SEMICONDUCTOR

Challenging **MCQ** questions by The Physics Cafe

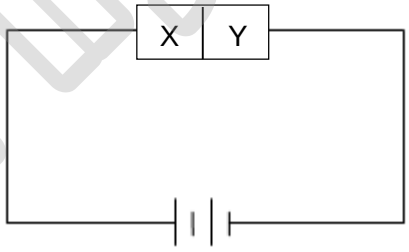
Compiled and selected by The Physics Cafe

1 Which of the following about doped semiconductors is correct?

		Charge of semiconductor	Majority charge carriers
A	**p – type**	positive	holes
	n – type	negative	electrons
B	**p – type**	neutral	holes
	n – type	neutral	electrons
C	**p – type**	positive	protons
	n – type	neutral	neutrons
D	**p – type**	neutral	protons
	n – type	neutral	electrons

2 A semiconductor X is made by doping germanium crystal with arsenic (donor). Another semiconductor Y is made by doping germanium with indium (acceptor). The two are joined end to end and connected to a battery as shown.

Which of the following statements is correct?



A X is p-type, Y is n-type and the junction is forward biased.

B X is n-type, Y is p-type and the junction is forward biased.

C X is p-type, Y is n-type and the junction is reverse biased

D X is n-type, Y is p-type and the junction is reverse biased.

3 Which of the following statements concerning semiconductors is false?

A In semiconductors, the number of holes in the valence band depends on the temperature of the semiconductor.

B In p-type semiconductors, the majority mobile charge carriers are holes and the minority carriers are electrons.

C In intrinsic semiconductors, the number of holes in the valence band is always equal to the number of electrons in the conduction band.

D Intrinsic semiconductors are not as good electric conductors as compared to extrinsic semiconductors because in intrinsic semiconductors, holes and electrons recombine in the presence of an applied electric field.

4 Which of the following statements concerning the semiconductor diode is correct?

A The size of the depletion region in the diode is fixed at all times.

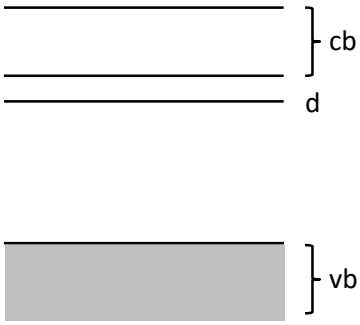
B It is possible to make a diode using intrinsic semiconductors without dopants.

C The depletion region is formed due to the difference in the mobile charge carrier concentration in the n-type and the p-type semiconductor.

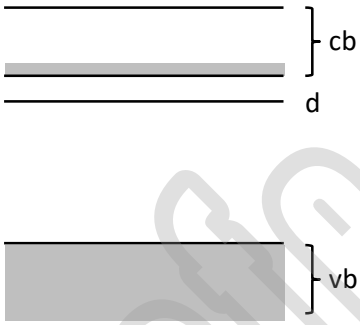
D The p-type side of the diode is positively charged and the n-type side is negatively charged. However, overall, the diode is electrically neutral.

5 Which diagram illustrates the valence band vb, the conduction band cb, and the dopant level d in an intrinsic semiconductor doped with electron-deficient impurity atoms that is at zero kelvin?

