RELATIVITY MTH6132

PROBLEM SET 2

HAND IN ONLY THE STARRED QUESTIONS.

Write your name and student number at the top of your assignment and staple all the pages together.

1* In Einstein's summation convention, which of the following expressions have a meaning:

$$(A^i B_i) C_j = (C_j D^j) B_i,$$
$$(A_k B^k) C_j = (A_m B^m) D_j$$
$$A_i B_j C_k D^k E_f = M_i N_j P_f Q_k,$$
$$A_i B_j = A_j B_i$$
$$A_m = \frac{D_k B_m}{\sqrt{C^k B_k}}$$

2* If lower case Latin indices take values 1 and 2, write down all the components of the following quantities in full

$$G_{ij}, \qquad A^i B_i, \qquad \Gamma^i{}_{jk}, \qquad \Gamma^i{}_{ij}, \qquad R^i{}_{jkl}$$

Hint: For example, if I had asked you to write down the components of A^i, the answer would be A^1 and A^2

3 Given the Lorentzian transformation formulae for the velocity and acceleration

$$V' = \frac{V - v}{1 - vV/c^2}, \qquad a' = \frac{a}{\gamma^3 (1 - Vv/c^2)^3},$$

which are the inverse expressions giving V in terms of v and V' and a in terms of v, V' and a'? Give a simple argument to explain the result. No long computation is required. Note: the right-handside of the expressions you obtain should not contain V!

4 A train travels along the x-axis past a platform at a speed v. A passenger at rest in the train holds a measuring ruler of length L parallel to the x-axis. Determine the speed at which the train must be travelling in order for the length of the ruler as measured by the observer at the platform to be $L/3$.

To be handed in on Wednesday 19th October by 6pm in the blue box in the second floor of the School of Mathematical Sciences.

<div align="right">Dr. Juan A. Valiente Kroon (G56)</div>