PHY180H1F TERM TEST I

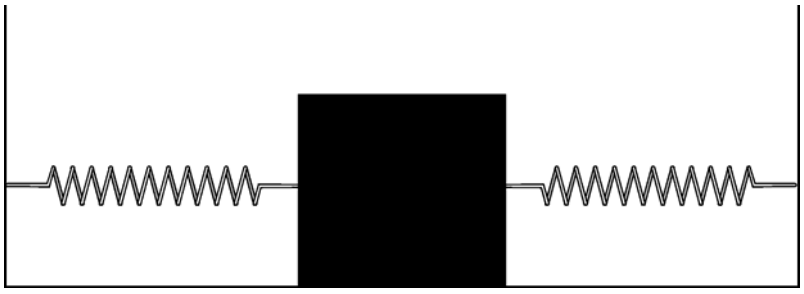
MONDAY, OCTOBER 17, 2005

Put your name, your tutorial number and your tutor's name on the examination booklet.
Answer all three questions. They are of equal value. Only aids are calculators, drawing instruments and a student supplied 8.5 x 11 inch aid sheet (both sides).

For this test the acceleration due to gravity is $g = 9.80\ ms^{-2}$.

1) A model airplane with mass of 0.750 kg is held by a wire so that it flies in a horizontal circle 30.0 m in radius. The airplane engine provides a net thrust of 0.800 N perpendicular to the wire which is attached to the plane.
   a) What is the net torque that the net thrust produces about the center of the circle?
   b) What is the angular acceleration of the airplane?
   c) What is the linear acceleration of the airplane tangent to its flight path?
   d) What is the magnitude of the total linear acceleration when the kinetic energy of the airplane is 50.0 J?

2) The block in the diagram which is shown at its equilibrium position has a mass of 1.00 kg and can slide back and forth without friction on the frictionless surface. The two springs are identical. It takes an axial horizontal force of 10.0 N to displace the centre of the block 5.00 cm to the right. (Right is positive.)



   a) What is the period of the resulting oscillation when the block is released from the position 5.00 cm to the right?
   b) Where will the centre of the block be 0.200 s after release?
   c) The problem is repeated as in part (a) but the clock is not started (i.e. t = 0) at the moment when the block is released. The clock is started when the centre of the block is to the left of the equilibrium position, the magnitude of the displacement is equal to one half of the amplitude and the block is moving to the right. Using a cosine function, write down the equation for the displacement of the block, in cm, as a function of time.
   d) If one of the springs is removed, will the period of oscillation be smaller, larger or the same as before? Give physical reasons for how you obtain your answer and then give your mathematical answer.

3) A particle is moving with uniform circular motion. Let $\vec{\mathbf{r}}$ be the position vector of the particle at some arbitrary point in the first quadrant. Express $\vec{\mathbf{r}}$ in two dimensional cylindrical coordinates and starting with this derive an expression for $\frac{\mathbf{d}\vec{\mathbf{r}}}{\mathbf{dt}}$ in cylindrical coordinates. Your answer should be in a form that can easily be interpreted to have physical meaning. With the use of a diagram, **explain all the steps in your derivation**.