AP PHYSICS 1 • EXERCISE SHEET

6.1 Rotational Kinetic Energy

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS rotational kinetic energy 转动动能

Objective

Build the skills to answer exam questions on **rotational kinetic energy**.

You must be able to:

- define **rotational kinetic energy** 转动动能 as $K_{rot} = \frac{1}{2}I\omega^2$
- explain that it depends on both the **rotational inertia** and the **angular velocity**
- find the **total kinetic energy** of an object that both translates and rotates
- apply **conservation of energy** to systems that include rotation

1 Worked examples

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

■ **Rotational kinetic energy**

$K_{rot} = \frac{1}{2}I\omega^2$ — the rotational partner of $\frac{1}{2}mv^2$.

■ **Total kinetic energy of a rolling body**

$$K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2.$$

■ **A rolling race**

Rolling down a ramp, a shape with smaller $I/(mR^2)$ ties up less energy in rotation, so it reaches the bottom **faster**. A solid sphere beats a hoop.

2 Practice

2.1 A flywheel of $I = 0.50$ kg m^2 spins at $\omega = 4.0$ rad s^{-1}. Find its rotational kinetic energy. [2]

2.2 A rolling ball has 6.0 J of translational and 2.4 J of rotational kinetic energy. Find its total kinetic energy. [1]

2.3 State why a solid sphere rolls down a ramp faster than a hoop of the same mass and radius. [2]

3 Exam-style questions

3.1 Rotational kinetic energy is [1]

A B
C D

A $\frac{1}{2}I\omega$
B $\frac{1}{2}I\omega^2$
C $I\omega$
D $\frac{1}{2}mv^2$

3.2 A hoop and a disc of equal mass and radius roll from rest down the same ramp. The one reaching the bottom first is the [1]

A B
C D

A hoop
B disc
C they arrive together
D it depends on the mass

3.3 A disc of $I = 0.10$ kg m^2 spins at $\omega = 12$ rad s^{-1}.

(a) Find its rotational kinetic energy. [2]

(b) If this energy came from a 0.20 kg mass falling, find the height it fell (take $g = 10$ m s^{-2}). [2]