AP PHYSICS C: MECHANICS • EXERCISE SHEET

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:

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

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 $I = 4$ kg m^2, starting from rest.

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

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

Solutions

2.1 $W = \tau\theta = 6 \times 4 = 24$ J.

2.2 $P = \tau\omega = 8 \times 5 = 40$ W.

2.3 The change in its rotational kinetic energy.

2.4 Radians.

3.1 **B** — $W = \tau\theta$.

3.2 **B** — $P = \tau\omega$ mirrors $P = Fv$.

3.3 (a) $W = 10 \times 3 = 30$ J. (b) $P = W/t = 30/2 = 15$ W.

3.4 (a) $\Delta K_{rot} = 50$ J. (b) $\frac{1}{2}I\omega^2 = 50 \Rightarrow \omega = \sqrt{100/4} = 5$ rad s^{-1}.