QUES 04:-

A hoop of radius r and mass m rotating with an angular velocity ω_0 is placed on a rough horizontal surface. The initial velocity of the centre of the hoop is zero. What will be the velocity of the centre of the hoop when it ceases to slip? **[JEE Mains-2013]**

(1) $\frac{r\omega_0}{4}$ (2) $\frac{r\omega_0}{3}$ (3) $\frac{r\omega_0}{2}$ (4) $r\omega_0$

Ans) (2)

When it ceases to slip;

$v_{cm} = \omega r$

$\omega = \omega_0 - \frac{fr \cdot r}{I} t$ — (i)

$v_{cm} = \frac{fr}{m} t$ — (ii)

$\frac{fr}{m} t = \left(\omega_0 - \frac{fr \cdot r}{I} t\right) r$

hoop → ring ($mR^2 = I$)

$\frac{fr}{m} t = \omega_0 r - \frac{fr}{m} t$

$\boxed{t = \frac{m\omega_0 r}{2fr}}$

$fr = \mu mg$

$t = \frac{m\omega_0 r}{2\mu mg} = \frac{\omega_0 r}{2\mu g}$

$v_{cm} = \mu g \left(\frac{\omega_0 r}{2\mu g}\right)$

$= \frac{\omega_0 r}{2}$