**Scholarship Level ‘Rotational Motion’ (some to be done in class…) Score / 8**

1) This wheel is a solid uniform disc (mass M, radius R). A string is wrapped around the rim and attached to a mass (m).

a) Explain why the Tension is only **mg** when the wheel is held **stationary (zero acceleration)**. [1]

b) Derive an equation for the angular acceleration. Use only variables R, g, m & M [1]

1. Your flatmate finds a can of soup (liquid) and a can of cat food (solid!). They are the same mass and radius. Unfortunately the labels are missing. Explain How could you help him identify the cans. [1]

1. The rotational inertia of the rod about one point is . The other is .

Explain which is which. [1]

1. A plank length L is supported at both ends. One support is removed. Calculate the **initial** angular acceleration. Hint use formula from question 3 [1]
2. Simone sits on a spinning chair with her arms crossed over her chest. She has a weight in each hand. She uncrosses her arms and extends them **radially**. Explain what happens to her angular speed. [1]

1. A turntable spins with angular velocity “ω”. An identical turntable, not initially spinning is dropped on top. Explain whether angular momentum and rotational kinetic energy are conserved. [1]

1. Explain with diagrams why a wheel on a ramp usually rolls. Under what conditions will it slide? [1]

(a sample diagram is given)

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**Scholarship Level Solutions**

1 a) When the mass is stationary, the total force is zero so the tension equals the weight. When the mass is accelerating, the total force is down so the tension must be less than the weight.

b) 

2) Roll them both down a ramp. They both lose the same amount of gravitational PE. The solid food will rotate with its can. The soup is a liquid so does not rotate as fast as its can. The solid food gains more rotational KE than the soup so has less translational KE so moves slower and loses the race.

3) The rod that is pivoted at the end has its mass distributed further from the point of rotation. Therefore it must have a greater rotational inertia, therefore it is the second formula

4) 

5) As the arms move towards the axis, I **decreases**, then the weights move away from the axis so I **increases**. Therefore as angular momentum is conserved (no external torque) her angular speed will **increase** then **decrease**.

6)Angular momentum is conserved because there are no external torques.



Rotational KE is not conserved. Half is converted to heat.



7) If there is no friction, the two forces on the wheel both act through the center of mass. Theswill cause pure translation (linear acceleration down the slope) If there is a friction force, its at a tangent, so this causes a torque causing the wheel to turn.