SUMMER – 2022 EXAMINATION

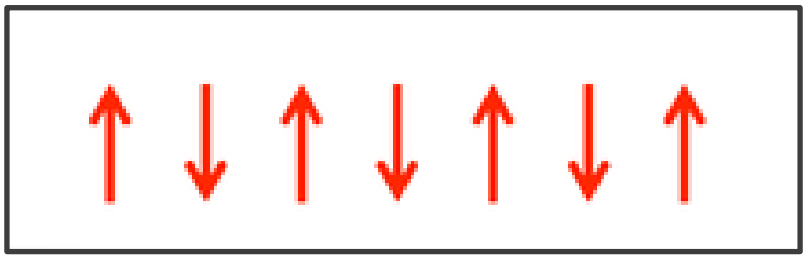
Subject Name: Electronic Engineering Materials **Model Answer** **Subject Code:** 22217

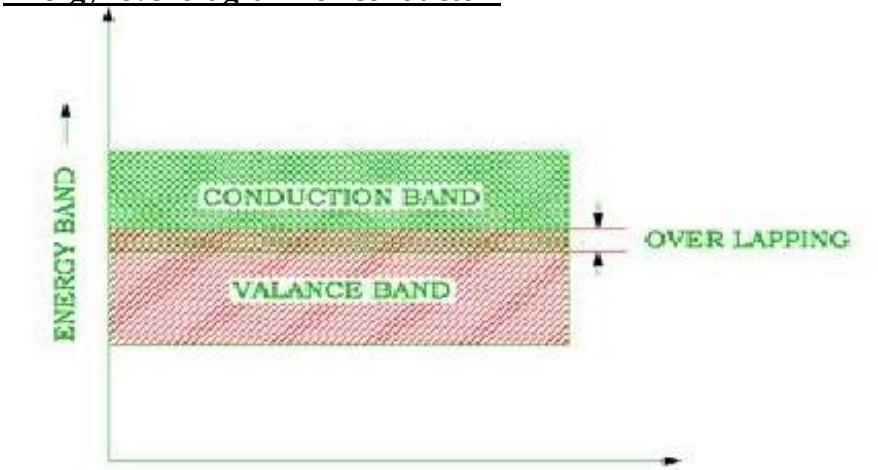
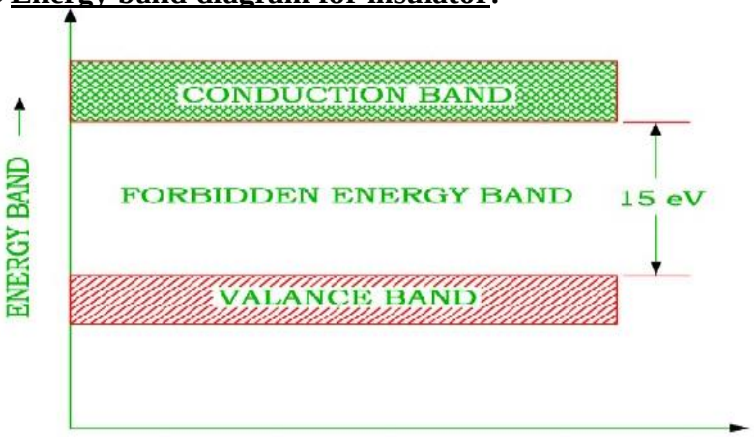
Important Instructions to examiners:

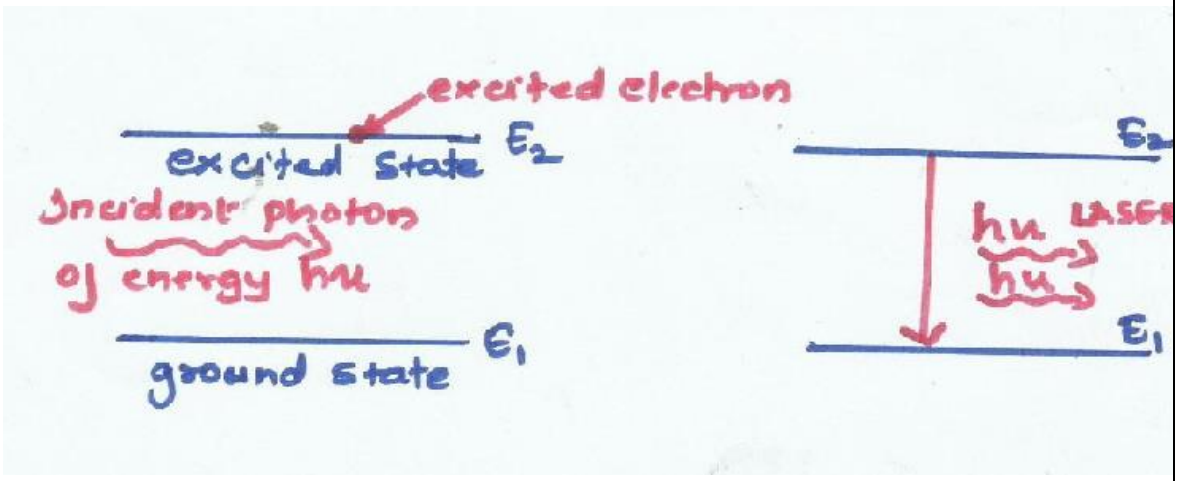
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

