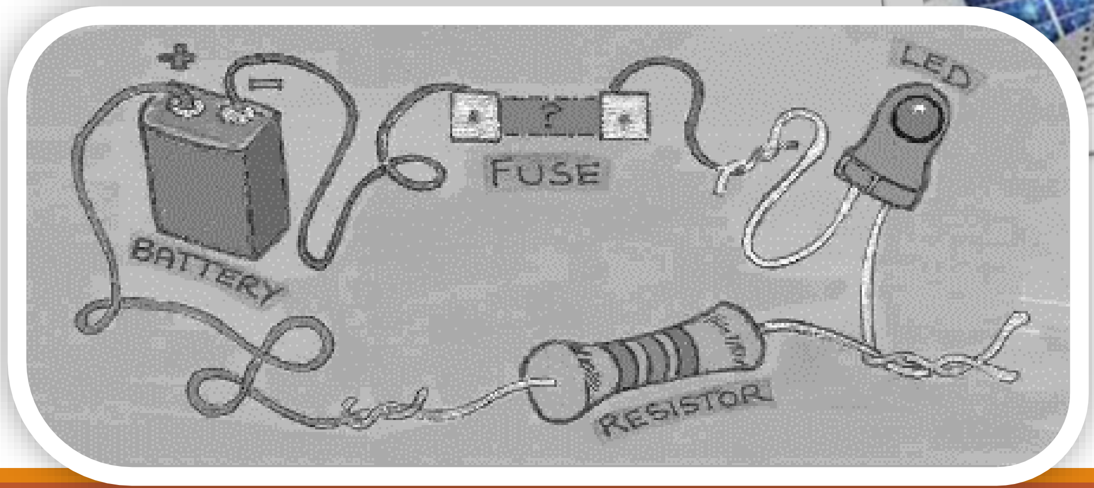
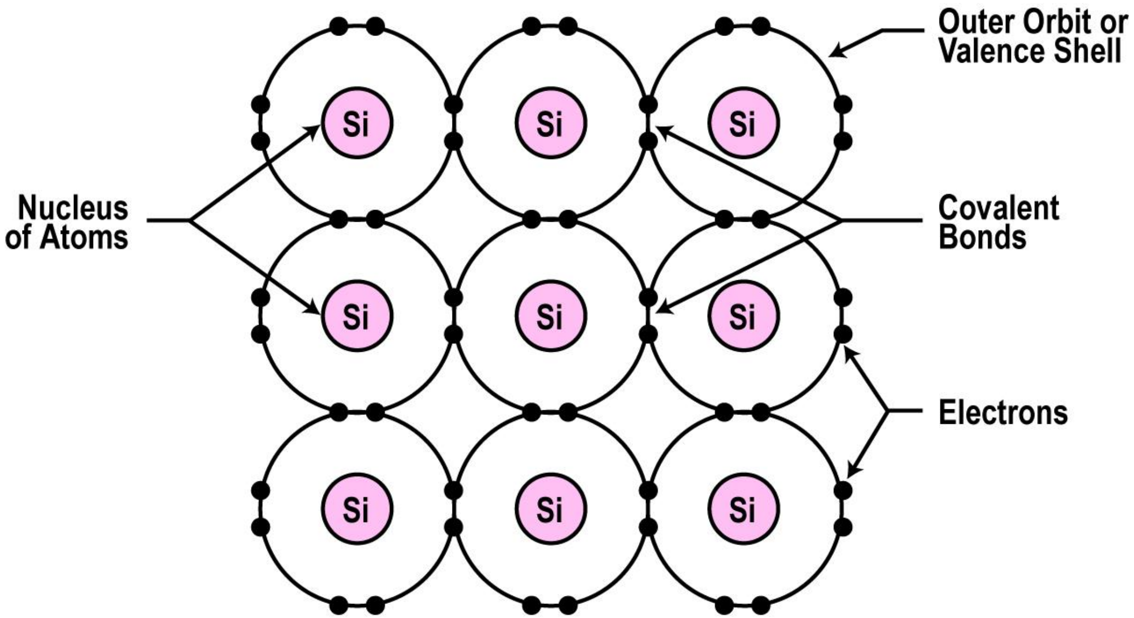
EHB222E QUESTIONS
3^{th} week



Q

A semiconductor is formed by ……… bonds.

