Semiconductor Fundamentals

In-Class Test 1 (2.5%)

Print Name:

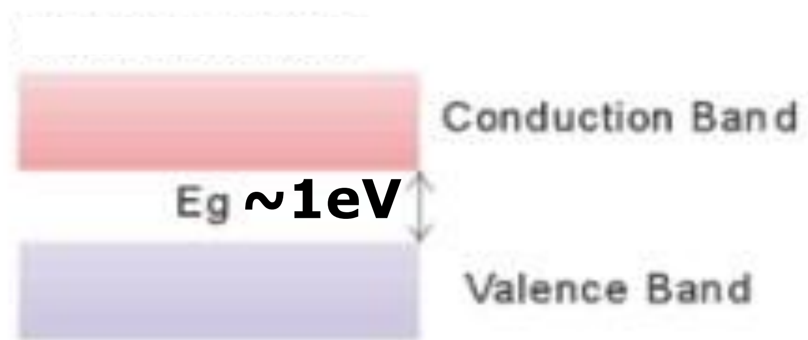
ID No:

Signature:

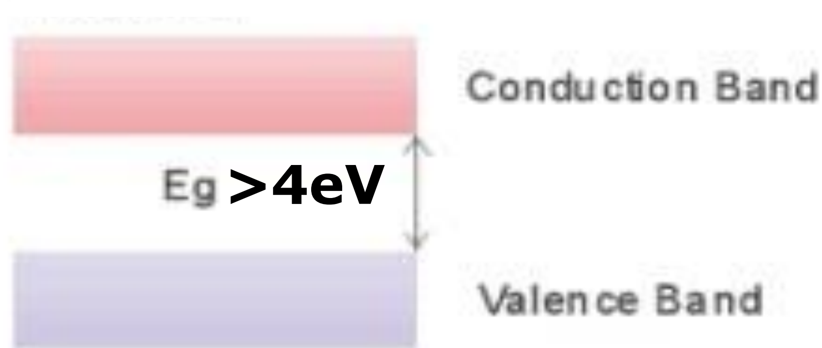
CT1. Which one is semiconductor?

(A)

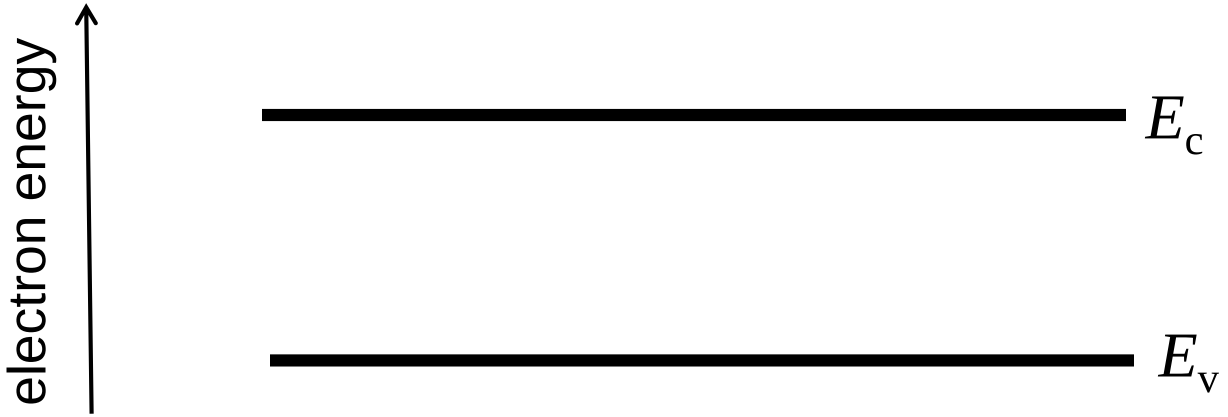
(B)



(C)



CT2. Which one is correct?



(A)

- ***E*$_{\mathbf{v}}$** is bottom edge of the conduction band
- ***E*$_{\mathbf{c}}$** is top edge of the valence band
- E_c and E_v are separated by the **band gap energy *E*$_{\mathbf{g}}$**

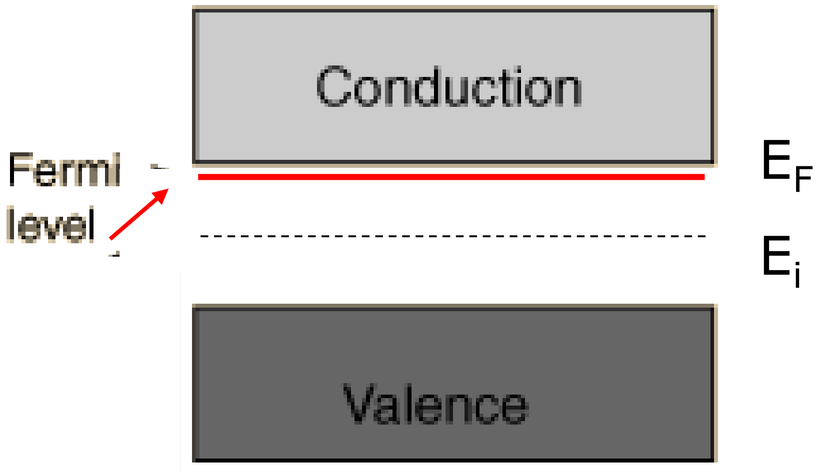
(B)

- ***E*$_{\mathbf{c}}$** is bottom edge of the conduction **level**
- ***E*$_{\mathbf{v}}$** is top edge of the valence **level**
- E_c and E_v are separated by the **level** gap energy ***E*$_{\mathbf{g}}$**

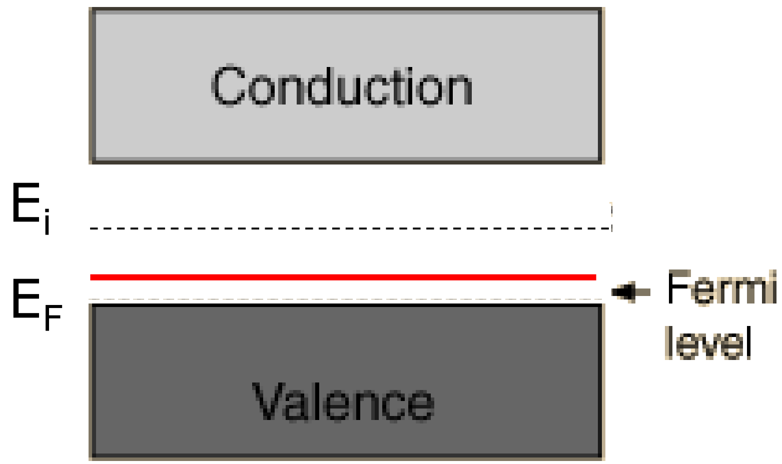
(C)

- ***E*$_{\mathbf{c}}$** is bottom edge of the conduction **band**
- ***E*$_{\mathbf{v}}$** is top edge of the valence **band**
- E_c and E_v are separated by the **band** gap energy ***E*$_{\mathbf{g}}$**

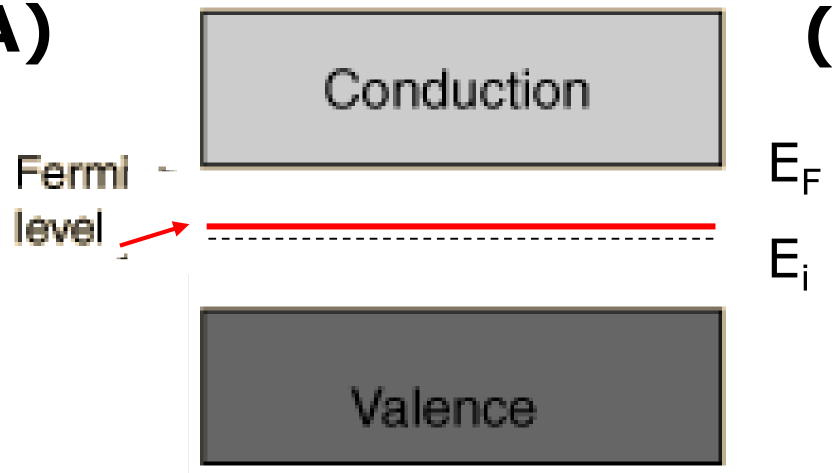
CT3. Which one is P-Type Semiconductor?