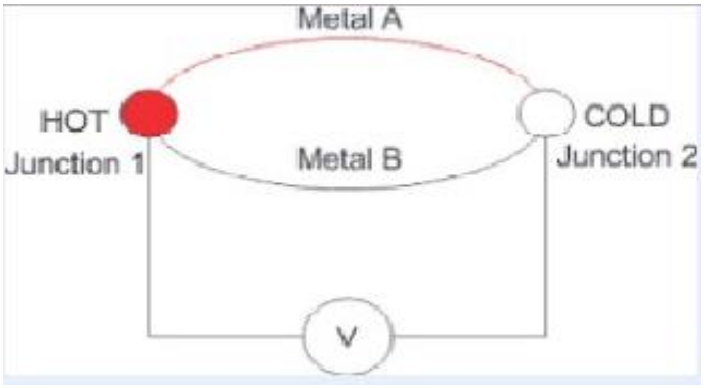
Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1		**Attempt any FIVE of the following :**	**12-Total Marks**
	a)	**List factors affecting resistivity of electric materials?**	**2M**
	Ans:	1)Alloying 2)Temperature 3)Cold Work 4)Age Hardening	**(1/2 mark each)**
	b)	**What is piezoelectricity?**	**2M**
	Ans:	The phenomenon in which production of polarization, takes place when mechanical stress is applied is known as "Piezoelectricity" **OR** Piezoelectricity is a special property of certain material which provides us with a means of converting mechanical energy into electrical energy and vice versa.	**(Definition 2M)**
	c)	**List any four dielectric materials.**	**2M**
	Ans:	Ceramics, distilled water, paper, Bakelite, porcelain, mica, polyethylene, glass, Metal oxides, Rubberolythene, cotton , silk , wood , polymer .	**(Any 4) (1/2 M each)**
	d)	**Define the term ' Permeability ' State its unit**	**2M**
	Ans:	**Permeability :** The capability of the magnetic material to conduct the magnetic flux is known as permeability. **Unit of Permeability**: Henry per meter or (H / m) or (Newton per Ampere Square)	**(Def 1M)** **(Unit 1M)**
	e)	**List any two magnetic materials.**	**2M**

	Ans:	**Magnetic Material:** Iron, steel, cobalt, nickel.	**(Any 2) (1 M each)**
	f)	**Trivalent impurity materials are called as Acceptor impurity' Justify your answer.**	**2M**
	Ans:	**Trivalent impurity materials** like Boron, Indium ,Gallium has 3 valence electron ,out of which all three are utilized in bonding with intrinsic semiconductor like silicon or germanium and the one Vacancy (Shortage of electron –Hole) is left to act as charge carrier which accept one electron to form fourth covalent bond hence, Trivalent impurity materials are called as **Acceptor impurity.'**	**(2M for justification)**
	g)	**Define Electroluminesence**	**2M**
	Ans:	Electroluminescence is a characteristic of a material, typically a semiconductor, that enables it to emit light in response to an electrical current or a strong electrical field.	**Definition -2M**
Q.2		**Attempt any THREE of the following .**	**12-Marks**
	a)	**State the requirements of good insulating materials.**	**4M**

	Ans:	**Requirement of good insulating material are:** i) Electrical ii) Mechanical iii) Thermal iv) Chemical (i) **Electrical characteristics**: A good insulating material has high resistivity and low leakage current. It has high dielectric strength and small dielectric loss. (ii) **Mechanical characteristics**: A good insulating material should have sufficient mechanical strength to withstand vibrations. iii) **Thermal characteristics**: A good insulating material should have small thermal expansion to avoid damages, It should be non-ignitable and self- extinguishable iv)**Chemical characteristics**: A good insulating material should be resistant to oils, gas, fumes acids and alkalies. It should not absorb water as water reduces insulation resistance and dielectric strength	**(1 M each)**
	b)	**Explain the concept of anti-ferromagnetism with neat diagram.**	**4M**
	Ans:	· When the neighboring magnetic moments are aligned anti-parallel. This phenomenon is called **Anti ferromagnetism**. · This phenomenon occurs below a certain temperature known as Neel temp (TN) · Example: Cobalt oxide, Nickel oxide, Chromium. · **Diagram** 	**(Definatio n-1M) (Explaina tion-1M) (Example 1M) (Diagram 1M)**

	c)	**Sketch energy band diagram of conducting and insulating material and label it well.**	**4M**
	Ans:	1)**Energy level diagram for conductor**:  FIG A : ENERGY BAND DIAGRAM FOR CONDUCTOR 2) **Energy band diagram for insulator:**  FIG C : ENERGY BAND DIAGRAM FOR INSULATOR	**(2M each)**
	d)	**Explain the principle of stimulated emission and radiation in LASER.**	

	Ans:	**Principle of stimulated emission:** · When a photon of energy hμ is incident on an atom (electron), then the electron gets excited and moves from lower energy level E1 to higher energy level E2. · After completion of life time, the excited electron comes to a lower energy level emitting a photon this is known as spontaneous emission. · But when before completing the life time of excited electron ,if the electron is triggered due to an action of incident photon. · The interaction between excited electron and incident photon can trigger the excited electron to make a transition to ground state. · This transition generates another photon which is identical to incident photon. 	**(3M Explanation)** **(1M diag)**
Q.3		**Attempt any THREE of the following :**	**12-Total Marks**
	a)	**Describe the principle of thermoelectric. State thermoelectric materials.**	**4M**

