Effect of Friction

<u>Solution:</u>

The correct answer is a.)

Energy Conservation with friction (which causes part of the potential energy to be converted to rotational K.E.) taken into account yields:

$$mgh = \left(\frac{1}{2}\right)mv_b^2 + \left(\frac{1}{2}\right)I\omega_b^2 \qquad \ldots (1)$$

For a solid sphere, moment of inertia about an axis passing through its center:

$$I = \left(\frac{2}{5}\right)mr^2 \qquad \ldots (2)$$

Effect of Friction

Also, friction causes the linear and angular speeds to be related linearly:

$$\omega = \left(\frac{v}{r}\right) \qquad \ldots (3)$$

Substituting (2) and (3) into (1), we get:

$$mgh = \left(\frac{1}{2}\right)\left[mv_b^2 + \left(\frac{2}{5}mr^2\right)\left(\frac{v_b}{r}\right)^2\right]$$

$$\Rightarrow \not{m}gh = \left(\frac{1}{2}\right)\not{m}v_b^2\left[1 + \left(\frac{2}{5}\right)\not{r}^2\left(\frac{1}{\not{r}^2}\right)\right] \Rightarrow \left(\frac{7}{10}\right)v_b^2 = gh \qquad \ldots (4)$$