(A)



(B)



(C)

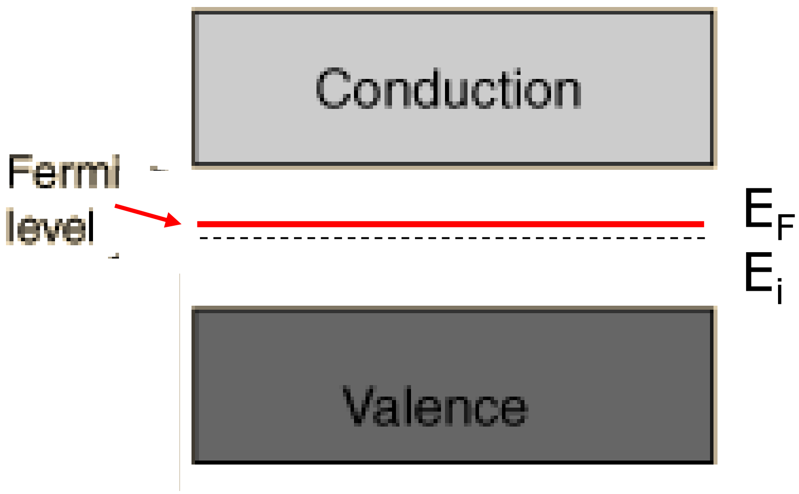
CT4

Energy band diagrams of two silicon materials, $Si_{(1)}$ and $Si_{(2)}$, are shown below and $(E_F-E_V)_{(1)} > (E_F-E_V)_{(2)}$,

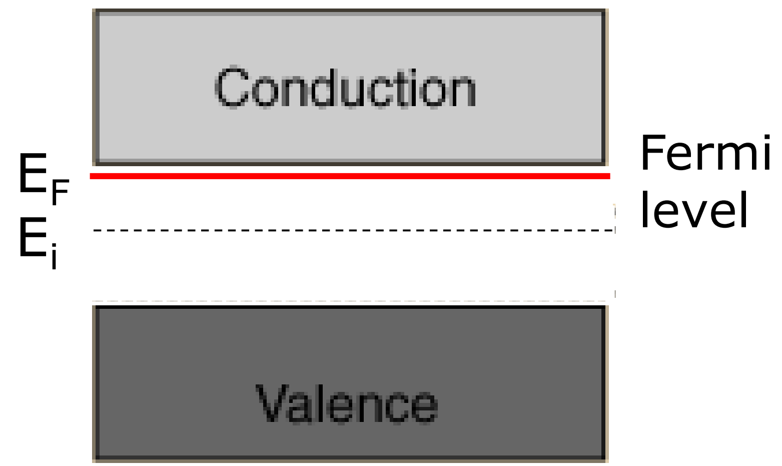
Which one is true, compared with $Si_{(2)}$?

(A) $Si_{(1)}$ is a stronger p-type. (B) $Si_{(1)}$ is a weaker p-type.

(C) $Si_{(1)}$ is a weaker n-type. (D) $Si_{(1)}$ is a stronger n-type.



$Si_{(1)}$



$Si_{(2)}$

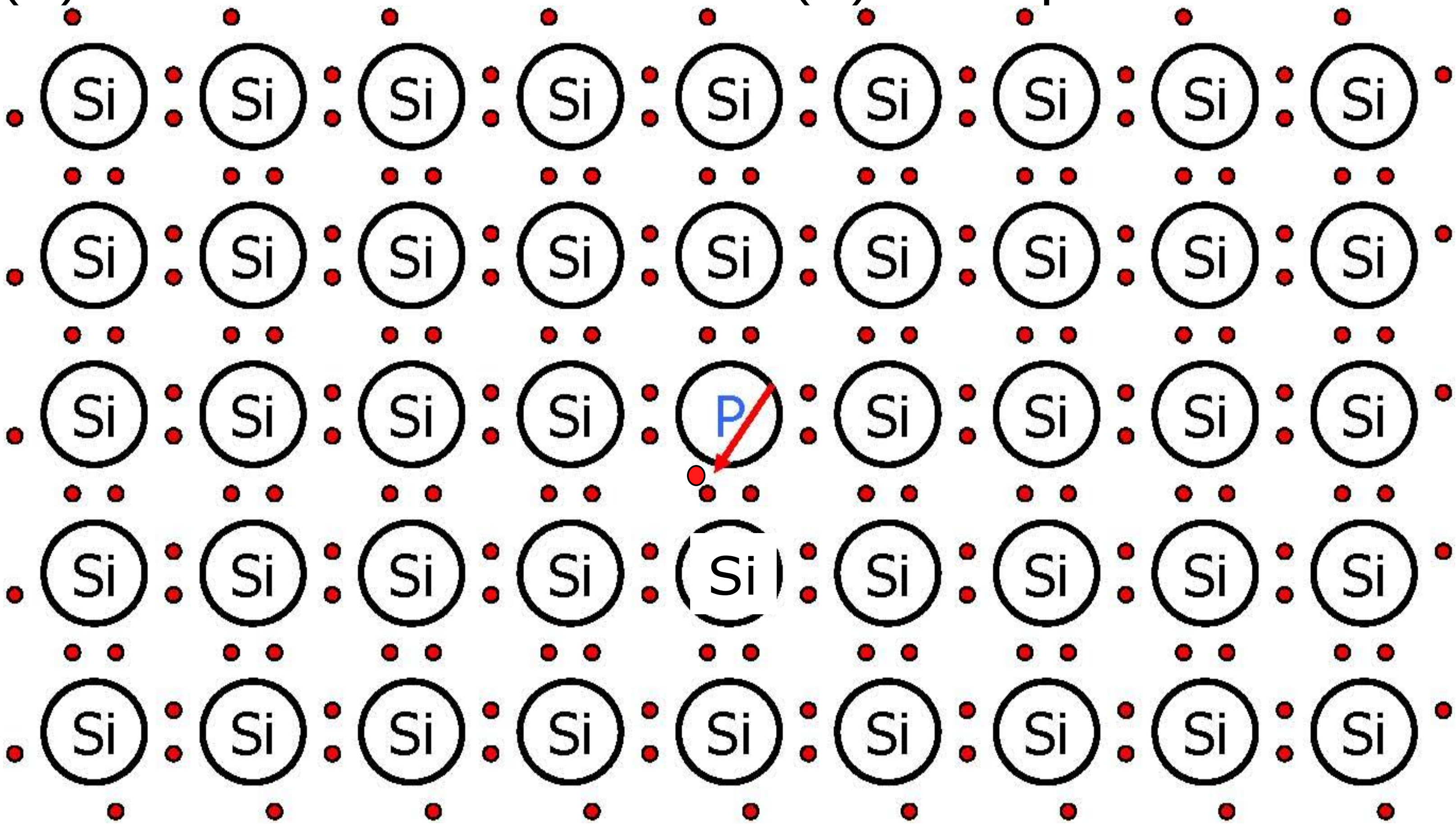
CT5. What kind of semiconductor it is ?

(A) It is an n-type semi.

(B) It is a p-type semi.

(C) It is an intrinsic semi.

