Allowed material: writing implements and a graphing calculator. You are not allowed to use any other material. There are some formulas and constants tabulated in last page of the exam. Justify the formulas you use in your answers and introduce the meaning of the symbols within these formulas. Solve each problem on separate page.

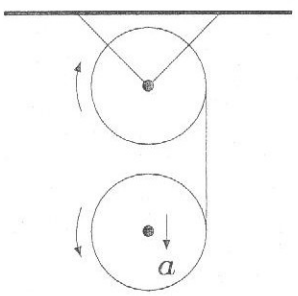
It is important that you at least try each problem. Good luck!

1. Define the following terms using at most about 30 words. Answering with only formulas will not yield full points. a) Free Body Diagram b) Impulse of a Force c) Hooke's Law d) Moment of Inertia e) Pascal's Law f) Elastic collision

2. Answer the following questions shortly but precisely. Use drawings to support your answer if needed. Using only drawings is, however, not a sufficient answer.
   (a) What is the Newton's second law and how is it related to momentum?
   (b) The gravitational pull of a large celestial body can be used to accelerate a space craft, by flying past it at a close distance. In the vicinity of the body, the orbit of the space craft can be approximated with an ellipse. Based on Kepler's second law, explain the basis of this increase in velocity.

3. An object floats upright in fluid with density ρ. The object has mass M, height h and uniform cross-sectional area A.
   (a) Calculate the distance from the surface of the liquid to the bottom of the object, i.e., how much the object sinks into the fluid in equilibrium.
   (b) How much deeper does the object sink when a downward force F is applied to it. You may assume the object does not sink in its entirety.

4. In the figure the upper disc can rotate freely about its fixed axis. A string is wound around both discs, thus connecting them. The lower disc is then released. The discs are identical, with radius of R and mass m.
   (a) Determine the linear acceleration a of the lower disc.
   (b) Determine the tension of the string.
   (c) Find the angular accelerations of both discs.



Problem 4.

5. A rocket is launched from rest in space. 81 % of its mass is fuel, which is burned and thus emitted at 2300 m/s relative to rocket. Assuming the there are no external forces on the rocker, find the velocity of the exhaust gases with respect to an observer at rest.

Write CLEARLY in each paper your name, student number, degree programme, the code of the study module, and the date of the exam. Solve each problem on separate page.