PHY 140Y
FOUNDATIONS OF PHYSICS
1998-99

Term Test #2
Tuesday, December 8, 1998
6:30 PM - 8:30 PM

INSTRUCTIONS:

Please give your name, student number, and TA's name on ALL examination booklet(s) used.
Answer ALL questions. Total marks = 100.
Marks, shown in brackets, will be given for workings and units as well as for final answers.
[Non-programmable] calculators may be used. No aid/crib sheets are allowed.

QUESTIONS:

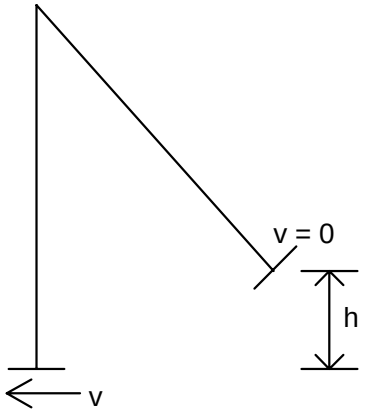
1. Define and briefly explain the difference between the following. ***[15 marks]***
   (a) conservative and nonconservative forces
   (b) potential energy and kinetic energy
   (c) the Special Theory of Relativity and the General Theory of Relativity

2. Briefly describe the Michelson-Morley experiment. Sketch the apparatus, explain the significance of the expected path difference, and comment on the significance of the results. ***[10 marks]***

3. (a) A child's swing has zero velocity when the distance h, shown in the diagram, is 1.8 m. What is the velocity of the swing at the lowest point? ***[5 marks]***

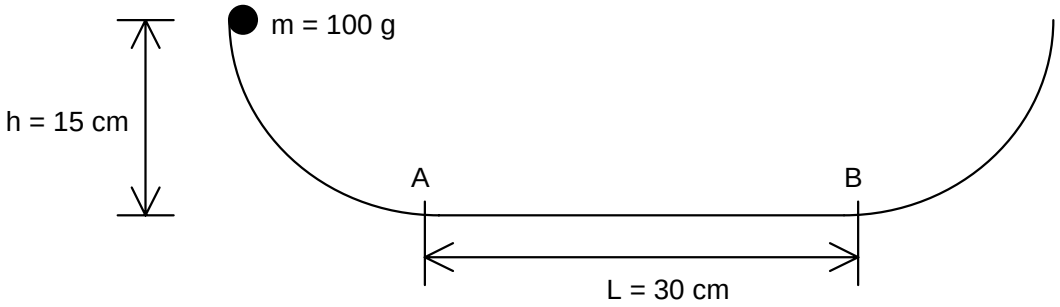
   (b) By considering work and energy, show that if a car has velocity v_o when the brakes are applied, and if the coefficient of kinetic friction between the tires and the road is μ_k, then the shortest distance in which the car can be brought to rest is

   $d = \frac{v_o^2}{2\mu_k g}$, where g is the acceleration due to gravity. ***[5 marks]***

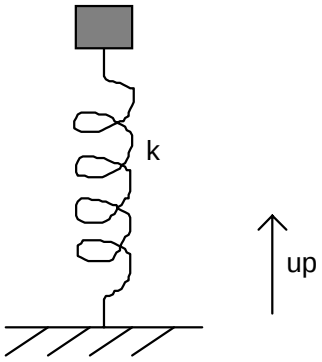


4. A ball of mass m = 100 g slides inside a bowl whose cross section has circular arcs at each side and a flat horizontal central portion between points A and B of length L = 30 cm, as shown below. The curved sides of the bowl are frictionless, and for the flat bottom, the coefficient of kinetic friction is $\mu_k = 0.15$. The ball is released from rest at the rim, which is 15 cm above the flat part of the bowl. ***[15 marks]***

(a) What is the speed of the ball at A?
(b) What is the speed of the ball at B?
(c) Where does the ball finally come to rest?



5. One end of a massless spring is placed on a flat surface, with the other end pointing upward, as shown below. A mass of 3.0 kg is placed on top of the spring, compressing it by 25 cm. The 3.0 kg mass is removed and replaced by a 5.0 kg mass. Then the spring is compressed by hand so that the end of the spring is 67 cm lower than the position of the spring with no mass attached. The spring is then released. What is the maximum kinetic energy of the 5.0 kg mass? ***[15 marks]***



6. (a) An observer in a frame of reference that is at rest observes a clock moving with constant velocity v, and finds that it is slow by a factor of two. What is the magnitude of v? ***[5 marks]***
(b) Measured at rest, two sides of a triangle which are mutually perpendicular are 1.6 m and 0.96 m long. The triangle is then made to move at constant velocity in a direction parallel to its 1.6 m side. This makes it appear that the two mutually perpendicular sides of the triangle are the same length. What is the speed of the triangle? ***[5 marks]***

7. Spaceship A of proper length L is travelling east at speed v_A, and spaceship B of proper length 2L is travelling west at speed v_B, both as seen from Earth. The pilot of spaceship A sets a clock to zero when the front of spaceship B passes by. (The spaceship pilots sit in the nose cones.) Use Lorentz transformations to derive an expression for the time at which, according to the pilot of spaceship A, the tail of spaceship B passes by. ***[15 marks]***

8. Solar energy reaches the Earth at the rate of about 1400 W/m^2 of surface area perpendicular to the direction to the Sun. By how much does the mass of the Sun decrease in each second? The mean radius of Earth's orbit is 1.5×10^8 km. Would the real mass loss of the Sun be greater than or less than your calculated answer, and why? ***[10 marks]***

END