Grade 10th physics second semester short notes

Contains:

- Three solid chapters such as:
  - ✓ Chapter-4: Electromagnetism
  - ✓ Chapter-5: Introduction to electronics
  - ✓ Chapter- 6: electromagnetic waves and geometrical optics
- The selected supplementary problems and questions with answer at the end of each chapter.

PHYSICS: 10

CHAPTER: 4: ELECTROMAGNETISM

4.1 Magnetism

The force between magnets

The magnetic force -is the force exerted between magnetic poles, producing magnetization force between magnets.

If you bring twobar magnets towards each other, then you will feel either a force ofattraction between them or a force of repulsion.

There are two properties of magnets. These are:

I. Like poles repel each other. and
II. Unlike poles attract each other. i.e North pole repel North pole or south pole repel south pole, but North pole attract south pole.

The attractive or repulsive force of a magnet is greater at the poles than at its middle portion.

The Earth's magnetic field

The Earth has a magnetic field that can be detected using a compass.

A compass needle is like a small suspended bar magnet. Its north seeking pole will point to the Earth's North Pole.

Magnetic domains

-Domains regions within a magnetic material which have uniform magnetization.

-is a microscopic set magnets within a magnet.

The 'N' end of one magnet is up against the 'S' end of another, and the two eff ectively cancel each other out (see Figure **a**below). We call these magnetic **domains**.

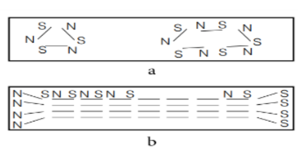


Fig. magnetic domains

Figure b above shows the steel when it is fully magnetized. Notice that there are a large number of north poles at one end of the bar, and the same number of south poles at the other.

When the domains are lined up, then the material is magnetic.

If the domains are arranged randomly, then the material loses its magnetism.

Magnetic substance-is a material attracted by a magnet.

Magnetic materials have atoms that act as tiny magnets which is called domains.

Magnetization- *the extent or degree to which an object is magnetized.*

-*is* the process by which an originally non-magnetic body, such as iron, cobalt and nickel or their alloys is changed into a magnet.

Magnetic shielding

A **magnetic shield-** stops the equipment from being aff ected by a magnet.

-Magnetic shielding comes in various forms depending on the equipment that needs to be protected.

The best magnetic shield is the combination with the smallest angle of deflection of the compass.

4.2 **Concepts of magnetic field**

- Magnetic field- is a region where a magnetic force may be exerted.
- It exists in a region of space if a moving charge there be experience a force due to its motion. If you put a compass down in a magnetic field, it will experience a force that makes it set in a particular direction.

Magnetic field lines/flux

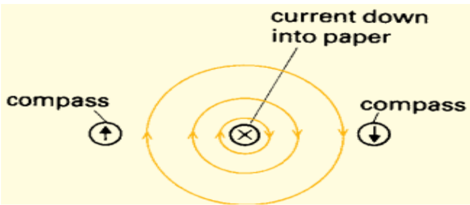
- Magnetic flux –is a measure of the strength of a magnetic field over a given area.
- The lines of force start on the north pole of the magnetand end on the south, just as they did with the horseshoe magnet.
  Where the field is strongest (close to the poles), there the lines offorce are closest together.

Magnetic field lines around a current- carrying wire

Magnetic fields are not only produced by metal magnets.

An electric current will cause a compass needle to deflect. In other words, an electric current gives rise to a magnetic field.

The magnetic field lines pattern of a current-carrying wire is as shown in Figure below.



× means current into paper,

• means current outof paper

The right-hand rule

- It used to determine the direction of magnetic field lines around a straight current-carrying wire.
- Hold the wire with your thumb going in the direction of the conventional current.
- The way your fingers then wrap round the wire is the way the field lines go.
- The magnitude of the magnetic field at a distance r away from an infinitely long straight wire carrying a current, I is:

$$\mathbf{B} = \frac{\mu_o I}{2\pi r}$$

Where B = magnetic flux density in T,**r = distance** in m.

$$\mu_o = permeabiliy\ of\ free\ space = 4\pi x 10^{-7} T.m/A$$

The magnetic field strength at a point due to a straight current-carryingwire/

Magnetic field strength at a point due to a current carrying wire

- a current-carrying wire produces amagnetic field.
- The current-carrying wire will experience a force, *F*.
- The strength of the magnetic field, *B*, produced by a current-carrying wire, depends on:
  - the force, *F*
  - the current flowing through the wire, *I*
  - the length of the wire, *L*.
- Force = magnetic field strength × current flowing through the wire ×length of wire.

F* = *B* × *I* × *L

Where

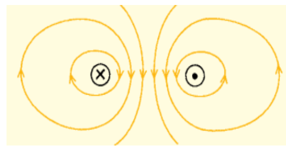
F = force in N, B = field strength in Tesla (T), I = current in A and L=length in m.

Magnetic field of a solenoid

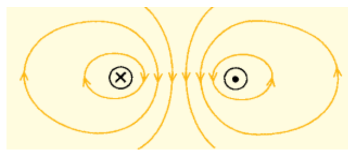
- **Solenoid- is** *a coil of wire in which a magnetic field is created by passing a current through it.*

The currents in each side of the coil both contribute to the overallmagnetic field. The field is strong in the center of the coil butweaker outside the coil.

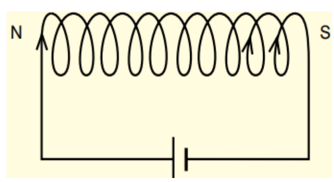
The magnetic field lines pattern of a current loop is as shown in Figure below.



The magnetic field lines pattern of a solenoid is as shown in Figure below.



To specify the polarity of a solenoid using the right-hand rule, a current flowing in a clockwise direction will behave like a south pole so a current flowing in an anticlockwise direction will behave like a North Pole see fig.below.



Strength of magnetic field in a solenoid

The strength of the magnetic field in a solenoid (again given the symbol *B*) depends on:

- the number of turns of wire per meter of length, *n*.
- the permeability of free space, μ.
- the current flowing through the wire, *I*.

The formula is:

field strength = permeability of free space × number of turns per meter of length × current

B = $\mu 0 nI$ where $n = \frac{N}{l}$

The magnetic force

- As the charged particle is moving in a magnetic field the force acts on it is experienced.

- The factor on which the force on current-carrying wire depends up on:
  - The strength of the field
  – The current flows through the conductor
  –The length of the conductor
  –The angle between the field and the conductor.
  F = BILsin $\boldsymbol{\theta}$

- The factors on which the force on a moving charges in a magnetic field depend.

-The field strength, B
-The size of the charge, q and
-Its velocity, *v*.

$$\boldsymbol{F = Bqv}$$

- We can determine the direction of force acting on a moving charge using right-hand rule.

Magnetic fields and the centripetal force

The centripetal force can be found usingthe equation:

$F = \frac{mv^2}{R}$................ (1)

Where *F* is the force, *m* is the mass of the particle, *v* is the velocity and *R* is the radius of the circle in which the particle is travelling.

A charged particle moving in a magnetic field will move in a circular path.

$B = Bqv$ .... (2)

Up on equating the two equations, we get:

$\frac{mv^2}{R} = Bqv.$

⇨ $\boldsymbol{\frac{mv}{R}}$ = Bq
⇨ $\boldsymbol{B = \frac{mv}{Rq}}$

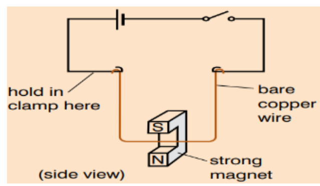
The motor effect

- ✓ Motor effect- a current carrying wire or coil can exert a force on a permanent magnet.
- ✓ A magnet exerts a force on a current-carrying wire.

- ✓ The motor effect is the effect the force experienced by a current-carrying conductor in a magnetic field.
- ✓ The motor effect tries to stop the dynamo effect.

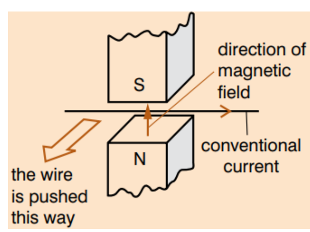
Demonstration of the motor effect

A length of fairly stiff copper wire is bent into a square U-shape and is hooked over at the ends.It is allowed to dangle from the ends of the rest of the circuit as shown, so it can swing freely but the electric current can still be fed into and out of it.



As soon as you switch on the current, you will see a force acting in the direction shown on the wire carrying the current as fig. below.

Reversing the current makes the wire move the opposite way, and so does reversing the direction of the magnetic field. Notice that the wire moves not in the direction of the magnetic field, but at right angles to it.



Fleming's left-hand rule
-used to predict the direction of the movement produced by the motor eff ect.

-Hold the thumb and first two fingers of your left- hand at right angles to each other.

The first **F**inger -points along the magnetic field

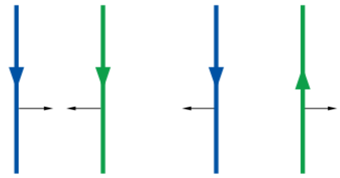
The se**c**ond finger- shows the **C**onventional **C**urrent, and

The **Th**umb -points in the direction of the **Th**rust (movement).

Magnetic force between two parallel current-carrying conductors

- ➢ Two parallel wires each carrying a current will interact with eachother.
- ➢ If the currents are both flowing the same way, they attractone another;
- ➢ If the currents are both flowing in opposite currents going opposite ways they repel each.

- The current in one wire creates a magnetic field that extends out to where the second wire is.
- The current in this second wire thenexperiences a force due to the motor effect.



The magnitude of the force which two wires that is a distance (r) r apart, each of length (l) and carrying-currents of I_1 and I_2 is given by:

$$F = \frac{\mu_{oI_1I_2}}{2\pi r} \qquad where\ B = \frac{\mu_{oI}}{2\pi r}$$

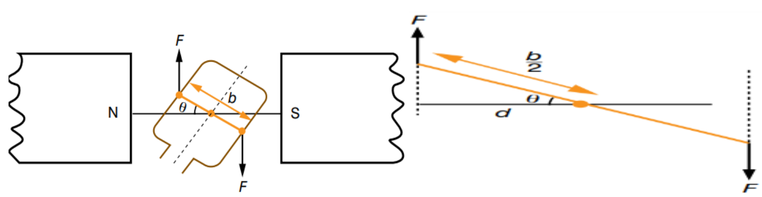
Ampere

States that: if one ampere is flowing in each of two parallel wires 1 m apart in a vacuum, then the force on each wire due to the other will be exactly 2×10^{-7} N on every meter length.

- ✓ From the above equation, we can get this value if I_1 and I_2 is 1A, r is 1m, the length is 1m and$\mu_o = 4\pi x 10^{-7} T.m/A$. Therefore, the force would be the same as 2×10^{-7} N.

Force on a rectangular current-carrying wire

Consider a coil of length *L* (as in Figure below) and *N* turns carrying a current *I*.



