Higher Semiconductors Answers

1. a) n-type doping.

b) Resistance decreases and so the current flow will increase.

2. a)

Conductors	**Semiconductors**	**Insulators**
All metals	Silicon	Plastic
Carbon	Germanium	Wood

b) A pure semiconductor that has impurity atoms added which each carry an extra electron to increase the current carrying capabilities of the material.

3. a) 3 valency electrons.

b) The resistance of the material will reduce.

c) The net charge is zero.

4. a) 5 valency electrons.

b) i) Yes.

ii) In the conduction band.

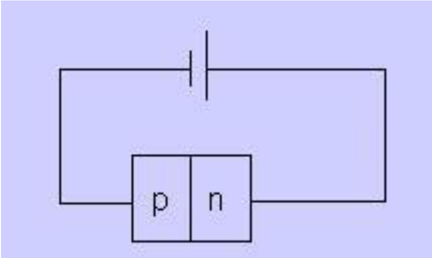
c) The resistance of the material will reduce.

d) The net charge is zero.

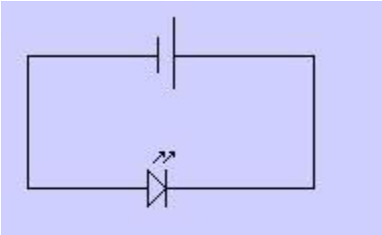
5. a) Electrons.

b) Holes.

6. a) i)



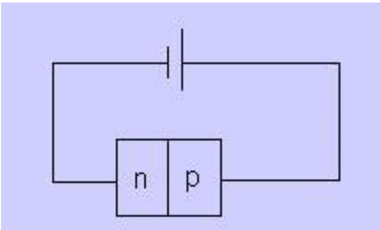
ii)



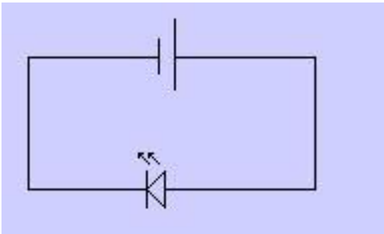
b) i) Current magnitude is of the order of microamperes. **(μA)**

ii) Conduction of holes.

7. a) i)



ii)



b) i) Current magnitude is of the order of milliamperes. **(mA)**

ii) Conduction of electrons.

c) i) Photons of light are given off.

ii) They fall from the higher energy conduction band to the lower energy valence band.

8. a) X -> Photodiode.

b) Photovoltaic mode.

9. a) **A** -> **Conductors**

B -> **Insulators**

C -> **Semiconductors**.

b) The band gap is much bigger in an insulator than a semiconductor.

c) i) The resistance of the material decreases.

ii) The current carrying capabilities increases.

iii) Some of the electrons in the valence band will jump to the conduction band.

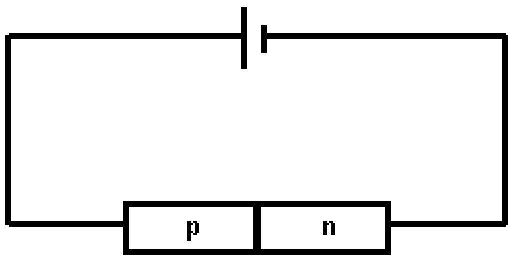
10. a) **X** -> p-type material

Y -> Depletion layer.

Z -> n-type material.

b) Band **B** has a **higher energy level**.

11. a) i)



Forward biased p-n junction

ii) Negative electrons flow from the N region to the P region.

Positive holes flow from the P region to the N region.

iii) When conduction band electrons in the n-type material pass into the p-type material they will fall into the lower energy valence band and will emit energy as photons of light.

b) i) Minimum voltage = 0.5V.

ii) Resistance decreases.

As the slope of the curve is getting steeper then **ΔI / ΔV** is increasing.

As ΔI / ΔV is increasing then **ΔV / ΔI** is decreasing.

As Ohms Law **R = V / I** then the resistance is decreasing.

12. a) The resistance of the material decreases.

b) i) When electrons from the n-type material combine with holes from the p-type material in the depletion layer they lose energy by creating the electron-hole pairs.
This energy lost is given off as photons of light.

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ii) λ = 477nm.

13. a) i) Photovoltaic mode.

ii) The light absorbed splits up the electron-hole pairs at the junction to create energy.

iii) The voltmeter reading increases as the intensity (Irradiance) of the light increases.

b) i) EMF = 0.508V.

ii) r = 433Ω.

c) Decreasing the load resistance will increase the current in the circuit.

This will increase the lost volts = Ir.

V_{tpd} = Reading on the voltmeter = EMF – Lost Volts.

Therefore there will be a lower reading on the voltmeter when the switch S is closed.

14. More photons from the lamp are absorbed by the photodiode **per second**.

More electron-hole pairs are split at the junction to create more free charge carriers.

This will increase the voltage across the p-n junction and increases the reading on the voltmeter.

15. a) Photons of light incident on the p-n junction provide enough energy to excite electrons into the conduction band and leave holes in the valence band.

At higher irradiance the number of free charge carriers produced increases and so the current increases for a given applied voltage.

OR

As the light Irradiance increases then more photons are absorbed at the photodiode **per second**.

More electron-hole pairs are split at the junction and this will increase the number of free charge carriers.

As the number of free charge carriers increases the current flow increases.

b) λ = 947nm.