+2 PHYSICS MINIMUM STUDY MATERIAL

VOLUME - I

LAW QUESTIONS:

1. **Coulomb’s law:**
   The force of attraction or repulsion between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them.

2. **Gauss’s law:**
   Total electric flux of the electric field $E$ over any closed surface is equal to $\frac{1}{\varepsilon_0}$ times the net charge enclosed by the surface.

3. **Ohm’s law:**
   At constant temperature, the steady current flowing through a conductor is directly proportional to the potential difference between the two ends of the conductor.

4. **Kirchoff’s laws:**
   **First law** – (Current law):
   The algebraic sum of the currents meeting at any junction in a circuit is zero.
   
   **Second law** – (voltage law):
   The algebraic sum of the product of resistance and current in each part of any closed circuit is equal to the algebraic sum of the emf’s of that closed circuit.

5. **Faraday’s laws of electrolysis:**
   **First law:**
   The mass of a substance liberated at an electrode is directly proportional to the charge passing through the electrolyte.
   
   **Second law:**
   The mass of a substance liberated at an electrode by a given amount of charge is proportional to the chemical equivalent of the substance.

6. **Lenz’s law:**
   The induced current produced in a circuit always flows in such a direction that it opposes the change or cause that produces it.

7. **Faraday’s laws of electromagnetic induction:**
   **First law:**
   Whenever the amount of magnetic flux linked with a closed circuit changes, an emf is induced in the circuit. The induced emf lasts so long as the change in magnetic flux continues.
   
   **Second law:**
   The magnitude of emf induced in a closed circuit is directly proportional to the rate of change of magnetic flux linked with the circuit.

8. **Fleming’s right hand rule:**
   If the forefinger, the middle finger and the thumb finger of the right hand are held in the three mutually perpendicular directions, then
   - the forefinger points along the direction of the magnetic field
   - the thumb finger is along the direction of motion of the conductor and
   - the middle finger points in the direction of induced current.
9. **Huygens’s principle:**
   - Every point on a given wave front may be considered as a source of secondary wavelets which spread out with the speed of light in that medium.
   - The new wave front is the forward envelope of the secondary wavelets at that instant.

10. **Brewster’s law:**
    The tangent of the polarizing angle is numerically equal to the refractive index of the medium.

**DEFINE QUESTIONS:**

1. **One coulomb (1 coulomb):**
   One coulomb is defined as the quantity of charge, which when placed at a distance of 1 metre in air or vacuum from an equal and similar charge, experiences a repulsive force of \(9 \times 10^9\) N.

2. **Electric field intensity:**
   Electric field intensity at a point, in an electric field is defined as the force experienced by a unit positive charge kept at that point. Its unit is \(N\ C^{-1}\).

3. **Potential difference:**
   It is defined as the amount of work done in moving unit positive charge from one point to another against the electric force. Its unit is volt.

4. **Unit of potential difference or one volt (1 volt):**
   The potential difference between two points is 1 volt if 1 joule of work is done in moving 1 Coulomb of charge from one point to another against the electric force.

5. **Electric potential:**
   The electric potential in an electric field at a point is defined as the amount of work done in moving a unit positive charge from infinity to that point against the electric force.

6. **Electric flux:**
   It is defined as the total number of electric lines of force, crossing through the given area. Its unit is \(N\ m\ C^{-1}\).

7. **Capacitance of a conductor:**
   It is defined as the ratio of the charge given to the conductor to the potential developed in the conductor. Its unit is farad.

8. **Unit of capacitance or 1 farad:**
   A conductor has a capacitance of one farad, if a charge of 1 coulomb given to it, rises its potential by 1 volt.

9. **Drift velocity:**
   It is defined as the velocity with which the free electrons get drifted towards positive terminal, when an electric field is applied. Its unit is \(m\ s^{-1}\).

10. **Mobility:**
    It is defined as the drift velocity acquired per unit electric field. Its unit is \(m^2V^{-1}s^{-1}\).

11. **Electrical resistivity:**
    It is defined as the resistance offered to current flow by a conductor of unit length having unit area of cross section. Its unit is \(\Omega\ m\).

