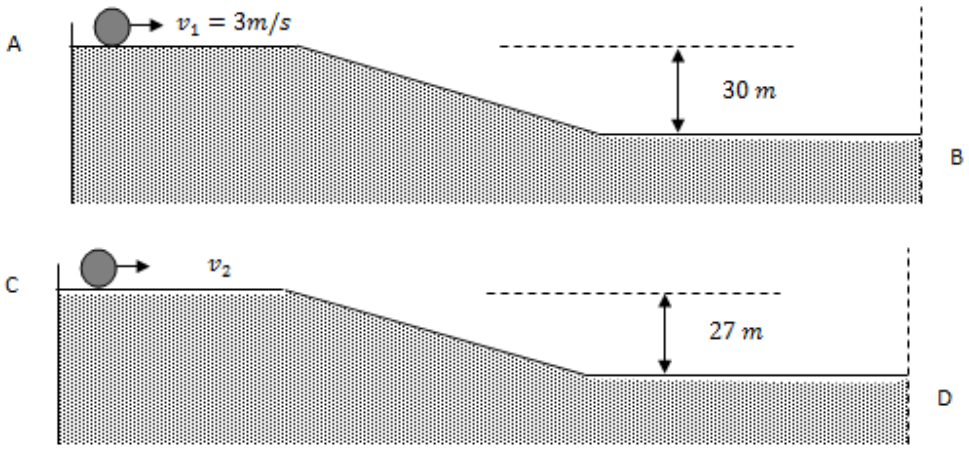
4. Two identical uniform discs roll without slipping on two different surfaces AB and CD (see figure) starting at A and C with linear speeds v_1 and v_2, respectively, and always remain in contact with the surfaces. If they reach B and D with the same linear speed and v_1 = 3 m/s, then v_2 in m/s is (g = 10 m/s^2)



Answer: When the disc roles we have Translational as well as rotational kinetic energy. By applying energy conservation law

Energy at A= Energy at B, $\frac{1}{2}m\left[1+\frac{K^2}{r^2}\right]{v_1}^2 + mg \times 30 = \frac{1}{2}m\left[1+\frac{K^2}{r^2}\right]v^2 \rightarrow (1)$

Energy at C = Energy at D, $\frac{1}{2}m\left[1+\frac{K^2}{r^2}\right]{v_2}^2 + mg \times 27 = \frac{1}{2}m\left[1+\frac{K^2}{r^2}\right]v^2 \rightarrow (2)$

For Disc Moment of inertia about the centre $\frac{1}{2}mr^2 = mk^2 \; or \; \frac{K^2}{r^2} = \frac{1}{2}$

From (1) and (2) $\frac{1}{2}m\left[1+\frac{K^2}{r^2}\right]{v_1}^2 + mg \times 30 = \frac{1}{2}m\left[1+\frac{K^2}{r^2}\right]{v_2}^2 + mg \times 27$

$or \frac{1}{2}\times\frac{3}{2}\times {v_1}^2 + 30g = \frac{1}{2}\times\frac{3}{2}\times {v_2}^2 + 27g$

$or \frac{3}{4}\times 3^2 + 3g = \frac{3}{4}\times {v_2}^2$

$or \; 9 + 40 = {v_2}^2$

$or \; v_2 = 7$

Answer: 7