IMPORTANT:

- This exam is closed book, closed notes. You may use a calculator, but NOT a cell phone calculator.
- You need to do your work in front of the computer please.
- Show your work. I need to see all steps.
- You will be given basic formulas, and this is your starting point. This course is NOT about memorizing formulas, so if your answer depends on a special formula, it must be derived from the standard starting points. [This is to your benefit; if you know how to use the basic formulas, you'll do fine.]
- You'll be given a formula sheet. Same as last time, plus some extra formulas.
- When you complete the exam, please upload your work promptly.

SUGGESTIONS:

- 1) Show all work. Explain if it might help with partial credit.
- 2) Use symbols as much as possible. It makes it easier to allocate partial credit.
- 3) Do not waste an excessive amount of time on any one problem or individual part. Note the point allocation, and budget your time accordingly.
- 4) Write clearly so that we can try to reconstruct your steps. Make figures of reasonable size.
- 5) Make sure that you do all the problems.

Problem 1: (20 Pts) When a toilet is flushed or a sink is drained, the water begins to rotate about the drain on the way down. Assuming no initial rotation and a flow initially directly straight toward the drain, explain what causes the rotation and which direction it has in the northern hemisphere. **[The more complete the**]

explanation, the more points!!! (Note that this is a small effect and in most toilets the rotation is caused by directional water jets.)

Would the direction of rotation reverse if water were forced up the drain? Explain your answer!!!

For this problem, put your text into Canvas, and your diagram on the paper to be scanned.

Problem 2: (20 Pts) In one amusement park ride, riders enter a large vertical barrel and stand against the wall on its horizontal floor. The barrel is spun up and the floor drops away. Riders feel as if they are pinned to the wall by a force something like the gravitational force. This is a fictitious force sensed and used by the riders to explain events in the rotating frame of reference of the barrel.

Explain in an inertial frame of reference (Earth is nearly one) what pins the riders to the wall, and identify all of the real forces acting on them.

For this problem, put your text into Canvas, and your diagram on the paper to be scanned.

Problem 3: (20 Pts)

a) Draw a free body diagram for a satellite in an elliptical orbit showing why its speed increases as it approaches its parent body and decreases as it moves away. Draw the figure to be scanned, and explain in text. b) Suppose Newton's gravitational law $F=GMm/r^2$ is modified by mysterious forces into $F=GMm/r^{2.1}$. [That is, the exponent is 2.1 instead of 2.0]. How would this affect Kepler's law relating area swept per unit time. How would this affect the shape of the orbit? Draw the figure to be scanned, and explain in text.