12. **Transition temperature or Critical temperature:**
    The temperature at which electrical resistivity of the material suddenly drops zero and the material changes from normal conductor to a superconductor is called the transition temperature or critical temperature.
13. **Temperature coefficient of resistance:**
   It is defined as the ratio of increase in resistance per degree rise in temperature to its resistance at 0° C. Its unit is per °C.

14. **Unit of self induction or 1 henry:**
   One henry is defined as the self-induction of a coil in which a change in current of one ampere per second produces an opposing emf of one volt.

15. **Quality factor or Q – factor:**
   \[ Q = \frac{voltage \ across \ L \ or \ C}{applied \ voltage} \]

16. **Power factor:**
   It is defined as the ratio of the average power to the apparent power.

17. **Coefficient of mutual induction:**
   The coefficient of mutual induction of two coils is numerically equal to the emf induced in one coil when the rate of change of current through the other coil is unity. Its unit is henry.

18. **Optic axis:**
   Inside the crystal there is a particular direction in which both the rays travel with same velocity. This direction is called optic axis.

**USES AND APPLICATION QUESTIONS:**

1. **Applications of capacitor:**
   * They are used in the ignition system of automobile engines to eliminate sparking.
   * They are used to reduce voltage fluctuations in power supplies and to increase the efficiency of power transmission.
   * They are used to generate electromagnetic oscillations and in tuning the radio circuits.

2. **Applications of secondary cells:**
   * They are rechargeable.
   * They have very low internal resistance.
   * They are used in cars, two wheelers and trucks etc.

3. **Applications of superconductors:**
   * They are used to levitate the trains above its rails.
   * They are used in electric transmission lines.
   * They are used as storage elements in computers.

4. **Uses of infra red rays:**
   * Its lamps are used in physiotherapy.
   * Its photographs are used in weather forecasting.
   * They are used to take Photograph of long distance objects.

5. **Uses of ultra – violet rays:**
   * They are used to destroy the bacteria and sterilizing surgical instruments.
   * They are used to preserve the food items.
   * They help to find the structure of atoms.

6. **Uses of Raman spectrum:**
   * It is used in all branches of science.
   * In industries, it is used to study the properties of materials.
   * It is used to analyse the chemical constitution.
7. Uses of polaroids:
   * They are used as polarizing sun glasses.
   * They are used to eliminate the head light glare in motor cars.
   * They are used as glass windows in trains and aeroplanes to control the intensity of light.

WHAT IS? AND WHAT ARE? QUESTIONS:
1. Equiopotential surface:
   If all the points of a surface are at the same electric potential, then it is called as equiopotential surface.

2. Electric dipole and its Dipole moment:
   Electric dipole – Two equal and opposite charges separated by a very small distance.
   Electric dipole moment - It is the product of the magnitude of the one of the charges and the distance between them. Its unit is C m.

3. Electric potential energy of two point charges:
   It is the work done to assemble the two point charges or work done in bringing each charge or work done in bringing a charge from infinite distance.

4. Electrostatic shielding
   It is the process of isolating a certain region of space from external field. It is based on the fact that electric field inside a conductor is zero.

5. Why is it safer to be inside a car than standing under a tree during lightning?
   * The metal body of the bus provides electrostatic shielding, where the electric field is zero.
   * During lightning the electric discharge passes through the body of the bus.

6. Electrostatic induction:
   It is the process of obtaining induced charges without any contact with another charge.

7. Dielectrics:
   It is an insulating material in which all the electrons are tightly bound to the nucleus of the atom.
   Example – ebonite, mica and oil.

8. Nonpolar molecule:
   A nonpolar molecule is one in which the centre of gravity of the positive charges coincide with the centre of gravity of the negative charges. Example - O₂, N₂, H₂.

9. Polar molecule:
   A polar molecule is one in which the centre of gravity of the positive charges is separated from the centre of gravity of the negative charges by a finite distance. Example - N₂O, H₂O, HCl.

10. Action of points or corona discharge:
   The leakage of electric charges from the sharp points on the charged conductor is known as action of points or corona discharge.

11. Superconductivity or Superconductors:
   The ability of certain metals, their compounds and alloys to conduct electricity with zero resistance at very low temperature is called superconductivity. The materials which exhibit this property are called superconductors.