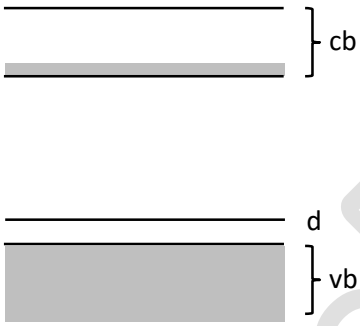
A



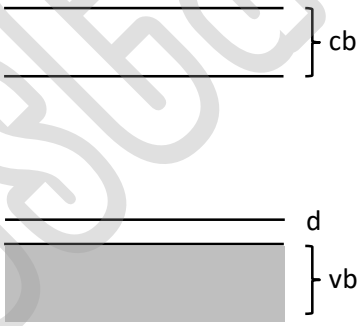
B



C

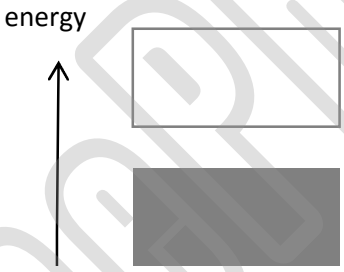


D

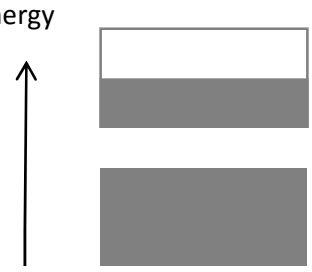


6 Which of the following diagrams best represents the highest two energy bands of a conductor at 0 K?

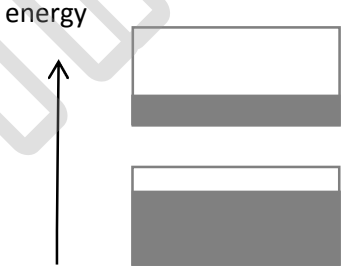
A



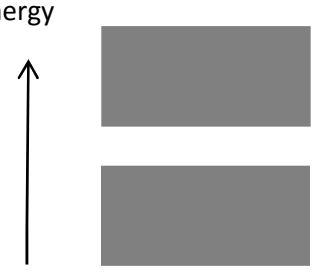
B



C



D



7 In a *p*-type semiconductor, the dopant

A donates an electron to the conduction band and the resultant vacancy acts as a mobile charge carrier.

B donates an electron to the conduction band to act as a mobile charge carrier.

C provides a vacancy in an energy level near to the top of the valence band to act as a mobile charge carrier.

D provides a vacancy in an energy level near to the top of the valence band to accept an electron from the valence band.

8 Which of the following statements is true?

A A p-type semiconductor conducts through holes only.
B An n-type semiconductor has a net negative charge.
C The number of electrons in the conduction band of an intrinsic semiconductor equals the number of holes in the valence band.
D The presence of impurities in an intrinsic semiconductor is used to increase its resistance.

9 Which of the following statements about the p-n junction is *correct*?

A A depletion region is formed when electrons and holes diffuse away from the p-n junction.

B The n-type semiconductor is negatively-charged while the p-type semiconductor is positively-charged.

C A considerable current flows across the p-n junction when the p-type semiconductor is connected to a negative terminal of a source and the n-type is connected to the positive terminal.

D The depletion region widens when the n-type semiconductor is connected to a positive terminal of a source and the p-type semiconductor is connected to the negative terminal.

10 The semiconductor material used to make light-dependent resistor (LDR) is silicon which has a small band gap of 1.1 eV.

Which of the following statements describes how the material interacts with photons?

A After absorbing energy from the photons, the valence band moves upwards towards the conduction band, making the band gap smaller so that more electrons can move from the valence band into the conduction band.

B After absorbing energy from the photons, the conduction band moves downwards towards the valence band, making the band gap smaller so that more electrons can move from the valence band into the conduction band.

C Valence electrons absorb energy from the photons and thus able to move from the valence band into the conduction band.

D Electrons in conduction band absorb energy from photons and thus can move faster.

11 The resistance of a piece of pure silicon falls as the temperature rises. Which statement is true?

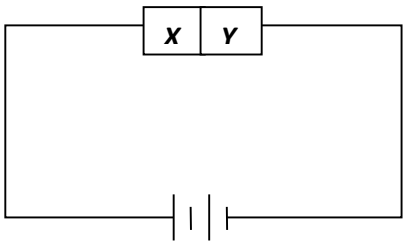
A The ratio of the positive to negative charge carriers increases.

B The ratio of the positive to negative charge carriers decreases.

C The charge carriers can move more easily at a higher temperature.

D The total number of charge carriers increases with temperature.

12 A semiconductor *X* is made by doping germanium crystal with arsenic (donor). Another semiconductor *Y* is made by doping germanium with indium (acceptor). The two are joined end to end and connected to a battery as shown.



Which of the following statements is correct?

A *X* is P-type, *Y* is N-type and the junction is forward biased.

B *X* is N-type, *Y* is P-type and the junction is forward biased.

C *X* is P-type, *Y* is N-type and the junction is reverse biased.

D *X* is N-type, *Y* is P-type and the junction is reverse biased.

13 Which of the following best describes a hole in an intrinsic semiconductor?

A A missing valence electron in a Group III atom.

B A missing valence electron in a Group IV atom.

C A missing valence electron in a Group V atom.

D An ionised acceptor atom.

14 Which statement about conduction of electricity in solids is correct?

A There are electrons below the valence band.

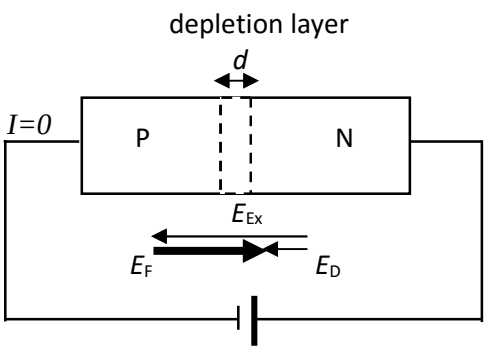
B The presence of impurities in an intrinsic semiconductor is used to increase its resistance.