- ✓ The plane of the coil makes an angle θ with the magnetic field.
- ✓ The magnitude of each force *F* will be *BILN*.
- ✓ These two forces provide a torque, a turning effect, on the coil.
- ✓ The total torque is the sum of the two moments.
- ✓ The distance the left-hand force acts from the pivot is *d*, which is $\frac{b}{2}\cos\theta$ (where b is the full width of the coil).
- ✓ Therefore its moment is $F \times \frac{b}{2}\cos\theta$.
- ✓ The two forces combined give double this moment, which is $Fb\cos\theta$.
- ✓ Torque on the coil = $BIAN \cos\theta \quad A = L \times b$.

The electric motor

- ✓ Electric motor- is a device that converts electrical energy into mechanical energy.
- ✓ The components of electric motor are - magnet, rotating coil (armature), split ring commutator, brush, source of electric energy and switch.

- **For dc motor**

- ✓ When electric current passes through a coil in a magnetic field, magnetic force produce a torque which turns the dc motors.

- **For ac motor**
  - ✓ **As** in the dcmotor case, a current is passed through the coil generating a torque on the coil. Since the current is alternating the motor will run smoothly only at the frequency of the sine wave.
- **Moving coil galvanometer**
  - ✓ The greater the current flowing around the coil of an electric motor,the more strongly it will try to turn.
  - ✓ This suggests a way to measurethe size of a current: let it flow through a motor, and make the coiltry to turn while it is held back by a spring.
  - ✓ The bigger the current,the further the coil will manage to stretch the spring. This is the basis of the moving-coil galvanometer.

4.4 Electromagnetic induction

Magnetic flux and magnetic field strength

- Magnetic flux = magnetic flux density (magnetic field strength) × area

  $\varnothing = B \times A$
- The unit for magnetic flux is T m^2 because B has the unit T and A has the unit m^2.

Electromagnetic induction

- It is the production of voltage across a conductor moving through a stationary magnetic field.
- It is the process of generating a current by relative motion between a wire and a magnetic field.
- It is known as the dynamo effect. i.e a way to cause to flow round that circuit as fig. below.

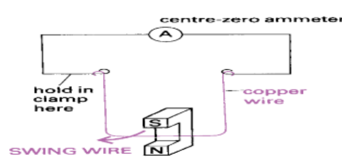


Fig. Demonstrate the dynamo effect.

- When a wire is moved through a magnetic field, a current is generated by thedynamo eff ect.
- Dynamo effect tries to stop the motor effect.
- Induced e.m.f. -voltage produced by electromagnetic induction.

Laws of electromagnetic induction

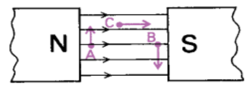
There are two laws of electromagnetic induction. These are:

1. Faraday's law -magnitude of the induced current and
2. Lenz's law-direction of the induced current.

1. Faraday's law of electromagnetic induction: states that

- The induced emf in a closed loop is directly proportional to the rate of change of magnetic flux in the loop.

- The dynamo effect means that a voltage will appear whenever a conductor cuts through a magnetic field as Figure below, which shows an end-on view of a wire being moved between the poles of a magnet.



- **Fig.** *An end-on view of a wire being moved between the poles of a magnet.*
- At A the wire is cutting through the field and so a voltage is created in it.
- The same thing happens at B, but because the wire is cutting through the field in the opposite direction the voltage will be the other way round.
- At C, however, even though the wire is moving in the magnetic field no lines of force are being cut, and so no voltage is generated.
- The law of emf is given by:

$\boldsymbol{\varepsilon} = -\frac{\Delta\emptyset}{\Delta t}$ where

ε -is induced e.m.f.

$\Delta\emptyset = \Delta BA$ -is change on magnetic flux

Δt -is change in time

The magnitude of emf depends on:

- The speed
- The magnetic field strength
- The number of turns.

So for N coil, $\boldsymbol{\varepsilon = -N\frac{\Delta\emptyset}{\Delta t}}$.

2. **The Lenz's law**
   - The direction of the induced current is such as to oppose the change that is causing it.
   - The negative sign indicates the direction of emf or (current).
   - It applies to any situation in which the dynamo effect occurs.

Inductors

- A component such as a coil in an electric circuit the main function of in which is to produce inductance.
- An inductor is essentially an electromagnet.
- The dynamo effect comes into play whenever the magnetic flux through it is changing.
- All electromagnets possess **inductance.**
- Inductance is defined as the property in an electrical circuit where a change in the electric current through that circuit induces an e.m.f. that opposes the change in current.

Types of inductance

a. Self-inductance
b. Mutual inductance

a. Self-inductance

- Self-inductance occurs when a current is first switched on in a coil and the build-up of the magnetic flux induces a voltage in the coil that opposes the battery in the circuit to delay the build-up of current.
- The induced e.m.f. depends on the rate at which the current in the coil is changing.
- Induced e.m.f. = a constant × the rate of change of the current.
- **Induced e.m.f. = *L* × the rate of change of current through the coil.**
  In symbol's, this is written ε
  $\varepsilon_{ind} = \frac{L\Delta I}{\Delta t}$

Where L = coil's **self-inductance in Henry (H)**
Its SI units are v.sec/A

It depends on the coil itself

- Its geometry,
- the number of turns on it,
- What its core is made from.

Mathematically $\mathbf{L = \frac{\emptyset}{I}}$

I = current in A.

$\emptyset$ = magnetic flux in Wb.

b. **Mutual inductance**

- Occurs when a changing current in one coil induces a voltage in a neighboring coil.
- When the flux from one coil threads through another coil, an emf can be induced in either one by the other.
- The coil that contains the power source is called the primary coil, N_p
- The other coil in which an emf is induced by the changing current in the primary is called the secondary, N_s.
- Mutual inductance occurs when a coil is in close proximity to another.
- The mutual inductance *M* of a pair of circuits is defined by:
  e.m.f. induced in one circuit = *M* × (rate of change of current in the other circuit).
- $\boldsymbol{\varepsilon_{mut} = \frac{M\Delta I_2}{\Delta t}}$
  The unit of *M* will also be the henry, H.
  M – Constant mutual inductance.

A simple a.c. generator

- Generator –is a device that converts mechanical energy to electrical energy.

- **The Comparison between the actions of d.c. and a.c. generators.**

d.c. generator	a.c. generator
Turns half a turn by motor effect then would stop unless battery leads could be reversed	Coil is turned rather than turning by motor effect
Split ring commutator reverses direction of current automatically	Slip rings connect to outside circuit

Transformer

- Transformer – is a device that transfers electrical energy from one circuit to another, usually with a change of voltage.
- Is used to step-up or step-down the voltage.
- The emf induced the secondary coil Vs is proportional to the primary voltage Vp and on the ratio of turns of the secondary coil Ns to turns on the primary coil Np.

$$\frac{\mathbf{V_S}}{\mathbf{V_P}} = \frac{\mathbf{N_S}}{\mathbf{N_P}}$$

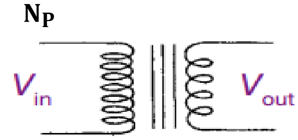
- Based on the number of turns of coil, we can classify transformer into two. These are:

A. Step down transformer

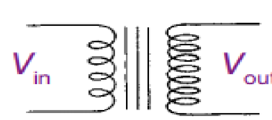
- If the number of turns in the primary coil is greater than the number of turns in the secondary coil the transformer is called step down transformer.
- $N_p > N_s$
- The output voltage of the transformer is less than the input voltage of the transformer is called step down transformer.
- $V_s < V_p$

B. Step up transformer

- If the number of turns in the primary coil is less than the number of turns in the secondary coil the transformer is called step down transformer.
- $N_p > N_s$
- The output voltage of the transformer is greater than the input voltage of the transformer is called step down transformer.
- $V_{s.} < V_p$
- In both type of transformers the ratio of Vs to Vp and Ns to Np are equal i.e
- $\frac{Voltage\ in\ secondary\ coil}{voltage\ in\ the\ primary\ coil} = \frac{number\ of\ turns\ in\ secondary\ coil}{number\ of\ turns\ in\ primary\ coil}$.
- $\frac{\mathbf{V_S}}{\mathbf{V_P}} = \frac{\mathbf{N_S}}{\mathbf{N_P}}$



A step-down transformer



b A step-up transformer

The ideal transformer equation

There are two ways in which a transformer may heat up:

1. Eddy currents may be induced in the iron core. Laminating the core has very nearly solved this problem.
2. The resistance (in ohms) of the windings of the coils themselves could cause heating.

- The power at the output of the transformer is:
- In an ideal transformer, the electric power delivered to the secondary circuit equals the power supplied to the primary circuit.
- An ideal transformer dissipates no power itself.

$\mathbf{P_{int} = p_{out}}$ **but** $\mathbf{p = VI}$

Thus, $\mathbf{V_pI_P = V_sI_s}$ **or** $\mathbf{V_{in}I_{in} = V_{out}I_{out}}$

Where: p – power, V- voltage and I- current.

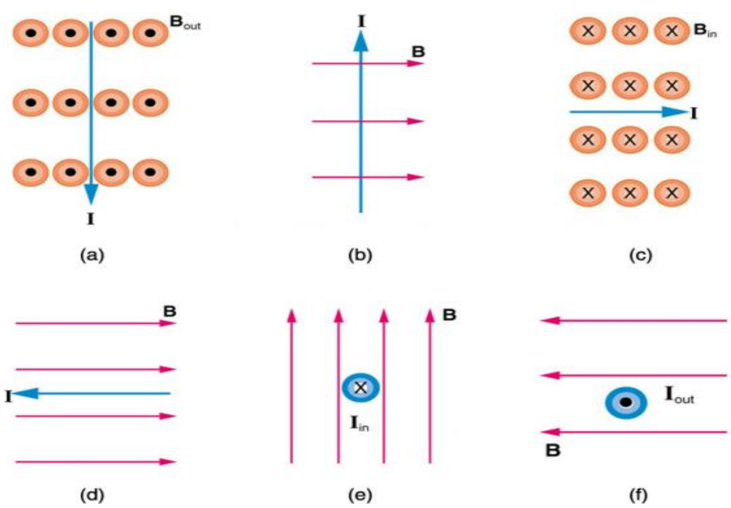
Up on rearranging these we get.

$$\frac{\mathbf{V_S}}{\mathbf{V_P}} = \frac{\mathbf{N_S}}{\mathbf{N_P}} = \frac{\mathbf{I_p}}{\mathbf{I_s}}$$

- Where V_{out} - is the alternating voltage produced in the secondary coil, and Vin is the alternating voltage which is applied to the primary coil, for Ns and N_p
- If the voltage is stepped up, then the current is stepped down by the same factor.

Grade10th physics several practice questions and some Examples
Answer the following questions accordingly.

