

6.1 Rotational Kinetic Energy

Name: _____ Class: _____ Date: _____

Total: 14 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:

- use **rotational kinetic energy** 转动动能: $K = \frac{1}{2}I\omega^2$
- recognise it as the analogue of $\frac{1}{2}mv^2$
- add translational and rotational kinetic energy for a rolling object
- find K , I , or ω given the others

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.

■ The rotational KE formula

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

A disc with $I = 0.5 \text{ kg m}^2$ spinning at $\omega = 4 \text{ rad s}^{-1}$ stores

$$K = \frac{1}{2}(0.5)(4)^2 = 4 \text{ J}.$$

■ The square of omega

Because ω is squared, doubling the spin rate quadruples the stored energy.

■ Rolling: two kinds of KE

A rolling object has both, so its total is

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

2 Practice

Now apply the methods above.

2.1 A wheel with $I = 2 \text{ kg m}^2$ spins at 3 rad s^{-1} . Find its rotational KE. [2]

2.2 If a spinning object's angular speed triples, by what factor does its rotational KE change? [1]

2.3 State the two terms in the total kinetic energy of a rolling object. [2]

2.4 A flywheel stores 18 J of rotational KE at $I = 4 \text{ kg m}^2$. Find its angular speed. [2]

3 Exam-style questions

3.1 Rotational kinetic energy is [1]

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

3.2 A rolling ball's total kinetic energy is [1]

- | | |
|---|---|
| A | B |
| C | D |
- A only $\frac{1}{2}mv^2$
 B only $\frac{1}{2}I\omega^2$
 C $\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$
 D zero

3.3 A solid disc has $I = 0.8 \text{ kg m}^2$ and spins at 5 rad s^{-1} .

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

(b) State its energy if the spin rate doubles. [1]

3.4 A rolling wheel has translational $\text{KE} = 12 \text{ J}$ and rotational $\text{KE} = 6 \text{ J}$.

(a) Find the total kinetic energy. [1]

(b) State the fraction stored in rotation. [1]