12. Changes occurring at the transition temperature or critical temperature:
   * The electrical resistivity drops to zero.
   * The conductivity becomes infinity.
   * The magnetic flux lines are excluded from the material.
13. **Why is copper wire not suitable for a potentiometer?**
   * Resistivity of copper wire is low
   * Temperature coefficient of resistance is high.

14. **Differentiate between electric power and electric energy:**

<table>
<thead>
<tr>
<th>Electric power</th>
<th>Electric energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is the rate of doing electric work</td>
<td>It is the capacity to do work</td>
</tr>
<tr>
<td>Its unit is watt</td>
<td>Its unit is joule</td>
</tr>
</tbody>
</table>

15. **Differentiate between emf and potential difference:**

<table>
<thead>
<tr>
<th>emf</th>
<th>Potential difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is the difference of potentials between the two terminals of a cell in an open circuit</td>
<td>It is the difference of potentials between any two points in a closed circuit</td>
</tr>
<tr>
<td>It is independent of resistance</td>
<td>It depends on the resistance</td>
</tr>
</tbody>
</table>

16. **Limitations of cyclotron:**
   * Maintaining a uniform magnetic field over a large area of the Dees is difficult.
   * At high velocities, relativistic variation of mass of the particle upsets the resonance condition.
   * At high frequencies, relativistic variation of mass of the electron is appreciable and hence electrons cannot be accelerated by cyclotron.

17. **Electromagnetic induction:**
The phenomenon of producing an induced emf due to the changes in the magnetic flux associated with a closed circuit is known as electromagnetic induction.

18. **Mutual induction:**
The phenomenon of producing an induced emf in a coil due to the change in current in the other coil is known as mutual induction.

19. **Methods of producing induced emf:**
The induced emf can be produced by
   * changing the magnetic induction (B)
   * changing the area (A) enclosed by the coil
   * changing the orientation of the coil (θ) with respect to the magnetic field.

20. **Alternating current:**
The current induced in the coil varies in magnitude and direction periodically, it is called an alternating current. \( i = I_0 \sin \omega t \)

21. **rms value of alternating current:**
The rms value of alternating current is defined as that value of the steady current, which when passed through a resistor for a given time, will generate the same amount of heat as generated by an alternating current when passed through the same resistor for the same time.

22. **Fraunhofer lines:**
The dark lines in the solar spectrum are called Fraunhofer lines.

23. **Tyndal scattering:**
   When light passes through a colloidal solution its path is visible inside the solution. This is because, the light is scattered by the particles of solution. The scattering of light by the colloidal particles is called Tyndal scattering.
24. **Raman effect:**
When a monochromatic light is allowed to pass through a substance, it is scattered and the scattered light contains some additional frequencies other than that of incident frequency. This is known as Raman effect.

25. **Stoke's lines and Anti-stoke’s lines:**
- **Stoke’s lines** – The lines having frequencies lower than the incident frequency.
- **Anti-Stokes lines** – The lines having frequencies greater than the incident frequency.

26. **Conditions to obtain sustained interference:**
- The two sources should be coherent
- Two sources should be very narrow
- The sources should lie very close to each other to form distinct and broad fringes.

27. **Double refraction:**
When a ray of unpolarised light is incident on a calcite crystal, two refracted rays are produced. This phenomenon is called double refraction.

28. **Optical rotation depends on the factors:**
- Thickness of the crystal
- Density of the crystal
- Wavelength of light used
- Temperature of the solutions.

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**LAWS:**

1. **Bragg’s law:**
If the path difference is equal to integral multiple of wavelength of X – ray, then the constructive interference will occur between the reflected beams and they will reinforce with each other. \(2d \sin \theta = n\lambda\)

2. **Moseley’s law:**
The frequency of the spectral line in the characteristic X – ray spectrum is directly proportional to the square of the atomic number \((Z)\) of the element considered. \(v \propto Z^2\)

3. **Postulates of special theory of relativity:**
- The laws of physics are the same in all inertial frames of reference.
- The velocity of light in free space is a constant in all the frame of reference.

