

6.3 Angular Momentum and Angular Impulse

Name: _____ Class: _____ Date: _____ Total: 9 marks

KEY WORDS angular momentum 角动量 • angular impulse 角冲量

Objective

Build the skills to answer exam questions on **angular momentum** and **angular impulse**.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ Angular momentum

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

■ 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.

■ Example

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

2 Practice

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

2.2 A torque of 4.0 N m acts for 3.0 s . Find the angular impulse. [1]

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

3 Exam-style questions

3.1 The angular momentum of a rotating rigid body is [1]

- A $I\alpha$
- B $I\omega$
- C $\frac{1}{2}I\omega^2$
- D $\tau\omega$

3.2 Angular impulse is equal to [1]

- A $\tau \Delta t$
- B $I\alpha$
- C Fd
- D $\frac{1}{2}I\omega^2$

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

(a) Find its initial angular momentum. [1]

(b) Find the time for friction to bring it to rest. [2]

Solutions

2.1 $L = I\omega = 0.50 \times 8.0 = 4.0 \text{ kg m}^2 \text{ s}^{-1}$.

2.2 $\Delta L = \tau \Delta t = 4.0 \times 3.0 = 12 \text{ kg m}^2 \text{ s}^{-1}$.

2.3 $\tau = \frac{\Delta L}{\Delta t} = \frac{12}{2.0} = 6.0 \text{ N m}$.

3.1 B.

3.2 A.

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