Torque

The following questions are concept based and a recap of the lesson. For questions with higher level difficulty, watch videos in the course.

1. Which of the following correctly gives the torque τ on a particle?
A. $\tau = F \times r$
B. $\tau = r \times F$
C. $\tau = r \cdot F$
D. $\tau = F / r$

Correct answer: B
Explanation: By definition, torque is the cross product of the position vector r (from O to the point of force application) and the force F. The order matters: $\tau = r \times F$, not $F \times r$

2. Magnitude of torque is given by $\tau = r F \sin\phi$. What does multiplying $\sin\phi$ to r F give?
A. Component of r parallel to F
B. Component of F parallel to r
C. Component of F perpendicular to r
D. Component of r perpendicular to F

Correct answer: C
Explanation: $\sin\phi$ isolates the component of F perpendicular to r ($F_\perp = F \sin\phi$). Only this perpendicular component produces rotation.

3. A force of 8 N acts at the end of a 0.25 m long lever arm, making an angle of 60° with the lever. What is the torque magnitude?
A. 1 N·m
B. √3 N·m

C. 4 N·m
D. 8 N·m

Correct answer: B
Explanation: $\tau = r F \sin\phi = 0.25\ m \times 8\ N \times \sin 60° = \sqrt{3}\ N\cdot m$.

4. If $\phi = 0°$ between r and F, what is the torque?
A. Maximum
B. Zero
C. Equal to r F
D. Equal to r F cos ϕ

Correct answer: B
Explanation: $\sin 0° = 0 \Rightarrow \tau = r F (0) = 0$. When F is parallel to r, no rotational "push" is applied.

5. Which of these is an alternative expression for torque using the moment arm $r_\perp$?
A. $\tau = r F \cos\phi$
B. $\tau = r_\perp F$
C. $\tau = r F \sin^2\phi$
D. $\tau = r_\perp F \cos\phi$

Correct answer: B
Explanation: Moment arm $r_\perp = r \sin\phi$ is the perpendicular distance from O to the line of action of F. Thus $\tau = r_\perp F$.

6. At what angle ϕ between r and F is the torque maximized?
A. 0°
B. 45°
C. 90°
D. 180°

Correct answer: C
Explanation: $\sin\phi$ is maximum (1) when $\phi = 90°$, so $\tau = r F$.

7. A particle lies at A(3 m, 0) in the xy plane and a force F = (0, 4 N) acts on it. What is the direction of τ?

A. +x-axis
B. –x-axis
C. +z-axis
D. –z-axis

Correct answer: C
Explanation: r = 3 i, F = 4 j. Using r × F and the right-hand rule (i → j), τ points along +k (the +z-axis).

8. In the "perpendicular component" interpretation, torque can be seen as τ = r F⊥. What is F⊥?
A. F cos ϕ
B. F sin ϕ
C. F tan ϕ
D. F cot ϕ

Correct answer: B
Explanation: F⊥ is the component of F perpendicular to r: F⊥ = F sin ϕ.

9. When pushing open a door, why is it harder to push near the hinge than at the handle?
A. F is smaller near the hinge
B. r⊥ is smaller near the hinge
C. ϕ is zero at the handle
D. r is zero at the handle

Correct answer: B
Explanation: Near the hinge the moment arm r⊥ is small, so τ = r⊥ F is small. Farther from the hinge (larger r⊥), torque increases, making it easier to open.

10. Why must torque always be calculated as r × F and never as F × r?
A. F × r gives the same magnitude but wrong direction
B. F × r gives a scalar, not a vector
C. r × F follows the chosen right-hand convention for angular momentum and torque
D. F × r is undefined in vector algebra

Correct answer: C
Explanation: The cross product is anti-commutative: F × r = –(r × F). Using r × F ensures consistency with the right-hand rule and with angular momentum conventions.