Name and Surname:
Student ID:
Department:
Signature:

Each question worth 20 points. You should show your work. You will lose points if you do not put the right units and put the vector signs for vectors.

1. Calculate the potential energy of a solid sphere of mass M and radius R. (*Hint:* You might consider the sphere as consisting of concentric shells added one after the other.)

2. Two trains A and B are moving towards each other at velocities relative to ground v_A and v_B respectively. At the instant that the distance between the trains is R, a bird starts flying from train A towards train B with a velocity v relative to the ground. The moment it reaches the other, it turns around and flies to train B with the same speed. Calculate the time elapsed between its departure and arrival to the train A.

3. Our unfortunate lover (that of the homework) is still trying to run away from the father of the girlfriend. Little by little he is getting desperate that he can get away from him. He arrives at a river which is 40 m wide, and there is a boat resting on the side of the river. In still water he can row with a speed of 30 m/s. The river is running at a speed of 20 m/s. He has to cross the river and reach the point directly across him. What should be the angle between his rowing direction and coast of the river so that he can reach the other point? How long does it take him to reach the other end?

4. When our unfortunate lover reaches the other side, he realizes that the father had taken the other boat to cross the river. As he is trying to find another way to escape, he notices a space canon which can launch a space capsule with a velocity v. If after being launched, there is no propulsion, what should be the minimum speed v such that the capsule can reach moon? (Let the mass of the moon and the earth be m and M respectively, and the distance between the two R. Let m_c be the mass of the capsule. Ignore friction effects.)(Unfortunately, the velocity of the capsule is too slow.To be continued...)

5. Consider a mass attached at the end of a rope which is being rotated vertically. Let the velocity of the mass be v at the topmost position. Calculate the tangential and centripetal acceleration of the mass as a function of the angle, θ, the rope makes with the vertical. What is the tension on the rope as a function of θ? What is the minimum speed v such that the mass can make circular motion?