

6. Energy and Momentum of Rotating Systems

Starter Quiz ·

AP Physics 1

Name: _____ Score: _____

1. A wheel with $I = 4 \text{ kg} \cdot \text{m}^2$ spins at $\omega = 3 \frac{\text{rad}}{\text{s}}$. What is its rotational kinetic energy, in joules?
_____ J
2. A constant torque of $5 \text{ N} \cdot \text{m}$ turns a wheel through 4 rad . How much work is done, in joules?
_____ J
3. A disk with $I = 2 \text{ kg} \cdot \text{m}^2$ spins at $\omega = 5 \frac{\text{rad}}{\text{s}}$. What is its angular momentum, in $\text{kg} \cdot \text{m}^2/\text{s}$?
_____ $\text{kg} \cdot \text{m}^2/\text{s}$
4. A skater with $I_1 = 6 \text{ kg} \cdot \text{m}^2$ spins at $2 \frac{\text{rad}}{\text{s}}$, then pulls in to $I_2 = 2 \text{ kg} \cdot \text{m}^2$. What is her new ω , in $\frac{\text{rad}}{\text{s}}$?
_____ rad/s
5. The total kinetic energy of a rolling object is:
☐ $\frac{1}{2}mv^2$ only
☐ $\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$
☐ $\frac{1}{2}I\omega^2$ only
☐ $mv^2 + I\omega^2$
6. What provides the centripetal force that keeps a satellite in a circular orbit?
☐ air resistance
☐ the satellite's engines
☐ an outward centrifugal force
☐ gravity
7. Which is the formula for rotational kinetic energy?
☐ $\frac{1}{2}mv^2$
☐ $I\omega$
☐ $\frac{1}{2}I\omega^2$
☐ mgh
8. A torque of $5 \text{ N} \cdot \text{m}$ turns a shaft at $\omega = 2 \frac{\text{rad}}{\text{s}}$. What is the power, in watts?
_____ W
9. Angular momentum is the rotational twin of linear momentum $p = mv$. Which is its formula?

☐ $\frac{1}{2}I\omega^2$

☐ $I\omega$

☐ $\tau\theta$

☐ $I\alpha$

10. Angular momentum is conserved when there is no external:

☐ motion

☐ torque

☐ force

☐ friction of any kind

AP Physics 11. **18 J**

$$E_k = \frac{1}{2}I\omega^2 = \frac{1}{2}(4)(9) = 18 \text{ J.}$$

2. **20 J**

$$W = \tau\theta = 5 \times 4 = 20 \text{ J.}$$

3. **10 kg · m²/s**

$$L = I\omega = 2 \times 5 = 10 \text{ kg} \cdot \text{m}^2/\text{s}.$$

4. **6 rad/s**

$$I_1\omega_1 = I_2\omega_2 \Rightarrow 12 = 2\omega_2 \Rightarrow \omega_2 = 6 \frac{\text{rad}}{\text{s}}.$$

5. $\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

A rolling body moves and spins, so its KE is the sum $\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$.

6. **gravity**

Gravity is the centripetal force: $\frac{GMm}{r^2} = \frac{mv^2}{r}$.

7. $\frac{1}{2}I\omega^2$

It is $\frac{1}{2}I\omega^2$ – the rotational twin of $\frac{1}{2}mv^2$.

8. **10 W**

$$P = \tau\omega = 5 \times 2 = 10 \text{ W.}$$

9. $I\omega$

$L = I\omega$ – inertia times angular velocity, the twin of mv .

10. **torque**

With no external **torque**, L cannot change: $I_1\omega_1 = I_2\omega_2$.