Physics 4243/5243
In class Exercise
Monday March 23rd

Problem 1:
Find the first two Brillouin zones for the two-dimensional hexagonal lattice. Show the contours of constant E for free electrons and indicate whether they are electron-like or hole like orbits.

Problem 2: (This online one slightly different than the one from class, but you get the idea.)
a) Sketch the Fermi contour for a 2D solid with a simple square lattice using the nearly free electron model and assuming one electron per atom.

b) Now suppose there is a low temperature phase transition in which all the atoms are dis placed by a small amount u to the positions indicated by xs. How does the Fermi contour change? Sketch it.

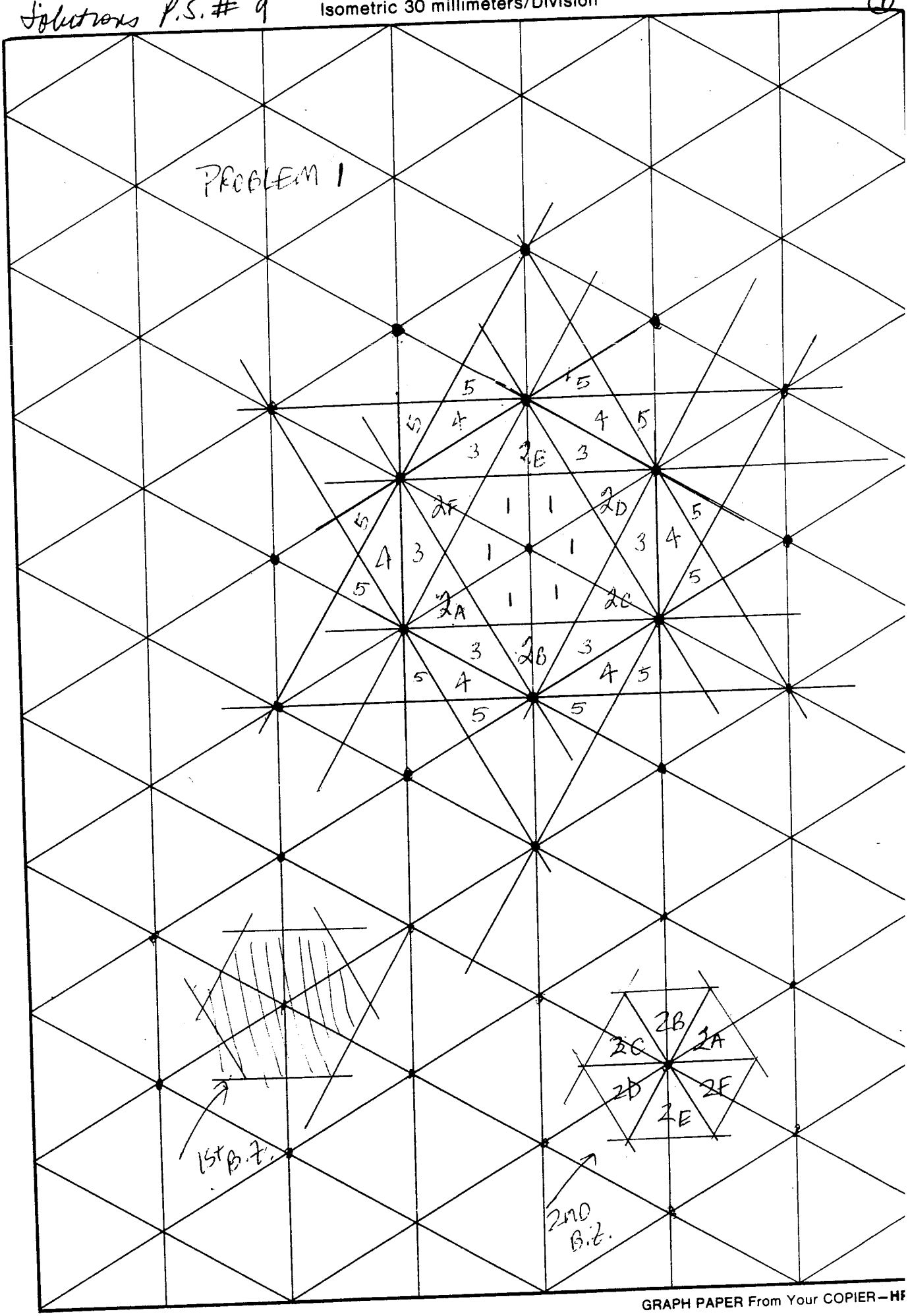
O→x x←O O→x x←O O→x x←O

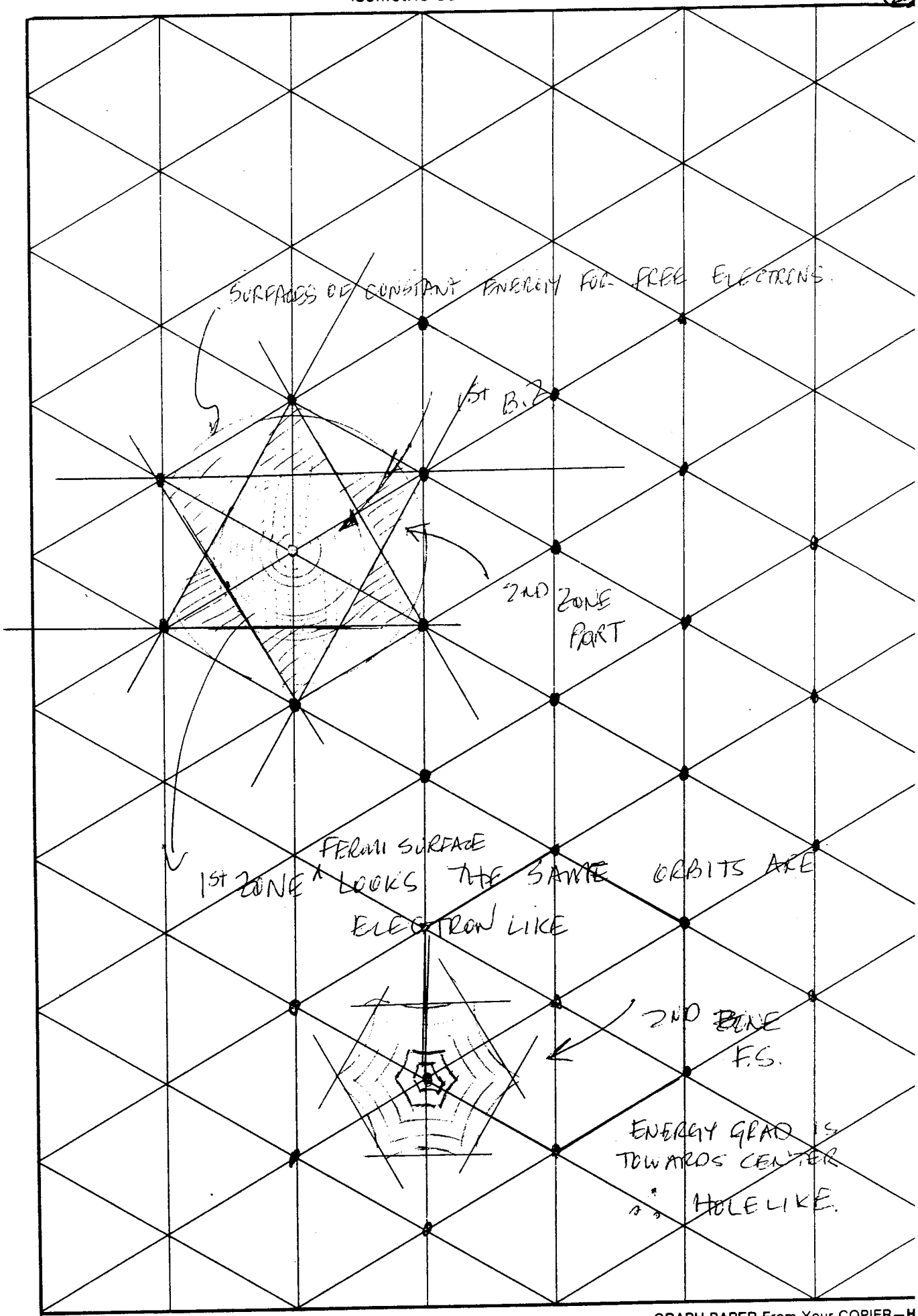
O→x x←O O→x x←O O→x x←O

O→x x←O O→x x←O O→x x←O

O→x x←O O→x x←O O→x x←O

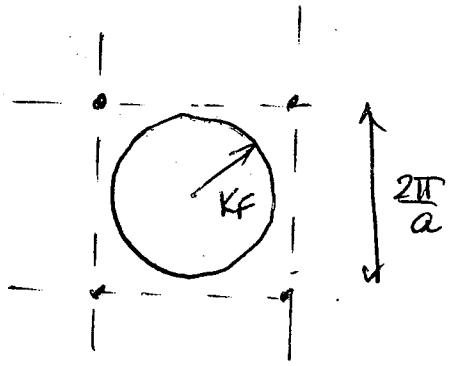
Solutions P.S. # 9 Isometric 30 millimeters/Division (1)





Problem 2

For undistorted lattice



$$\frac{k_F = \frac{\sqrt{2\pi}}{a}}{\frac{1}{2}\text{box} \; \frac{\pi}{a}} = 0.798$$

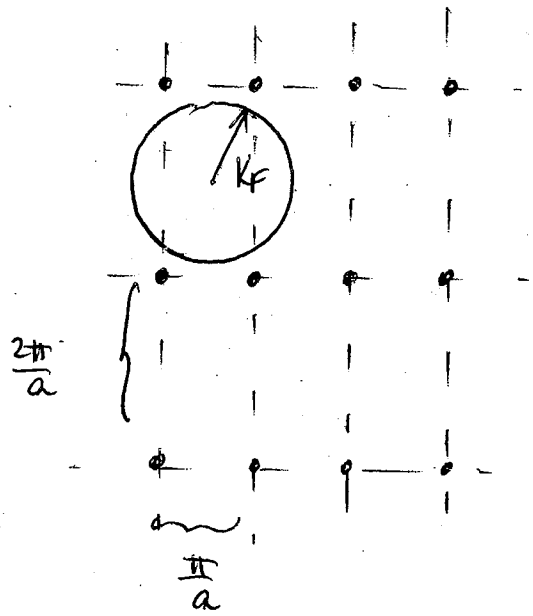
in r.l.

Completely filled 1st B.Z.