	Ans:	**Principle**: When two dissimilar metals are connected with each other at their ends a thermocouple junction is formed. This thermocouple junction formed between them when kept at different temperatures, An EMF is generated this EMF is known as Thermoelectric emf. This thermoelectric emf will force a continuous current. This current is known as thermoelectric current and the whole phenomenon is called the **thermoelectric effect** or **Seeback effect**.  The most commonly used thermoelectric material as a thermocouple are **(any one)** 1)Copper-constantan 2)Iron –constantan 3)Chromel –constantan	**(3M)** **(1M)**
	b)	**Describe dielectric strength and dielectric constant with respect to dielectric materials.**	**4M**

Ans:

Dielectrics are defined as the material whose electrical conductivity is less than 10-6 mhos, they do not conduct electricity like an insulator but do store the charge and hence widely used in Capacitors

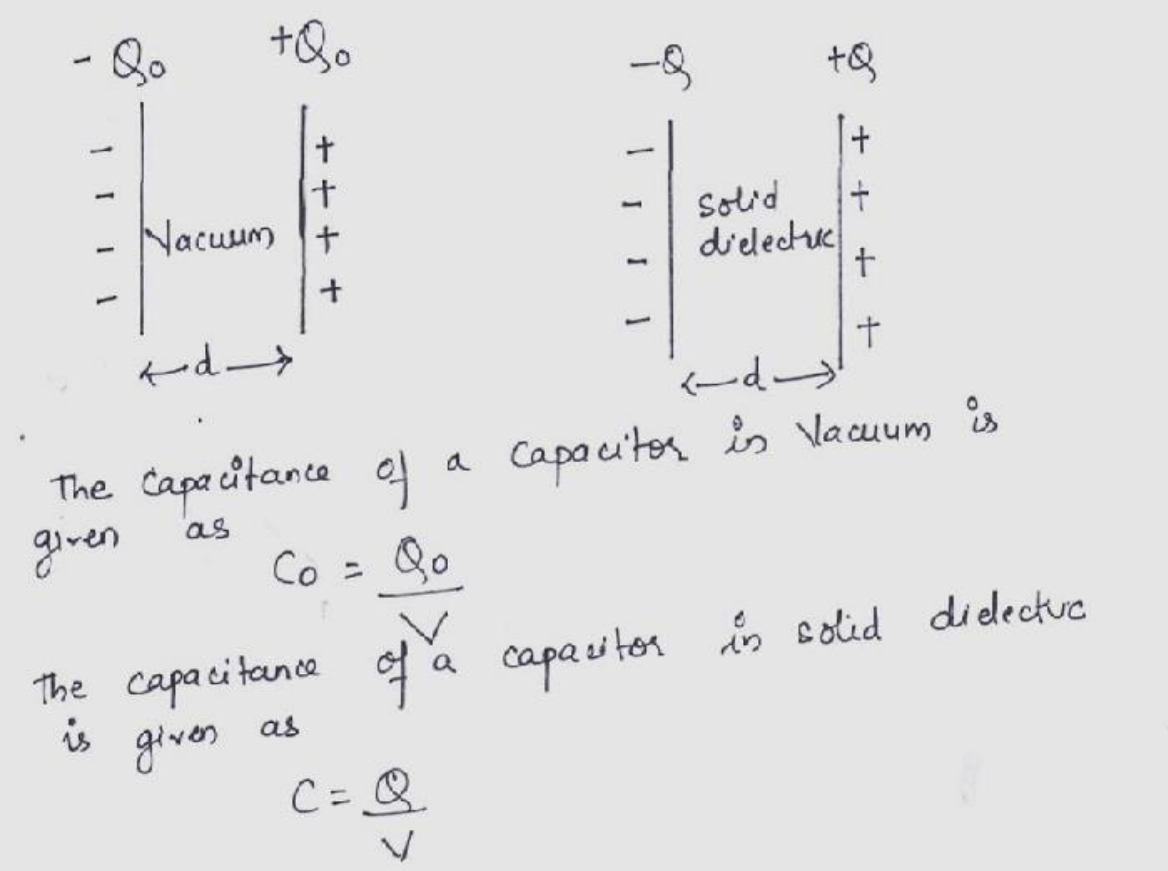
Dielectric strength and dielectric constant with respect to dielectric material can be explained in following way

The function of a capacitor is to store charge. its capacity to store charge is measured in terms of capacitance (C)

The presence of dielectric material between the two-conducting materials in the capacitor helps the capacitor to store charge or else the circuit gets completed and current starts flowing.

When electric field is applied across the dielectric material, the electrons of atoms are acted upon by the electric field and are displaced in a direction opposite to that of electric field this results in separation of positive and negative charges hence dipoles are created in the dielectric material and said to be polarized

Exp-2M



Dia-2M

But $C \propto \frac{A}{d}$

where, A = Area of cross section of metal plates
d = distance between metal plates.

