2017 SCORING GUIDELINES

Question 3

12 points total | **Distribution of points**

(a) 1 point

Correct answer: "To the right of *C*"
Reasoning cannot earn credit if the incorrect selection is made.

For an explanation that the torque exerted by the disk or the angular momentum of the disk is greater when farther from the pivot — 1 point

Example 1: The disk exerts a greater torque on the rod when it pushes the rod farther from the pivot.
Example 2: The disk has greater angular momentum when it's farther from the pivot. The disk loses almost all its speed during the collision and hence gives the rod almost all its angular momentum. So the rod ends up with more angular momentum when the disk hits it farther from the pivot.

(b) 2 points

Correct answer: "Yes"
If "No" is selected, the explanation may still earn full credit if an incorrect selection was made in part (a).

For a selection consistent with the selection from part (a) — 1 point
For indicating that the equation shows that ω increases with increasing x — 1 point

Example: According to the equation, ω increases with x; a bigger x produces a bigger angular speed. This agrees with my reasoning from part (a), where I said a bigger x creates a bigger angular speed after the collision.

(c) 3 points

For focusing on functional dependence (instead of, for example, considering units/dimensions) — 1 point
For addressing m_{disk}, I, or both — 1 point
For correctly concluding that the equation is wrong because of the dependence on m_{disk}, I, or both — 1 point

Example: If m_{disk} is large, then more angular momentum will be transferred during the collision. But the equation shows the angular speed decreasing with increasing m_{disk}, because it is in the denominator.

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Question 3 (continued)

Distribution of points

(d) 4 points

For using an expression of conservation of angular momentum for the disk and rod — 1 point
Note: This point is not awarded for equating angular and linear momentum.
For indicating that the initial angular momentum of the system is equal to $m_{disk} v_0 x$ — 1 point
For a dimensionally correct expression for the post-collision angular momentum that includes $I\omega$ — 1 point
For indicating the correct rotational inertia of the system after the collision: $I + m_{disk} x^2$ — 1 point

(e) 2 points

Correct answer: "Greater than"

For indicating, either directly or by analogy to the linear case, that the disk's angular momentum with respect to the pivot changes more in the bouncy scenario than in the original scenario OR for using a similar argument in terms of impulse — 1 point
Note: This point is for describing what happens to the disk.
For using conservation of angular momentum or momentum-impulse reasoning to conclude that the rod gains more angular momentum, and hence more angular speed, in the bouncy scenario — 1 point
Note: This point is for describing what happens to the rod.

Example: After the bouncy collision, the disk has angular momentum in the clockwise direction. To keep the system angular momentum constant, the magnitude of the rod's counterclockwise angular momentum must be greater than before.