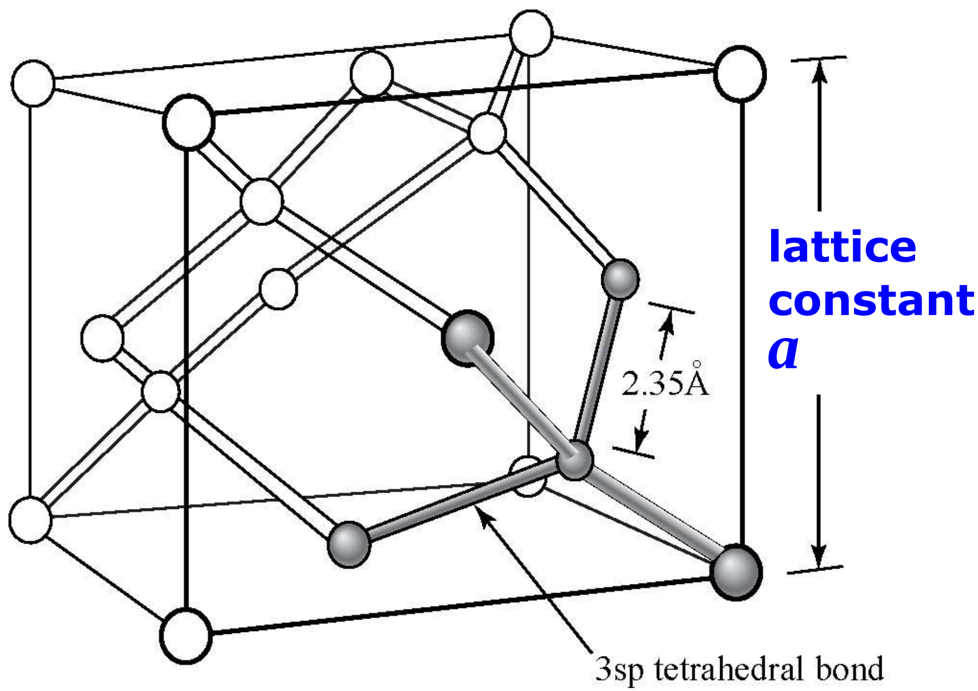
(D) It is a pure semi.



CT6. What are the correct approximate **atomic density** and **lattice constant *a*** respectively for silicon crystal at room temperature?

(A) 5×10^{20} & 0.54nm (B) 5×10^{22} & 0.54nm

(C) 5×10^{22} & 54Å (D) 5×10^{28} & 54Å



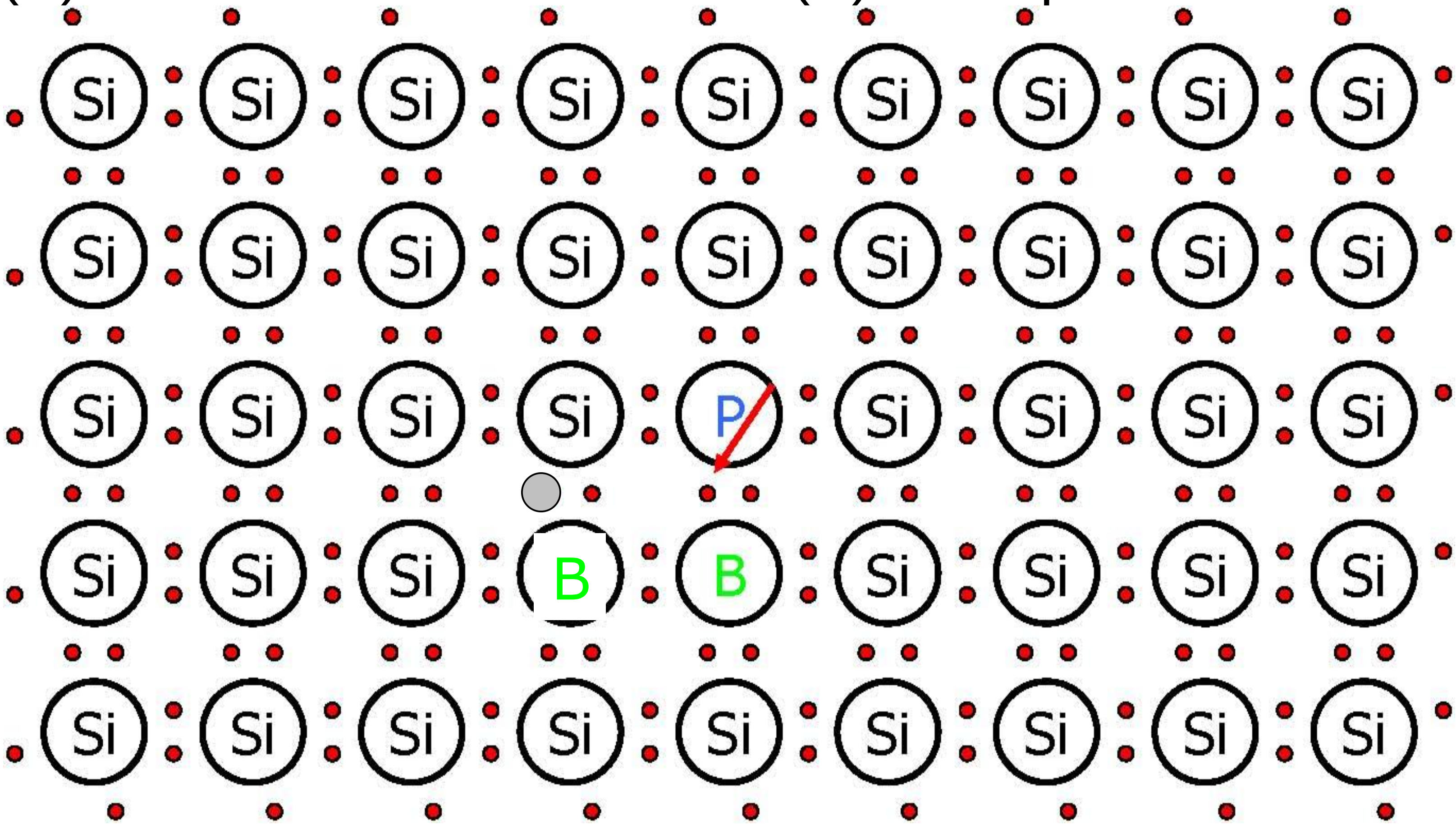
CT7. What kind of semiconductor it is ?

(A) It is an n-type semi.

(B) It is a p-type semi.

(C) It is an intrinsic semi.

(D) It is a pure semi.



