

6. Energy and Momentum of Rotating Systems

Starter Quiz ·

AP Physics C: Mechanics

Name: _____ Score: _____

1. A wheel with $I = 2 \text{ kg} \cdot \text{m}^2$ spins at $\omega = 3 \text{ rad/s}$. Its rotational kinetic energy (in J)?
_____ J
2. A constant torque of $6 \text{ N} \cdot \text{m}$ turns a wheel through $\theta = 4 \text{ rad}$. The work done (in J)?
_____ J
3. A flywheel with $I = 5 \text{ kg} \cdot \text{m}^2$ spins at $\omega = 4 \text{ rad/s}$. Its angular momentum (in $\text{kg} \cdot \text{m}^2/\text{s}$)?
_____ $\text{kg} \cdot \text{m}^2/\text{s}$
4. A skater with $I_i = 8 \text{ kg} \cdot \text{m}^2$ spins at 2 rad/s , then pulls in to $I_f = 4 \text{ kg} \cdot \text{m}^2$. Her new angular speed (in rad/s)?
_____ rad/s
5. A wheel of radius 0.3 m rolls without slipping at $\omega = 10 \text{ rad/s}$. Its forward speed (in m/s)?
_____ m/s
6. A satellite moves to a lower circular orbit. Its orbital speed...
 - ☐ stays the same
 - ☐ increases
 - ☐ decreases
7. If you triple a wheel's angular speed but keep its rotational inertia, its rotational kinetic energy becomes...
 - ☐ 6 times larger
 - ☐ 9 times larger
 - ☐ 3 times larger
 - ☐ unchanged
8. Positive net rotational work makes a spinning object speed up.
 - ☐ True ☐ False
9. Angular momentum $L = I\omega$ is the rotational twin of which linear quantity?
 - ☐ momentum $p = mv$
 - ☐ force $F = ma$
 - ☐ energy $\frac{1}{2}mv^2$

10. Angular momentum is conserved exactly when...

- ☐ the object is at rest
- ☐ no forces act at all
- ☐ the net external torque is zero

AP Physics C: Mechanics1. **9 J**

$$K = \frac{1}{2}I\omega^2 = \frac{1}{2}(2)(3)^2 = 9 \text{ J.}$$

2. **24 J**

$$W = \tau\theta = 6 \times 4 = 24 \text{ J.}$$

3. **20 kg · m²/s**

$$L = I\omega = 5 \times 4 = 20 \text{ kg} \cdot \text{m}^2/\text{s.}$$

4. **4 rad/s**

$$I_i\omega_i = I_f\omega_f \Rightarrow 8 \times 2 = 4 \times \omega_f, \text{ so } \omega_f = 4 \text{ rad/s.}$$

5. **3 m/s**

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

6. **increases**

$$v = \sqrt{GM/r}, \text{ so a smaller } r \text{ gives a larger } v.$$

7. **9 times larger**

$$\omega \text{ is squared, so } 3^2 = 9 \text{ times the energy.}$$

8. **True**

$$W_{\text{net}} = \Delta K_{\text{rot}}; \text{ positive work raises the rotational kinetic energy, so } \omega \text{ rises.}$$

9. **momentum** $p = mv$

$$I \text{ mirrors } m \text{ and } \omega \text{ mirrors } v, \text{ so } L = I\omega \text{ mirrors } p = mv.$$

10. **the net external torque is zero**

$$\text{Zero net external torque means } dL/dt = 0, \text{ so } L \text{ stays constant.}$$