$\therefore$ for solid dielectric $C = \epsilon \frac{A}{d}$

for Vacuum dielectric $C_0 = \epsilon_0 \frac{A}{d}$

where ϵ = Absolute permittivity of solid dielectric

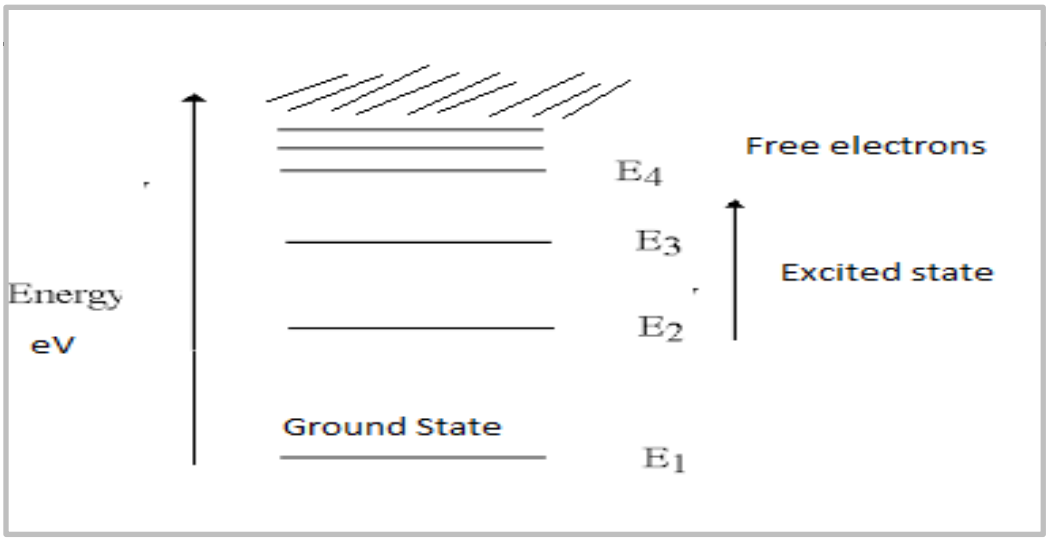
ϵ_0 = Absolute permittivity of Vacuum dielectric

$\therefore \frac{C}{C_0} = \frac{\epsilon}{\epsilon_0}$

$\frac{C}{C_0} = \epsilon_r$ (Relative permittivity or dielectric constant)

	c)	**Explain how energy levels are formed in material**	**4M**

Ans:



Explanation:

Atoms of any material have a series of well defined and discrete allowed energy levels E1,E2…….. The sequential representation of energy levels is known as the energy level diagram.
In the energy level diagram Vertical axis represents the Energy (eV) and Horizontal axis represents Energy levels.

E1 represents the lowest energy level and is called the ground state. An electron gets excited to a higher energy level by absorbing energy as the electron cannot stay in the excited state for a longer time. It jumps to the ground state by emitting energy.

The energy levels get closer at the upper end as it reaches ionization level.

However, when two atoms are brought close to each other, it leads to intermixing of electrons in the valence shells. As a result, the number of permissible energy levels is formed which is called an energy band

There are three types of energy levels (bands) in metals

1) **Valence band:** The range of energies formed by valence electrons are known as valence band.valence electrons are electrons which are present in the outermost shell of an atom.
2)
3) **Conduction Band**: The range of energies formed by conducting electrons are known as conduction band. Conducting electrons are valence electrons which are free to move.
4)
5) **Forbidden Energy Gap**: The gap between valence band and conduction band is known as forbidden energy gap.

Diagram-2M

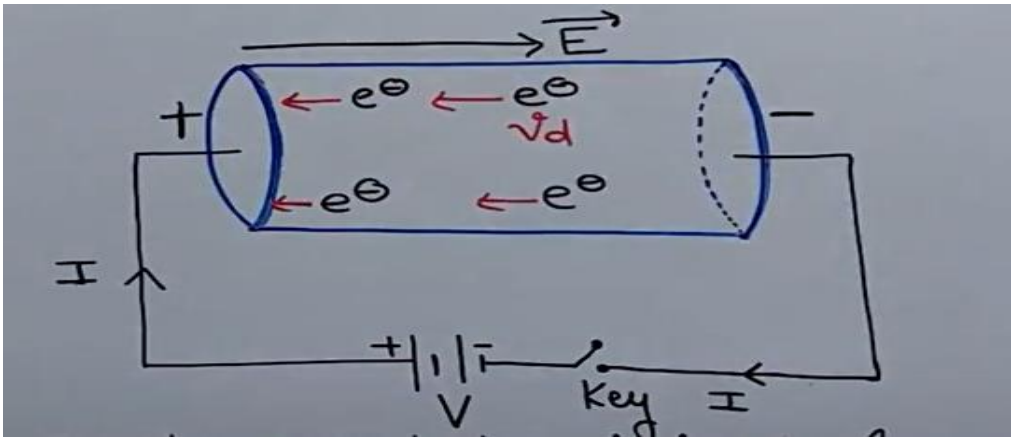
Explanation-2M

	d)	**List any four photoemissive materials .State features of any one of them.**	
	Ans:	**Definition:** Photoemissive materials are those which emit electrons when radiation of suitable frequency is incident on it. **Various photoemissive materials are as follows** · **Zinc** · **Potassium** · **Lead sulphate** · **Sodium** · **Cadmium sulphide** · **silicon, cadmium telluride, gallium arsenide and copper indium Diselenide** All of photoelectric materials are used in various photovoltaic cells as burglar alarm, Television, Lux meter, exposure meter Relevant combination of material is used in making LED to emit lights of different colors like violet, green,blue,yellow,orange,red,infrared and ultraviolet **(Any relevant point should be given marks)**	**(2M)** **(2M)**
Q.4		**Attempt any THREE of the following :**	**12-Total Marks**
	a)	**Define Electron mobility . State its significance in electronic components.**	

Definition (1M)

Electron mobility :-It is defined as drift velocity of an electron per unit strength of the electric field applied across the conductor is known as electron mobility.