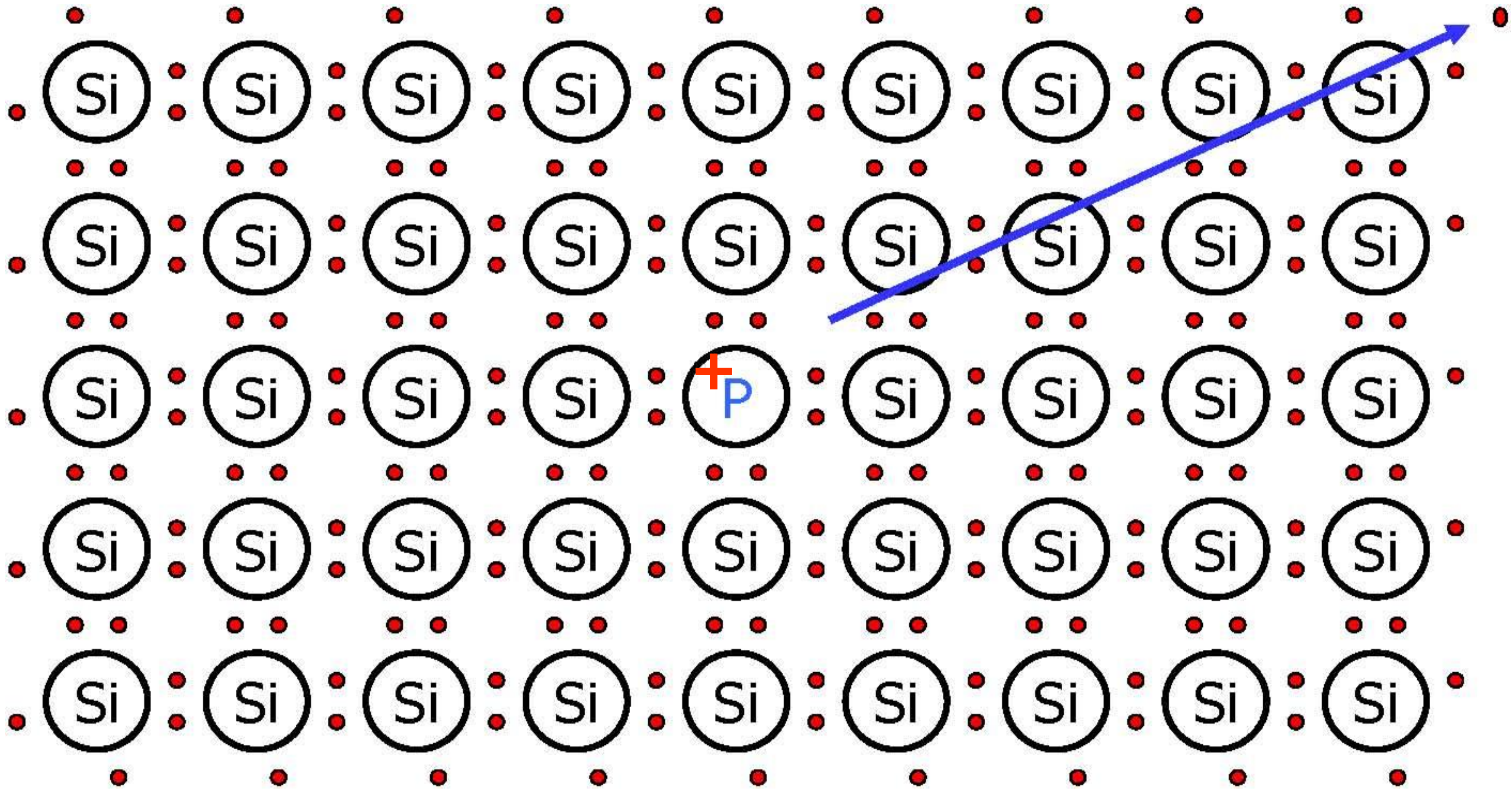
CT8. Which one is correct on P^+ ion?

(A) It is a hole.

(B) It is a mobile positive charge.

(C) It is a electron.

(D) It is a fixed positive charge.



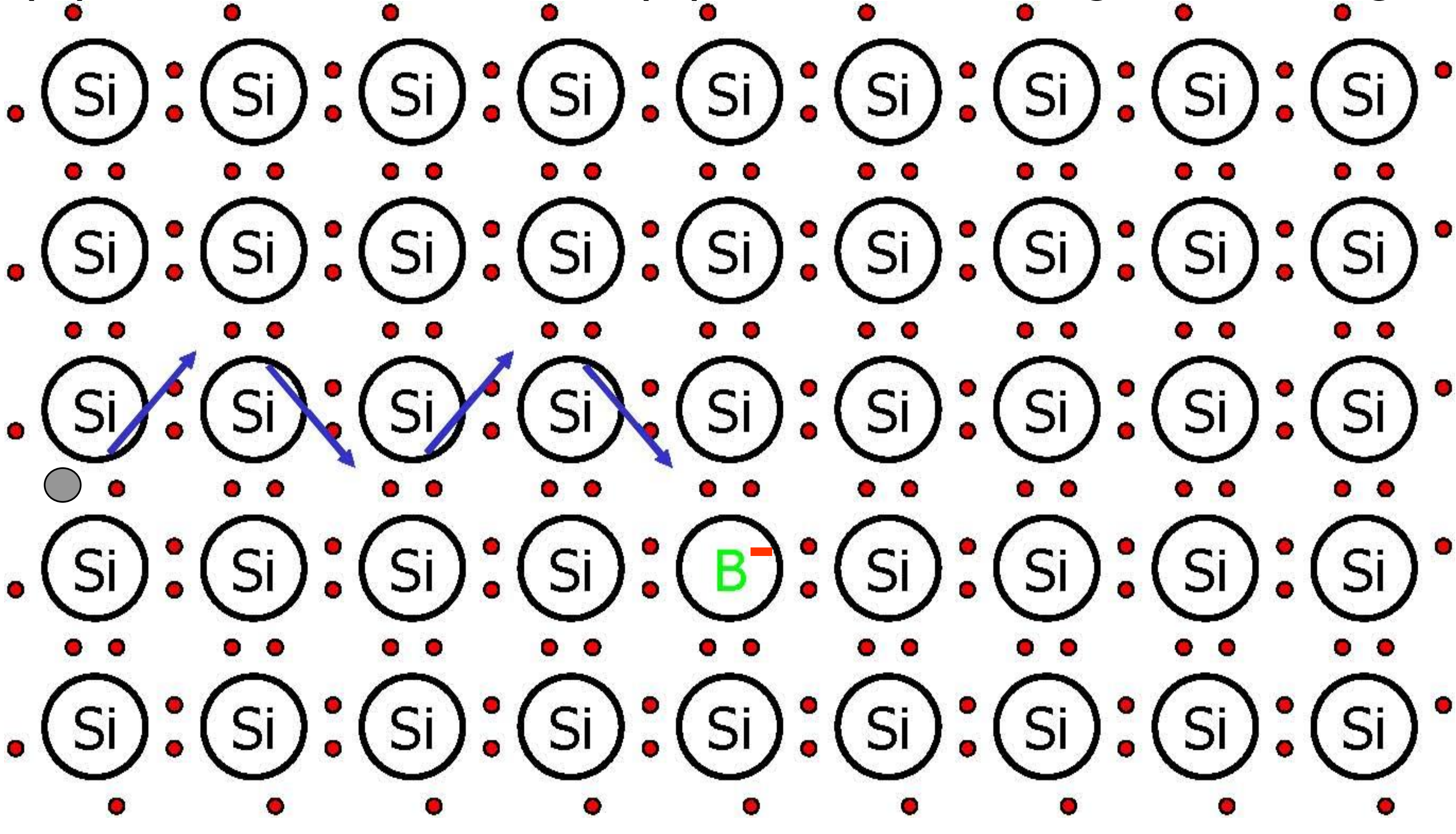
CT9. Which one is correct on B^- ion?

(A) It is a hole.

(B) It is a mobile negative charge.

(C) It is an electron.

