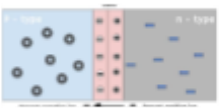
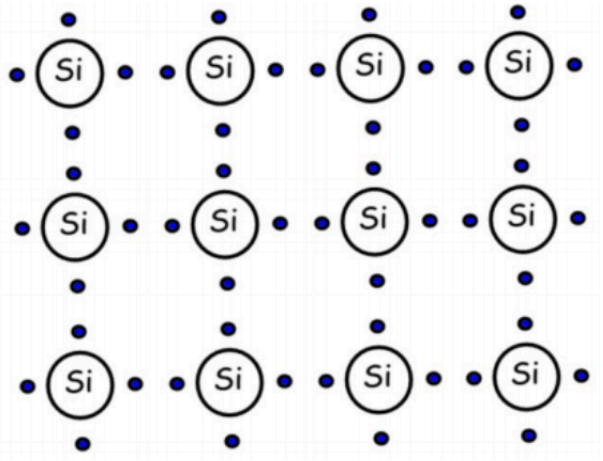
Electricity

Semiconductors



1) The diagram represents a small section of silicon crystal. It is an example of an intrinsic semiconductor.



   a) State the meaning of an intrinsic semiconductor.

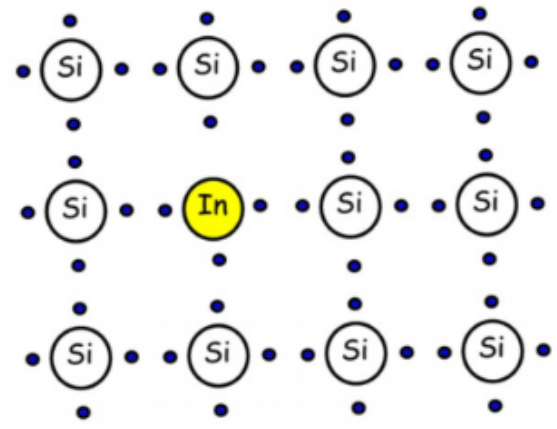
   b) The diagram shows the bonding electrons when the crystal is at zero Kelvin.
   Explain why the crystal is an insulator.

   c) State how you could make this crystal a better conductor of electricity.

2) For a n- type semiconductor state the type of majority charge carriers in the crystal.

3) Describe what is meant by a ***positive hole*** ?

4) The diagram shows a section of a doped semiconductor.



   a) State the type of semiconductor shown..
   b) Explain how the make up of this crystal makes it a better conductor.

5) State whether each of the following statements is true or false:

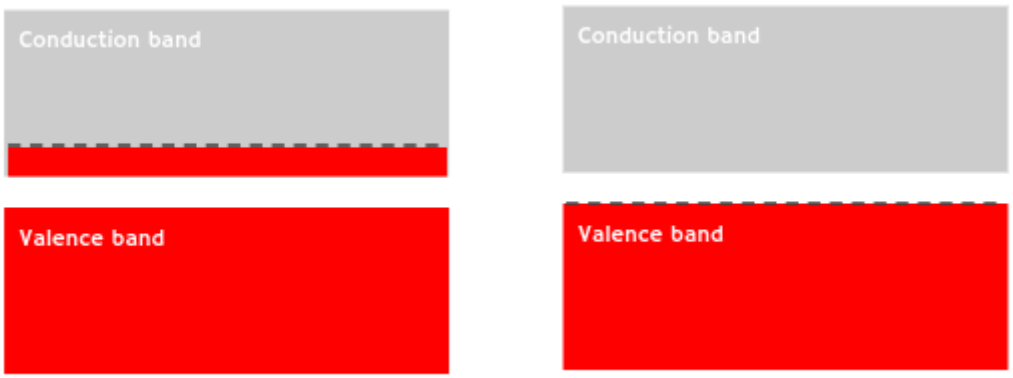
   a) The majority of charge carriers in a p-type semiconductor are positive holes.

   b) When an intrinsic semiconductor is doped with an element with five valence electrons then the semiconductor crystal becomes negatively charged.