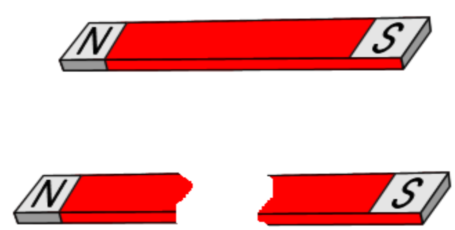
1. What is electromagnetic induction?
2. State the laws of electromagnetic induction.
3. Define magnetic flux.
4. A square coil of side 5 cm lies perpendicular to a magnetic field of flux density 4.0 T. The coil consists of 200 turns of wire. What is the magnetic flux cutting the coil?
5. What is eddy current?
6. What is the term solenoid?
7. What is the direction of the magnetic force on the current in each of the six cases in Figure below?



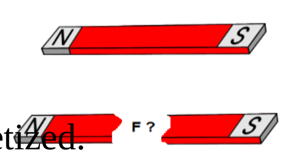
Multiple choice

8. Magnetic flux through a wire loop depends on:
   a) thickness of the wire c) resistivity of the wire
   b)Geometrical layout of the wire d) material that the wire is made of
9. An induced emf produced in a motionless circuit is due to ‹
   a) a static (steady) magnetic field c) a strong magnetic field
   b) a changing magnetic field d) the Earth's magnetic field
10. Motional emf relates to an induced emf in a conductor which is:
   a) long b) moving c) stationary d) insulated
11. Faraday's law says that
   a) an emf is induced in a loop when it moves through an electricfield
   b) the induced emf produces a current whose magnetic field opposes the original change
   c) the induced emf is proportional to the rate of change of magnetic flux
   d) all are correct.

12. A generator is a device that:
    a) Transforms mechanical into electrical energy
    b) Transforms electrical into mechanical energy
    c) Transforms low voltage to high voltage
13. Which of the following laws is used to find the direction of the induced current in a loop of wire placed in a changing magnetic field?
    A. Lenz’s Law B. Faraday’s Law C. Ampere's Law D. Gauss’s Law
14. What are some similarities between a motor and a generator?
A. They both rely on Faraday’s Law. C. Both need to be rotated by an external force.
B. Both require an input current to work. D. Ampere’s Law explains the operation of both.
15. Lenz’s law concerning the direction of an induced current in a conductor by a magnetic field could be a restatement of?
    A. Ampere’s Law B. Ohm’s Law C. Tesla’s Law
    D. The Law of Conservation of Energy
16. How can the magnetic flux through a coil of wire be increased? Select two answers:
    A. Increase the magnitude of the magnetic field that passes outside the loop
    B. Increase the magnitude of the magnetic field that passes through the loop.
    C. Increase the cross sectional area of the loop.
    D. Orient the loop so its normal vector is perpendicular to the external magnetic field direction.
17. A transformer has a primary to secondary turn’s ratio of 15 to 1. If the primary is rated at 240 V, then the secondary voltage is: a. 120 V b.24 v c.16 v d.12 v
18. A transformer has a primary rated at 240 V and a secondary rated at 120 V. The primary to secondary turns ratio is: a. 4:1 b. 2 :1 c. 0.5 d. 0.25
19. A control transformer has a secondary rated 10.4 A at 24 V. The primary is rated480 V, and the primary to secondary turns ratio is 20 to 1. Of the following, which isthe primary full-load current?a. 2.08 A b. 1.22 A c. 0.80 A d. 0.52 A
20. A bar magnet is divided in two pieces. Which of the following statements is true?



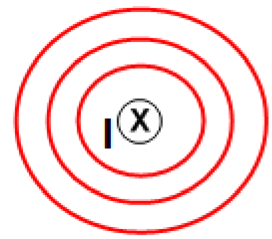
A. The bar magnets demagnetized.
B. The magnetic field of each separated piece becomes stronger.
C. The magnetic poles are separated.
D. Two new bar magnets are created.
E. The electric field is created
21. A bar magnet is divided in two pieces. Which of the following statements is true about the force between the broken pieces if they face each other with a small separation?
A. There is an electric repulsive force between the broken pieces.
B. There is an electric attractive force between the broken pieces.
C. There is a magnetic repulsive force between the broken pieces.
D. There is a magnetic attractive force between the broken pieces.
E. There is no force between the broken pieces since they are demagnetized.



22.A DC current produces a/an:
A. Magnetic field. B. Electric field C. Gravitationalfield.
D. Electromagnetic field. E. None from the above.

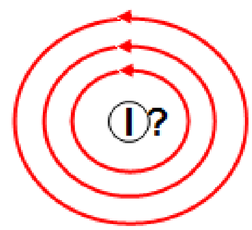
23.An electric current flows into the page.
What is the direction of the magnetic field?

A. To the bottom of the page. B. To the top of the page.
C. Clockwise.D. Counter clockwise. E. To the right.



24.A current-carrying wire is placed perpendicular to the page.
Determine the direction of the electric current from the direction of the magnetic field.

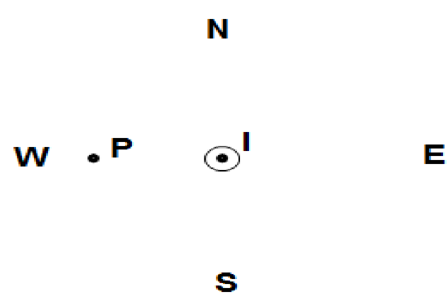
A. Into the page.B. Out of the page. C. Clockwise.
D. Counter-clockwise. E. To the left.



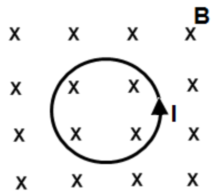
25.A vertical wire carries an electric current into the page.
What is the direction of the magnetic field
At point P located to the south from the wire?

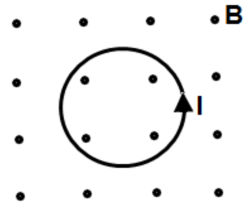
A. West B. North.
C. East. D. South.
E. Down

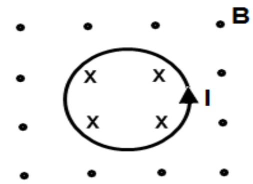
26.A vertical wire carries an electric current out of the page.
What is the direction of the magnetic field
At point P located to the west from the wire?
A. West B. North.
C. East. D. South E. Down.

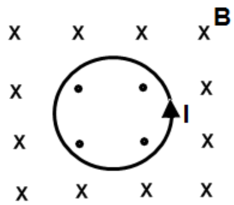


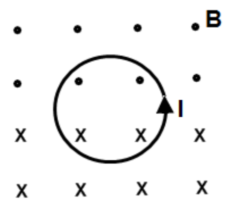
27.Which of the following diagrams represents the magnetic field due to a circular current?

A. 

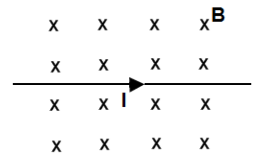
B. 

C. 

D. 

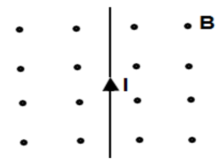
E. 

28. A straight long wire carries an electric current to the right. The current is placed in a uniform magnetic field directed into the page. What is the direction of the magnetic force on the current?



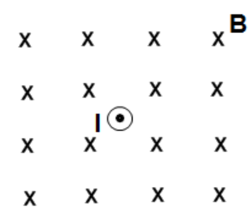
A. To the Left. B. To the Right. C. To the bottom of the page.
D. To the top of the page. E. Out of the page.

29. A straight long wire carries an electric current to the top of the page .The current is placed in a uniform magnetic field directed out the page. What is the direction of the magnetic force on the current?



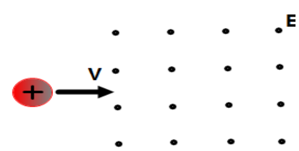
A. To the Left. B. To the Right
C. To the bottom of the page. D. To the top of the page. E. Out of the page

30. A straight long wire carries an electric current out the page. The current is placed in a uniform magnetic field directed into the page. What is the direction of the magnetic force on the current?



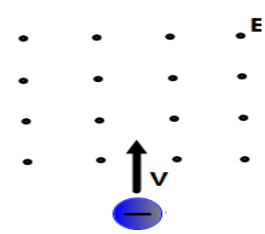
A. Left. B. Right. C. To the bottom of the page.
D. To the top of the page.
E. There is no magnetic force on the current.

31. A positive charge moving with a constant velocity v enters a region of a uniform magnetic field pointing out the page. What is the direction of the magnetic force on the charge?



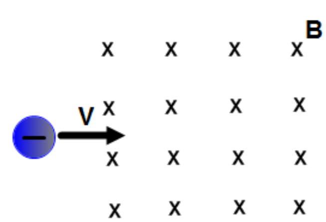
A. Left. B. Right C. To the bottom of the page
D. To the top of the page. E. There is no magnetic force on the current.

32. A negative charge moving with a constant velocity v enters a region of a uniform magnetic field pointing out the page. What is the direction of the magnetic force on the charge?



A. Left. B. Right. C. To the bottom of the page.
D. To the top of the page.
E. There is no magnetic force on the current

33. A negative charge moving with a constant velocity v enters a region of a uniform magnetic field pointing into the page. What is the direction of the magnetic force on the charge?

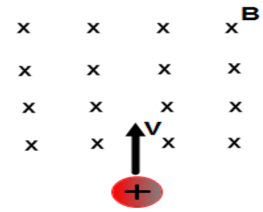


A. Left. B. Right C. to the bottom ofthepage.
D. To the top of the page.

E. There is no magnetic force on the current..

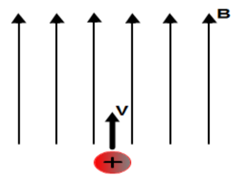
34. A positive charge moving with a constant velocity v enters a region of a uniform magnetic field pointing into the page. What is the direction of the magnetic force on the charge?

A. Left. B. Right. C. To the bottom of the page.
D. To the top of the page.
E. There is no magnetic force on the current.



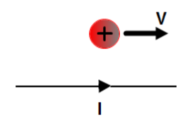
35. A positive charge moving with a constant velocity v enters a region of a uniform magnetic field pointing to the top of the page. What is the direction of the magnetic force on the charge?

A. Left. B. Right. C. To the bottom of the page.
D. To the top of the page.
E. There is no magnetic force on the charge.



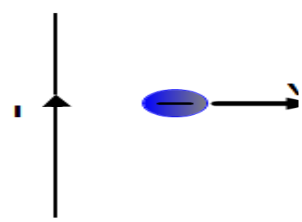
36. A positive charge moves in parallel to a current carrying wire. What is the direction of the magnetic force on the charge?

A. Left. B. Right. C. To the bottom of the page.
D. To the top of the page. E. There is no magnetic force on the charge.



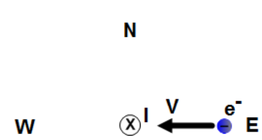
37. A negative charge moves away from a current carrying wire. What is the direction of the magnetic force on the charge?

A. Left. B. Right. C. To the bottom of the page.
D. To the top of the page
E. There is no magnetic force on the charge.



38. A vertical wire carries an electric current into the page. An electron approaches the current from east. What is the direction of the magnetic force on the electron?

