14.1 In an n-type silicon, which of the following statement is true:

(a) Electrons are majority carriers and trivalent atoms are the dopants.
(b) Electrons are minority carriers and pentavalent atoms are the dopants.
(c) Holes are minority carriers and pentavalent atoms are the dopants.
(d) Holes are majority carriers and trivalent atoms are the dopants.

SOLUTION:

The correct statement is (c).

In n-type silicon, electrons are the majority carriers, while holes act as the minority carriers. A n-type semiconductor is formed by doping silicon atoms with pentavalent impurity like phosphorus.

14.2 Which of the statements given in Exercise 14.1 is true for p-type semiconductors.

SOLUTION:

From previous question 14.1, the correct statement is (d).

In p-type semiconductor, holes are the majority carriers, while electrons are the minority carriers. A p-type semiconductor is formed by doping silicon atoms with trivalent impurity like aluminium.

14.3 Carbon, silicon and germanium have four valence electrons each. These are characterised by valence and conduction bands separated by energy band gap respectively equal to $(E_g)_C$, $(E_g)_{Si}$ and $(E_g)_{Ge}$. Which of the following statements is true?

(a) $(E_g)_{Si} < (E_g)_{Ge} < (E_g)_C$
(b) $(E_g)_C < (E_g)_{Ge} > (E_g)_{Si}$
(c) $(E_g)_C > (E_g)_{Si} > (E_g)_{Ge}$
(d) $(E_g)_C = (E_g)_{Si} = (E_g)_{Ge}$

SOLUTION:

The correct statement is (c).

Of the three given elements, the energy band gap of carbon is the maximum and that of germanium is the least.

The energy band gap of these elements is related as: $(E_g)_C > (E_g)_{Si} > (E_g)_{Ge}$

14.4 In an unbiased p-n junction, holes diffuse from the p-region to n-region because

(a) free electrons in the n-region attract them.
(b) they move across the junction by the potential difference.
(c) hole concentration in p-region is more as compared to n-region.
(d) All the above.

SOLUTION:

The correct statement is (c).

Charge carriers diffuse across a junction from a region of higher concentration to one of lower concentration. In an unbiased p-n junction, the p-region has a higher concentration of holes than the n-region, causing holes to diffuse from the p-region to the n-region.

14.5 When a forward bias is applied to a p-n junction, it

(a) raises the potential barrier.
(b) reduces the majority carrier current to zero.
(c) lowers the potential barrier.
(d) None of the above.

SOLUTION:

The correct statement is (c).

Applying a forward bias to a p-n junction reduces the potential barrier. In this case, the potential barrier opposes the applied voltage, leading to a decrease in the barrier across the junction.

14.6 In half-wave rectification, what is the output frequency if the input frequency is 50 Hz. What is the output frequency of a full-wave rectifier for the same input frequency.

SOLUTION:

Input frequency (v_{in}) = 50 Hz.

For Half Wave Rectifier:

Input frequency (v_{in}) = Output frequency (v_{out}) = 50 Hz.

For Full Wave Rectifier:

Output frequency (v_{out}) = 2 Input frequency (v_{in}) = 2 × 50 = 100 Hz.