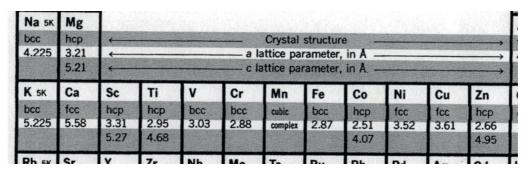
## Condensed Matter Physics: Weekly Problem 3

These problems are to be formatively self-assessed by you, the student. Students taking part in the peermarking pilot scheme will also be required to mark one of their peer's weekly problems. A mark scheme, out of 10, will be provided with each solution to aid your assessment before your timetabled weekly workshop. Information underlined/boxed in red in the model solutions is required for marks to awarded.

**Summary:** In this problem, we will explore vibrations in solids using phonons as a model for describing the transmission of sound in crystalline solids. You will need to refer to Lecture 6.



- **a.** The metal iron has a bcc structure with the unit cell length of a = 0.287 nm (Kittel Table 1.3, page 20). Calculate the speed of sound propagating along the [100] axis where the spring constant is C = 5.00 N m<sup>-1</sup>. [3 marks]
- **b.** At what wavelength would the speed fall to 50 % of the speed calculated above? **[1 mark]**
- **c.** Explain physically why the speed drops. [1 mark]
- **d.** What is the maximum frequency that can be generated along the [100] axis? [2 marks]
- **e.** Describe the Debye approximation. Would the value for (d) above be lower or higher if the Debye approximation were used? Illustrate your answer with a sketch of the phonon dispersion curve in the first Brillouin zone. [3 marks]