Significance (3M)



Ans:

Drift velocity $v_d = eE\tau / m = eV\tau / ml$

where, τ = relaxation time, e = charge on electron,

E = electric field intensity, l = length of the conductor

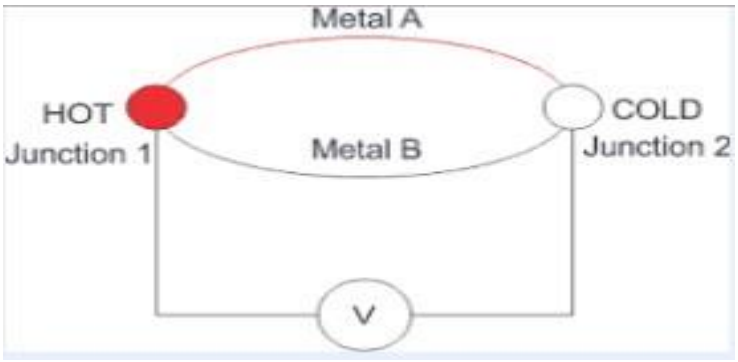
V = potential difference across the ends of the conductor

m = mass of electron.

Mobility: The drift velocity of electron per unit electric field applied is mobility of electron.

Mobility of electron (μ) = v_d / E

Its SI unit is $m^2s^{-1}V^{-1}$.

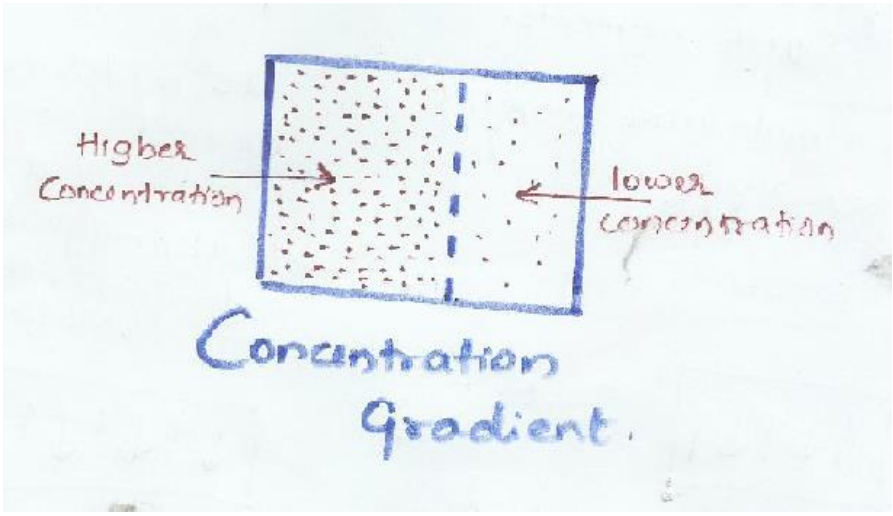
	b)	**Explain seebeck effect and give its two application .**	**4M**
	Ans:	**(Diagram & Explanation = 2M, Any 2 Applications = 1M each)** **Diagram:**  **Explanation: -** Thermoelectric effect is also called seebeck effect. **Principle:** When two dissimilar metals are connected with each other at their ends a thermocouple junction is formed. This thermocouple junction formed between them when kept at different temperatures, An EMF is generated this EMF is known as Thermoelectric emf. This thermoelectric emf will force a continuous current this current is known as thermoelectric current and the whole phenomenon is called as thermoelectric effect or Seeback effect **Applications: -** 1. Measurement of the temperature difference between two objects. 2. Used in the thermoelectric generator, these function like a heat engine. 3. Used in power plants for converting waste heat into additional power (a form of energy recycling). 4. In automobiles as automotive thermoelectric generators (ATGs) for increasing fuel efficiency. 5. Space probes often use radioisotope thermoelectric generators with the same mechanism but using radioisotopes to generate the required heat difference.	

	c)	**Explain the concept of magnetostriction effect and state its application**	**4M**
	Ans:	**Concept of magnetostriction effect:** · When a ferromagnetic material is magnetized then the material exhibits small change in its dimensions, this phenomenon is called magnetostriction effect. · Magnetic permeability is dependent on the magnetostriction effect, the magnetostriction effect should be minimized in order to obtain high value of permeability **For example, in case of iron:** Iron crystal expands when magnetized in easy direction and contracts when magnetized in hard direction. **Magnetostriction property is used in generation of following ultrasonic waves** **1. Ultrasonic signaling** **2. Ultrasonic cleaning** **3. Ultrasonic Soldering** **4. Ultrasonic drilling**	Concept-2M Application-2M
	d)	**Compare P-type and N-type semiconductor materials using following points** i) **Impurities used** ii) **Majority carriers** iii) **Bands in which conduction takes place** iv) **Minority carriers**	**4M**

