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Physics Mid-Term Assignment:

Q1:

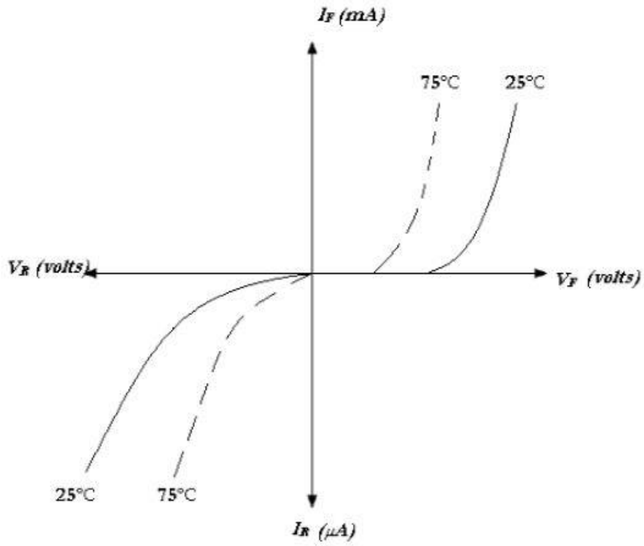
(a) Discuss the significance of the knee of the characteristics curve in forward Bais?

Ans:

The significance is the knee of the characteristics curve in forward bias is the point which the barrier potential is overcome and current will increase rapidly (The minimum voltage required for conducting the diode is known as "Kee voltage"). Also, Knee voltage is the characteristic voltage of a P-N junction. It's around 0.6–0.7 V for Silicone and 0.2–0.3 for Germanium. The shape of the forward bias side of the P-N junction characteristic curve looks like the knee, so it's named knee voltage.

The "knee" is the first quadrant of the current vs voltage characteristics curve (I vs V) of a semi-conductor diode represents an abrupt change in its conduction, at a voltage which produces the necessary electric field to cancel the intrinsic electric field in the junction.

(b) What happens to the barrier potential when temperature increases?



Ans:

In semiconductors, there is a layer near the P-N junction which is partially devoid of free charge carriers. This layer is known as depletion layer.

For the diffusion of charge carriers from one region to another, there is a barrier across junction known as potential barrier. This is the amount of voltage which must be applied for the flow of free charge carriers.

This barrier potential is directly proportional to the concentration of free charge carriers.

Barrier potential is inversely proportional to the temperature. Higher the temperature, greater will be the mobility of charge carriers and lower potential difference across the junction can break the potential barrier. But as the temperature lowers, kinetic energy of charge carriers decreases and higher will be the value of potential barrier. Also the potential barrier has the highest value when temperature is at 300K. At temperature 600K, the potential barrier has the lowest value.

Q2:

(a) Compare the depletion regions in forward Bais and reverse Bais?

Ans:

The holes from the P-Type will attract the electrons in N-Type and the electrons in N-Type attract the holes from P-Type, forming negative and positive ions. The main difference between the depletion regions are that, on applying a forward voltage to a PN junction device the depletion width decreases with the increase in supplied voltage. While, when reverse biasing is provided to a P-N junction device the width of the depletion region increases with supplied voltage.

“(In forward bias condition, the external bias voltage enables the electrons to overcome the barrier potential of the depletion region. ... In reverse bias condition, the positive side of the external bias voltage is connected to the n region while the negative side is connected to the p region)”.

(B) When does reverse breakdown occur in a diode?

Ans:

In the reverse bias condition of a diode, when voltage is increased, the current (of the order of micro ampere), in the beginning remains almost constant. This current is called reverse saturation current and is formed by minority charge carriers.

Now, if we increase the reverse voltage, at one stage the current increases suddenly. This value of reverse voltage is known as (breakdown voltage).

In the reverse bias condition the dynamical resistance is ~ 10^6 ohm.

Also, (the reverse current in a diode is normally very small. If the external bias voltage is increased so on, the reverse current increases drastically at a particular value of the reverse bias voltage. This particular value of the reverse bias voltage is known as breakdown voltage).