4. **\(\alpha\) – decay law:**
When a radioactive nucleus disintegrates by emitting an \(\alpha\) – particle, the atomic number decreases by two and mass number decreases by four.

\[ _{88}^{226}\text{Ra} \rightarrow _{86}^{222}\text{Rn} + _2^4\text{He} \]

5. **\(\beta\) - decay law:**
When a radioactive nucleus disintegrates by emitting a \(\beta\) - particle, the atomic number increases by one and the mass number remains the same.

\[ _{90}^{234}\text{Th} \rightarrow _{91}^{234}\text{Pa} + _{-1}^0\text{e} \]

6. **Radioactive law of disintegration:**
The rate of disintegration at any instant is directly proportional to the number of atoms of the element present at that instant. \(-\frac{dN}{dt} \propto N\)

7. **De- Morgan’s theorems:**
- **First theorem** : The complement of a sum is equal to the product of the complements. \(\overline{A + B} = \overline{A} \cdot \overline{B}\)
- **Second theorem** : The complement of a product is equal to the sum of the complements. \(\overline{A \cdot B} = \overline{A} + \overline{B}\)
DEFINE QUESTIONS:

1. **Excitation potential energy:**
   The energy required to raise an atom from its normal state into an excited state is called excitation potential energy of the atom.

2. **Ionisation potential energy:**
   The ionization potential is that accelerating potential which makes the impinging electron acquire sufficient energy to knock out an electron from the atom and thereby ionize the atom.

3. **Critical potential:**
   The critical potential of an atom, is defined as the minimum potential required to excite a free neutral atom from its ground state to higher state.

4. **Stopping potential:**
   The minimum negative potential given to the anode for which the photoelectric current becomes zero is called stopping potential.

5. **Threshold frequency:**
   It is defined as the minimum frequency of incident radiation below which the photoelectric emission not possible completely, however high the intensity of incident radiation may be.

6. **Work function:**
   It is defined as the minimum amount of energy required to liberate an electron from the metal surface.

7. **Frame of reference:**
   A system of co-ordinate axes which defines the position of a particle in two or three dimensional space is called a frame of reference.

8. **One atomic mass unit (1amu):**
   One atomic mass unit – one twelfth of the mass of carbon atom $^{12}C$.

9. **Mass defect:**
   The difference in the total mass of the nucleons and the actual mass of the nucleus is known as the mass defect.

10. **Binding energy:**
    When the protons and neutrons combine to form a nucleus, the mass that disappears is converted into an equivalent amount of energy, called binding energy of the nucleus.

11. **Radioactivity:**
    The phenomenon of spontaneous emission of highly penetrating radiations such as $\alpha$, $\beta$ and $\gamma$ rays by heavy elements having atomic number greater than 82 is called radioactivity.

12. **Curie:**
    Curie is defined as the quantity of a radioactive substance which gives $3 \times 10^{10}$ disintegrations per second.

13. **Artificial radioactivity:**
    The phenomenon by which even light elements are made radioactive by artificial methods is called artificial radioactivity.

14. **One Roentgen:**
    One roentgen is defined as the quantity of radiation which produces $1.6 \times 10^{12}$ pairs of ions in 1 gram of air.

15. **Input impedance of a transistor:**
    It is defined as the ratio of small change in base – emitter voltage to the corresponding change in base current at a given $V_{CE}$. Its unit is $\Omega$.

16. **Band width of an amplifier:**
    It is defined as the frequency interval between lower cut off and upper cut off frequencies. $BW = f_U - f_L$

17. **Output impedance of a transistor:**
    It is defined as the ratio of small change in collector – emitter voltage to the corresponding variation in the collector current at a constant base current. Its unit is $\Omega$.

18. **Define modulation factor:**
    It is defined as the ratio of the change in amplitude in carrier wave after modulation to the amplitude of the unmodulated carrier wave.
USES, APPLICATIONS, LIMITATIONS AND CHARACTERISTICS – QUESTIONS:

1. Characteristics of laser:
   * It is monochromatic
   * It is coherent
   * Does not diverge at all
   * It is extremely intense

2. Conditions to achieve laser action:
   * There must be an inverted population.
   * The excited state must be a metastable state.
   * The emitted photons must stimulate further emission.

