Exercise walk-through

Torque and Work ▪ 6.2

eXercise

You must be able to

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

Method — Work by a torque

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

Method — The rotational work-energy theorem

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

Method — Rotational power

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

Practice 2.1 ▪ 1 mark

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

Solution 2.1

Method: Rotational power

Worked steps

$W = \tau\,\Delta\theta = 5.0 \times 4.0 = 20$ J **B1**.

Practice 2.2 ▪ 2 marks

A motor applies 20 N m at $\omega = 15$ rad s^{-1}. Find its power output.

Solution 2.2

Method: Rotational power

Worked steps

$P = \tau\omega = 20 \times 15 = 300$ W M1 A1.

Practice 2.3 ▪ 1 mark

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

Solution 2.3

Method: The rotational work-energy theorem

Worked steps

30 J (all the net work becomes rotational kinetic energy) B1.

Exam-style 3.1 ▪ 1 mark

The work done by a torque is

A $\tau\omega$

B $\tau\,\Delta\theta$

C $I\alpha$

D $\frac{1}{2}I\omega^2$

Solution 3.1

Method: Work by a torque

A $\tau\omega$

B $\tau\,\Delta\theta$ ✓

C $I\alpha$

D $\frac{1}{2}I\omega^2$

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

Rotational power is equal to

A τ/ω

B $\tau\omega$

C $\tau + \omega$

D $I\alpha$

Solution 3.2

Method: Rotational power

A τ/ω

B $\tau\omega$ ✓

C $\tau + \omega$

D $I\alpha$

Worked steps

B.

Exam-style 3.3 ▪ 2 marks

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

(a) Find the work done.

(b) Find the final angular velocity.

Solution 3.3

Method: Rotational power

Worked steps

(a) $W = \tau\,\Delta\theta = 2.0 \times 10 = 20$ J M1 A1. (b) $\frac{1}{2} I\omega^2 = 20 \Rightarrow \omega = \sqrt{\frac{2(20)}{0.40}} = 10$ rad s^{-1} M1 A1.