

6.2 Torque and Work

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS rotational kinetic energy • rotational power

Objective

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

You must be able to:

- calculate the **work done by a torque** , $W = \tau \Delta\theta$
- relate the work done by a net torque to the change in **rotational kinetic energy**
- define **rotational power** as $P = \tau\omega$
- find the work from the **area** under a torque-versus-angle graph

1 Key knowledge and worked examples

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

■ Work by a torque

$W = \tau \Delta\theta$, with $\Delta\theta$ in radians. This is the rotational partner of $W = Fd$.

■ The rotational work-energy theorem

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

■ Rotational power

$P = \tau\omega$. A torque of 8.0 N m through $\Delta\theta = 2.0$ rad does $W = 16$ J.

2 Practice

2.1 A torque of 5.0 N m turns a wheel through 4.0 rad. Find the work done. [1]

2.2 A motor applies 20 N m at $\omega = 15$ rad s⁻¹. Find its power output. [2]

2.3 A net work of 30 J is done on a flywheel starting from rest. State its final rotational kinetic energy. [1]

3 Exam-style questions

3.1 The work done by a torque is [1]

- ☐ **A** $\tau\omega$
B $\tau \Delta\theta$
C $I\alpha$
D $\frac{1}{2}I\omega^2$

3.2 Rotational power is equal to [1]

- ☐ **A** τ/ω
B $\tau\omega$
C $\tau + \omega$
D $I\alpha$

3.3 A wheel of $I = 0.40 \text{ kg m}^2$, initially at rest, has a 2.0 N m torque applied through 10 rad.

(a) Find the work done. [2]

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

Solutions

Each answer shows the steps, then the **result**.

2.1

- $W = \tau \Delta\theta = 5.0 \times 4.0 = 20 \text{ J}$

2.2

- $P = \tau\omega = 20 \times 15 = 300 \text{ W}$

2.3

- 30 J (all the net work becomes rotational kinetic energy)

3.1 B

- $\tau \Delta\theta$.

3.2 B

- $\tau\omega$.

3.3

(a)

- $W = \tau \Delta\theta = 2.0 \times 10 = 20 \text{ J}$

(b)

- $\frac{1}{2}I\omega^2 = 20 \Rightarrow \omega = \sqrt{\frac{2(20)}{0.40}} = 10 \text{ rad s}^{-1}$