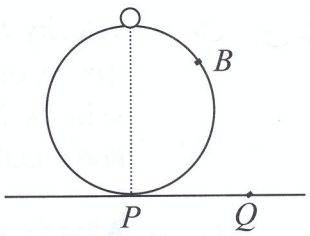
6. **(a)** A particle of mass m kg lies on the top of a smooth sphere of radius 2 m. The sphere is fixed on a horizontal table at P.

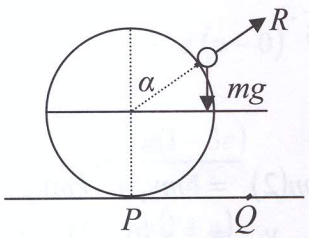
2010



The particle is slightly displaced and slides down the sphere. The particle leaves the sphere at B and strikes the table at Q.

Find **(i)** the speed of the particle at B

(ii) the speed of the particle on striking the table at Q.



(*i*) $mg\cos\alpha - R = \dfrac{mv^2}{2}$

$R = 0 \quad \Rightarrow v^2 = 2g\cos\alpha$ — 5

$\frac{1}{2}mv^2 = mg(2-2\cos\alpha)$

$\frac{1}{2}m(2g\cos\alpha) = mg(2-2\cos\alpha)$ — 5

$\Rightarrow \cos\alpha = \frac{2}{3}$

$\Rightarrow v = \sqrt{\dfrac{4g}{3}}$ m s^{-1} — 5

(*ii*) Total energy at Q = Total energy at B

$\frac{1}{2}mv_1^{\,2} = \frac{1}{2}mv^2 + mg(2+2\cos\alpha)$

$\frac{1}{2}mv_1^{\,2} = \frac{1}{2}m\left(\dfrac{4g}{3}\right) + mg\left(2+\dfrac{4}{3}\right)$ — 5

$\Rightarrow v_1 = \sqrt{8g}$ m s^{-1} — 5

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