	Ans:		**1 marks for each point**

Parameters	**P-type semiconductor**	**N-type semiconductor**
i)Impurities used	Trivalent such as Boron, Gallium, Indium, Aluminum	Pentavalent such as Phosphorus, antimony Arsenic, Bismuth
ii)Majority carriers	Holes	Electron
iii)Bands in which conduction takes place	Valence band	Conduction band
iv)Minority carriers	Electron	Holes

	e)	**Explain diffusion (current) in a semiconductor.** **4M**

	Ans:	**Explanation:-** · When some voltage is applied to a semiconductor bar ,the holes move towards the negative terminal and electrons move towards the positive terminal,this movement of holes and electrons constitute electric current which is known as drift current. · Even in absence of applied voltage flow of electric current in a semiconductor is possible provided concentration gradients exist. · A concentration gradient exists when either the number of electrons or holes is greater in one region of a semiconductor as compared to another region. · When concentration gradients exist ,the carriers (either electron/holes) move from the region of higher concentration to lower concentration; this process is called diffusion and the electric current produced due to diffusion is known as diffusion current. **Diagram:-** 	**(3M for explanation ,1M for Diagram)**
Q.5		**Attempt any TWO of the following :**	**12-Total Marks**
	a)	**Explain superconductivity and give any four applications of it.**	**6M**

	Ans:	**Superconductivity is a phenomenon of exactly zero electrical resistance. Superconductivity is a quantum mechanical phenomenon. It is characterized by the Meissner effect.** **The electrical resistance of a metallic conductor decreases gradually as temperature is lowered.** **Applications:- (any 4)** Some of the technological applications of superconductivity includes: ● The production of sensitive magnetometers based on SQUIDs (superconducting ● Fast digital circuits ● Powerful superconducting electromagnets used in maglev trains, magnetic resonance imaging (MRI) and Nuclear magnetic resonance(NMR) machines, magnetic confinement fusion reactors (e.g. tokamaks), and the beam-steering and focusing magnets used in particle accelerators ● Low-loss power cables ● RF and microwave filters (e.g., for mobile phone base stations, as well as military ultrasensitive/selective receivers) ● Fast fault current limiters ● High sensitivity particle detectors, including the transition edge sensor, the superconducting bolometer, the superconducting tunnel junction detector, the kinetic inductance detector, and the superconducting nanowire single-photon detector ● Railgun and Coilgun magnets ● Electric motors and generators superconductor, the resistance drops abruptly to zero when the material is cooled **below its critical temperature.**	Explanation-2M Application-4M(each point 1M)
	b)	**Classify liquid dielectric material and explain breakdown in liquid dielectric materials.**	**6M**

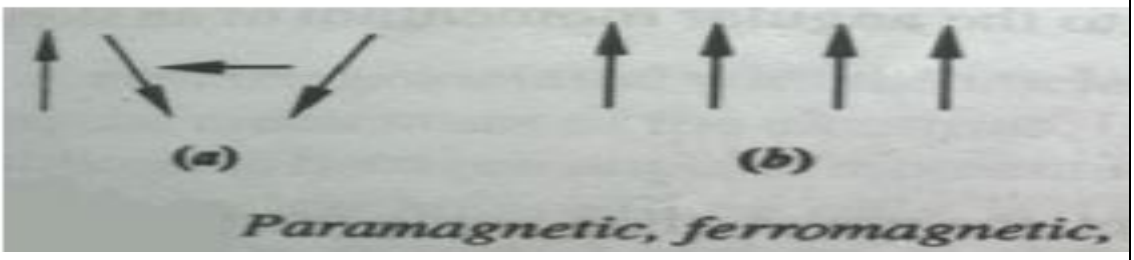
	Ans:	**Liquid dielectric materials are classified as** **1. Transformer Oil (mineral oil)** **2. Silicone Oil** **3. Synthetic hydrocarbons** **4. Chlorinated Hydrocarbon** **5. Ester** **Breakdown in liqud dielectrics** Break down in liquid dielectrics breakdown breakdown depends upon their purity. In highly contaminated liquid dielectrics emulsified water and Solid Mechanical Particles and Suspended particles form Conducting bridge between the Electrodes to Cause breakdown. In Technically pure dielectric liquids the gas Contained in the dielectric will get ionized and this will start the breakdown . The ionized gas acts as a conducting medium , resulting into breakdown.	Classification-3M Explanation-3M
	c)	**Explain the properties of magnetic materials with examples.** i) **Ferromagnetism** ii) **Paramagnetism** iii) **Diamagnetism**	**6M**

Ans:

i)Ferromagnetism

It is a substance in which the resultant magnetic moments of individual atoms align themselves in parallel by giving rise to spontaneous magnetization.
A ferromagnetic material consists of a number of regions called as domains, which are permanently magnetised. The atomic moments in the individual domains are aligned parallel to one another at a temperature below Curie point.
Above Curie temperature , the domain may disrupt and material loose its magnetic properties.
Current is in the direction of H and the value is very high.

