1. You see a lightening flash and hear the corresponding thunder $\Delta t$ later. What is the formula for the distance $s$ between you and the position of the lightening strike in terms of $\Delta t$? Identify all terms in your expression.

Extra credit: What assumption(s) must you make to come up with this expression?

2. A fast train enters a straightaway at high velocity $v_f$. The engineer sees another train a distance $\Delta s$ ahead moving slower, $v_s < v_f$, and breaks with constant acceleration of magnitude $a$. Give a formula for the minimum value of $\Delta s$ such that the engineer avoids a collision.

3. A simple means of measuring reaction time without a clock is to catch a vertically-oriented ruler released from rest: The person being tested holds an open hand with thumb and pointer on either side of the bottom of the ruler; when the ruler is released at some random instant, the person grasps the ruler as quickly as possible. Come up with a formula for the reaction time in terms of the distance $h$ from the bottom edge of the ruler to the position it was grasped.

4. A rocket is fired vertically upward. It’s motor runs for the time interval $\Delta t_a$ during which the rocket ascends with an upward acceleration $a_a$. Once its fuel is spent, the rocket coasts upward to some maximum height before falling back to the earth. Neglecting air resistance, yaw (tilt or deviation from the axis of the rocket), rotation of the earth, and any other secondary complicating factors, you can assume the lands at its launch site. (continued...)

You may refer to books and notes, but you may not, in any form, seek assistance from, or offer assistance to, any person other than the instructor. Failure to abide by these instructions subjects you to penalties enumerated in the syllabus.

Each question is worth 4 points. Each "extra credit" question is worth 1 point.

Name ________________________________

I, a student member of the George Mason University community, pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.

Signature ________________________________

Physics 160, Section 003
In-Term Examination I
Spring, 2005
(a) What is the maximum upward velocity reached by the rocket?

(b) What is the rocket’s maximum height?

(c) What is the rocket’s velocity when it hits the ground?

(d) With the aid of a velocity versus clock reading history, prove that regardless of the time interval \(\Delta t_a\) or the magnitude of the upward acceleration \(a_u\), the rocket takes longer to go up than to come down.

Extra credit: In terms of the variables given and \(g\), determine the value of the excess time of the upward flight over the falling flight. That is, show that the difference between the time interval of ascent and time interval of descent is a positive definite number regardless of \(a_u\) and \(\Delta t_a\).

5. A bow, which consistently shoots arrows with the same initial velocity (magnitude \(v_0\)), has a maximum range \(R\). The center of a target, located a distance \(\frac{2}{3} R\) from the face of the bow, is at the same height above the ground as the arrow when released. At what elevation angle(s) \(\theta\) should the arrow be pointed at release so that it strikes the center of the target? [Hint: Find \(R\) in terms of \(v_0\) and \(g\); determine flight time interval \(\Delta t\) for the vertical trajectory in terms of \(v_0\) and \(g\); substitute \(\Delta t\) into expression for horizontal trajectory and derive an expression for \(\theta\).]