

**PREFLIGHTS****LESSON 37 – ELECTROMAGNETISM IN THE 4-VECTOR  
(TENSOR) NOTATION****LEARNING OBJECTIVE:**

**Taking account of relativistic transformations, formulate Maxwell's equations and the Lorentz force law using 4-vector and tensor notation.**

**1)** (a) What is a tensor? (b) What is a second-rank tensor? (c) What is an antisymmetric, second-rank tensor? *Your book does not define tensors very well, so you may want to take a couple minutes to look in another source – your Guide to Essential Math, another math book, the Internet, etc.*

**2)** Why can **E** and **B** not be written as the spatial parts of 4-vectors? Why must they be written as a tensor?

**3)** On page 536, the book works through the equation for  $\bar{t}^{01}$ . Which of the following is the correct equation for  $\bar{t}^{12}$ ?

a.  $\bar{t}^{12} = \Lambda_0^0 \Lambda_2^0 t^{02} + \Lambda_1^1 \Lambda_2^1 t^{12}$

b.  $\bar{t}^{12} = \Lambda_2^0 \Lambda_0^2 t^{02} + \Lambda_2^1 \Lambda_1^2 t^{12}$

c.  $\bar{t}^{12} = \Lambda_0^1 \Lambda_0^2 t^{12} + \Lambda_1^1 \Lambda_2^2 t^{12}$

d.  $\bar{t}^{12} = \Lambda_0^1 \Lambda_2^2 t^{02} + \Lambda_1^1 \Lambda_2^2 t^{12}$

4) **Note: This is a review question from Chapter 11.** In Problem 11.14 on pp. 464-465, the speed of the electron, which can be calculated from the electric force between an electron and proton and the equation for uniform circular motion, is  $2.25 \times 10^6$  m/s. Using this value for speed and the other values given in the problem, calculate the lifetime of the Bohr atom, making the simplifying assumption that the electron stays in a constant-radius orbit until it loses all of its energy (this will give a high estimate of the lifetime). Type in your answer (with units) below.

5) What did you find difficult or confusing in the pre-class work? If nothing was difficult or confusing, tell me what you found most interesting. Please be as specific as possible.

6) Document whatever help you received on the preclass work.