Name: _____ Date: _____ Class Period: _____

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

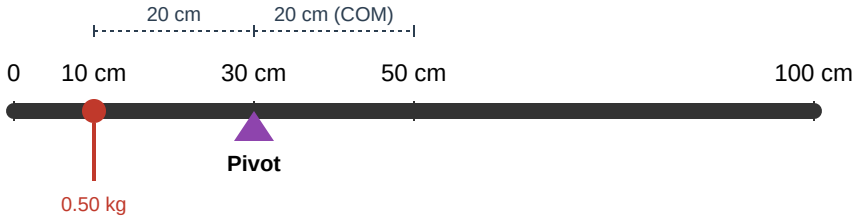
Answer: _____

5 Rotational Kinematics

PART II: FREE RESPONSE

FRQ 1 Torque Calculation (12 pts)

A uniform meter stick (mass 0.20 kg) is pivoted at the 30 cm mark. A 0.50 kg mass hangs from the 10 cm mark.



(a) (3 pts) Draw a free-body diagram of the meter stick. Label all forces and the distances from the pivot where they act. (Include weight of stick at center of mass.)

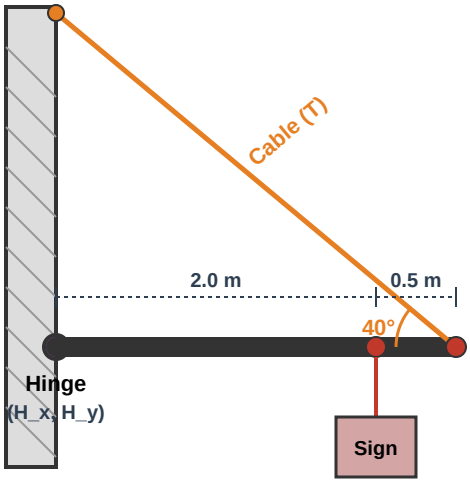
(b) (4 pts) Calculate the net torque about the pivot. Is the system in equilibrium?

(c) (3 pts) Where should a 0.30 kg mass be placed to put the system in equilibrium?

(d) (2 pts) If the added mass in (c) is removed, describe the initial motion of the meter stick. Which direction does it rotate and why?

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.