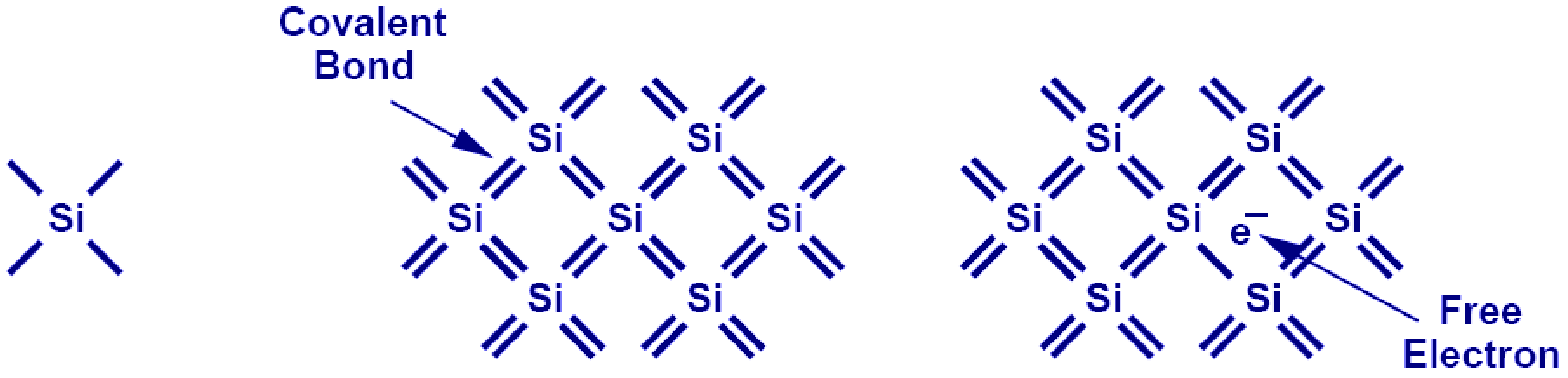
a) Covalent
b) Electrovalent
c) Co-ordinate
d) Slope
e) None of the above



Si = Silicon Nucleus with 14 Protons

When a pure semiconductor is heated, its resistance …... .

a) Goes up
● Goes down
c) Remains the same
d) Can't say
e) None of the above



(a) (b) (c)

A semiconductor has generally …………… valence electrons.

