PHY 116 From Newton to Einstein
Exercise Sheet 2: Kinetics

Date issued: 3rd October 2012 Hand in by 4pm, 8th October 2012

All questions were taken from Young and Freedman

A1) A person sees an object and records its position as a function of time and distance. It is given by

$$\vec{r}(t) = -(5.0\text{ m/s})t\,\hat{i} + (10.0\text{ m/s})t\,\hat{j} + [(7.0\text{ m/s})t - (3.0\text{ m/s}^2)t^2]\hat{k}\,.$$

a). Find the displacement, velocity and acceleration vectors for the object at t = 5.0s.

b). Is the acceleration of the object constant, or does it change with time? (Explain why.) **[4]**

A2) The human body can survive a negative acceleration trauma incident (sudden stop) if the maximum acceleration is less than 250 m/s^2 (approximately 25g). If you are in a car accident with an initial speed of 105 km/h and are stopped by an airbag, over what distance must the airbag stop you if you are to survive the crash? **[3]**

A3) A brick is dropped (with zero initial velocity) from the roof of a building. The brick strikes the ground in 2.5s. Ignoring air resistance,

a) How tall, in metres, is the building?

b) What is the magnitude of the brick's velocity just before it reaches the ground?

c) Sketch a_y-t, v_y-t, and y-t graphs for the motion of the brick. **[5]**

A4) A car is stopped at a traffic light. It then travels along a straight road so that its distance from the light is given by $x(t) = bt^2 - ct^3$, where b = 2.40m/s^2 and c = 0.12m/s^3.

a) Calculate the average velocity of the car for the time interval t = 0 to t = 10s.

b) Calculate the instantaneous velocity of the car at i) t = 0, ii) t = 5s and iii) t = 10s.

c) How long after starting from rest is the car at rest again? **[3]**

B5) A ball is thrown vertically up from the ground with a speed v_0. At the same instant, a second ball is dropped from rest from a height H, directly above the point where the ball was thrown. There is no air resistance.

a) Find the time at which the two balls collide.

b) Find the value of H, in terms of v_0 and g, such that at the instant when the two balls collide, the first ball is at the highest point of its motion. **[5]**

Note: The question numbers start with A or B to denote the level of difficulty.