Q3:

(A) Find the difference between electric potential energy and electric potential?

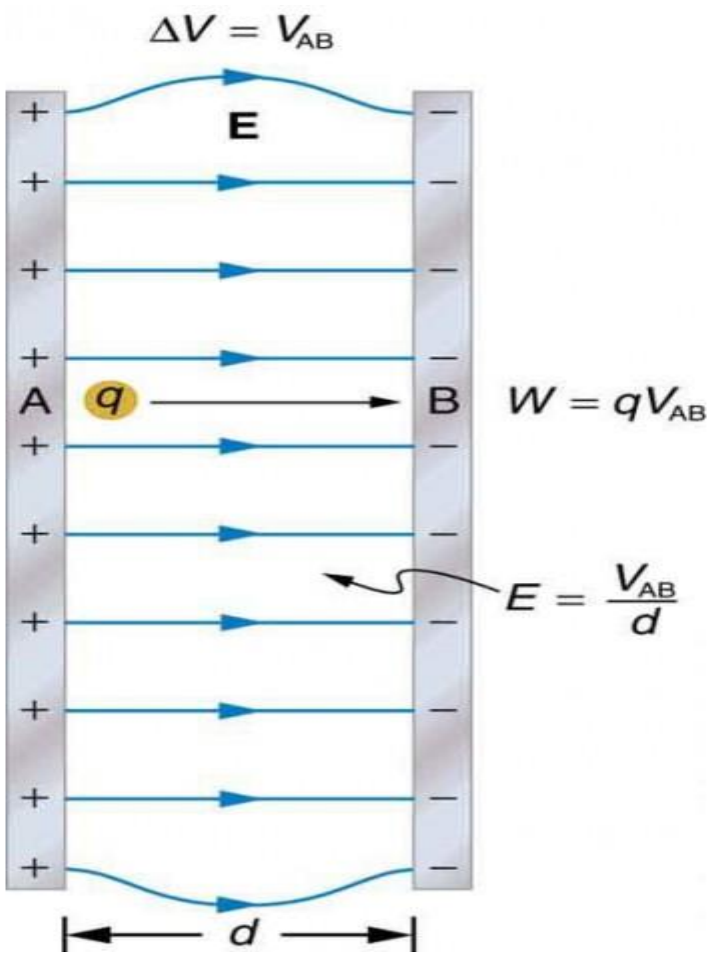
Electric potential is the amount of electrical potential energy that a unitary point electric charge would have if located at any point in space, and is equal to Work done by an electric field in carrying a unit positive charge from infinity to that point.

Whereas electric potential,

It is a potential energy that results from conservative Coulomb force and is associated with the configuration of a particular set of point charges within a defined system. An *object* may have electric potential energy by virtue of two key elements: its own electric charge and its relative position to other electrically charged *objects*.

(B) How to find the potential difference between any two points in the electric field lines?

In a uniform **electric field**,
the **equation** to **calculate** the **electric potential difference** is super easy: V = Ed. In this **equation**, V is the **potential difference** in volts, E is the **electric field** strength (in newton's per coulomb), and d is the distance **between** the **two points** (in meters).



The work done by the electric field in Figure 1 to move a positive charge q from A, the positive plate, higher potential, to B, the negative plate, lower potential, is

W = −ΔPE = −qΔV.

The potential difference between points A and B is

−ΔV = −(VB − VA) = VA − VB = VAB.

Entering this into the expression for work yields W = qVAB.

Work is W = Fd cos θ;

Here $\cos \theta = 1$,

Since the path is parallel to the field, and so $W = Fd$.

Since $F = qE$, we see that $W = qEd$

Substituting this expression for work into the previous equation gives;

$qEd = qVAB$.

The charge cancels, and so the voltage between points A and B is seen to be

{VAB = EdE = VABd{VAB=EdE=VABd

(Uniform E − field only)

where d is the distance from A to B, or the distance between the plates in Figure 1. Note that the above equation implies the units for electric field are volts per meter. We already know the units for electric field are newtons per coulomb; thus the following relation among units is valid: 1 N/C = 1 V/m.