5. Torque and Rotational Dynamics

Starter Quiz · 课前小测

AP Physics C: Mechanics Name: _____ Score: _____

1. A disk spins at $f = 4$ turns per second. What is its angular velocity (in rad/s)?

   _____ rad/s

2. A wheel of radius 0.5 m spins at $\omega = 8\ \frac{\text{rad}}{\text{s}}$. The linear speed of a rim point (in m/s)?

   _____ m/s

3. A 20 N force pushes perpendicular to a wrench 0.25 m from the bolt. What torque results (in N · m)?

   _____ N · m

4. Two 3 kg masses sit 2 m from an axis on a light rod. Total rotational inertia (in kg · m^2)?

   _____ kg · m^2

5. A 20 kg child sits 3 m left of a pivot. A 30 kg child balances it on the right. How far from the pivot must they sit (in m)?

   _____ m

6. Angular acceleration α is the rotational twin of which linear quantity?

   ☐ position

   ☐ velocity

   ☐ acceleration

   ☐ mass

7. Two points on the same rigid spinning disk, at different radii, share the same...

   ☐ linear speed

   ☐ angular velocity

   ☐ distance travelled

   ☐ centripetal acceleration

8. Moving a mass twice as far from the axis changes its contribution to I by a factor of...

   ☐ 2

   ☐ 4

   ☐ 1 (no change)

   ☐ 0.5

9. For an object to be in full static equilibrium, which must be true?

- ☐ net force is zero only
- ☐ net torque is zero only
- ☐ both net force and net torque are zero
- ☐ the object must be at rest and never moving

10. In $\tau = I\alpha$, rotational inertia I plays the role of which quantity in $F = ma$?
    - ☐ force
    - ☐ mass
    - ☐ acceleration
    - ☐ velocity

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Answers · 答案

AP Physics C: Mechanics

1. **25.13 rad/s**

   $\omega = 2\pi f = 2\pi(4) \approx 25.13 \ \frac{\text{rad}}{\text{s}}$.

2. **4 m/s**

   $v = \omega r = 8 \times 0.5 = 4 \ \frac{\text{m}}{\text{s}}$.

3. **5 N · m**

   $\tau = rF \sin 90^\circ = 0.25 \times 20 \times 1 = 5 \ \text{N} \cdot \text{m}$.

4. **24 kg · m^2**

   $I = \sum mr^2 = 3(2)^2 + 3(2)^2 = 12 + 12 = 24 \ \text{kg} \cdot \text{m}^2$.

5. **2 m**

   Balance torques, $20 \times 3 = 30 \times x$, so $x = 60/30 = 2$ m.

6. **acceleration**

   $\alpha = d\omega/dt$ mirrors $a = dv/dt$ – angular acceleration is the twin of linear acceleration.

7. **angular velocity**

   A rigid body turns as one, so every point has the same ω. Linear speed differs with radius.

8. **4**

   $I \propto r^2$, so doubling r multiplies the contribution by $2^2 = 4$.

9. **both net force and net torque are zero**

   Static equilibrium requires zero net force *and* zero net torque.

10. **mass**

    Torque ~ force, I ~ mass, α ~ acceleration. So I is the rotational mass.