One twirls a circular ring (of mass M and radius R) near the tip of one's finger as shown in Figure 1. In the process the finger never loses contact with the inner rim of the ring. The finger traces out the surface of a cone, shown by the dotted line. The radius of the path traced out by the point where the ring and the finger is in contact is r. The finger rotates with an angular velocity ω_0. The rotating ring rolls without slipping on the outside of a smaller circle described by the point where the ring and the finger is in contact (Figure 2). The coefficient of friction between the ring and the finger is μ and the acceleration due to gravity is g. **[JEE ADV. 2017]**

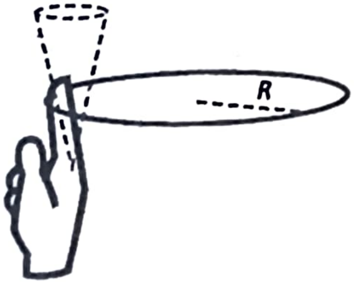

Figure 1

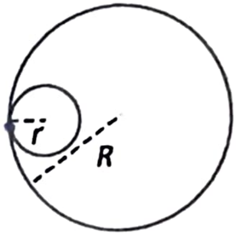

Figure 2

The total kinetic energy of the ring is

(A) $M\omega_0^2(R-r)^2$

(B) $\frac{1}{2}M\omega_0^2(R-r)^2$

(C) $M\omega_0^2R^2$

(D) $\frac{3}{2}M\omega_0^2(R-r)^2$

The correct answer is:

(A) Here $\omega_0(R-r)=\omega R \quad \therefore \quad \omega=\omega_o\left(\frac{R-r}{R}\right)$

Now total kinetic energy of the ring (Kinetic rotational + kinetic translational)

$$K.E_{total}=\frac{1}{2}(2MR^2)\omega^2=M\omega_0{}^2(R-r)^2$$