AP PHYSICS C: MECHANICS • EXERCISE SHEET

5.4 Rotational Inertia

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS rotational inertia转动惯量

Objective

Build the skills to answer exam questions on **rotational inertia**.

You must be able to:

- describe **rotational inertia** 转动惯量 I as resistance to a change in rotation
- use $I = \sum m_i r_i^2$ for point masses
- explain that mass farther from the axis contributes more
- recall that I depends on the mass distribution and the axis chosen

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Rotational inertia of point masses

$$I = \sum m_i r_i^2.$$

A 2 kg mass at $r = 3$ m from the axis has $I = 2 \times 3^2 = 18$ kg m^2.

■ Distance matters most

Because r is squared, mass far from the axis dominates. Moving a mass from 1 m to 2 m quadruples its contribution.

■ It depends on the axis

The same object has different I about different axes. A rod is easier to spin about its centre than about one end.

2 Practice

Now apply the methods above.

2.1 A 3 kg mass sits 2 m from the axis. Find its rotational inertia. [2]

2.2 State what rotational inertia measures. [1]

2.3 Two 1 kg masses sit at $r = 1$ m and $r = 2$ m. Find the total I. [2]

2.4 If a mass is moved twice as far from the axis, by what factor does its contribution to I change? [1]

3 Exam-style questions

3.1 Rotational inertia depends on [1]

A	B
C	D

A only the total mass
B the mass and how it is distributed about the axis
C only the speed
D the colour of the object

3.2 A point mass's contribution to rotational inertia is [1]

A	B
C	D

A mr
B mr^2
C $\frac{1}{2}mr^2$
D m/r

3.3 A 4 kg mass sits at $r = 1.5$ m and a 2 kg mass at $r = 3$ m on a light rod.

(a) Find the total rotational inertia. [2]

(b) State which mass contributes more, and why. [1]

3.4 A solid disc and a ring have the same mass and radius.

(a) State which has the larger rotational inertia. [1]

(b) Explain why, in terms of mass distribution. [2]