

5.4 Rotational Inertia

Name: _____ Class: _____ Date: _____

Total: 10 marks**KEY WORDS** rotational inertia 转动惯量 • parallel-axis theorem 平行轴定理 • torque 力矩

Objective

Build the skills to answer exam questions on **rotational inertia**.**You must be able to:**

- define **rotational inertia** 转动惯量 (moment of inertia) as the resistance to a change in rotation
- explain that it depends on both the **mass** and its **distribution** about the axis
- calculate the rotational inertia of point masses with $I = \sum mr^2$
- use the **parallel-axis theorem** 平行轴定理, $I = I_{cm} + Md^2$

1 Worked examples

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

■ Rotational inertia of point masses

 $I = \sum mr^2$. Mass **far** from the axis contributes most (the r^2).

■ Common rigid bodies

Solid disc $I = \frac{1}{2}MR^2$; hoop $I = MR^2$; solid sphere $I = \frac{2}{5}MR^2$; rod about its centre $I = \frac{1}{12}ML^2$.

■ Parallel-axis theorem

 $I = I_{cm} + Md^2$, where d is the distance from the centre of mass to the new axis.

2 Practice

2.1 Two 0.50 kg masses sit 0.40 m from an axis. Find the total rotational inertia. [2]

2.2 State how the rotational inertia changes if the masses are moved farther from the axis. [1]

2.3 A solid disc has $M = 4.0$ kg and $R = 0.30$ m. Find its moment of inertia ($I = \frac{1}{2}MR^2$). [2]

3 Exam-style questions

3.1 The rotational inertia of an object depends on [1]

A	B
C	D

A its mass only

B its mass and how the mass is distributed about the axis

C its speed only

D the applied torque

3.2 For the same mass and radius, which shape has the **largest** rotational inertia? [1]

A	B
C	D

A solid disc

B hoop

C solid sphere

D rod about its centre

3.3 A 0.20 kg point mass is 0.50 m from an axis.

(a) Find its rotational inertia about that axis. [2]

(b) State its rotational inertia about a parallel axis passing through the mass itself. [1]