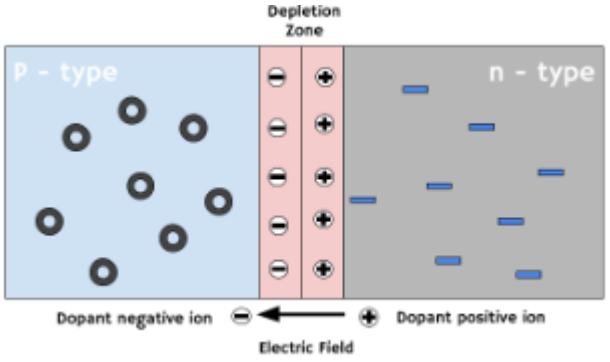
   c) An intrinsic semiconductor becomes a better conductor when it is heated.

   d) The majority of charge carriers in a n-type semiconductor are negatively charged electrons.

6) Explain which of these band diagrams represents a metal. The dotted line represents the Fermi level.



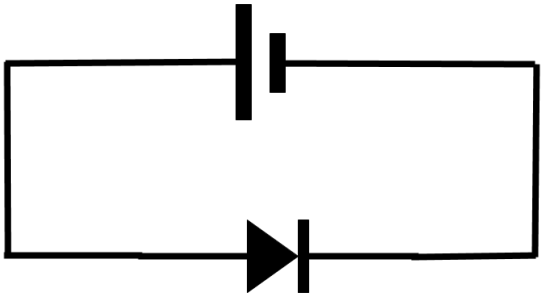
7) Copy the following diagram of a pn junction diode and add show the proper connection of a battery to make it a forward biased diode.



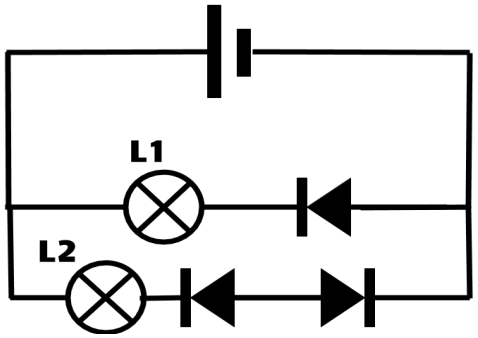
   a) Explain the formation of the depletion zone.

   b) Describe what happens to the charge carriers when the external battery is connected so that it is forward biased.

8) A diode is connected to an electric cell as shown. State whether it is forward or reversed biased.



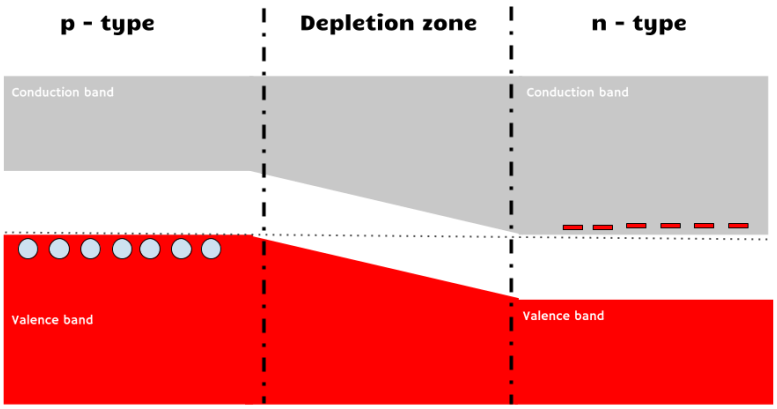
9) Lamps L1 and L2 both light when connected to the electric cell. Three diodes are now added to the cell. State which lamps will light. Justify your answer.



10) Which of the following statements about the band theory is/are true?

a) In all metals the conduction band is full.
b) The energy gap between the conduction and valence band of an insulator is very small.
c) In a semiconductor the energy gap between the valence and conduction band is not as big as in an insulator.
d) Current will flow through a semiconductor crystal provided there are free moving electrons in the conduction band.

11) This is a picture of the band diagram of a light emitting diode. The diode is connected to an electric cell and is forward biassed.



a) The LED does not light even though it is connected correctly and the cell works.
Explain why the LED does not light.

b) The LED is connected to a battery and this time gives off a red light.
Describe how light is produced from the depletion layer.

c) Red light has a wavelength of 700 nm. Calculate the energy gap between the n and p type semiconductors.

12) The diagram on the right shows the band diagram for a reversed biased diode.

a) Explain why the electrons in the n type cannot move into the depletion zone.

b) Explain what happens to the band diagram when the diode is forward biased?