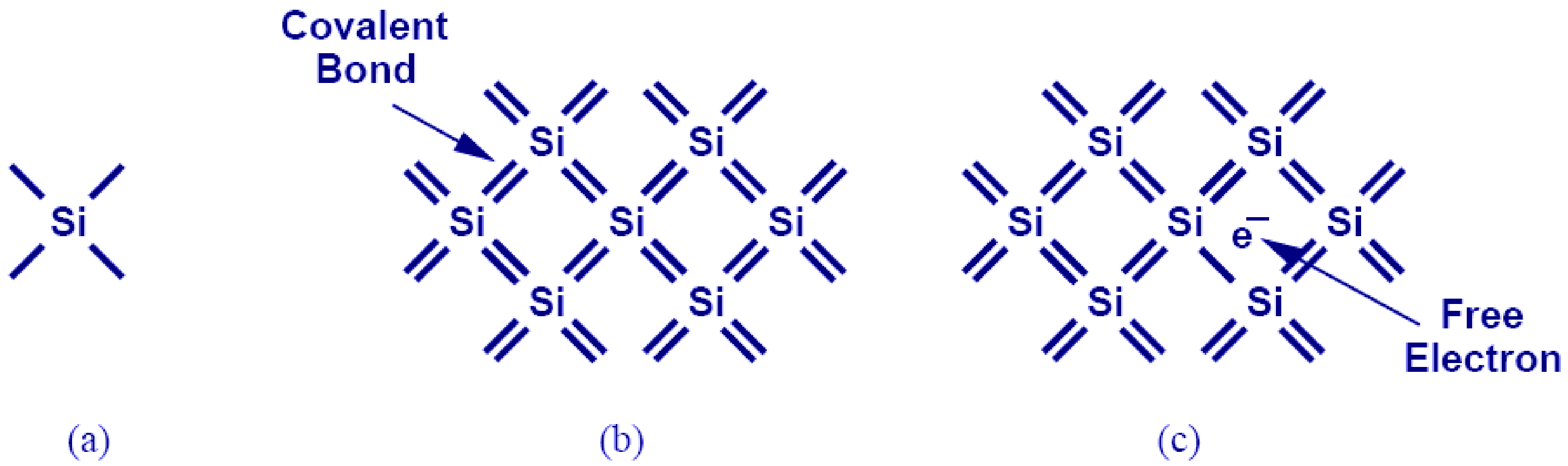
a) 2 b) 3 c) 6

d) 4 e) None of the above

In an intrinsic semiconductor, the number of free electrons ….

Q

[redacted] Equals the number of holes
b) Is greater than the number of holes
c) Is less than the number of holes
d) Are sometimes less than number of holes
e) None of the above



Semi-conductor

What is a semiconductor? How does a semiconductor differ from a conductor? Explain within two sentences.

Answer:

Question 1

In an n-type material, the donor atom density is 10e17 atoms/cm^3. What is free electron density?

Answer:

$$N_D \approx n$$

Free electron density is 10e17 atoms/cm^3 after doping

Question 2

You have a diode with the following doping properties: $N_D = 10^{18}$ cm^{-3} and $N_A = 10^{15}$ cm^{-3}.

$n_i = 1.5 \times 10^{10}$ cm^{-3}, $q = 1.602 \times 10^{-19}$ C, $\mu_n = 1600$ cm^2/Vs, $\mu_p = 400$ cm^2/Vs, $V_T = 25$ mV

a) Find majority and minority carrier concentrations in n- and p-type doped silicon.

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Region	**Majority Carriers**	**Minority Carriers**
n-type		
p-type		

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Region	**Majority Carriers**	**Minority Carriers**
n-type	$n_n = N_D = 10^{18}$ cm^{-3}	$p_n = n_i^2/N_D = 255$ cm^{-3}
p-type		

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n-type	$n_n = N_D = 10^{18}$ cm^{-3}	$p_n = n_i^2/N_D = 255$ cm^{-3}
p-type	$p_p = N_A = 10^{15}$ cm^{-3}	$n_p = n_i^2/N_A = 2.55 \times 10^5$ cm^{-3}

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b) Find the barrier voltage.

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b) Find the barrier voltage.

$$V_B = -V_T \ln\left(\frac{n_i^2}{N_A N_D}\right) = -25mV \ln\left(\frac{(1.5x10^{10})^2}{10^{18}x10^{15}}\right) = 728mV$$

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c) Calculate the specific conductivities of n- and p-type doped silicon.

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c) Calculate the specific conductivities of n- and p-type doped silicon.

$$\sigma = q(n\mu_n + p\mu_p)$$

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c) Calculate the specific conductivities of n- and p-type doped silicon.

$$\sigma_n = q\mu_n N_D = 256\ S/cm$$

$$\sigma_p = q\mu_p N_A = 0.06\ S/cm$$

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$\varepsilon_o = 8.85 \, x \, 10^{-12} F/m, \ \varepsilon_r = 12$

d) Determine the depletion zone width. How large is the depletion zone in n- and p-type regions around the junction?

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$$W = \sqrt{\frac{2.\varepsilon_o.\varepsilon_r.V_B}{q}\left[\frac{1}{N_D} + \frac{1}{N_A}\right]}$$

V_B is found in the previous pages as 0.728 V

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$$W = \sqrt{\frac{2.(8.85x10^{-12}F/m).12.(0.728V)}{1.602x10^{-19}C}\left[\frac{1}{10^{18}cm^{-3}} + \frac{1}{10^{15}cm^{-3}}\right]}$$

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$W = 0.98\ \mu m$ $\qquad\qquad x_n N_D = x_p N_A$

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$N_D / N_A = 1000$ $\quad x_p / x_n = 1000$ $\quad w \cong x_p$

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$x_p \cong 0.98\ \mu m$ $\qquad$ $x_n = {x_p}/{1000} \cong 0.98\ nm$