C In a semiconductor, the energy gap between the valence and conduction band is about 3 eV

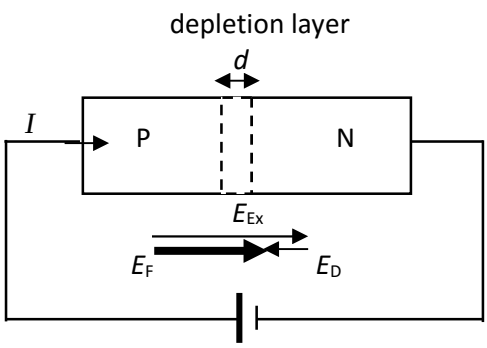
D Outside the depletion region of a semiconductor PN junction, the P-type material and the N-type material is not electrically neutral.

15 A P-N junction is connected to an external d.c. source. Which of the following correctly shows the direction of the conventional current *I*, relative width of the depletion layer *d*, directions as well as relative strengths of the external electric field E_{Ex}, internal electric field E_D due to the depletion layer and the resultant electric field E_F acting on the P-N junction?

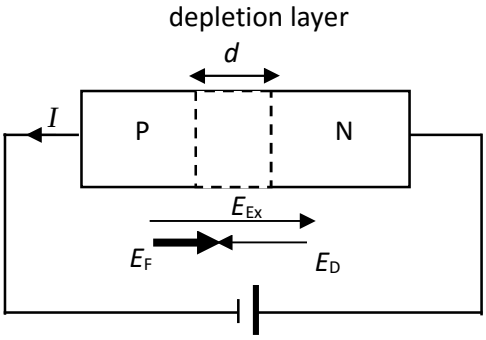
A



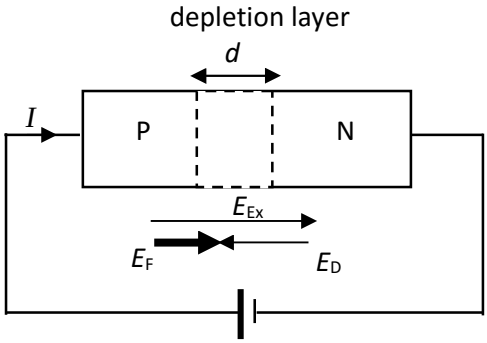
B



C



D



SEMICONDUCTOR WORKED SOLUTIONS

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1 Ans: **B**

P and N-type semiconductors are neutral. You simply doped with valency V or III elements.

2 Ans: **D**

X being doped by Gp V arsenic, would have valence electrons as mobile charge carriers, hence n-typed. Y being doped by Gp III indium, would have holes as mobile charge carriers, hence p-typed. The connection of XY with battery increases the potential barrier, hence reverse biased.

3 Ans: **D**

Option A: The higher the temperature of the semiconductor, the higher the probability that the electrons in the valence band would be promoted to the conduction band leaving behind holes in the valence band.

Option B: In the p-type semiconductor, the acceptor atoms will be creating more holes in the extrinsic semiconductor. Therefore, there will be more holes compared to conducting electrons that are mobile to conduct electricity.

Option C: The electrons and the holes in an intrinsic semiconductor exist in pairs.

Option D: Doping adds additional energy levels in the energy gap, thus allowing electrical conductivity to increase.

4 Ans: **C**

Option A: The depletion region size is changed, depending on the orientation of the connection of the e.m.f. in the external circuit.
Option B: The diode is made from extrinsic semiconductors (dopants are added to intrinsic semiconductors).
Option C: True.
Option D: The diode's depletion region is negatively charged in the p-type side and positively charged for the n-type side of the diode.

5 Ans: **D**

6 Ans: **B**

7 Ans: **D**

8 Ans: **C**

A A p-type semiconductor conducts through holes **and electrons**.
B An n-type semiconductor **is electrically neutral**.
C The number of electrons in the conduction band of an intrinsic semiconductor equals the number of holes in the valence band. **(True)**
D The presence of impurities in an intrinsic semiconductor is used to **decrease** its resistance.

9 Ans: **D**

Recall formation of depletion region in p-n junction and the application of forward-biased and reverse-biased voltages.

10 Ans: **C**

Recall band theory to explain the change in conductivity of intrinsic semiconductor.

11 Ans: **D**
For intrinsic semiconductor, the number of electron-hole pair increases with temperature.

12 Ans: **D**
X is N-type, Y is P-type and the junction is reverse biased.

13 Ans: **B**
An intrinsic semiconductor is made up of Group IV atoms.

14 Ans: **A**

15 Ans: **B**