

6.2 Torque and Work

Name: _____ Class: _____ Date: _____

Total: 15 marks

KEY WORDS torque 力矩 • rotational work 转动功 • rotational power 转动功率
• rotational kinetic energy 转动动能

Objective

Build the skills to answer exam questions on **torque and work**.

You must be able to:

- calculate **rotational work** 转动功: $W = \tau\theta$
- use **rotational power** 转动功率: $P = \tau\omega$
- apply the rotational work-energy theorem: $W_{net} = \Delta K_{rot}$
- recognise these as analogues of $W = Fd$ and $P = Fv$

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.

■ Work done by a torque

$$W = \tau\theta,$$

with θ in radians. A 5 N m torque turning a wheel through 2π rad does $W = 5 \times 2\pi \approx 31.4$ J.

■ Rotational power

$$P = \tau\omega.$$

A motor delivering 4 N m to a shaft at 10 rad s^{-1} outputs $P = 40$ W.

■ Work-energy theorem

The net rotational work equals the change in rotational kinetic energy:

$$W_{net} = \Delta K_{rot} = \frac{1}{2}I\omega_f^2 - \frac{1}{2}I\omega_i^2.$$

2 Practice

Now apply the methods above.

2.1 A 6 N m torque turns a wheel through 4 rad. Find the work done. [2]

2.2 A motor supplies 8 N m at 5 rad s^{-1} . Find the power. [2]

2.3 State what the net rotational work done on a body equals. [1]

2.4 In $W = \tau\theta$, in what unit must θ be? [1]

3 Exam-style questions

3.1 The work done by a constant torque is [1]

- | | |
|---|---------------|
| A | τ/θ |
| B | $\tau\theta$ |
| C | $\tau\omega$ |
| D | $I\alpha$ |

3.2 Rotational power is the analogue of [1]

- | | |
|---|----------|
| A | $W = Fd$ |
| B | $P = Fv$ |
| C | $F = ma$ |
| D | $p = mv$ |

3.3 A motor applies 10 N m while a wheel turns through 3 rad in 2 s.

(a) Find the work done. [2]

(b) Find the average power. [2]

3.4 A net torque does 50 J of work on a wheel with $I = 4 \text{ kg m}^2$, starting from rest.

(a) State the change in rotational kinetic energy. [1]

(b) Find the final angular speed. [2]