PHYSICS 2101 – 2
Instructor: Juhan Frank
Quizz 3 – Spring 2000 – Monday February 7

Part I – Multiple Choice questions (2 pts/question; total = 4 pts) Identify the correct answers by placing a check between the brackets [ ].

Assume no air friction or lift and constant muzzle velocity:

1) When the target is closer than the range, it can be hit at
   a. [x ] two possible angles of elevation.
   b.[ ] only one angle of elevation.
   c.[ ] no angle: it is impossible to hit the target.
   d.[ ] three possible angles of elevation.
   e.[ ] two possible angles of elevation and the flight time is the same. In e. the time of flight is longer for the higher elevation.

2) An example of motion at constant speed but non-zero acceleration:
   a.[ ] a car moving at constant rate of 50 mi/h along a straight highway.
   b.[ ] a train moving at constant velocity $\mathbf{v} = 50\mathbf{i} + 60\mathbf{j}$ mi/h.
   c.[x ] a satellite moving around the Earth in a circular orbit at constant speed.
   d.[ ] a hockey puck sliding on ice.
   e.[ ] a freely-falling elevator whose cable has snapped.

Part II – Problem (6 pts)
Two guns A and B are pointed horizontally in the same direction (parallel to each other) at the same height of 1m above the ground. Gun A has a muzzle velocity of 100 m/s while gun B has a muzzle velocity of 200 m/s. Suppose each fires a bullet. Which bullet will travel farther? Which bullet will hit the ground first, and why. If they hit the ground simultaneously, explain why. You may need one or more of the following equations: $x - x_0 = v_0 \cos \theta_0 t$, $y - y_0 = v_0 \sin \theta_0 - \frac{1}{2}gt^2$, $v_y = v_0 \sin \theta_0 - gt$.

You may justify your answers with or without explicit numerical calculations.

Since there is no horizontal acceleration, the bullets will travel horizontally at their original muzzle velocities. Therefore B will travel twice as far in any given time. They fall to the ground simultaneously because they are fired from the same height and B will travel twice the distance travelled by A.

With explicit calculations:

Since $\theta_0 = 0$, then $\sin \theta_0 = 0$ and $y - y_0 = -\frac{1}{2}gt^2$. The same equation for A and B. If the ground level is chosen $y = 0$, then $y_0 = 1$ m, and the bullets will free-fall simultaneously in a time $t_{eff} = \sqrt{2y_0/g} = 0.452$ s. Chosing $x_0 = 0$, the distance travelled by A is $x = v_0 t_{eff} = 45.2$ m, while B travels 90.4 m in the same time.