ii)**Para magnetism**: Para magnetism is a form of magnetism whereby certain materials are weakly attracted by an externally applied magnetic field, and form internal, induced magnetic fields in the direction of the applied magnetic field. Paramagnetic materials include most chemical elements and some compounds; they have a relative magnetic permeability **slightly greater than 1** (i.e., a small positive magnetic susceptibility) and hence are attracted to magnetic fields. Para magnetism is due to the presence of unpaired electrons in the material, so all atoms with incompletely filled atomic orbitals are paramagnetic. Due to their spin, unpaired electrons have a magnetic dipole moment and act like tiny magnets. An external magnetic field causes the electrons' spins to align parallel to the field, causing a net attraction. Paramagnetic materials include aluminum, oxygen, titanium, and iron oxide (FeO).



iii)**Diamagnetism**:

Diamagnetic materials are repelled by a magnetic field; an applied magnetic field creates an induced magnetic field in them in the opposite direction, causing a repulsive force. The magnetic permeability of diamagnetic materials is less than μ0, the permeability of vacuum. In most materials diamagnetism is a weak effect which can only be detected by sensitive laboratory instruments, but a superconductor acts as a strong diamagnetic because it repels a magnetic field entirely from its interior. Diamagnetic materials, like water, or water-based materials, have a relative magnetic permeability that is less than or equal to 1. Diamagnetic material includes copper, water ,wood etc,

No spin alignment is present.

2M Each Point

Q.6		Attempt any TWO of the following :	12-Total Marks
	a)	State the different modes of electron emission in metal. Explain any one mode of emission	6M

Ans:

The different modes of electron emission in metal are: **2M**

1. Thermionic emission
2. Photoelectric emission
3. Field emission
4. Secondary emission

Explanation: **4M**

1. **Thermionic Emission**:

The Electron emission from a metal surface, which occurs by supplying the thermal energy to the metal is called as **Thermionic Emission.**

At Room temperature, the free electrons of a metal do not possess sufficient energy to cause electron emission. As the temperature of a metal is increased the electrons acquire energy more than the work function (Φ) due to which electrons gets accelerated and is emitted from the surface of metal.

OR

2. **Photoelectric emission**:

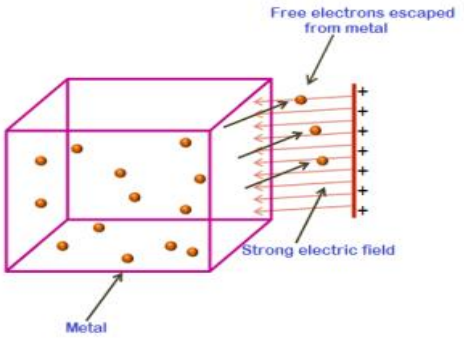
The Electronic Emission from the metal surface when illuminated by light is called photoelectric emission."
When a beam of light is made to strike the surface of metal due to which the electrons are emitted from its surface.
The number of electrons emitted from the metal surface depends upon the intensity and frequency of incident light.
Higher the intensity and frequency of light higher is the emission . This emitted electrons are called photoelectrons.

OR

3. **Field emission**

Electric field electron emission is the process by which free electrons are emitted from the metal surface when strong electric field is applied. Electric field electron emission is also called as electron field emission, field electron emission and field emission. Electric field electron emission occurs not only in metals, but also in liquids. Field electron emission occurs in metals that are placed at very strong electric field. In other words, field electron emission occurs when large amount of energy in the form of electric field is applied to the free electrons in the metals.

Explanation-2M



OR

4. Secondary emission

When a solid surface is bambarded by electrons of adequately high energy , secondary electrons are emitted from the solid surface.

The electrons being bambarded are called primary electrons. The number of secondary electrons will depend on the energy of primary electrons.

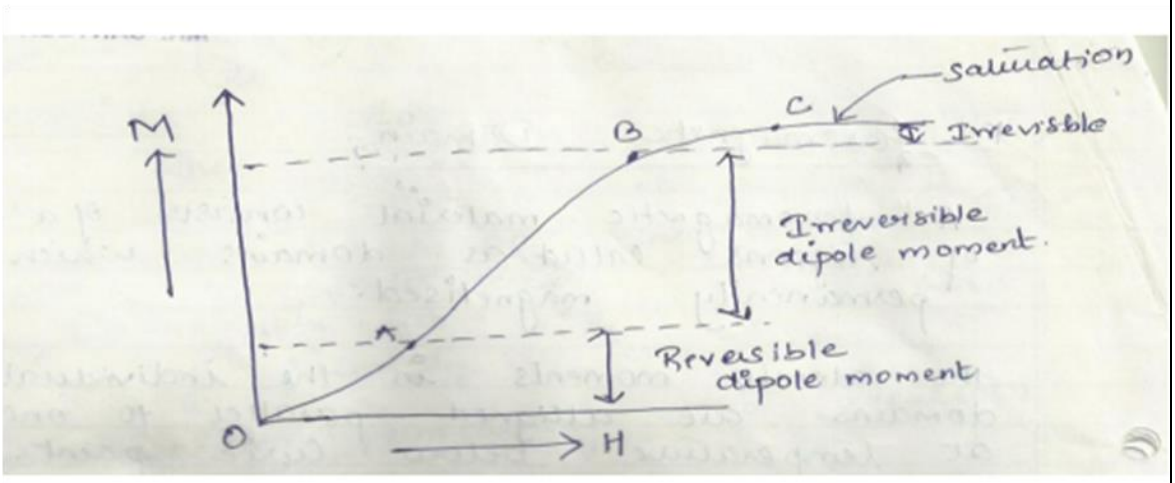
The high-speed electrons that strike the free electrons in the metal are called primary electrons whereas the free electrons emitted from the metal surface are called secondary electrons. We are emitting the secondary electrons from the metal surface. Hence, the process of emitting the secondary electrons from the metal surface is called secondary emission.