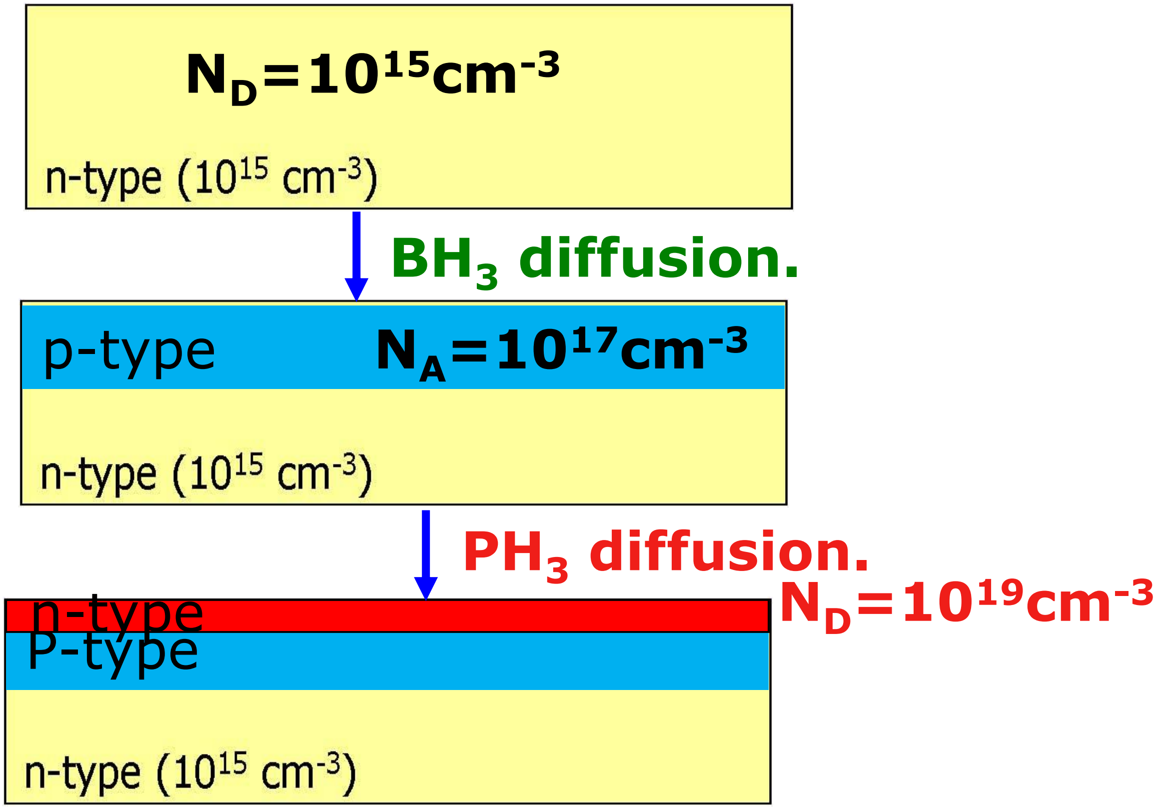
(D) It is a fixed negative charge.



CT10. Fig. shows a formation of an npn transistor. After PH_3 diffusion, the **hole** density of the **middle** layer is

(A) $10^{19}cm^{-3}$. (B) $10^{18}cm^{-3}$. (C) $10^{17}cm^{-3}$.

(D) $10^{16}cm^{-3}$. (E) $10^{15}cm^{-3}$.

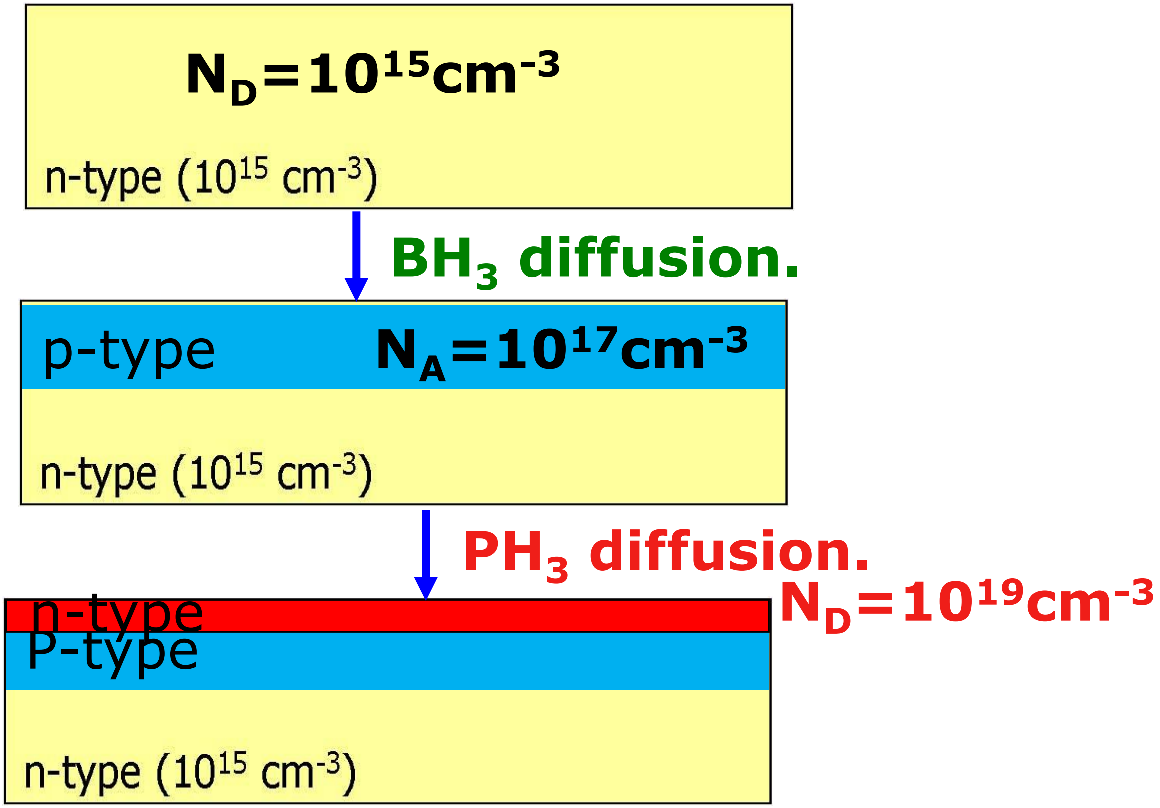


CT11. Fig. shows a formation of npn transistor.

After PH_3 diffusion, the electron density of the middle layer is

(A) $10^{19}cm^{-3}$. **(B) $10^{17}cm^{-3}$.** **(C) $10^{15}cm^{-3}$.**

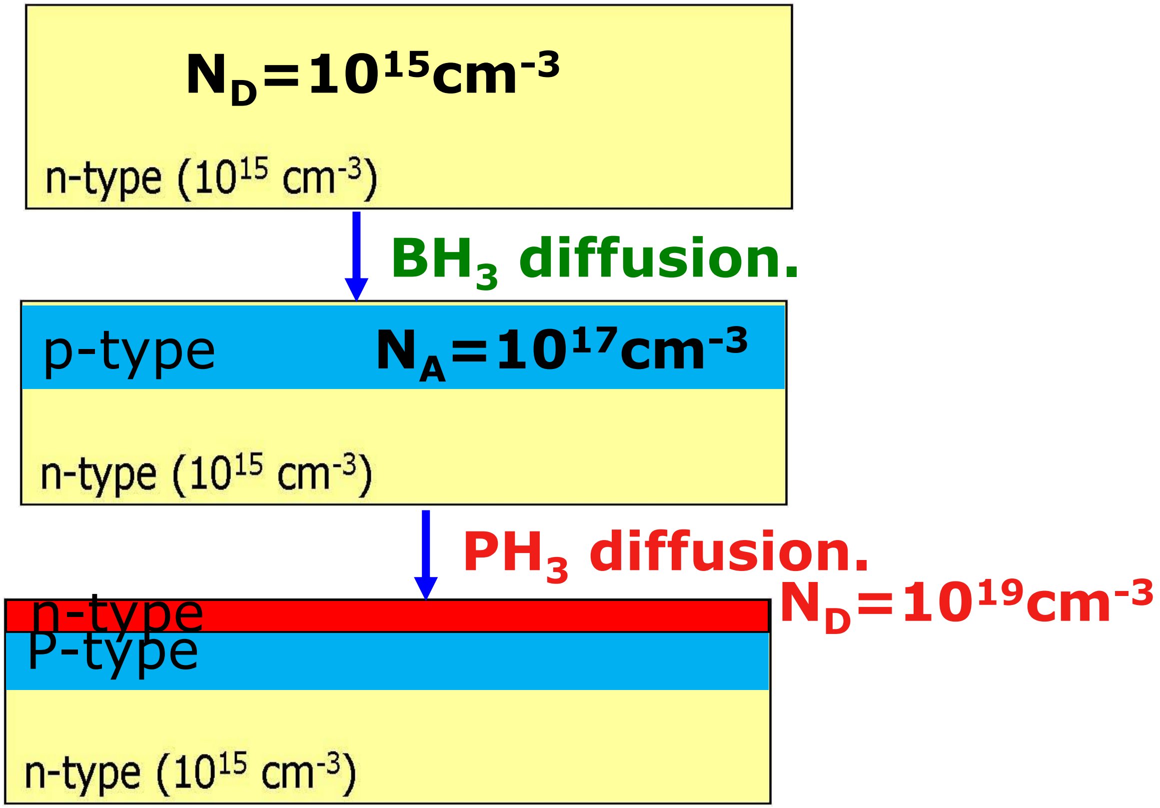
(D) $10^{3}cm^{-3}$. **(E) $10^{1}cm^{-3}$.**