A. East. B. West. C. North.
D. South. E. Into the page



Physics: 10

Chapter –five

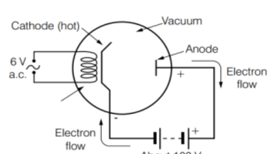
Introduction to Electronics

5.1 Vacuum tube devices

- **Thermionic emission-** the escape of electrons from a heated metal surface.
- If the metal is heated up, they move faster, and some of the more energetic electrons can then escape from the surface of the metal in a way very similar to evaporation of the faster molecules from the surface of a liquid.
- If the current to the heating wire is turned off there is no current in the diode circuit, as there is no thermionic emission from the cathode.
- It does not become significant until high temperatures are reached.
- It provides a controllable supply of electrons in a vacuum.

- **Cathode ray oscilloscope** -electronic test equipment that provides visual images of electrical signals and oscillations.
- **Vacuum tubes: - is an electronic device which controls the flow of electrons in vacuum.**

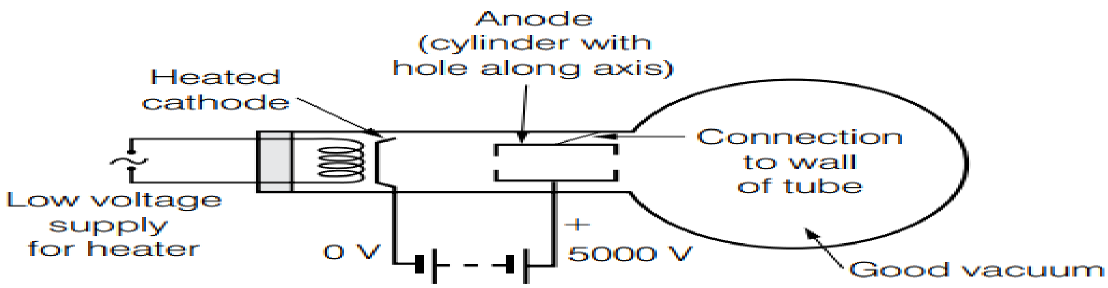
- **The thermionic diode**
- **Diode** –diode an electrical component with two electrodes, used for rectification.
- Rectification –the process of converting ac to dc.
- The name diode refers to the fact that the device has two electrodes: an anode and a cathode.
- A metal plate (the cathode) was heated so as to emit electrons, by placing the cathode in front of what amounted to an electric heater (a tungsten wire).



- The electrons 'boiled off' from the hot cathode and were attracted to the anode – a cold metal plate which was commonly at about +100 V with respect to the cathode. In this way the circuit was completed and current flowed.
- Current could pass across it in one direction.
- If the polarity of the main battery was reversed, the cold anode would not emit electrons into the vacuum and so current would not flow.

❖ Cathode rays

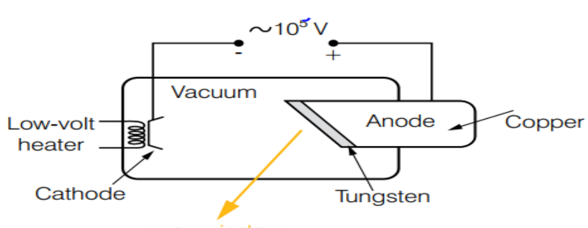
- **Cathode rays -**are a beam of electrons moving through a vacuum at a high speed.
- The electrons produced by the cathode are called cathode rays.
- They are produced by an **electron gun**, which is a vacuum tube device.
- **Electron gun-** an electrical component producing a beam of electrons moving through a vacuum at high speed.



e^- Gun

❖ The X-ray

- The X-ray machine -is also a vacuum tube device.
- Electrons are released from the cathode by thermionic emission and are then accelerated through a p.d. of the order of 100 kV so as to hit the anode at an extremely high speed.
- When such fast-moving cathode rays are suddenly stopped, X-rays are produced.
- **To minimize the heating effect**: -it is made of a large block of copper to conduct the heat away. -The other end being equipped with cooling fins or having cold liquid pumped round it.

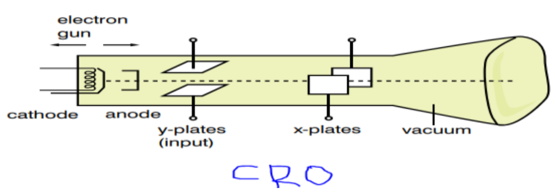


* **X-rays** are used medically for investigations, and for treatment of some tumours.
* They are also used to check welds in pipes and to investigate the contents of cases in airport security checks.
* They can also be used in the laboratory to investigate the atomic structure of crystals, and in astronomy,
* **X-rays** detected from space can give useful information.
* The great danger with X-rays is that they are ionizing radiation.
* They can cause radiation burns and damage to the DNA within cells, which can lead to tumours or sterility.

* To minimize it there should be adequate lead shielding (lead absorbs X-rays).

❖ Cathode ray oscilloscope (CRO)

- CRO – is vacuum tube device.
- In a CRO the beam of electrons produces a spot on a fluorescent screen at the end of the tube.
- Two sets of deflecting plates
- The y-direction and in the x-direction plates.



* Gain control -*a device adjusting the amount of beam deflection in a cathode ray oscilloscope*.
* **In an oscilloscope tube what is the purpose of:**

- ✓ **The heater**-The heater warms the cathode to encourage thermionic emission.
- ✓ **The grid**-is used to control the path the electron**.**
- ✓ **The cathode**–is used to emit the electrons.
  -Electrons are emitted from the cathode.
- ✓ **The anode**–is used to accelerate the emitted electrons.
  -Electrons are attracted to the anode.
- ✓ **The x- plate**-is used to deflect the electrons.
  -Voltages are applied to the x plates to move the beam of electrons from side to side (horizontally).
- ✓ **The y-plate**- is used to deflect the electrons.
  -Voltages are applied to the y-plates to move the beam of electrons up and down (vertically).

* **Some uses of the CRO**

  - ✓ Direct current-
  - ✓ Sensitivity-
  - ✓ Time base-
  - ✓ Alternating current-
  - ✓ Finding the period and frequency of alternating currents or voltages using the CRO.

5.2 Conductors, semiconductors and insulators

* **when considering conduction, materials fall into three classes:**
* **Conductors** – metals and carbon – in which atomic structure charge is carried by unfixed or 'conduction' electrons.
* **Insulators** – glass, plastic and most non-metals – in whose atomic structure electrons are held firmly and are largely unable to move.
* **Semiconductors** – such as silicon (the most important), germanium, lead sulphide, selenium and gallium arsenide – in which electric current is able to flow through the atomic structure.

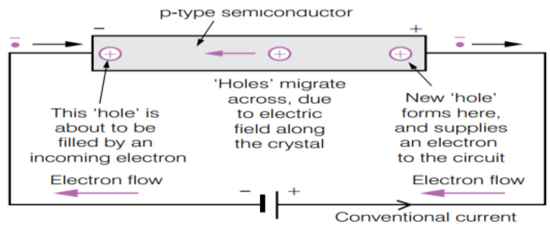
* **Types of semiconductors**

There are two types of semiconductor. These are:

- ✓ Intrinsic/pure semiconductors
- ✓ Extrinsic /doping semiconductor

* **Intrinsic/pure semiconductors-** A pure semiconductor has not containing any dopant.
* **Conduction in pure (intrinsic) semiconductors**

  * They have resistivity between those of insulators and those of conductors.
  * They form the basis of many of the devices that we take for granted in a technological society.
  * Their conductivity is not aff ected by any external factors.
  * In an intrinsic semiconductor, electric current is carried by moving electrons. Example .silicon and germanium.
  * Contain moving positive charges that carry current.
  * **Lattice structure of the atoms in an intrinsic semiconductor**
  * At room temperature there will always be a few free electrons that have been 'shaken free' of their atoms by thermal excitation (when the material has absorbed energy from the surroundings).
  * The eff ect of an electron leaving an atom is therefore to create a positive charge in the semiconductor lattice. Tis positive charge is called a hole.
  * ***Hole****-the lack of an electron at a position where one could exist in an atomic lattice.*
  * When an electric field is applied to the semiconductor (that is, when it is connected to a source of e.m.f.) the electrons and holes move in opposite directions, and the semiconductor exhibits **intrinsic conduction**.
  * The current in a pure semiconductor consists of free electrons moving through the semiconductor lattice in one direction, with an equal number of positively charged holes moving in the other direction as fig below.



Charge carriers and resistance in a semiconductor

* While the resistance of metallic conductors rises as they warm up, with semiconductors the resistance falls greatly as their temperature goes up.
* This is because when the temperature of a semiconductor is raised, more electrons (charge carriers) have enough energy to break free.
* As the number of charge carriers increases, the resistance of the **semiconductor** material decreases and the material conducts better.

5.3 Semiconductors (impurities, doping)

* **Extrinsic semiconductor- a semiconductor that has been doped**
* **Doping- deliberately** *introducing impurities into a semiconductor to change its electrical properties*.
* This process introduces extra charge carriers by replacing atoms in the semiconductor lattice with atoms of an impurity of similar size.
* This alters the semiconductor's conducting properties by introducing extra-large carriers to the semiconductor lattice, forming what is called an extrinsic semiconductor.

  * **Majority and minority carriers**

* **P-type and n-type semiconductor**

  * <u>**P-type semiconductor**</u>

* a semiconductor in which the majority carriers are holes, due to doping.
* Holes- are the majority carriers.
* Electrons- are minority carriers.
* Called acceptor
* **Acceptor-** impurity atoms added to a semiconductor, which trap electrons
* Trivalent atoms doped with pure semiconductors.
* Trivalent impurities e.g., boron, aluminum, indium, and gallium have 3 valence electrons.
* Example silicon with boron.

* **<u>n-type semiconductor</u>**

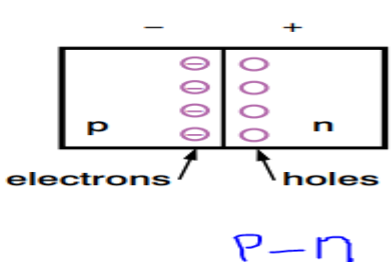
* **n-type semiconductor -***a semiconductor in which the majority carriers are electrons, due to doping .*
* The **majority carriers** - are negative electrons
* The **minority carriers** are holes.
* It is called donor.
* **Donor-** *impurity atoms added to a semiconductor which release free electrons*.
* Pentavalent impurities such as phosphorus, arsenic, antimony, and bismuth have 5 valence electrons.
* Pentavalent atoms doped with pure semiconductors.
* It doped with atoms w/c has **five outer valenc**e electrons.
* Example Silicon with Arsenic.

* **Conduction in a doped semiconductor**

- The number of free electrons and holes can be altered dramatically by doping.
- For example, the addition of only one arsenic atom per million silicon atoms increases the conductivity 100 000 times.

