

Solutions

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

2.1

- When the net external torque is zero

2.2

- no external torque, so angular momentum is conserved:

$$I_i\omega_i = I_f\omega_f \quad \Rightarrow \quad \omega_f = \frac{I_i\omega_i}{I_f} = \frac{(6 \text{ kg m}^2)(2 \text{ rad s}^{-1})}{2 \text{ kg m}^2}$$

- $\omega_f = \mathbf{6 \text{ rad s}^{-1}}$

2.3

- It doubles

2.4

- No

3.1 B

- zero net external torque

3.2 C

- $L = I\omega$ is conserved, so $\omega_f = \frac{I_i}{I_f}\omega_i = 3\omega_i$

3.3

(a)

- angular momentum is conserved as the clay lands:

$$I_i\omega_i = I_f\omega_f \quad \Rightarrow \quad \omega_f = \frac{(4 \text{ kg m}^2)(3 \text{ rad s}^{-1})}{6 \text{ kg m}^2}$$

- $\omega_f = \mathbf{2 \text{ rad s}^{-1}}$

(b)

- Yes – no external torque acts on the turntable-plus-clay system

3.4

(a)

- Tucking lowers I ; since $I\omega$ is fixed, ω rises

(b)

- Gravity acts through the center of mass, giving no torque about it

3.5

(a)

- no external torque, so angular momentum is conserved:

$$I_i\omega_i = I_f\omega_f \quad \Rightarrow \quad \omega_f = \frac{(6.0 \text{ kg m}^2)(2.0 \text{ rad s}^{-1})}{2.0 \text{ kg m}^2}$$

- $\omega_f = \mathbf{6.0 \text{ rad s}^{-1}}$

(b)

- rotational kinetic energy before and after, $K = \frac{1}{2}I\omega^2$:

$$\Delta K = \frac{1}{2}(2.0 \text{ kg m}^2)(6.0 \text{ rad s}^{-1})^2 - \frac{1}{2}(6.0 \text{ kg m}^2)(2.0 \text{ rad s}^{-1})^2 = 36 \text{ J} - 12 \text{ J}$$

- $\Delta K = \mathbf{+24 \text{ J}}$
- the extra energy comes from internal work done in pulling the mass inwards