CT12. **Fig. shows a formation of npn transistor. After PH_3 diffusion, the hole density of the top layer is**

(A) $10^{19}cm^{-3}$. **(B) $10^{18}cm^{-3}$.** **(C) $10^{17}cm^{-3}$.**

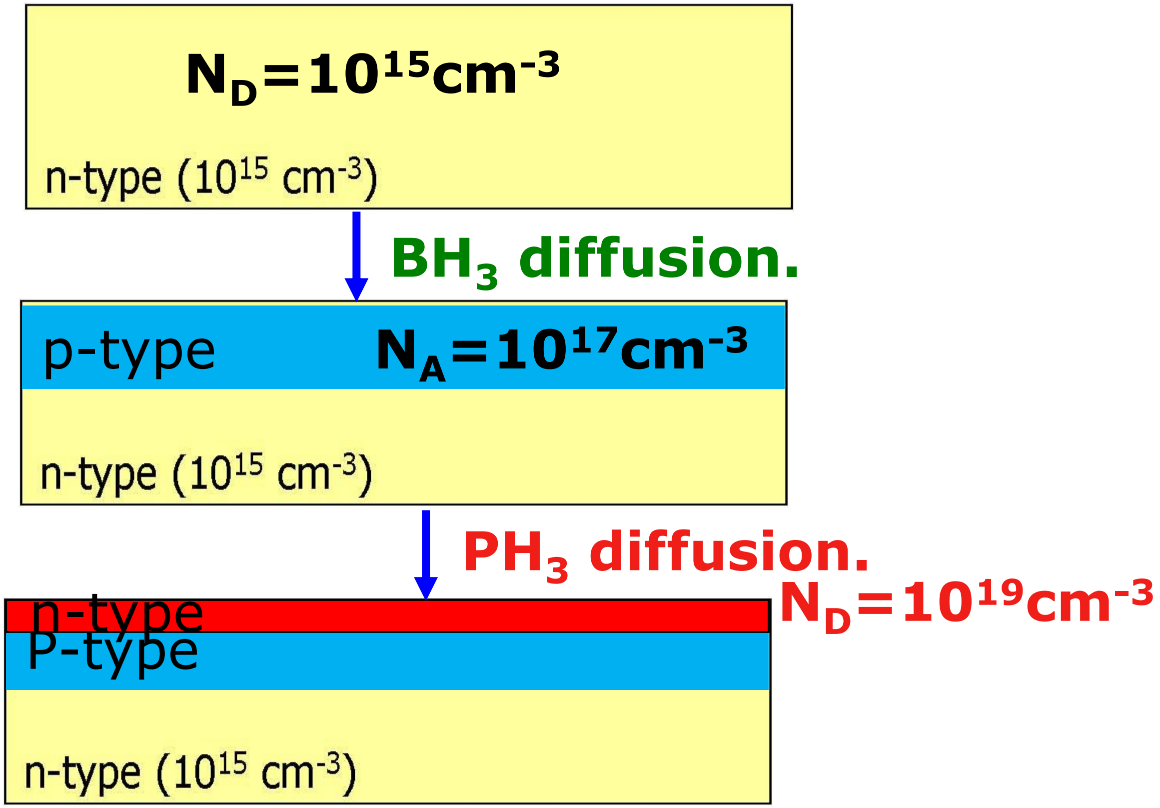
(D) $10^{3}cm^{-3}$. **(E) $10^{1}cm^{-3}$.**



CT13. Fig. shows a formation of npn transistor. After PH_3 diffusion, the **electron** density of the **top** layer is

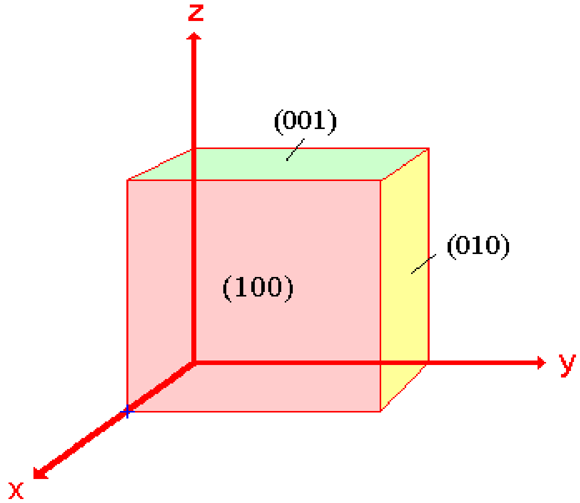
(A) $10^{19}cm^{-3}$. (B) $10^{18}cm^{-3}$. (C) $10^{17}cm^{-3}$.

(D) $10^{3}cm^{-3}$. (E) $10^{1}cm^{-3}$.



CT14.

Miller indices (*h k l*) for planes are defined as



(A)
- *h*: inverse *x*-intercept of plane
- *k*: inverse *y*-intercept of plane
- *l*: inverse *z*-intercept of plane

or (B)
- *h*: *x*-intercept of plane
- *k*: *y*-intercept of plane
- *l*: *z*-intercept of plane

CT15.

There are two collision or scattering mechanisms that affect the carrier mobility μ: phonon or lattice scattering effect μ_L, and ionized impurity scattering effect μ_I, where

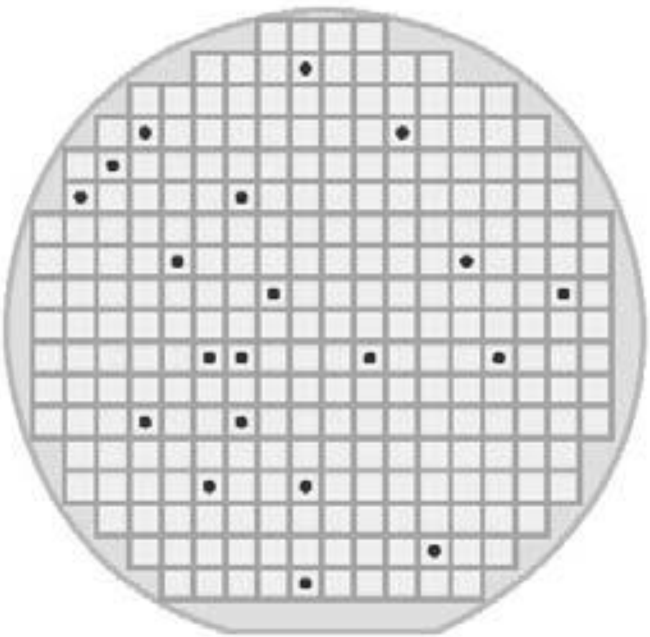
(A) $\mu_L \propto T^{+3/2}$ and $\mu_I \propto T^{-3/2} / N_I$

