5. Torque and Rotational Dynamics

Starter Quiz ·

AP Physics 1 Name: _____ Score: _____

1. A wheel goes from rest to $\omega = 12$ $\frac{\text{rad}}{\text{s}}$ in 4 s. What is its angular acceleration, in $\frac{\text{rad}}{\text{s}^2}$?

   _____ rad/s^2

2. A point is 0.3 m from a wheel's axis, spinning at $\omega = 10$ $\frac{\text{rad}}{\text{s}}$. What is its linear speed, in $\frac{\text{m}}{\text{s}}$?

   _____ m/s

3. A 20 N force acts at right angles, 0.4 m from a bolt. What is the torque, in N · m?

   _____ N · m

4. Two 0.5 kg balls sit 2 m from the axis on a light rod. What is the rotational inertia, in kg · m^2?

   _____ kg · m^2

5. A 300 N child sits 2 m from a seesaw pivot. How far from the pivot must a 400 N child sit to balance it, in metres?

   _____ m

6. In the rotational second law $\tau = I\alpha$, which quantity plays the role of mass?

   ☐ rotational inertia I

   ☐ angular acceleration α

   ☐ torque τ

   ☐ angular velocity ω

7. How many radians are there in one complete turn?

   ☐ π

   ☐ 1

   ☐ 360

   ☐ 2π

8. On a rigid spinning disk, how do a rim point and a point near the hub compare?

   ☐ the hub point does not move

   ☐ same ω, but the rim has larger v

   ☐ same v, but the rim has larger ω

   ☐ same ω and same v

9. A force is aimed straight through the pivot. What torque does it produce?

- ☐ a negative torque
- ☐ zero
- ☐ half the maximum
- ☐ the maximum

10. Rotational inertia depends on:
    - ☐ the speed of rotation
    - ☐ the total mass only
    - ☐ the colour of the object
    - ☐ the mass and how it is distributed about the axis

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Answers ·

AP Physics 1

1. **3 rad/s^2**

   $\alpha = \Delta\omega/\Delta t = 12/4 = 3\ \frac{\text{rad}}{\text{s}^2}$.

2. **3 m/s**

   $v = r\omega = 0.3 \times 10 = 3\ \frac{\text{m}}{\text{s}}$.

3. **8 N · m**

   $\tau = rF\sin 90^\circ = 0.4 \times 20 \times 1 = 8\ \text{N} \cdot \text{m}$.

4. **4 kg · m^2**

   $I = \sum mr^2 = 2 \times (0.5 \times 2^2) = 4\ \text{kg} \cdot \text{m}^2$.

5. **1.5 m**

   $300 \times 2 = 400 \times d_2 \Rightarrow d_2 = 600/400 = 1.5\ \text{m}$.

6. **rotational inertia I**

   Rotational inertia I is the rotational analog of mass – the resistance to angular acceleration.

7. 2π

   One full circle is 2π radians (≈ 6.28).

8. **same ω, but the rim has larger v**

   All points share ω; the rim has a larger radius, so $v = r\omega$ is larger there.

9. **zero**

   $\theta = 0$ means $\sin\theta = 0$, so $\tau = 0$ – a force through the pivot cannot turn it.

10. **the mass and how it is distributed about the axis**

    $I = \sum mr^2$ depends on both the mass and its distance from the axis (squared).