b)	**Write one application for the given dielectric materials.**		**6M**
	i)	**Mica**	
	ii)	**PVC**	
	iii)	**Polythene**	
	iv)	**Glass**	
	v)	**Rubber**	
	vi)	**Cotton**	

	Ans:	**i) <u>Mica</u>** 1. It is used in radio circuits, capacitor, radio tubes, segment insulation etc. **2.** It is used in high voltage machines, traction motors, switches, plugs, fuse, holder, parts of sockets etc. **ii)<u>PVC</u>** It is used in insulation of wires and cables in domestic wiring as well as in aircraft and factory wiring **iii) <u>Polythene</u>** **1)** It is used for making insulators for cables and radio frequency generators 2) It is used to produce yarns, cloths and films. 3) The synthetic resins are popular in the electrical installations. **iv) <u>Glass</u>** Alkaline glasses are used for optical and electrical applications. 2) Pyrex glasses are used for oven proof utensils. **v)<u>Rubber</u>** It is used in flexible wires, jack cards and installation wires 2. It is used in manufacturing tubes, tyres etc. **vi) <u>Cotton</u>** **1)** It is used to Manufactured tubes, tyres. 2) It is used to make Flexible wires and installation wires 3) cotton impregnated with wax or varnishes are used in windings of magnet coils and small medium sized mechanics.	1M-each point
	c)	**Draw and explain the typical magnetization curve for a ferromagnetic materials State the applications of ferromagnetic materials.**	**6M**

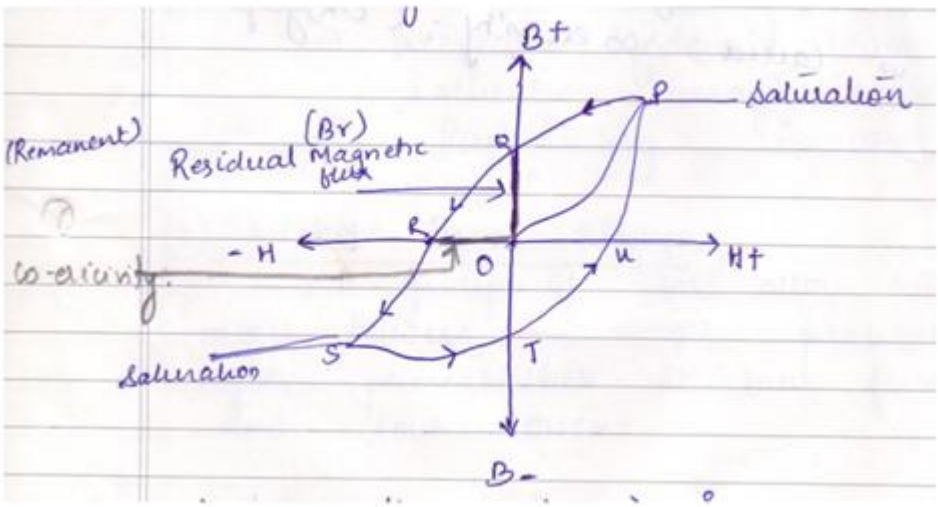
Ans:

Explanation: The above graph is a magnetization curve for a ferromagnetic material. It is magnetization (M) against field strength(H) Magnetization curve is divided into 3 regions. Region O TO A –the value of H is small, the domain wall moment is mostly reversible. Region A TO B-the walls of H are higher, the domain wall movement continues to take place and is irreversible. Region B TO C- in this region the ferromagnetic material is magnetized and the dipole moments are aligned in the direction of the magnetic field. Above point C it is saturation.



Curve-2M

OR



Explanation -2M

Applications-2M

Explanation: The phenomenon of magnetisation and demagnetisation of ferromagnetic material is known as hysteresis. It is observed that as the electric field increases magnetic field(H) increases and therefore magnetic flux density (B) also increases, but when it decreases, B does not decreases at the same rate at which it was increased. The magnetic material does not get demagnetised, it retains some magnetisation, this is hysteresis. As the magnetic field (H) increases, the magnetic flux density (B) too increases, but B stops increasing and reaches saturation. The curve OP is a saturation

		curve when it decreases the curve does not follow the path, it follows a different path PQ. That means rate of decrease of B is not same as rate of increase of B. When magnetic field (N) reaches zero H=0, that means B should be zero but B≠0, that means material does not get demagnetized there is some residual magnetism i.e. OQ (graph is Remanent flux density Br. When H is increased in reverse direction B also increases in reverse direction and again get saturated. **Applications of ferromagnetic material are:** It is used as a preferable choice for aviation instrumentation, electronic tubes, electromagnetic valve, magnetic separator and electromagnetic shielding.	