Answer on Question #56549 - Physics - Mechanics - Relativity

(D) All the particles on the surface have the same linear speed.

5-26 A plank P is placed on a solid cylinder S, which rolls on a horizontal surface. The two are of equal mass. There is no slipping at any of the surfaces in contact. The ratio of the kinetic energy of P to the kinetic energy of S is :

(A) 1 : 1
(B) 2 : 1
(C) 8 : 3
(D) 11 : 8

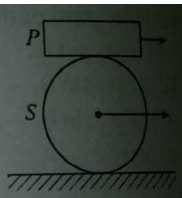

Figure 5.92

Solution.

Let cylinder is moving with speed V. The kinetic energy of S (E_s) is consist of the energy of translatory motion E_t and the energy of rotary motion E_r.

$$E_s = E_t + E_r;$$

$$E_t = \frac{mV^2}{2};$$

$$E_r = \frac{I\omega^2}{2} \ ,$$

Where I is moment of inertia of cylinder (for solid cylinder $I = \frac{mR^2}{2}$), ω is angular velocity ($\omega = \frac{V}{R}$). So

$$E_r = \frac{1}{2} * \frac{mR^2}{2} * \left(\frac{V}{R}\right)^2 = \frac{mV^2}{4};$$

$$E_s = \frac{mV^2}{2} + \frac{mV^2}{4} = \frac{3mV^2}{4}.$$

The speed the plank P (V_p) is equal to the speed of the top point cylinder which is twice more than speed of translatory motion. So $V_p = 2V$.

$$E_p = \frac{mV_p^2}{2} = \frac{m(2V)^2}{2} = 2mV^2;$$

$$\frac{E_p}{E_s} = \frac{2mV^2}{\frac{3mV^2}{4}} = \frac{8}{3}$$

Answer: C (8:3).