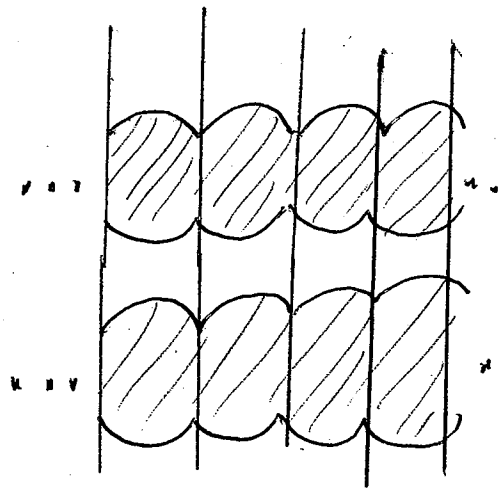
de Haas - van Alphen would just show oscillations

$$\frac{1}{\Delta B} = \frac{2\pi e}{\hbar c S} \qquad \text{where } S = \pi k_F^2$$

For distorted lattice

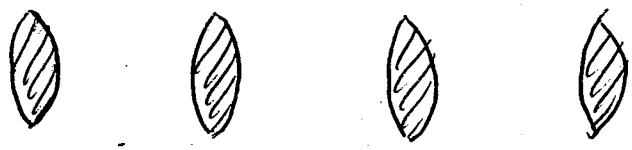


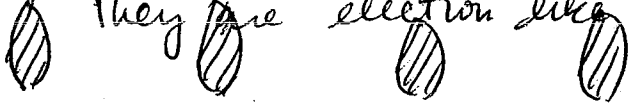
Same k_F but now it spills into second B.Z in $\hat{x}$ direction



NO CLOSED ORBITS IN 1ST ZONE

But in second zone there are closed orbits





They are electron like orbits

And there is an oscillation in $\frac{1}{\Delta B} = \frac{2\pi e}{\hbar c S}$

Where S is the size of the

 → area.