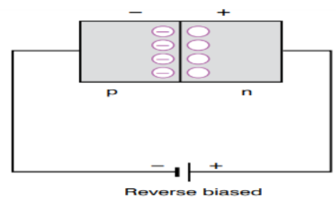
* **The p-n type semiconductor**

* Suppose a p-type semiconductor is in contact with an n-type one.
* Both pieces of semiconductor were electrically neutral overall before they were contact.
* Some of the n-type's electrons move, or 'fall' into the p-type's holes after contact. This movement is known as diffusion current.
* It causes the p-type to become slightly
* Negative while the n-type is left equally positive, leaving a 'depletion zone' for a small distance each side of the boundary (of the order of 1 μm).
* a shortage of 'holes' on one side and of free electrons the other.

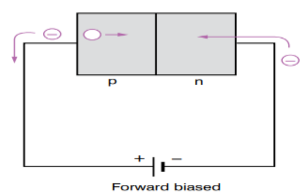


* This prevents any more electrons from crossing the boundary, so the diode will not conduct in that direction.
* In the depletion zone there are no more 'holes' in the p-type and no free electrons in the n-type, so it forms a non- conducting strip which blocks all current.

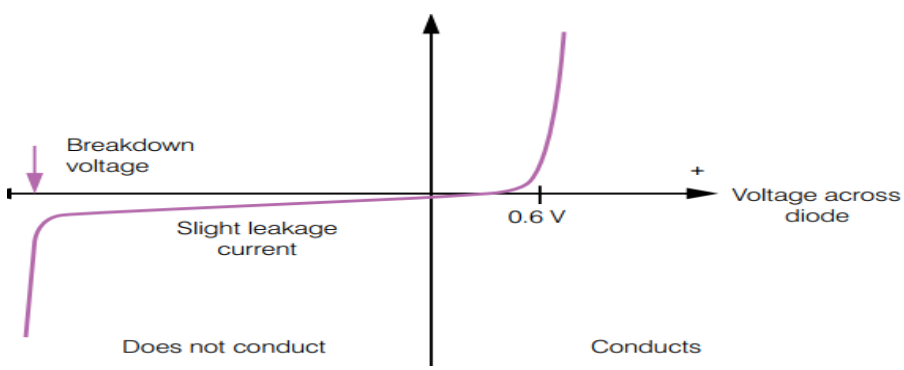
- **Forward and reverse bias**
- **Reverse biased - C***onnecting the positive terminal of a cell to the n-type region of a diode, and the negative terminal to the p-type region, preventing conduction*.
- No current flow.



- **Forward biased-** *connecting the positive terminal of a cell to the p-type region of a diode, and the negative terminal to the n-type region, allowing conduction*.
- In this direction the junction will conduct.
- Current flow.

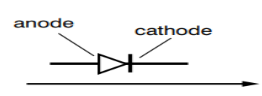


- Current–voltage characteristics of the semiconductor diode

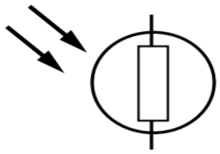


Some semiconductor devices

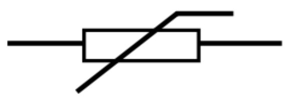
- **Diode**
- A diode is an electronic component with two electrodes – an anode and a cathode – which will only allow electric current to pass through it in one direction.



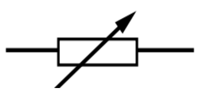
* **LDR**
* A light-dependent resistor conducts electricity, but in the dark it has a very high resistance. Shining light on it appears to 'unjam' it, because its resistance falls. The brighter the light, the better it conducts.



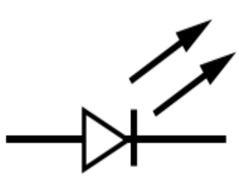
* **Thermistor**
* **It** is a piece of semiconductor material that has a high resistance in the cold. Its resistance drops as it becomes warmer.



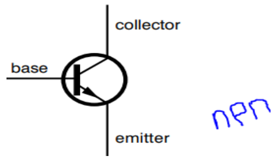
* **Variable resistor**
* **It** is a very useful component in electronic circuits, particularly in circuits containing **transistors**.



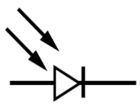
* **LED**
* **It** can be seen in a multitude of devices.
* When a current is passed in the forward direction, an LED emits light.
* Is a very useful component – if there is one in a circuit, it is possible to see immediately if current is flowing.
* LEDs are now available in a range of colors – red, green, blue, white. White LEDs are increasingly being used in lighting; they produce light very efficiently (using relatively little energy).



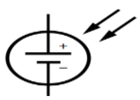
* **Transistor-***a semiconductor device used to amplify or switch electronic signals.*
* A **bipolar junction transistor** is made of three layers of doped semiconductor and it has three terminals – the base is connected to the central layer, the other two (the collector and the emitter) are each connected to one of the outer layers.



* **Photodiode-** is a light-sensitive diode used to detect light or to measure its intensity. Photodiodes are reverse biased so they do not conduct.
* Light incident on the photodiode frees a few more electrons and the device starts to conduct.

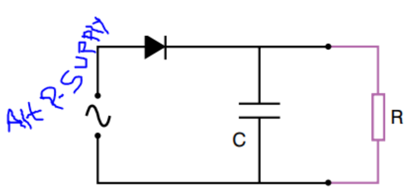


* **Photovoltaic cell**
* **It** is a form of photodiode.
* The base layer of a photovoltaic solar cell is made of p-type semiconductor material. This is covered with a layer of n-type semiconductor material.
* When light strikes the junction between n- and p-types of semiconductor, electrons flow through the structure of the cell.
* Photovoltaic cell**-** *a cell that converts solar energy into electrical energy*.



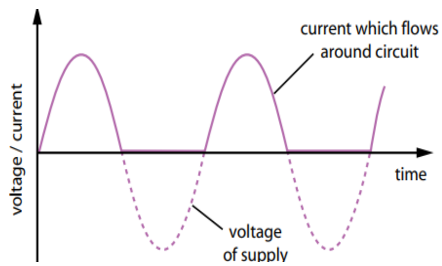
❖ Rectification using the p–n junction diode

* **Using one diode**
  Direct current can be obtained from an alternating current generator by putting a diode in the circuit.
* The **diode** allows the current to flow one way, but on the other half of the cycle the current cannot flow back again through the diode.

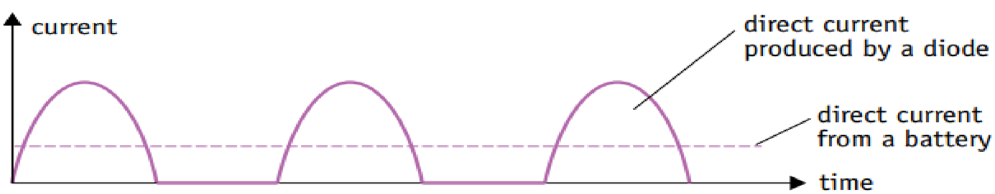


❖ **Half-wave rectification.**

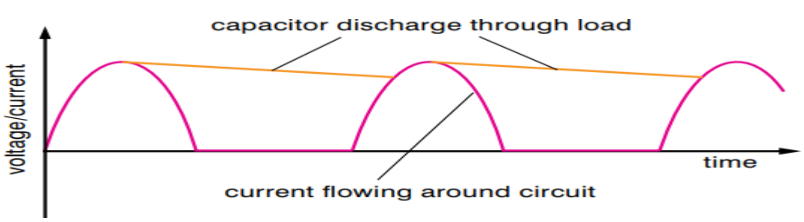
- ✓ **It uses one diode.**
- ✓ A *capacitor is used* to help to smooth the fluctuationsin this current.
- ✓ A semiconductor diode can produce half-wave rectification from an alternating supply.



* It is direct current, because the charges always flow in the same direction and so will make progress round the circuit.

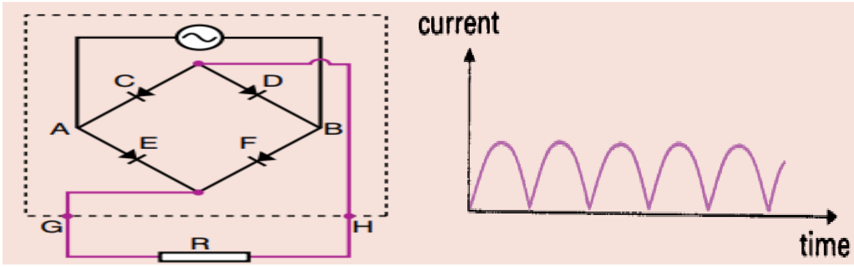


* The capacitor is filled up to the peak voltage of the supply, then as the power supply's voltage drops to zero we can think of the capacitor as feeding the outside circuit.



❖ **Full wave rectification**

* An arrangement made from four diodes is known as a **bridge rectifier**.
* Conduct in both direction.
* **Bridge rectifier** *an arrangement of four diodes which produce full-wave rectification of an alternating current.*



5.4 Transistors (p-n-p, n-p-n)

- Transistors- are important components of electronic circuits because they use the input of relatively small circuits to control circuits carrying large currents.
- This makes them very important as switches and amplifiers.

The bipolar junction transistor

- The bipolar junction transistor is a three-layer semiconductor device.
- Both p-n-p and n-p-n transistors have three terminals:
- 1. The base
- is the connection to the central layer.
- Base- *one of three regions forming a bipolar junction transistor.*
- *This layer separates the emitter and collector layers.*
- *If a voltage greater than around 0.6 V is applied to the base terminal, current will flow through the transistor from base to emitter.*
- 2. The Collector
- *One of the three regions forming a bipolar junction transistor.*
- *When used in a circuit, a positive voltage is applied to the collector terminal.*
- 3. The Emitter- *one of the three regions forming a bipolar junction transistor. Current will only flow from the emitter terminal if a voltage greater than around 0.6 V is applied to the base terminal.*

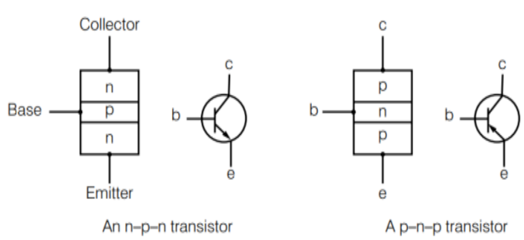


Fig.*Transistor layouts.*

Transistor biasing

- Biasing' refers to placing voltages across the terminals of a device. In terms of voltages, the base has to be at a voltage intermediate between that of the emitter and the collector.

- Provided V_{BE} is greater than about 0.6 V, the base–collector junction will conduct, so bases current will flow.

Transistor characteristics

- A transistor has only three terminals, so one of them will inevitably be common to both.
- It can be any of the three, so the circuitry can be classified as common emitter, common base or common collector as fig. below.

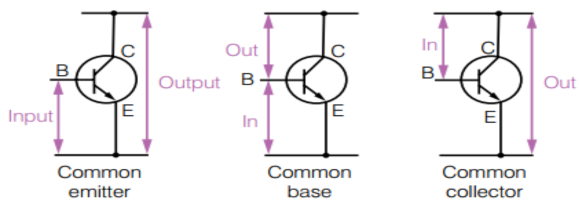


Fig. transistor *circuitry*

$$\text{Current gain } (h_{fe}) = \frac{transistor\ output\ (collector\ current)}{transistor\ input\ (base\ current)} = \frac{I_C}{I_B}$$

The static characteristics for a **Bipolar Transistor** can be divided into the following three main groups.

