Exercise walk-through

Angular Momentum and Angular Impulse ▪ 6.3

eXercise

You must be able to

- define **angular momentum 角动量** of a rigid body as $L = I\omega$
- define **angular impulse 角冲量** as $\Delta L = \tau \, \Delta t$
- relate a net angular impulse to the change in a system's angular momentum

Method — Angular momentum

$L = I\omega$, measured in kg $\mathrm{m}^2\,\mathrm{s}^{-1}$ — the rotational partner of $p = mv$.

Method — Angular impulse

$\Delta L = \tau\,\Delta t$: a net torque acting for a time changes the angular momentum, just as $\vec{J} = \vec{F}\,\Delta t$ changes linear momentum.

Method — Example

A disc with $I = 2.0$ kg m^2 at $\omega = 3.0$ rad s^{-1} has $L = 6.0$ kg m^2 s^{-1}.

Practice 2.1 ▪ 1 mark

A disc of $I = 0.50$ kg m^2 spins at $\omega = 8.0$ rad s^{-1}. Find its angular momentum.

Solution 2.1

Method: Angular momentum

Worked steps

$L = I\omega = 0.50 \times 8.0 = 4.0$ kg m^2 s^{-1} B1.

Practice 2.2 ▪ 1 mark

A torque of 4.0 N m acts for 3.0 s. Find the angular impulse.

Solution 2.2

Method: Angular impulse

Worked steps

$\Delta L = \tau\,\Delta t = 4.0 \times 3.0 = 12$ kg m^2 s^{-1} B1.

Practice 2.3 ▪ 2 marks

A wheel's angular momentum changes by 12 kg $\mathrm{m}^2\,\mathrm{s}^{-1}$ in 2.0 s. Find the net torque.

Solution 2.3

Method: Angular impulse

Worked steps

$$\tau = \frac{\Delta L}{\Delta t} = \frac{12}{2.0} = 6.0 \text{ N m} \quad \text{M1 A1}.$$

Exam-style 3.1 ▪ 1 mark

The angular momentum of a rotating rigid body is

A $I\alpha$

B $I\omega$

C $\frac{1}{2}I\omega^2$

D $\tau\omega$

Solution 3.1

A $I\alpha$

B $I\omega$ ✓

C $\frac{1}{2}I\omega^2$

D $\tau\omega$

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

Angular impulse is equal to

A $\tau \Delta t$

B $I\alpha$

C Fd

D $\frac{1}{2} I\omega^2$

Solution 3.2

Method: Angular impulse

A $\tau \Delta t$ ✓

B $I\alpha$

C Fd

D $\frac{1}{2} I\omega^2$

Worked steps

A.

Exam-style 3.3 ▪ 1 mark

A flywheel of $I = 0.20$ kg m^2 spins at 30 rad s^{-1}. A constant friction torque of 0.60 N m acts on it.

(a) Find its initial angular momentum.

(b) Find the time for friction to bring it to rest.

Solution 3.3

Method: Angular impulse

Worked steps

(a) $L = I\omega = 0.20 \times 30 = 6.0$ kg m^2 s^{-1} B1. (b) $\Delta t = \dfrac{L}{\tau} = \dfrac{6.0}{0.60} = 10$ s M1 A1.