PH4442 - Problem Sheet 3

(Answers should be returned on 14/02/2006)

1. Prove Trace theorems 10 and 12 of the handout (Griffiths p.239). You may assume as proven all previous relations/theorems, 1-9.

2. Starting from the expression for the spin-averaged amplitude squared for the electron-muon scattering process given in the lectures in terms of the particle four-momenta and masses, show that (if masses can be negletced)

$$\frac{d\sigma}{d\Omega} = \frac{\alpha_{QED}^2}{2s}\frac{s^2+u^2}{t^2}$$

and in the CM frame, with scattering angle θ,

$$\frac{d\sigma}{d\Omega} = \frac{\alpha_{QED}^2}{2s}\frac{1+\cos^4\theta}{\sin^4\theta}\,.$$

3. Extract the cross section for the QED process $e^+e^- \to \mu^+\mu^-$ at high energies (where the particle masses can be ignored). Express it in terms of the scattering angle θ and the centre-of-mass energy $\sqrt{s}$.