Input Characteristics:

- Common Base - $\Delta V_{EB} / \Delta I_E$
- Common Emitter - $\Delta V_{BE} / \Delta I_B$

Output Characteristics:

- Common Base - $\Delta V_C / \Delta I_C$
- Common Emitter - $\Delta V_C / \Delta I_C$

Transfer Characteristics:

- Common Base - $\Delta I_C / \Delta I_E$
- Common Emitter - $\Delta I_C / \Delta I_B$

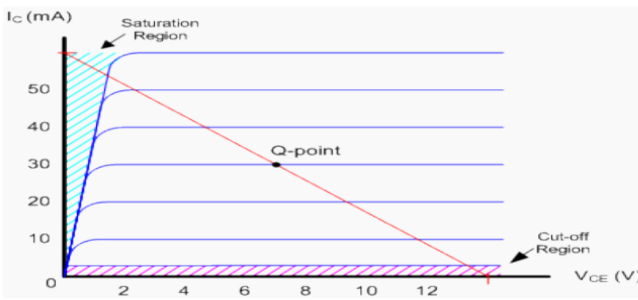
Bipolar Transistor Configurations

1. Common Emitter Configuration - has both Current and Voltage Gain.
2. Common Base Configuration - has Voltage Gain but no Current Gain
3. Common Collector Configuration - has Current Gain but no Voltage Gain.

Transistor as switch and as amplifier

The Transistor as a Switch

.Transistor switches can be used to switch and control lamps, relays or even motors.
• When using bipolar transistors as switches they must be fully "OFF" or fully "ON".
• Transistors that are fully "ON" are said to be in their Saturation region.
• Transistors that are fully "OFF" are said to be in their Cut-off region.
• In a transistor switch a small Base current controls a much larger Collector current (as shown figure below).



1. Cut-off Region - Both junctions are Reverse-biased, Base current is zero or very small resulting in zero Collector current flowing, the device is switched fully "OFF".
2. Saturation Region - Both junctions are Forward-biased, Base current is high enough to give a Collector-Emitter voltage of 0v resulting in maximum Collector current flowing, the device is switched fully "ON"

- A potential divider is used to raise or lower the voltage at the base to control the base current. If there is no base current, the milliammeter records no collector current either.
- Move the slider on the potential divider up and down – the base current rises and falls, and the movement on the milliammeter seems to track whatever the base current is doing but with much larger variations.

Logic gates

- **Logic gates** are tiny silicon chips on which are etched combinations of transistors and resistors.
- Logic gates work in terms of 1s (a voltage is present) and 0s (the voltage is not present).
- In logic gates two binary numbers are: one and zero.
- One represents – ON, True.
- Zero represents (0)- OFF, False.
- They typically have two inputs and one output.
- **Logic gates-** *an electronic device that performs a logical operation on two inputs and produces a single logic output.*

- **There are five types of logic gates. These are:**
  - ✓ NOT gate
  - ✓ AND gate
  - ✓ NAND gate
  - ✓ OR gate
  - ✓ NOR gate

The NOT gate

- It has a single input, and its output is always the opposite.
- A ‘0’ at the input means a ‘1’ at the output, and vice versa.

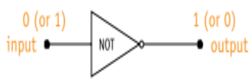


Fig. NOT gate

Input	Output
0	1
1	0

Fig. Truth table

The AND gate

- It has two inputs and one output.
- Like two switches in series.
- Gives True only when the two inputs are true, otherwise false.
  - Formula: if the A and B are the two inputs then,
  - A x B = output.

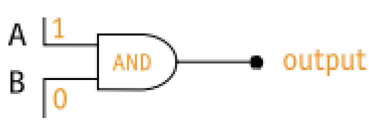


Fig. AND gate

Inputs		output
A	B	A x B
0	0	0
0	1	0
1	0	0
1	1	1

Fig. OR gate truth table

The NAND gate

- It has two inputs (A and B) and output.
- The little circle at the output indicates that each value is reversed.
- It is AND gate with the output inverted.
- Gives false only if the two inputs are true, otherwise false.
  - Formula: if the A and B are the two inputs then,
  - AxB = $\overline{\boldsymbol{output}}$.

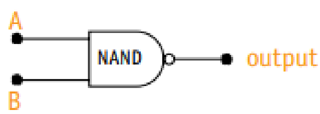


Fig. NAND gate

Inputs		Output
A	B	$\overline{A \times B}$
0	0	1
0	1	1
1	0	1
1	1	0

Fig. NAND gate truth table

The OR gate

- It has two inputs (A and B) and output.
- Like two switches in parallel.
- It gives false only if the two inputs are false, otherwise true.
- Formula: if the A and B are the two inputs then,

A + B = **output.**

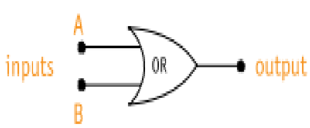


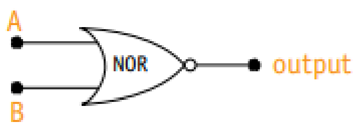
Fig. OR gate

Inputs		Output
A	B	A + B
0	0	0
0	1	1
1	0	1
1	1	1

Fig. OR gate truth table

The NOR gate

- It has two inputs (A and B) and output.
- The little circle at the output indicates that each value is reversed.
- It is OR gate with the output inverted
- It gives true only if the two inputs are false.
  - Formula: if the A and B are the two inputs then,
  - $A + B = \overline{\boldsymbol{output}}$.



inputs		output
A	B	$\overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

Fig. NOR gate

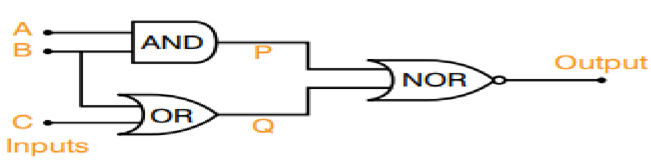
Fig. NOR gate truth table

The summary to truth table is as follows:

Inputs		Logic gates output			
A	B	AND	NAND	OR	NOR
0	0	0	1	0	1
0	1	0	1	1	0
1	0	0	1	1	0
1	1	1	0	1	0

Combinations of logic gates

- More than one logic gate may be combined to increase the range of control tasks that can be performed.
- If there are three inputs this time, this will give $2^3 = 8$ different Combinations of 0s and 1s.
- As an example, consider the arrangement shown in Figure below. How does it behave?



The truth table for the above combinations is given as:

INPUT A	INPUT B	INPUT C	POINT P	POINT Q	OUTPUT
0	0	0	0	0	1
0	0	1	0	1	0
0	1	0	0	1	0
0	1	1	0	1	0
1	0	0	0	0	1
1	0	1	0	1	0
1	1	0	1	1	0

The action of logic gates

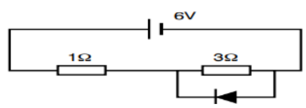
- A simple burglar alarm
- A thermostat for a hot water tank
- **A security lock to get 'behind the counter' at a bank**
- **An automatic plant waterier**
- Integrated circuits

Practice questios
Answer the following questions accordingly.

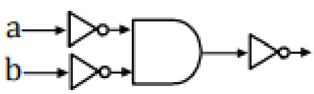
1. What property of a diode makes it useful in a rectifier circuit?
2. A diode can be used as a rectifier. What is the function of a rectifier?
3. What is a depletion layer?
4. Explain how a pure semiconductor can be converted into (i) a p-type and (ii) an n-type semiconductor.
5. Distinguish between intrinsic and extrinsic conduction in a semiconductor.
6. What is a semiconductor?
7. Explain how conductivity changes with doping.
8. In n-type semiconductors, number of holes ___number of electrons.
   (a) Equal (b) Greater than (c) Less than (d) Cannot define
9. In p-type semiconductors, number of holes ___number of electrons.
   (a) Equal (b) Greater than (c) Less than (d) Twice
10. A diode will conduct when:
    A. the anode is made positive with respect to the cathode B. the cathode is made positive with respect to the anodeC. the anode and cathode are at exactly the same potential.
11. When a diode is forward biased it will:
    (a) exhibit a very low resistance
    (b) exhibit a very high resistance
    (c) exhibit no resistance at all.
12. A full-wave rectifier will operate:
    (a) only on positive half-cycles of the supply
    (b) only on negative half-cycles of the supply
    (c) on both positive and negative half-cycles of the supply.
13. In n-p-n transistor , the base will be
    a. P material b. n material c. either of the above d. none of the above
14. A p-n-p transistor has
    a. Only accepted ions b. only donor ions c. two p-regions and one n-region
15. Which of the following is valid for both p-n-p as well as n-p-n transistor?
    A. the emitter injects holes into the base region
    B. the electrons are the minority carriers in the base region.
    C. the EB junction is the forward biased for active operation.
    D. when a biased in the active region, current flows into their emitter terminal.
16. In the symbols of p-n-p transistor and n-p-n transistor the arrow on the emitter shows the direction on the flow of.
    A. electrons, electrons B. holes, holes
    C. holes, electrons D. electrons, holes
17. What are another name for anode and cathode?
18. List different types of active components include.

Use the following circuit for questions 19 and 20.

19. What size current will be drawn from the battery?
20. If the battery is turned round, what size current will it now supply?



21. What is the main reason to dope a semiconductor material?
22. What is the difference between p-n junction diode and extrinsic semiconductor?
23. Write the truth table for this logic gate.



24. What is the universal logic gate? Give the example.
25. A circuit containing only OR and NOT gates must be a combinational circuit. True/False.
26. Draw a circuit diagram with an AND gate. Each input should be connected to the output of a separate NOT gate. By writing truth tables show that this whole circuit behaves as a NOR gate.

27. Which one of the following statements is TRUE about the deflecting systems of CRO?

A. The vertical plates deflect the spot up and down on the screen.
B. The horizontal plates deflect the spot horizontally on the screen.
C. Deflecting systems change electric fields to deflect cathode rays.
D. All of the above.

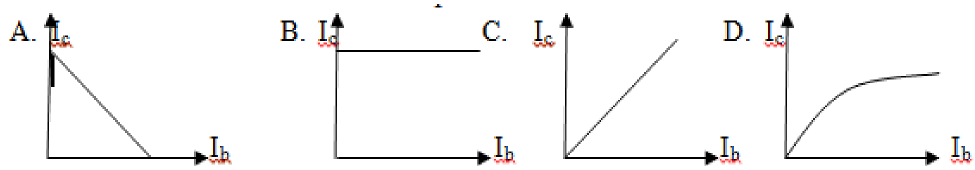
28. Doped materials such as silicon and germanium are called

A. Intrinsic semiconductors
B. P-type semiconductors.
C. extrinsic semiconductors.
D. n-p-n semiconductors.

29. In a forward bias mode

A. Majority charge carriers are holes.
B. Depletion layer decreases.
C. Minority charge carriers are holes.
D. conventional current flows.

