Name:_____ ID:_____

Physics 202 Ecampus

Midterm Exam 1

1/19/2022

Collaboration is not allowed. Allowed on your desk are: ten 8.5 x 11 inch doubled sided sheets of notes that are bound together, non-communicating graphing scientific calculator, 1 page of scratch paper, writing utensils, and the exam. You will have 80 minutes to complete this exam.

For questions 1 through 3 **fill in the square** next to all correct answers. A given problem may have more than one correct answer. Each correctly bubbled answer will receive two points. There are **8** correct answers in this section and only the first **8** filled in answers will be graded. There is no partial credit.

1. Alexa the ant is riding on a spinning disc near the edge. The center of mass of the disk is not moving but it is spinning clockwise about it's center. The angular acceleration of the disc is constant and positive. Which of the following statements are true?

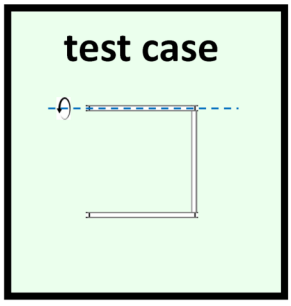
   □ (a) Alexa is slowing down
   □ (b) Alexa is speeding up
   □ (c) Alexa is traveling at a constant speed
   □ (d) Alexa's tangential acceleration is decreasing
   □ (e) Alexa's tangential acceleration is constant
   □ (f) Alexa's radial acceleration is decreasing
   □ (g) Alexa's radial acceleration is constant

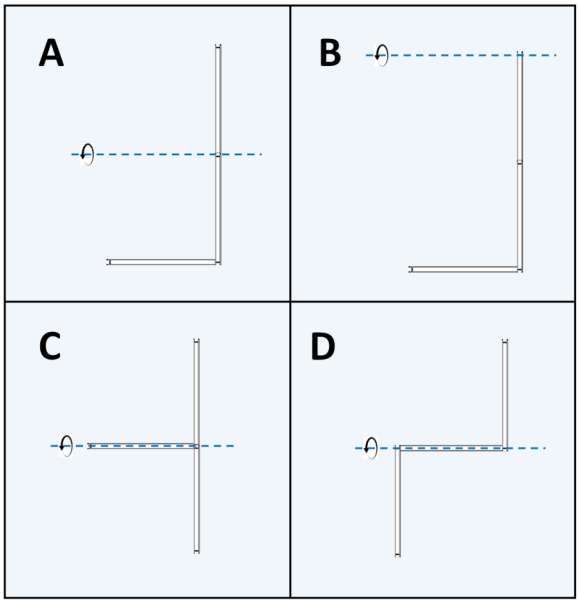
2. A system has an angular acceleration about the center of mass of -2 rad/s^2 and the system's center of mass has an acceleration of 0 m/s^2. Which of the following statements are true?

   □ (a) The net torque on the system is zero.
   □ (b) The net torque on the system is non-zero.
   □ (c) The net force on the system is zero.
   □ (d) The net force on the system is non-zero.
   □ (e) The velocity of the center of mass of the system must be zero.
   □ (f) The velocity of the center of mass of the system must be non-zero.
   □ (g) Not enough information is provided to determine the system's center of mass velocity.

3. Three identical rods are put together to form various shapes. These shapes then have a reference axis about which there is a moment of inertia. Which of the following have a greater moment of inertia about their reference axis than the test case?