or (B) $\mu_I \propto T^{-3/2}$ and $\mu_L \propto T^{+3/2} / N_I$

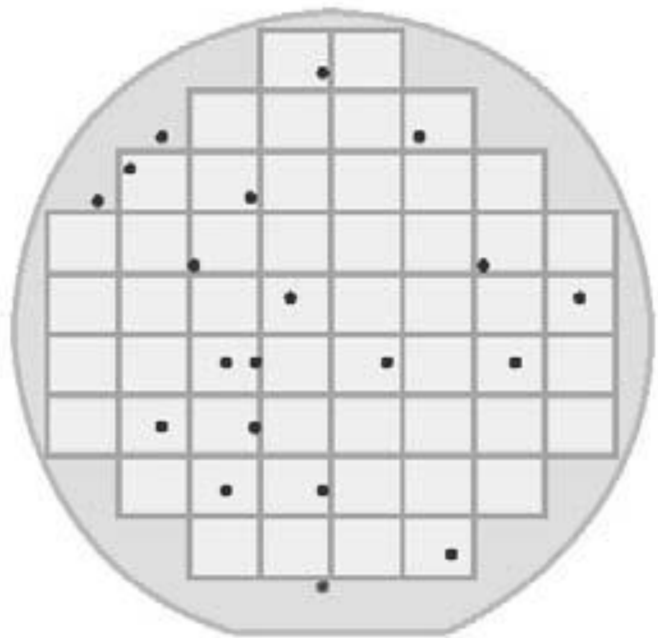
or (C) $\mu_L \propto T^{-3/2}$ and $\mu_I \propto T^{+3/2} / N_I$

CT16. Their yields are, respectively,

(A) 92% and 70%.
(B) 92% and 30%.
(C) 7.6% and 30%.
(D) 70 and 7.6%.



20 Bad Die
264 Gross Die

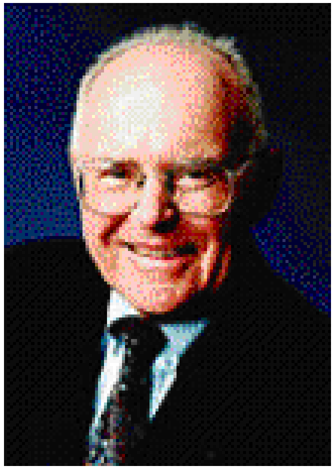


16 Bad Die
54 Gross Die

CT17. Moore's Law shows

(A) density of IC devices is <u>doubling</u> with *every two new generation*.

(B) the number of transistors on a chip will <u>double</u> *every 18 to 24 months*.



(C) Components (such as inductors) per chip will <u>double</u> *every 1.5 - 2 years*.

(D) semiconductor technology will <u>double</u> its effectiveness *every 8 months*.

CT18. The number of electrons per unit volume per unit energy, $n(E)$, is $f(E)g_c(E)$, where

(A) $g_c(E) = [4\pi(2m_n^*)^{3/2}/h^3]\sqrt{E-E_c}$ **is the number of quantum states in the conduction band per unit volume per unit energy and** $f(E) = 1/\{1+\exp[(E-E_F)/(kT)]\}$ **is called the Fermi-Dirac distribution function and gives the probability that an allowed quantum state at the energy *E* is occupied by an electron.**

or (B) $f(E) = 1/\{1+\exp[(E-E_F)/(kT)]\}$ **is the number of quantum states in the conduction band per unit volume per unit energy and** $g_c(E) = [4\pi(2m_n^*)^{3/2}/h^3]\sqrt{E-E_c}$ **is called the Fermi-Dirac distribution function and gives the probability that an allowed quantum state at the energy *E* is occupied by an electron.**

CT19.

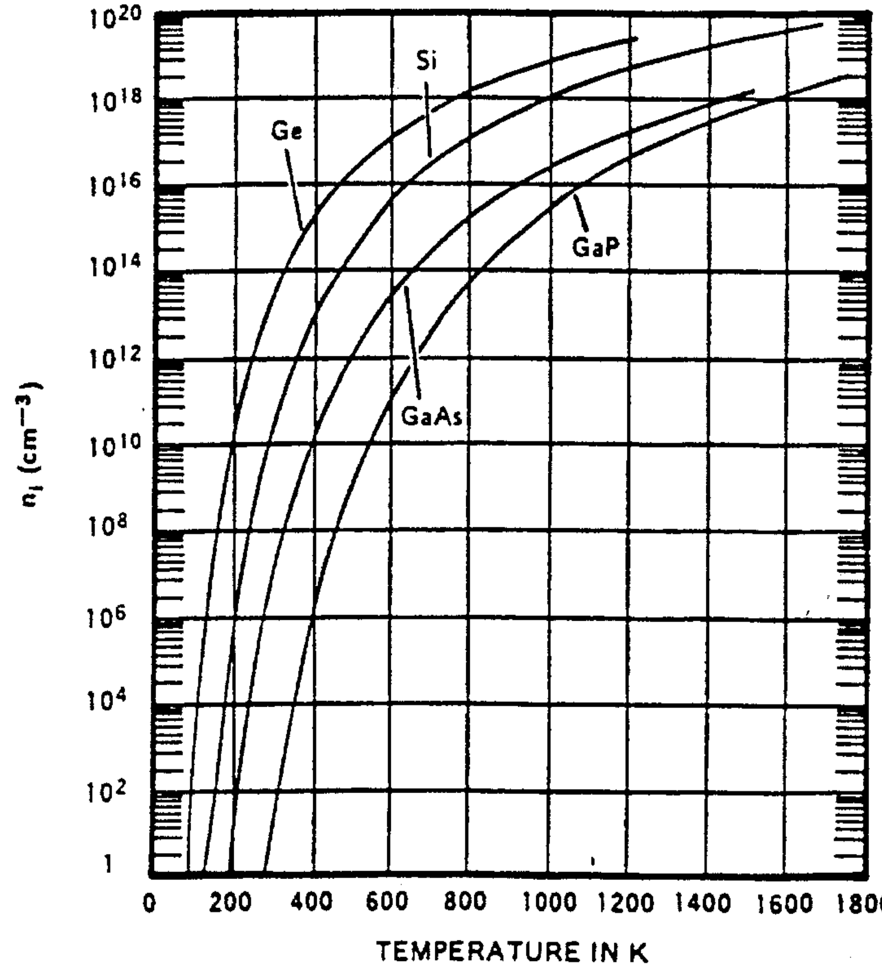
At the same temperature, n_i(Ge) is higher than n_i(Si), because:

(A) Ge is cheaper.

(B) The temperatures for both materials are not the exact same.

(C) Energy gap of Si is bigger.

(D) Energy gap of Si is smaller.

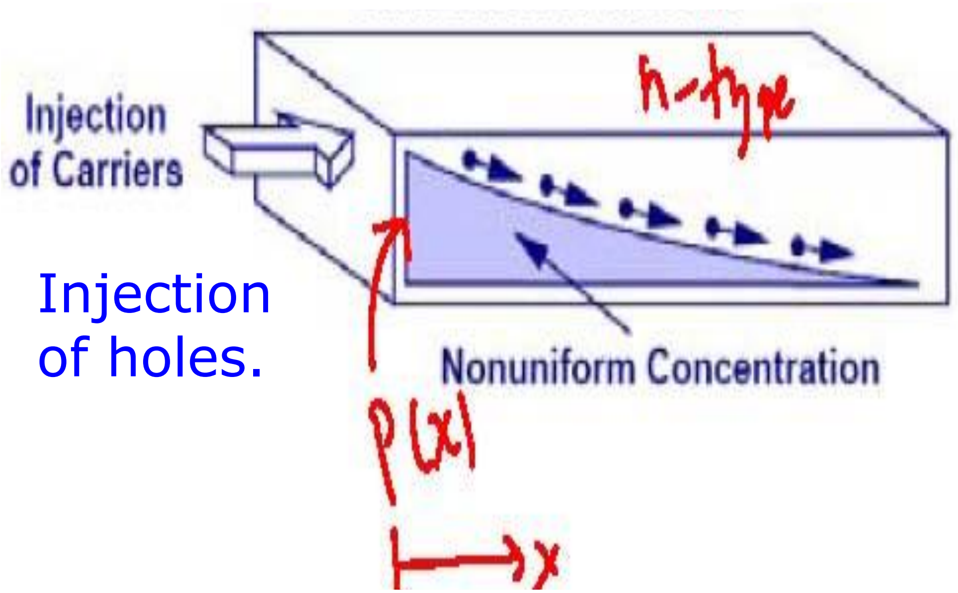


CT20. Hole diffusion current is at

(A) opposite x direction.