30. Which one of the following graphs shows relation between collector current and base current when a transistor acts as an amplifier?



31.Which of the following is true about p-type semiconductor? It is __.
A. Acceptor B. donor C. Trivalent atom D. pentavalent atom**: select two answer**.
32.Which of the following is true about n-type semiconductor? It is __.
A. Acceptor B. donor C. Trivalent atom D. pentavalent atom: **select two answer.**
33.Diode is an electrical device uses to rectify an electrical signal. What is the purpose of rectifier? It Converts
A. Ac to dc B. dc to ac C. ac to ac D. electrical energy to mechanical energy.
34.The electrical device which used as a switch and amplifier is__
A. Transistor B. resistor C. Diode D. capacitor
35. Not an example for intrinsic semiconductor.
(a) Si (b) Al (c) Ge (d) Sn
36.Not an example for extrinsic semiconductor.
A. Aluminum **B.** arsenic **C.** boron D. gallium
37.The arrow direction in the diode symbol indicates
a. Direction of electron flow.
b. Direction of hole flow (Direction of conventional current)
c. Opposite to the direction of hole flow d. None of the above
38.When the diode is forward biased, it is equivalent to
a. An off switch
b. An On switch
c. A high resistance
d. None of the above
39.Under normal reverse bias voltage applied to diode, the reverse current in Si diode:
a. 100 mA b. order of µA c. 1000 µA d. None of these
40.Avalanche breakdown in a diode occurs when
a. Potential barrier is reduced to zero.
b. Forward current exceeds certain value.
c. Reverse bias exceeds a certain value.
d. None of these
41.Reverse saturation current in a Silicon PN junction diode nearly doubles for very
a. 2^0 rise in temp. b. 5^0 rise in temp. c. 6^0 rise in temp. d. 10^0 rise in temp.

42.. When a reverse bias is applied to a diode, it will
a. Raise the potential barrier
b. Lower the potential barrier
c. Increases the majority-carrier a current greatly
d. None of these.

PHYSICS 10:

CHAPTER: SIX (6)

ELECTROMAGNETIC WAVES AND GEOMETRICAL OPTICS

Electromagnetic waves:

- Are a transverse waves.
- Are produced when a magnetic and an electric field are at right angles to each other.
- Charges that are accelerated in an electric and magnetic field produce electromagnetic wave.
- They carry energy and momentum that may be transferred to matter with which they interact.
- Propagate both in vacuum and medium.

Mechanical waves:

- Travel through a medium with time.
- They have frequency, period and amplitude.

Types of waves

There are two types' waves.

1. **Transverse wave**
   - Waves that vibrate perpendicular to the direction of wave propagation.
   - All waves are produced by vibrations.
   - Example all electromagnetic wave such as x-ray , micro-waves , radio waves,

Definition of terms

- The Amplitude – is the distance that waves above or below the base line.
  -Measured in meter (m).
- The frequency – the number of complete waves passing a given point in a second.
  -Measured in Hertz (Hz).
- The wavelength – is the distance between successive equivalent points on a wave.
  -Measured in meter (m)
- Rays- straight lines extending from a point to represent the direction of energy flow in a wave.

The wave equation

The frequency, wavelength and speed of a wave related by the formula:

Speed = frequency x wavelength

$$V = f\,\lambda$$

Where - speed: m/s,frequency: Hertz and wavelength: meters.

- Speed – the distance travelled per unit time.

2. **Longitudinal waves**
   - Waves that vibrates in the same direction to the wave motion.
   - Example sound wave.

Electromagnetic waves emitted by the sun

- They have a wide continuous range of frequencies and wavelengths – this is called the electromagnetic spectrum.
- Electromagnetic spectrum the entire frequency range of electromagnetic waves.
- In a vacuum all waves travel at a speed of $3x10^8$ m/s.
- As we go from left to right the frequency decreases whereas the wavelength increases.
- The energy also decreases.

Some uses of electromagnetic radiation

- Visible light is the most important part of the electromagnetic Spectrum to everyday life.
- X-rays are used to take pictures of inside the body to show any bone fractures.
- They are absorbed more by bone (which is denser than the surrounding muscles).
- Infrared radiation is used in infrared cameras which are used in rescue operations to detect the presence of bodies.
- Microwaves and radio waves are used for communications
  – For example, radio and telephone signals.

Reflection of light

- Rectilinear propagation of light simply means that light waves travel in straight lines.
- Reflection- the bouncing of light rays from a non-transparent medium.

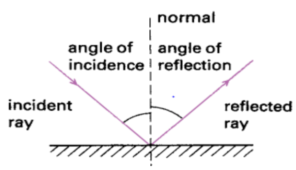


Fig.*Angles are measured from the normal.*

The law of reflection states that:

1. The angle of reflection is equal to the angle of incident.
   - ✓ $\theta_r = \theta_i$
   - ✓ Where $\boldsymbol{\theta_i}$- is the angle of incidence and $\boldsymbol{\theta_r}$- is the angle of the reflected ray that Propagates in the same medium.
2. The reflected ray, the incident ray and normal all lies in the same plane.

Plane mirror

- A mirror whose surface lies in a plane.
- Regular and diffuse reflection:

  Image formed by plane mirror:
  - ✓ Virtual image
  - ✓ The same size of object as image.
  - ✓ Erected and laterally inverted.

Types of spherical mirror

There are two types of curved mirror:

1. **Concave mirrors**
    - a mirror with a reflecting surface that bulges inwards, away from the light source.
    - Their curvature in all directions is the same.
    - The images formed are: - virtual i.e the right way up.

      -Its larger than the object.

      -The field of view is less than that in plane mirror.

      - It's a converging mirror.

      -sometimes used as a men's shaving mirror.
2. **Convex mirrors**
    - a mirror with a reflecting surface that bulges outwards, towards the light source.
    - The rays from any point on the object diverge after reflection as though they were coming from some point behind the mirror.
    - Reflect the light so it spreads out.
    - Can act as a looking glass.
    - The image formed by a convex mirror is upright, virtual, and smaller than the object.
    - The image formed is **-virtual**:- a short way behind it.

      Its properties:
      - ✓ Always the right way up.
      - ✓ Always has a magnification of less than 1.
      - ✓ It has a striking clarity.

- ❖ A positive sign is used where the light is–In front of the mirror.

  -the front side
- ❖ A negative sign is used behind the mirror.

  –The back side

  -Where virtual images are formed.

Terms used in concave and convex mirrors

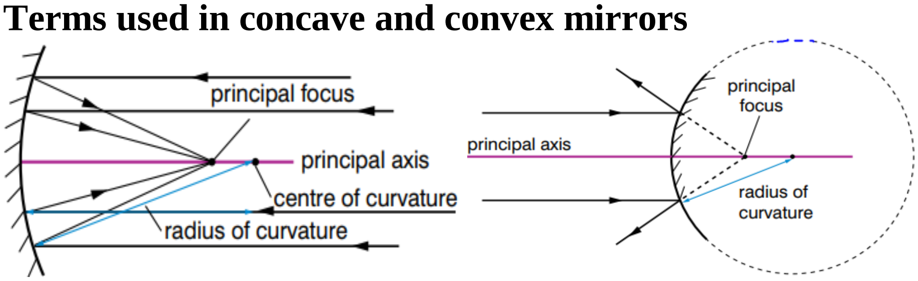


Fig. concave and convex mirrors ray diagrams.

Definition of terms:

- Principal axis - the line passing through the optical vertex and center of curvature of the face of a curved mirror.
- Principal focus - the point at which all light reflecting from a curved mirror converges.
- Radius of curvature - the radius of the sphere that forms the basic curve of a concave mirror.
- **Real images** - an image that can be captured on a screen.
  -are formed at the point the rays of light actually intersect.
- **Virtual image**s - an image that cannot be captured on a screen.
  -are formed at the point the rays of light appear to originate.
  -The light appears to diverge from that point.

The Mirror equation

The equation of mirror is given by:

$\frac{1}{si} + \frac{1}{so} = \frac{1}{f} = \frac{2}{C}$ and C = 2f

Where si – image distance
So – object distance
C- Radius of curvature
f - Focal length -the distance from the center of a curved mirror to the principal focus.

- The focal length is half the radius of curvature.
  - If the image is virtual, then we use a negative sign for the distances.

Notes on Images

- With a concave mirror, the image may be either real or virtual.
  –When the object is outside the focal point, the image is real.
- –When the object is at the focal point, the image is infinitely far away. –When the object is between the mirror and the focal point, the image is virtual.
- With a convex mirror, the image is always virtual and upright.
  –As the object distance increases, the virtual image gets smaller.

The magnification

- **It's the ratio between the height of an image and the height of the object.**
- Magnification = $\frac{the\ height\ of\ the\ image}{the\ height\ of\ the\ object}$
- Magnification = $\frac{h_i}{h_o} = \frac{s_i}{s_o}$
- Magnification doesn't always mean enlargement.
- The image can be smaller than the object.

6.3 Refraction of light

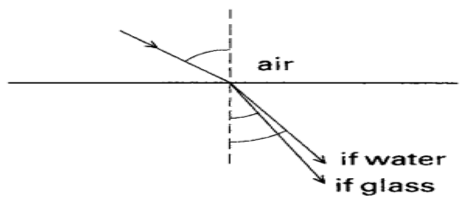
Refraction- is the change in the direction of travel of a light beam that occurs as the light crosses the boundary between one transparent medium and another.

The light gets bent

- As it comes out *from* the water or the glass,it is refracted away from the normal.
- As the light goes *in* to the water or the glass, it is bent towards the normal.
- The only time the light does not get refracted as it crosses the boundary is if it hits the surface ‘square on’, right along the normal.

The refractive index and Snell’s law

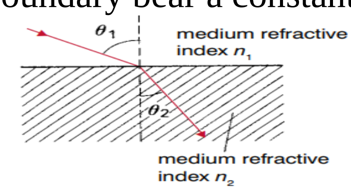
- **Refractive index-** *a measure of the extent to which a medium refracts light.*
- **It has no unit and denoted by n.**
- The refractive index is a number larger than 1 such that the greater the number the greater the refraction produced.
- For, example the water (n = 1.33) has the smaller refractive index than the glass (n = 1.52), so its surface bends the light less (see the fig. below).



Figure, *the greater the refractive index, the more the light is bent.*

Snell’s law states that:

- Whenever light crosses a boundary between two transparent media, the sines of the angles on each side of the boundary bear a constant ratio to each other.



