

Solutions

Each answer shows the steps, then the **result**.

2.1

- rolling without slipping:

$$v = \omega r = (5 \text{ rad s}^{-1})(0.4 \text{ m})$$

- $v = \mathbf{2 \text{ m s}^{-1}}$

2.2

- Zero (instantaneously at rest)

2.3

- $\frac{1}{2}mv^2$ (translational) and $\frac{1}{2}I\omega^2$ (rotational)

2.4

- rolling without slipping, $v = \omega r$:

$$\omega = \frac{v}{r} = \frac{2 \text{ m s}^{-1}}{0.1 \text{ m}}$$

- $\omega = \mathbf{20 \text{ rad s}^{-1}}$

3.1 B

- $v = \omega r$

3.2 C

- the solid sphere (smallest rotational inertia per mr^2) wins

3.3

(a)

- The solid disc

(b)

- both lose the same PE, $mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$
- the hoop has the larger I (mr^2 against $\frac{1}{2}mr^2$), so more of its energy goes into spin and less into $\frac{1}{2}mv^2$; it moves more slowly and arrives later

3.4

(a)

- rolling without slipping, $v = \omega r$:

$$\omega = \frac{v}{r} = \frac{6 \text{ m s}^{-1}}{0.2 \text{ m}}$$

- $\omega = \mathbf{30 \text{ rad s}^{-1}}$

(b)

- $v = \omega r$ no longer holds – the speeds decouple