3. The facts of Laue experiment on X-rays:
   * X-rays are electromagnetic waves of extremely short wavelength.
   * The atoms in the crystal are arranged in a regular three dimensional lattice.

4. Limitations of electron microscope:
   * It is operated in only in high vacuum.
   * This prohibits the use of the microscope to study living organisms which would evaporate and disintegrate under such conditions.

5. Uses of electron microscope:
   * It is used in the industry, to study the structure of textile fibers, surface of metals etc.
   * In medicine and biology, it is used to study virus, and bacteria.
   * In physics, it has been used in the investigation of atomic structure and structure of crystals in detail.

6. Classification of neutrons based on kinetic energy:
   * Slow neutrons of energy $0 – 1000$ eV
   * Fast neutrons of energy $0.5 – 10$ MeV
   * Thermal neutrons of energy $0.025$ eV

7. Uses of nuclear reactor:
   * They are mainly used for power production.
   * They are useful to produce radio isotopes.
   * They are used in scientific research.

8. Advantages of negative feedback:
   * Highly stabilized gain
   * Increased bandwidth
   * Less distortion

9. Barkhausen condition for oscillation:
   * The loop gain is $A \beta = 1$
   * The net phase shift around the loop is $0^\circ$ or integral multiples of $2\pi$.

10. Advantages of integrated circuits:
    * Small in size
    * Reliability
    * Very small weight
    * Reduced cost

11. Important characteristics of OP-AMP (operational amplifier):
    * Very high input impedance
    * Very high gain
    * Very low output impedance
12. Advantages of amplitude modulation:
   * Easy transmission and reception
   * Lesser bandwidth requirements
   * Low cost

13. Limitations of Amplitude modulation:
   * Noisy reception
   * Low efficiency
   * Small operating range

14. Advantages of optical fibers:
   * Transmission loss is low
   * Fiber is lighter and less bulky than equivalent copper cable
   * More information can be carried by each fiber than copper cables

15. Applications of optical fibers:
   They are used in
   * Voice telephones
   * Video phones
   * Message services
   * Data network

WHAT IS? WHAT ARE? – QUESTIONS:

1. Cathode rays:
   The rays coming from the cathode when the pressure inside the discharge tube is reduced to 0.01 mm of Hg are called cathode rays.

2. Energy level diagram:
   Taking the energy values on linear scale, horizontal lines are drawn which represent energy levels of the hydrogen atom. This diagram is known as energy level diagram.

3. X – rays:
   When fast moving electrons strike a solid target, an invisible penetrating radiation is produced, called as X – rays.

4. Hard X – rays and Soft X – rays:

<table>
<thead>
<tr>
<th>Hard X – rays</th>
<th>Soft X – rays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength is 1 A°</td>
<td>Wavelength is 4 A° and above</td>
</tr>
<tr>
<td>Frequency is high</td>
<td>Frequency is low</td>
</tr>
<tr>
<td>Energy is high</td>
<td>Energy is low</td>
</tr>
<tr>
<td>Penetrating power is high</td>
<td>Penetrating power is low</td>
</tr>
</tbody>
</table>

5. Photoelectric effect:
   It is the phenomena by which a good number of substances, chiefly metals, emit electrons under the influence of radiation such as γ rays, X – rays, ultraviolet and even visible light.

6. Photoelectric cells and types:
   It is a device which converts light energy into electrical energy. Types of photoelectric cells are
   1. Photo emissive cell
   2. Photo voltaic cell
   3. Photo conductive cell

7. Matter waves:
   The waves associated with the moving particle under suitable conditions are called matter waves.
8. Inertial and Non - inertial frames of reference:

   **Inertial frame of reference:**
   A frame of reference is said to be inertial, when the bodies in this frame obey Newton’s law of inertia and other laws of Newtonian mechanics.

   **Non - inertial frame of reference:**
   A frame of reference is said to be a non – inertial frame, when a body not acted upon by an external force, is accelerated. In this frame, Newton’s laws are not valid.

9. Cosmic rays:
   The ionizing radiation many times stronger than γ – rays entering the earth from all the directions from cosmic or interstellar space is known as cosmic rays.

10. Pair production and annihilation of matter:
    **Pair production:**
    The conversion of a photon into an electron – positron pair on its interaction with the strong electric field surrounding a nucleus is called pair production.

