PHY180H1F TERM TEST II

NOVEMBER 25, 2004

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 toy cannon uses a spring to project a ball of mass 5.30 grams. The spring whose mass can be ignored is originally compressed by 5.00 cm and has a force constant of 8.00 N/m. When the cannon is fired, the ball moves 15.0 cm from the start (where the spring is fully compressed) to the end of the horizontal barrel of the cannon.
   a) If there is no friction between the ball and the barrel, at what point does the ball reach its maximum speed?
   b) If there is a constant frictional force of 0.0320 N between the ball and barrel, at what point does the ball reach its maximum speed?
   c) For the frictional force in (b), what is the speed of the ball as it leaves the barrel of the gun?

2) A woman with a mass of 60.0 kg stands at the rim of a horizontal turntable having a moment of inertia of 500 $kg \cdot m^2$ and a radius of 2.00 m. The turntable is initially at rest and is free to rotate about a frictionless, vertical axle through its centre. The woman then starts walking around the rim clockwise (as viewed from above the system) at a constant speed of 1.50 m/s relative to the Earth.
   a) In what direction and with what angular speed does the turntable rotate?
   b) How much work does the woman do to set herself and the turntable into motion?
   c) If the origin is at the centre of the turntable, what is magnitude of the angle, in degrees, between the initial and final position vectors of the woman after the turntable has completed one revolution?

3) A rocket is to be used in outer space where gravity can be ignored. For this problem you can assume that all the fuel is consumed when the rocket accelerates. When type **A** fuel is used, half the rocket's initial mass must be fuel in order for the rocket to accelerate from rest to a speed **X** m/s (i.e. the ratio of the mass of the fuel to that of the empty rocket is 1). When type **B** fuel is used, the speed of the ejected gas is twice the speed of ejected gas for type **A** fuel. If type **B** fuel is used to accelerate the rocket from rest to a speed of **X** m/s, what is the ratio of the mass of the fuel to that of the empty rocket?