AP PHYSICS 1 • EXERCISE SHEET

6.3 Angular Momentum and Angular Impulse

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

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

2 Practice

2.1 A disc of $I = 0.50$ kg m^2 spins at $\omega = 8.0$ 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 kg $\text{m}^2\,\text{s}^{-1}$ 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 $I = 0.20$ 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]

4 Go further

- work through the **6.3 Angular Momentum and Angular Impulse** lesson on the **Learn** page;
- read the **Energy and Momentum of Rotating Systems** section of the AP Physics 1 handout on the **Know** page.

Solutions

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

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

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

3.1 **B**.

3.2 **A**.

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