Physics 861 { Fall 01

Problem set 10 - Due Thursday, Nov 29

1. The stress-strain relation in an isotropic solid can be written

$$E_{ij} = A(S_{ij} + p\pm_{ij}) + A^{0}p\pm_{ij} \qquad (1)$$

where $p = ¡ (S_{11} + S_{22} + S_{33})=3$ is the pressure.

(a) Relate the constants A and A^{0} to the bulk modulus B and shear modulus ^{1}.

(b) Relate the constants A and A^{0} to Young's modulus E and Poisson's ratio ^{o}:

[The next questions can be answered independently of (a) and (b)]

(c) In the limit (near melting, perhaps) when an isotropic solid becomes like a liquid with bulk modulus B, what are the values of E, ^{1} and ^{o}?

(d) In a cubic crystal, the Cauchy relations reduce to $C_{12} = C_{44}$. When $C_{11} ¡ C_{12} = 2C_{44}$ the crystal becomes an isotropic solid. Knowing this, ¯nd the values of E, ^{1} and ^{o} for an isotropic solid of bulk modulus B when Cauchy's relations are satis¯ed.

(e) You will see from the above that a solid that obeys Cauchy's relations cannot transform continuously into a liquid. Why not?

2.

Problem 2, page 486, of Ashcroft - Mermin

3.

Problem 7, page 640, of Ashcroft - Mermin.

(a) Answer the questions posed by Ashcroft- Mermin.

(b) In eq. (30.36), what is the value of G for an isotropic crystal in terms of the standard elastic constants B; E; ^{1}; ^{o}? Try to get the simplest answer, rather than an awful combination of constants.

(c) What is the displacement u_z as a function of x and y? Here z is the dislocation axis and $r^2 = x^2 + y^2$. Assume, again, an isotropic crystal.

(d) Assume that the dislocation is parallel to one of the axes in a cubic crystal. Recall that the equations of elastic equilibrium are, quite generally,

$$\sum_{j} @S_{ij}=@x_j = 0 \qquad (2)$$

Is u_z of the same form as in part (c), for the appropriate value of G, and how is G related to C_{11}; C_{12} and C_{44}?