    **Annihilation of matter:**
    The converse of pair production in which an electron and positron combine to produce a photon is known as annihilation of matter.

11. Intrinsic semiconductor:
    A semiconductor which is pure and contains no impurity is known as an intrinsic semiconductor.

12. N – type semiconductor:
    When a small amount of pentavalent impurity such as arsenic is added to a pure germanium semiconductor crystal, the resulting crystal is called N – type semiconductor.

13. P – type semiconductor:
    When a small amount of trivalent impurity is added to a pure semiconductor crystal, the resulting semiconductor crystal is called P – type semiconductor.

14. Rectification:
    The process in which alternating voltage or alternating current is converted into direct voltage or direct current is known as rectification. The device used for this process is called rectifier.

15. Feedback and Its types:
    It is the process of returning a fraction of output signal to the input signal and combining with the input signal.

    **Negative feedback** – If the magnitude of the input signal is reduced by the feedback, the feedback is called negative feedback.

    **Positive feedback** – If the magnitude of the input signal is increased by the feedback, such feedback is called positive feedback.

16. Universal gates and Why they are called like that:
    NAND and NOR gates are called universal gates because they can perform all the three basic logic functions such as NOT, OR and AND.

17. Integrated circuits:
    An integrated circuit consists of a single – crystal chip of silicon, containing both active and passive elements and their interconnections.

18. Uses of cathode ray oscilloscope:
    * It is used to measure the a.c and d.c voltage.
    * It is used to find the frequency of a.c voltage.
    * It is used in cardiology to measure the heart beats.

19. Skip distance:
    In the sky wave propagation, for a fixed frequency, the shortest distance between the point of transmission and the point of reception along the surface is known as the skip distance.

20. Scanning:
    It is the process by which an electron beam spot is made to move across a rectangular area, so as to cover it completely.
1. **Properties of electric lines of force:**
   - They start from positive charge and terminate at negative charge.
   - They never intersect each other.
   - The direction of $E$ is given by the tangent drawn to the line of force.
   - The lines of force are close together if $E$ is large and they are wider apart if $E$ is small.
   - Each unit positive charge gives rise to $\frac{1}{\varepsilon_0}$ lines of force in free space.

2. **Applications of Superconductors:**
   - They form the energy saving power systems namely superconducting generators.
   - They can be used to levitate the trains above its rails.
   - They can be used to launch satellites into the orbits without the use of rockets.
   - They can be used as electric transmission lines.
   - They are used as storage device in computers.

3. **Special features of magnetic Lorenz force:**
   - The force is zero if the charge is at rest.
   - The force is proportional to the charge.
   - The force is proportional to the magnetic induction.
   - The force is proportional to the speed of the charge.
   - The force is oppositely directed for the charges of opposite sign.

4. **Faraday’s laws of electromagnetic induction:**
   - **First law:**
     Whenever the amount of magnetic flux linked with a closed circuit changes, an emf is induced in the circuit. The induced emf lasts so long as the change in magnetic flux continues.
   - **Second law:**
     The magnitude of emf induced in a closed circuit is directly proportional to the rate of change of magnetic flux linked with the circuit.

5. **Characteristics of electromagnetic waves:**
   - They are produced by accelerated charges.
   - They do not require any material medium for propagation.
   - They are transverse in nature.
   - Variation of maxima and minima in both $\vec{E}$ and $\vec{B}$ occur simultaneously.
   - They travel in vacuum with the velocity of light.
   - They are not deflected by electric and magnetic fields.

6. **Uses of polaroids:**
   - They are used as polarizing sun glasses.
   - They are used to eliminate the head light glare in motor cars.
   - They are used to improve colour contrasts in old oil paintings.
   - They are used to produce three – dimensional moving pictures.
   - They are used as glass windows in trains and aeroplanes to control the intensity of light.

7. **Properties of cathode rays:**
   - They travel in straight line.
   - They affect the photographic plates.
   - They produce fluorescence.
   - They ionize the gas.
   - They are deflected by electric and magnetic fields.
8. **Properties of canal (or positive) rays:**
   - They travel in straight line.
   - They affect the photographic plates.
   - They produce fluorescence.
   - They ionize the gas.
   - They are deflected by electric and magnetic fields.

