

QUIZ: TORQUE & STATICS (DAYS 1–4)

Instructions: Show all work for full credit. Partial credit is available on FRQs. Calculator permitted. Time: ~40 minutes. Total: 38 points.

PART I: MULTIPLE CHOICE (3 PTS EACH)

1 Angular Kinematics

A wheel accelerates from rest at $\alpha = 5.0 \text{ rad/s}^2$. After 4.0 s, the angular velocity is:

- (A) 10 rad/s (B) 20 rad/s (C) 40 rad/s (D) 80 rad/s

Answer: _____

2 Linear-Angular Relationship

Two points on a spinning disk: Point P is at the rim (radius R) and Point Q is at radius $R/2$. Which statement is true?

- (A) P and Q have the same linear speed
(B) P has twice the angular velocity of Q
(C) P has twice the linear speed of Q
(D) P and Q have the same centripetal acceleration

Answer: _____

3 Torque Calculation

A 0.40 m wrench is used to loosen a bolt. A force of 60 N is applied at the end of the wrench at 90° to the wrench. The torque about the bolt is:

- (A) 12 N·m (B) 24 N·m (C) 48 N·m (D) 150 N·m

Answer: _____

4 Equilibrium Conditions

A beam is in static equilibrium. A student claims " $\Sigma F = 0$ is sufficient for equilibrium." Which counterexample disproves this?

- (A) A book resting on a table
(B) A ball in free fall
(C) Two equal forces applied at opposite ends of a beam in opposite directions (a couple)
(D) A car moving at constant velocity

Answer: _____

5 Rotational Kinematics

A disk decelerates uniformly from 120 rad/s to rest in 6.0 s. The total angle turned is:

- (A) 20 rad (B) 360 rad (C) 720 rad (D) 1440 rad

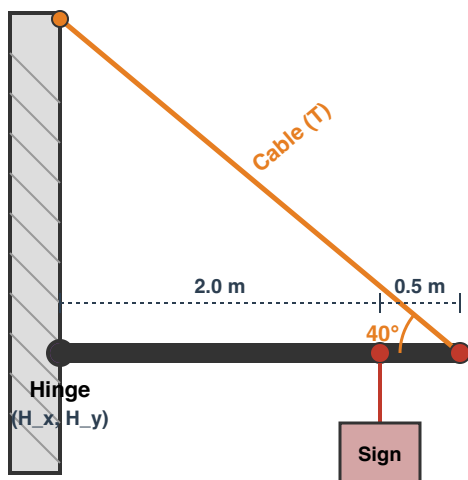
Answer: _____

FRQ 1 Torque Calculation (12 pts)

A horizontal meterstick is shown with a pivot (purple triangle) at the 30 cm mark. A red mass labeled "0.50 kg" is suspended from the 10 cm mark. The center of mass (COM) is indicated by a dashed line at the 30 cm mark, labeled "20 cm (COM)". The distance from the pivot to the mass is labeled "20 cm". The meterstick is marked from 0 to 100 cm.

FRQ 2 Shop Sign / Statics (15 pts)

A horizontal beam of length 2.5 m and mass 12 kg is attached to a wall by a hinge at the left end. A cable attached to the right end makes a 40° angle with the beam and connects to the wall above the hinge. A 25 kg sign hangs from a point 2.0 m from the wall.



(a) (3 pts) Calculate the weight of the beam and the weight of the sign.

(b) (5 pts) Taking torques about the hinge, find the tension T in the cable. Show your work clearly.

(c) (4 pts) Find the horizontal and vertical components of the hinge force.

(d) (3 pts) The cable can withstand a maximum tension of 500 N. What is the maximum sign mass that can be hung at the 2.0 m mark? (Assume the beam mass stays the same.)

FRQ 3 Angular Kinematics & Circular Motion (8 pts)

A centrifuge starts from rest and accelerates uniformly. After 15 s, it reaches 8000 rpm.

(a) (3 pts) Convert 8000 rpm to rad/s. Find the angular acceleration α .

(b) (3 pts) How many revolutions does the centrifuge make during this 15 s spin-up?

(c) (2 pts) A test tube is 0.12 m from the rotation axis. At full speed, what is the centripetal acceleration of the tube? Express as a multiple of g .

End of Quiz — Check your work. Make sure all FRQs show complete reasoning and proper units.