AP PHYSICS C: MECHANICS • EXERCISE SHEET

5.1 Rotational Kinematics

Name: _____ Class: _____ Date: _____ **Total: 15 marks**

KEY WORDS angular acceleration 角加速度 • angular velocity 角速度 • radians 弧度 • torque 力矩

Objective

Build the skills to answer exam questions on **rotational kinematics**.

You must be able to:

- use **angular velocity** 角速度 ω and **angular acceleration** 角加速度 α
- apply the rotational equations of motion (analogues of the linear ones)
- convert between revolutions, degrees, and radians
- relate constant α to ω and θ over time

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 analogues

Position, velocity, and acceleration become angle θ, angular velocity ω, and angular acceleration α. For constant α:

$$\omega = \omega_0 + \alpha t, \qquad \theta = \omega_0 t + \tfrac{1}{2}\alpha t^2.$$

■ Using the equations

A wheel starts from rest ($\omega_0 = 0$) with $\alpha = 3$ rad s^{-2}. After 4 s:

$$\omega = 0 + 3(4) = 12 \text{ rad s}^{-1}.$$

■ Radians

One full turn is 2π rad. Angular quantities in the equations must be in radians.

2 Practice

Now apply the methods above.

2.1 A disc spins at a constant 6 rad s^{-1}. State its angular acceleration. [1]

2.2 A wheel starts from rest with $\alpha = 2$ rad s^{-2}. Find ω after 5 s. [2]

2.3 How many radians are in one full revolution? [1]

2.4 A flywheel at 10 rad s^{-1} decelerates at 2 rad s^{-2}. Find ω after 3 s. [2]

3 Exam-style questions

3.1 The rotational analogue of linear acceleration is [1]

- **A** angular velocity
- **B** angular acceleration
- **C** torque
- **D** angular momentum

3.2 A wheel starts from rest and reaches 20 rad s^{-1} in 4 s. Its angular acceleration is [1]

- **A** 5 rad s^{-2}
- **B** 80 rad s^{-2}
- **C** 16 rad s^{-2}
- **D** 0.2 rad s^{-2}

3.3 A turntable starts from rest with $\alpha = 4$ rad s^{-2}.

(a) Find its angular velocity after 3 s. [2]

(b) Find the angle turned in that time. [2]

3.4 A fan blade slows from 30 rad s^{-1} to rest in 6 s at constant deceleration.

(a) Find the angular acceleration. [2]

(b) State its sign and what it means. [1]

Solutions

2.1 Zero (constant ω).

2.2 $\omega = \omega_0 + \alpha t = 0 + 2(5) = 10$ rad s^{-1}.

2.3 2π rad.

2.4 $\omega = 10 + (-2)(3) = 4$ rad s^{-1}.

3.1 B — angular acceleration.

3.2 A — $\alpha = 20/4 = 5$ rad s^{-2}.

3.3 (a) $\omega = 4(3) = 12$ rad s^{-1}. (b) $\theta = \frac{1}{2}(4)(3)^2 = 18$ rad.

3.4 (a) $\alpha = (0 - 30)/6 = -5$ rad s^{-2}. (b) Negative — it is decelerating (slowing the spin).