The first 7 minutes of your oral exam will be to answer to the best of your ability one of the following questions:

1. Use reasonable assumptions, draw supporting diagrams and derive the relativistic Doppler shift equation that describes the observed light frequency \( f' \) by observer \( S' \) that is approaching with speed \( v \) toward a stationary source \( S \) giving off light of frequency \( f \).

2. What is the "spacetime interval" \( \Delta S \)? What does "invariant" mean? You are given the Lorentz coordinate and time transformation. Use Lorentz coordinate and time transformation to show that \( \Delta S' \) for a frame traveling at speed \( v \) is indeed equal to \( \Delta S \).

\[ x' = \gamma (x - vt) \quad \text{and} \quad t' = \gamma \left( t - \frac{vx}{c^2} \right) \]

3. Start with the general form of Newton's 2nd Law. Show that the work done by this force is equal to the total relativistic energy minus the rest mass energy. What is the work done by a force equal to?

4. Make up and work through an example to illustrate that, in a collision of two masses moving at relativistic speeds in a completely inelastic collision, the mass after the collision is not equal to the sum of the two masses entering into the collision. What is the final mass after the collision equal to?

5. Make up an experiment whereby you could measure Planks Constant \( h \) and the work function \( \varphi \) of the metal. What graph would you need? How can you use the graph in order to measure Planks Constant \( h \) and the work function \( \varphi \) of the metal, and why does this work?

6. Suppose that you have an X-Ray photon of frequency \( f \) that strikes an electron (loosely bound in its parent atom). Write down the conservation equations that would be necessary to determine the final frequency \( f' \) of the photon and its scattering angle. What final result is obtained?

The remaining 6 minutes will be questions from your student examiners. You will be graded on your Oral, and your student examiners will be graded on the quality of their questions.

Good Luck!!

J. Artz

**TESTING GROUPS:**

TUESDAY MARCH 11, 2014: 10 AM - 11 AM: AMY, JACOB, CONNOR, MICAH

TUESDAY MARCH 11, 2014: 11:15 AM - 12:15 PM: COLE D., MARTIN, JOSIAH, PETER

TUESDAY MARCH 11, 2014: 1 PM - 2 PM: ANDREW "COLE" K, JOHN B., JUSTIN, SAM

WED. MARCH 12, 2014: 1:45 – 2:45 PM: JOHN R., PAUL, JESSE, ALEC