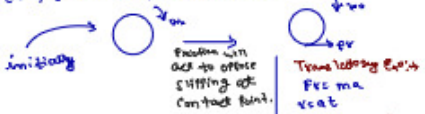
$\rightarrow V_{com} = 0$

b]

$V_{point} = \omega_0 R$ → initially

After it comes in contact of table,
⇒ The friction will oppose the relative motion (slipping) at that point, hence velocity (point) will decrease.

[C] Analyse the motion; see I will demonstrate in the figure how force will act.



Translatory motion
$F_{ext} = ma$
$f_r = ma_{cm}$

Rotatory motion
⇒ Clockwise

$\Sigma\tau = I\alpha$
$f_r R = I\alpha$
$\alpha = \frac{f_r R}{I}$ (1)

$\omega = \omega_0 - \frac{f_r R t}{I}$ (2)

$= \left(\omega_0 - \frac{f_r R t}{I}\right)$ (2)

(Clockwise)

Using this slipping condition is $V = \omega R$

$\frac{f_r t}{m} = \left(\omega_0 - \frac{f_r R t}{I}\right) R$

@ both eq
@ values

$I = \frac{mR^2}{2}$ → disc

$\frac{f_r t}{m} = (\omega_0 R) - \frac{2 f_r \cdot t}{m}$

$\frac{3 f_r t}{m} = \omega_0 R$

$t = \frac{(\omega_0 R\, m)}{3 f_r}$

→ {Can be used for future reference}

⇒ So Answer is simply v_{com} increases; And above is method to find Exact value

(d) friction force (as demonstrated in C Part)

(e) $(V_{com} = \omega R)$ → (as demonstrated in C Part)

(f) demonstrated in C Part.