9. **Properties of X – rays:**
   - They are electromagnetic waves of extremely short wavelength.
   - They travel in straight line with the velocity of light.
   - They affect the photographic plates.
   - They ionize the gas.
   - They are not deflected by electric and magnetic fields.

10. **Medical applications of X – rays:**
    - They are used for detecting fractures, tumours in the human body.
    - They are used for the diagnosis of tuberculosis, stones in kidneys, gall bladder etc.
    - They are used to cure skin diseases, malignant sores, cancer and tumours.
    - Hard X – rays are used to destroy tumours very deep inside the body.

11. **Industrial applications of X – rays:**
    - They are used to detect the defects or flaws within a material.
    - They are used to test the homogeneity of welded joints, insulating materials etc.
    - They are used to analyse the structure of alloys and the other composite bodies.
    - They are used to study the structure of materials like rubber, cellulose, plastic fibres etc.

12. **Industrial applications of X – rays:**
    - They are used to study the structure of crystalline solids and alloys.
    - They are used to identify the chemical elements with their atomic numbers.
    - They are used to analyse the structure of complex molecules by X – ray diffraction pattern.

13. **Industrial applications of laser:**
    - They are used to drill holes in diamonds, hard sheets etc.,
    - They are used to cut the thick sheets of hard metals and welding.
    - They are used to vapourize the unwanted material during the manufacture of semiconductor chips.
    - They are used to test the quality of the materials.

14. **Medical applications of laser:**
    - Laser beam is used for micro surgery.
    - They are used in the treatment of kidney stone, tumour, in cutting and sealing the small blood vessels in brain surgery and retina detachment.
    - They are used in endoscopy.
    - They are used in the treatment of human and animal cancer.

15. **Scientific and Engineering applications of laser:**
    - They are used to transmit large number of messages at a time in radio, television and telephone.
    - They are used in optical fiber communication.
    - They are used to measure the distance between the earth and the moon.
    - They are used in Raman spectroscopy.
    - They are used in holography.
16. **Applications of photoelectric cells:**
* They are used in cinematography to reproduce sound.
* They are used for controlling the temperature of the furnaces.
* They are used for automatic switching on and off of the street lights.
* They are used in opening and closing of door automatically.
* They are used in burglar alarm and fire alarm.

17. **Laws of photoelectric emission:**
* For a given photosensitive material, there is minimum frequency called the threshold frequency, below which emission of photoelectrons stops completely, however great the intensity may be.
* For a given photosensitive material, the photoelectric current is directly proportional to the intensity of the incident radiation, provided the frequency is greater than the threshold frequency.
* The photoelectric emission is an instantaneous process. i.e. there is no time lag between the incidence of radiation and the emission of photoelectrons.
* The maximum kinetic energy of the photo electrons is directly proportional to the frequency of incident radiation, but is independent of its intensity.

18. **Einstein's photoelectric equation:**
* **Work function** – the minimum energy required to liberate an electron from the metal surface.
* **Energy of the incident photon** = Work function + Kinetic energy of the emitted electron
* \( h\nu = w + \frac{1}{2}mv^2 \)
* \( h\nu = w + \frac{1}{2}mv^2_{max} \)
* \( \nu = \nu_0 \)
* \( h\nu_0 = w \)
* \( h(\nu - \nu_0) = \frac{1}{2}mv^2_{max} \)

19. **de Broglie wavelength of matter waves:**
* \( E = h\nu \)
* \( E = mc^2 \)
* \( h\nu = mc^2 \)
* \( \frac{hc}{\lambda} = mc^2 \quad (\nu = \frac{c}{\lambda}) \)
* \( \lambda = \frac{h}{mc} \)
* If \( c = \nu \)
* \( \lambda = \frac{h}{P} \)
* \( P = mv \)

20. **de Broglie wavelength of an electron:**
* \( \frac{1}{2}mv^2 = eV \)
* \( \nu = \sqrt{\frac{2eV}{m}} \)
* \( \lambda = \frac{h}{mv} \quad \lambda = \frac{h}{\sqrt{2meV}} \)
* \( \lambda = \frac{12.27}{\nu} \ \text{Å} \)
* \( E = eV \)
* \( \lambda = \frac{h}{\sqrt{2me}} \)
21. Length contraction:

\[ l = l_0 \sqrt{1 - \frac{v^2}{c^2}} \]
\[ l < l_0 \]

* The length of the rod is in motion is contracted by a factor \( \sqrt{1 - \frac{v^2}{c^2}} \) called Lorentz-Fitzgerald contraction.