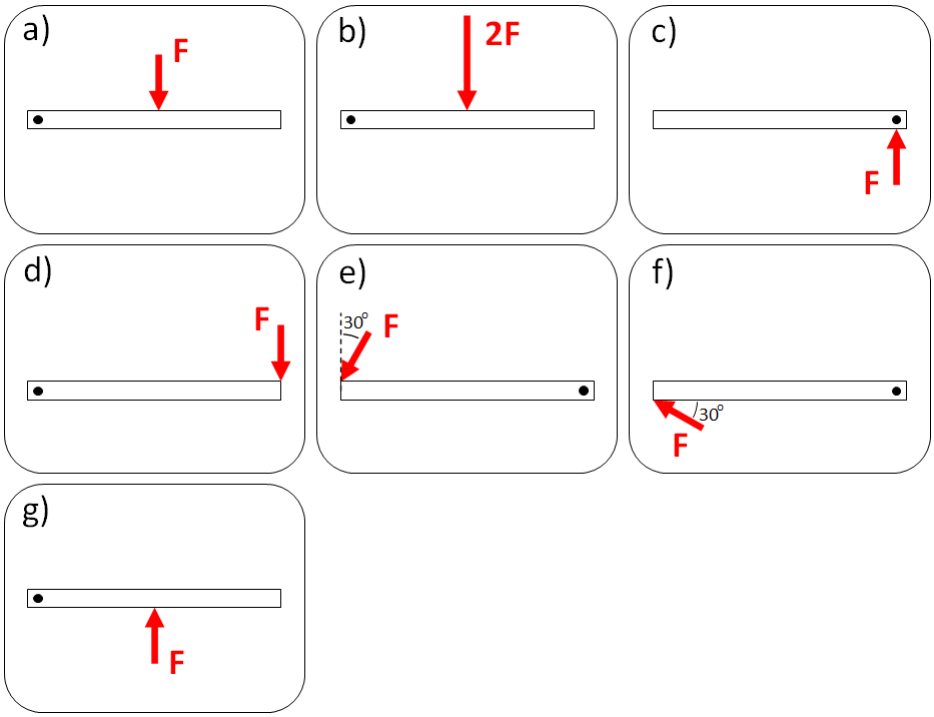
   □ (a)
   □ (b)
   □ (c)
   □ (d)



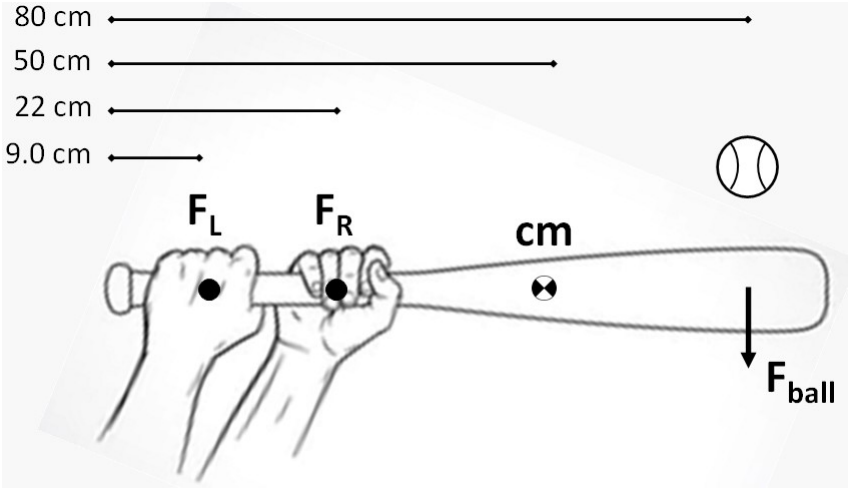


4. (5 points) Rank the pictured torques on a solid beam from most negative to most positive. The black dot in the beam is a fixed pivot axis which is located at the very end of the beam (notice that c, e, and f have different pivots!). You may assume that forces are either applied at the end or the center of the beam. Angles that appear to be 90 degrees, are 90 degrees. If torques are equal in magnitude, please indicate this. If any of the torques are zero, please indicate this.

An example ranking (**which is not correct**), would be: a < b = c < d < e = f < g.