(B) positive x direction.

$$J_p = -qD_p \frac{dp}{dx}$$



Injection of holes.

Notation:

$D_p \equiv$ hole diffusion constant (cm^2/s)

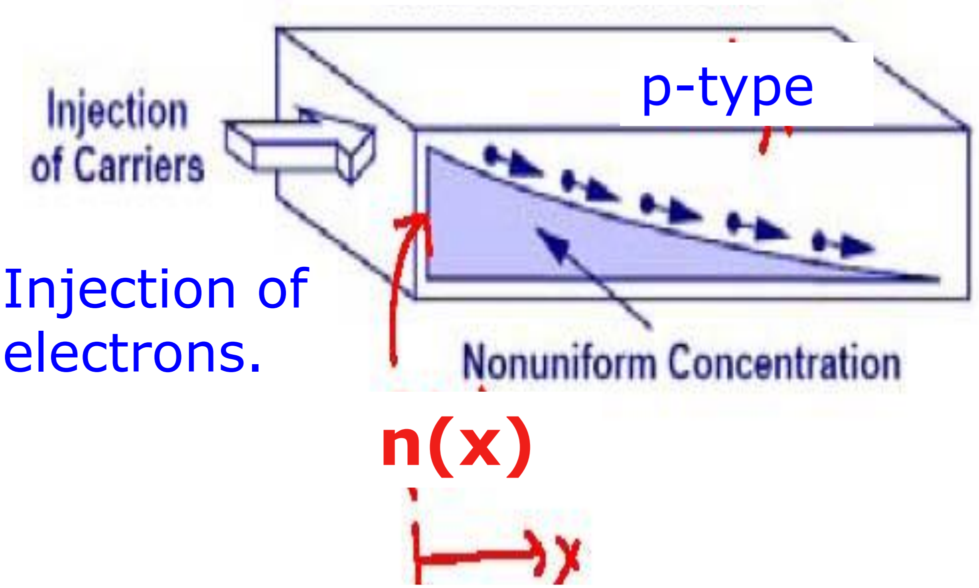
$D_n \equiv$ electron diffusion constant (cm^2/s)

CT21. Electron diffusion current is at

(A) opposite x direction.

(B) positive x direction.

$$J_n = qD_n \frac{dn}{dx}$$



Notation:

$D_p \equiv$ hole diffusion constant (cm^2/s)

$D_n \equiv$ electron diffusion constant (cm^2/s)

CT22. Hole drift current is

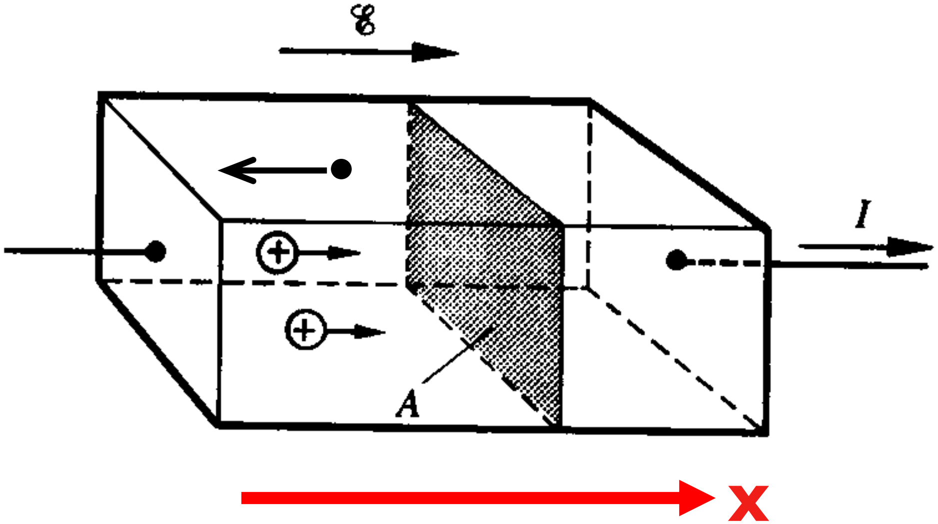
(A) at opposite x direction.

(B) at positive x direction.

(C) zero.

hole current density: $$J_p = (+q)\,p v_h = q p \mu_p E$$

p-type
Silicon



CT23. Electron drift current is

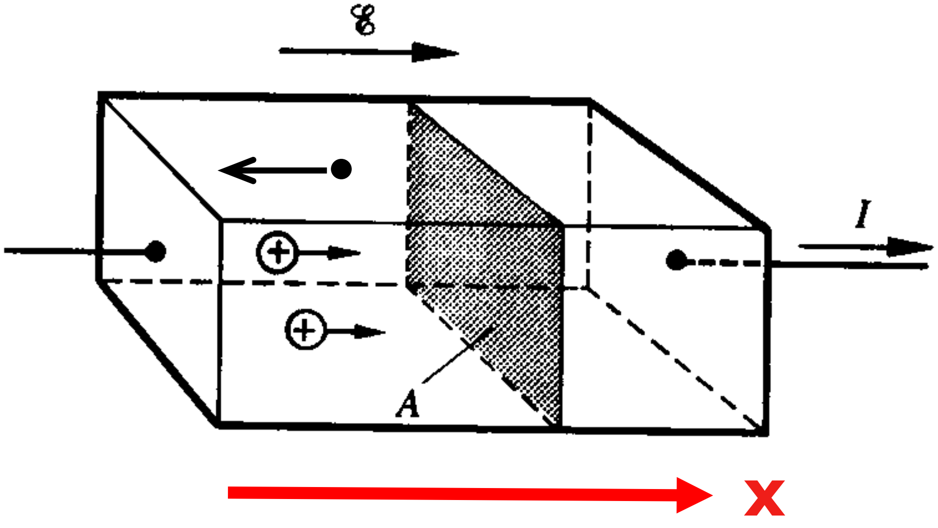
(A) at opposite x direction.

(B) at positive x direction.

(C) zero.

electron current density: $$J_n = (-q)nv_e = qn\mu_n E$$

p-type
Silicon



CT24. On the relation: $\rho \equiv \dfrac{1}{\sigma} = \dfrac{1}{qn\mu_n + qp\mu_p}$ (ohm•cm)

(A) ρ is resistivity, σ is conductivity and μ is mobility.
(B) ρ is resistivity, μ is conductivity and σ is mobility.
(C) σ is resistivity, ρ is conductivity and μ is mobility.

CT25. **Which one is true ?**

(A) **Generation** is a process of creating electron-hole pairs and exciting an electron from the valence band to the conduction band is referred to as **recombination**.

(B) **Recombination** is a process by which an electron from conduction band is moved to the valence band, and *annihilating* an electron-hole pairs is referred to as **generation**.

(C) **Recombination** is a process by which an electron from conduction band is moved to the valence band, and exciting an electron from valence band to conduction band is referred to as **generation**.