* Example: A circular object will appear as an ellipse for a fast moving observer.

22. Time dilation:

\[ t = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}} \]
\[ t > t_0 \]

* To a stationary observer, time interval appears to be lengthened by a factor \( \sqrt{1 - \frac{v^2}{c^2}} \)

* A moving clock appears to be slowed down to a stationary observer.

* Example: The clock in the moving space ships will appear to go slower than the clocks on the earth.

23. Classification of Nuclei:

- **Isotopes**: They are atoms of same element having same atomic number but different mass number.
- **Isobars**: They are atoms of different elements having same mass number but different atomic number.
- **Isotones**: They are atoms of different elements having same number of neutrons.

24. Characteristics of nuclear force:

* It is charge independent.
* It is not electrostatic force.
* It is the strongest force in nature.
* It is not a gravitational force.
* It is a short range force.

25. Properties of Neutrons:

* They are present in all nuclei, except hydrogen.
* They are not deflected by electric and magnetic fields.
* They are stable inside the nucleus and unstable outside the nucleus.
* As they are neutral, they can easily penetrate any nucleus.

* They are classified into
  - Slow neutrons
  - Fast neutrons
  - Thermal neutrons
26. Properties of alpha, beta and gamma rays:

<table>
<thead>
<tr>
<th>Alpha rays</th>
<th>Beta rays</th>
<th>Gamma rays</th>
</tr>
</thead>
<tbody>
<tr>
<td>They are deflected by electric and magnetic fields.</td>
<td>They are deflected by electric and magnetic fields.</td>
<td>They are not deflected by electric and magnetic fields.</td>
</tr>
<tr>
<td>They affect the photographic plates</td>
<td>They affect the photographic plates</td>
<td>They affect the photographic plates</td>
</tr>
<tr>
<td>They produce fluorescence</td>
<td>They produce fluorescence</td>
<td>They produce fluorescence</td>
</tr>
<tr>
<td>Penetrating power is low</td>
<td>Penetrating power is high</td>
<td>Penetrating power is very high</td>
</tr>
<tr>
<td>Ionisation power is very high</td>
<td>Ionisation power is low</td>
<td>Ionisation power is very low</td>
</tr>
</tbody>
</table>

27. Advantages and Disadvantages of Digital communication:

**Advantages:**
- The transmission quality is high.
- It is independent of the distance between the terminals.
- The capacity of the transmission system can be increased.
- It is used in optical fibers and wave guides to transfer data.

**Disadvantages:**
- A digital system requires larger bandwidth.
- It is very difficult to gradually change over from analog to digital transmission.

28. Advantages and Applications of fiber optical communication:

**Advantages:**
- Transmission loss is low.
- Fiber is lighter and less bulky than equivalent copper cable.
- More information can be carried by this communication.
- There is no interference in the transmission of light from electrical disturbances.

**Applications:**
- This communication is used in
  - voice telephones
  - video phones
  - message services
  - data network

29. Uses of Radar:

- It works on the principle of radio echoes.
- They are used in air and sea navigation.
- They are used for the safe landing of air crafts.
- They are used for the weather forecasting.
- They are used to discover the position of buried metals, oils and ores.

30. Merits and Demerits of satellite communication:

**Merits:**
- Mobile communication can be easily established by this communication.
- It is suitable for long distances.
- It is better than optical fiber communication.
- It is independent of sending and receiving stations.
- It is most economical for thin traffic remote areas like north east regions in India, Ladakh, etc.,

**Demerits:**
- Between talks there is a time gap which becomes quite annoying.
- This time delay reduces the efficiency of satellite in data transmission.
- An imperfect impedance match may cause echo, received back after a delay.
- Repair of satellite is almost impossible, once it has been launched.