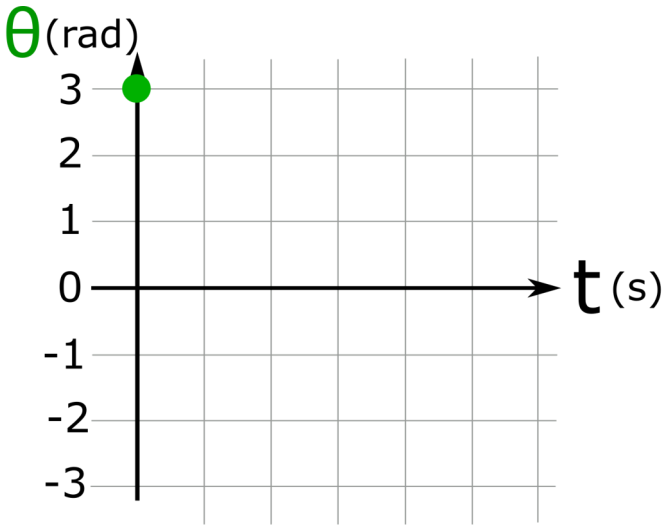


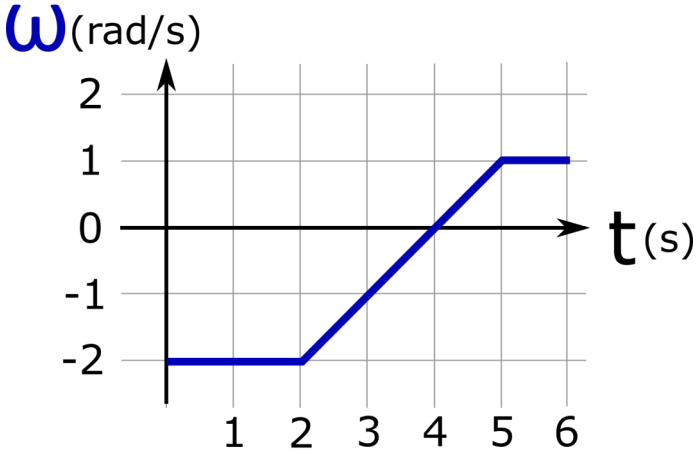
5. (8 points) Viewed from the side as shown, a person holds a 0.94 kg wood bat with their left hand 9.0 cm from the left end of the bat, and their right hand 22 cm from the left end of the bat. The center of mass of the baseball bat is 50 cm from the left end of the bat. A ball, falling vertically, bounces 80 cm from the left end of the bat. During the bounce, the ball exerts an average force of 29 N on the bat. During the collision, the baseball bat is held still and without rotation by the person's hands. Find the average force exerted by the person's left hand during the ball's bounce on the bat.

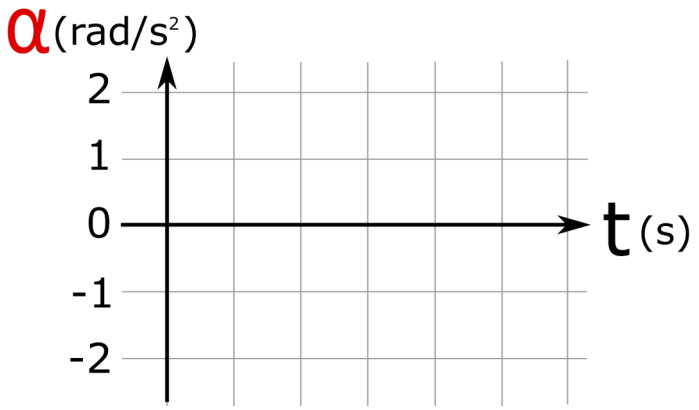


6. (10 points) The figure below shows the angular velocity for a system graphed as a function of time.

(a) What is the angular acceleration (in rad/s^2) of the system at t = 3 seconds?
(b) What is the change in angular position (in radians) of the system between 0 and 2 seconds?
(c) Carefully draw a scaled graph of the angular acceleration as a function of time on the provided graph. Clearly label sections of your graph as quadratic, linear, or constant.
(d) Carefully draw a scaled graph of the angular position as a function of time on the provided graph. The initial angular position is 3 rad. Clearly label sections of your graph as quadratic, linear, or constant.







7. (12 points) An engineer designs a system to increase the rotational speed of a flywheel (large disk). The flywheel has a 70.0 cm radius and a moment of inertia equal to 5.40 kg·m^2. In one experiment, the flywheel begins (t = 0 s) from rest, and a 80.0 N·m torque is applied to it.

   (a) What is the angular acceleration of the flywheel during the time it speeds up.
   (b) What is the angular velocity of the flywheel, in rpm (revolutions per minute), at Δt = 10 s?
   (c) What is the speed of a point on the outside edge of the flywheel at Δt = 10 s?
   (d) How far has a point on the outside edge of the flywheel traveled in the first 10 s?
   (e) What is the translational (linear) acceleration vector at Δt = 10 s?