

### Level 3 Condensed Matter Physics- Part II

#### Weekly problem 4

(1) In a superconductor persistent current measurement no noticeable decrease in the current is observed after 1 year. The precision of the measurement is estimated at 0.1% of the current measured. Calculate a lower limit for the average scattering time  $\tau$  in the superconductor.

[3 marks]

(2) Lead is a Type I superconductor with critical temperature 7.2 K and critical field 0.080 T at 0 K. Calculate the maximum current that can be carried in a 1 mm diameter Pb wire at liquid-He temperature (4.2 K). [4 marks]

(3) The magnetic susceptibility of a Type II superconductor is measured to be -0.7 in the mixed state. If the susceptibility of the normal phase is  $2 \times 10^{-5}$  calculate the volume fraction of superconducting and normal phases within the material. For simplicity assume the magnetic susceptibility follows a rule of mixtures type law for composite materials, and that the London penetration depth is small compared to the spacing between normal material filaments.

[3 marks]