Mathematically, for a particular boundary:

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1} \quad \text{Snell's law}$$

- **Refraction occurs** with all types of waves, including ripples on the surface of water and sound waves.
- The bending is caused by a change in the speed of the wave when it crosses a boundary.
- The refractive index can be defined measured also the ratio of the speeds on either side of the boundary – the faster speed over the slower speed.
- If the speed of light in a vacuum is denoted by *c* and its (slower) speed in the medium is *v*, then the refractive index *n* of the medium will be given by:

$$n = \frac{C}{V}$$

If $n_1 = \frac{C}{V_1}$ and $n_2 = \frac{C}{V_2}$ then, Snell’s law becomes

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1} = \frac{V_1}{V_2} = \frac{\lambda_1}{\lambda_2}.$$

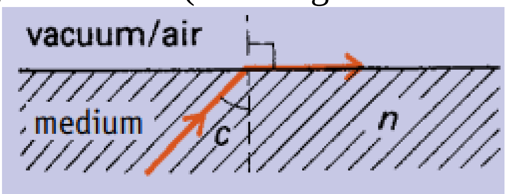
Lateral displacement

- **Lateral displacement-** the perpendicular distance between the pathway of the incident light ray and the one that emerges after refraction from two surfaces of a medium.
- The passage of a ray of light through a parallel-sided transparent medium results in the lateral displacement of a ray.
- To find the refractive index (n) of a liquid and a solid in the form of a rectangular glass block.

$$n = \frac{real\ depth}{apparent\ depth}$$

Total internal reflection

- Total internal reflection is the complete reflection of light from inside an object.
- It happens when light strikes the inner surface at an angle greater than the critical angle for the material.
- The **critical angle** is the particular angle of incidence for which the light emerges along the surface (at an angle of refraction of 90°).



From the above fig. as the incidence angle tends to critical angle C, then the refracted angle approaches to 90^o.

Therefore, apply the Snell's law becomes:

$$\mathbf{n} = \frac{\sin 90^0}{\sin C} = \frac{1}{\sin C}$$

- Different materials have different critical angles, because the speed of light varies from material to material.
- Light travels most slowly in a diamond, which has the smallest critical angle known. This small critical angle means that much of the light inside a diamond is totally internally reflected. In a diamond gemstone, total internal reflection occurs at each of the many facets oriented in many directions -- hence the sparkle of a diamond.

Fiber Optics

- **Fiber optics -** *glass or plastic fibers that carry light along their length.*

Applications of fiber optics

- A fiber can be used to monitor the temperature inside a jet engine.
- The optical cable carries the radiation from the hot surfaces inside to a pyrometer mounted outside the engine.

Based on total internal reflection ‹

- Fiber has inner "core" of optically dense glass ‹

- Outer "cladding" of less optically dense glass
- Light rays passed through core to make shallow reflections with surface⇒ 100% reflection at each bounce

Convex and concave lenses

- Lenses are commonly used to form images by refraction in optical instruments.

Convex \converging lenses

- Convex lens a lens having at least one surface curved like the outer surface of a sphere
- The principal axis of the lens is the line passing through the center of the lens, perpendicular to it.

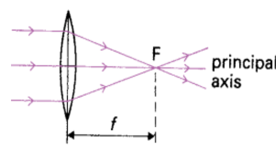


Fig. convex lens

- Light which enters the lens parallel to its principal axis will be converged to the point marked 'F', the principal focus.
- They have positive focal lengths.
- They are thickest in the middle.
- The parallel rays pass through the lens and converge at the focal point.
- The parallel rays can come from the left or right of the lens.

***Concave\diverging* lenses**

- **Concave lens-** a lens having at least one surface curved like the inner surface of a sphere
- They have negative focal lengths.
- They are thickest at the edges.
- The parallel rays diverge after passing through the diverging lens.
- The focal point is the point where the rays appear to have originated.

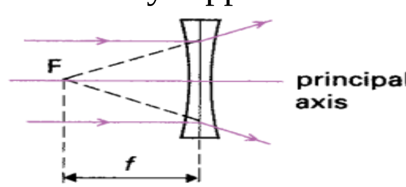


Fig. concave lens

- A beam of light parallel to its principal axis will emerge spreading out, as if coming from its principal focus as shown in Figure above.

- To measure the strength of a lens, used by opticians, is to specify its power *p*.
- Power of lens $=\frac{1}{its\ focal\ length}$

dioptre – is a unit of measurement of the optical power of a lens i.e m^{-1}.

Magnification

- This is just a number: the number of times the image is larger than the object.
- A magnification of less than 1 means that the image is smaller.
- Defined as the height of the image divided by the height of the object.
- Magnification $= \frac{image\ height}{object\ height} = \frac{h_i}{h_o} = \frac{s_i}{s_o}$

The thin lens formula

$$\frac{1}{f} = \frac{1}{s_i} + \frac{1}{s_o}$$

Where
f= the focal length of the lens
*s*o= the distance from the object to the center of the lens
*s*i = the distance from the center of the lens to where the image is formed

Finding the position and nature of an image formed by a convex and concave lens

Ray Diagram for Converging Lens, s_o> f

- The image is real.
- The image is inverted.
- The image is on the back side of the lens.

Ray Diagram for Converging Lens, s_o< f

- The image is virtual.
- The image is upright.
- The image is on the front side of the lens.

Ray Diagram for diverging Lens,

- The image is virtual.
- The image is upright.
- The image is on the front side of the lens.

How an image is formed due to combination of thin lenses

- The image produced by the first lens is calculated as though the second lens were not present.
- The light then approaches the second lens as if it had come from the image of the first lens.
- *The image formed by the first lens is treated as the object for the second lens.*
- The image formed by the second lens is the final image of the system.

- If the image formed by the first lens lies on the back side of the second lens, then the image is treated at a virtual object for the second lens.
  $-s_o$ will be negative
- The overall magnification is the product of the magnification of the separate lenses.
- It is also possible to combine thin lenses and mirrors.

The simple microscope and the telescope

- A simple microscope is a magnifying glass.
- If the object lies between the focus of the lens and the lens itself, the light comes out diverging.
- No real image will be formed: wherever you put a screen, you cannot recreate on it an image of the original point of light.
- As you move the screen back from the lens, all you can get is an ever widening circle of light.
- The image formed the **right way** up and **enlarged.**
- A **telescope** is designed for seeing more detail in an object that is a long distance away.
- If we are using a lens, the only magnified images that are possible are formed with a converging lens having the object within 2 f (as in the projector) or within f (as in the simple microscope).
- The solution is to use the objective lens to form a real image in its focal plane. You then examine that image through a magnifying glass (the eye lens) or a whole set of converging lenses (the eyepiece).
- Objective lens *first lens encountered by incoming light rays from the object.*
- Eyepiece lens -*lens nearest to the eye.*

The camera and human eye

- The human eye works rather like that of the camera, where a converging lens forms a tiny upside-down image of the distant world on a screen.
- Retina- *light-sensitive cells lining the inner surface of the eye.*
- Optic nerve- *nerve transmitting visual information from the retina to the brain.*
- Pupil- *an opening in the center of the iris of the eye.*

A comparison between the camera and the human eye will be as follows:

	Focusing mechanism	**Image capture**	**Image orientation**
Human eye	muscles around eye	retina	upright image
Camera	adjusting lens	film	inverted image

Defects of the eye and their correction with lenses

- The first three defects in vision described below all involve the lens in the eye.
- The fourth one is due to the shape of the cornea.

1. *Short sight* (*myopia*).

-This happens if the lens is too strong for the eye or, looked at another way; the eyeball is too long for the lens.

-to correct this fault we use diverging lens.

2. *Long sight* (*hypermetropia*).

-This time the lens is too weak.

- corrected by converging lens.

3. *Old sight* (*presbyopia*).

-As people age, the lens in their eye may become less supple.

- The two lenses are used.

4. Astigmatism.

- *This problem arises if a person's cornea has a different curvature in the horizontal plane from that in the vertical plane.*

Diffraction of light

- Diffraction of light (or any type of wave) is a change in direction that happens as the waves move through or round obstacles.
- Diffraction is greatest when the wavelength of the waves is long compared to the size of the gap or obstacle.

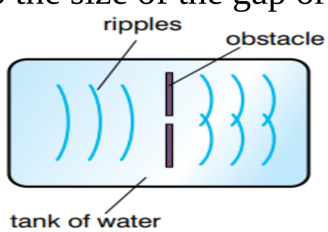


Fig.Diffraction.

- Diffraction grating -a material with a large number of narrow, regularly spaced slits, designed to produce a diffraction pattern.

The dispersion of white light to produce a spectrum

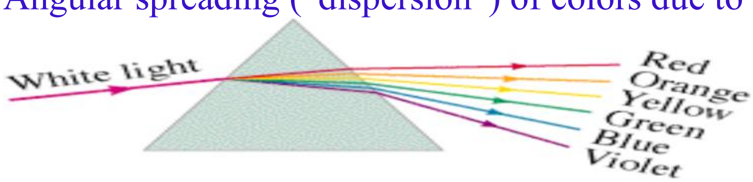
Dispersion

When light travels from one medium to another:

- Speed decreases
- Wavelength decreases
- Frequency constant

n decreases as λ increases

- For red light ($\lambda = 700$ nm) $\Rightarrow$ n is smaller (less bending)
- For blue light ($\lambda = 400$ nm) $\Rightarrow$ n is bigger (more bending)
- Angular spreading ("dispersion") of colors due to refraction



- White light has a range of wavelengths, from blue to red.
- A range of wavelengths will produce a range of speeds.
- The amount of refraction is related to speed and so the different wavelengths in white light are refracted by different amounts to produce a spectrum.
- The rays are deviated by the prism.
- Spectroscopic instruments need to resolve spectral lines of nearly the same wavelength.

The Fresnel lens

- Fresnel lenses are thinner and lighter than conventional spherical lenses.
- They are made with separate sections known as Fresnel zones mounted in a frame.
- Fresnel lenses are used to concentrate solar light for use in solar cookers, solar forges, and solar collectors to heat water for domestic use.
- Solar constant *the average solar power striking the Earth's atmosphere in regions directly facing the Sun is about 1370 W/m^2. This is the solar constant*.

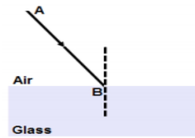
Practice questions and Examples
Answer the following questions accordingly.

1. Define the terms wavelength, amplitude, frequency, time period and speed.
2. List the Properties of Electromagnetic Waves
3. Distinguish between mechanical and electromagnetic waves.
4. What is the difference between refraction and reflection?
5. Define the term diffraction.
6. The speed of light is 3.0 x 10^8 m/sec. The wavelength of red light is 700 nm. What is the frequency of this wave? Frequency is f and wavelength is λ.
7. Snell's Law describes:
   (a) Huygens' construction (c) Magnification
   (b) Reflection ‹ (d) Refraction
8. For refracted light rays, the angle of refraction:
   (a) is always equal to the incident angle
   (b) is always greater than the incident angle
   (c) is always less than the incident angle ‹
   (d) is always equal to the critical angle ‹
   (e**)** can be less than, greater than, or equal to angle of incidence
9. Total internal reflection
   (a) refers to light being reflected from a plane mirror
   (b) may occur when a fisherman looks at a fish in a lake
   (c)may occur when a fish looks at a fisherman on a lake

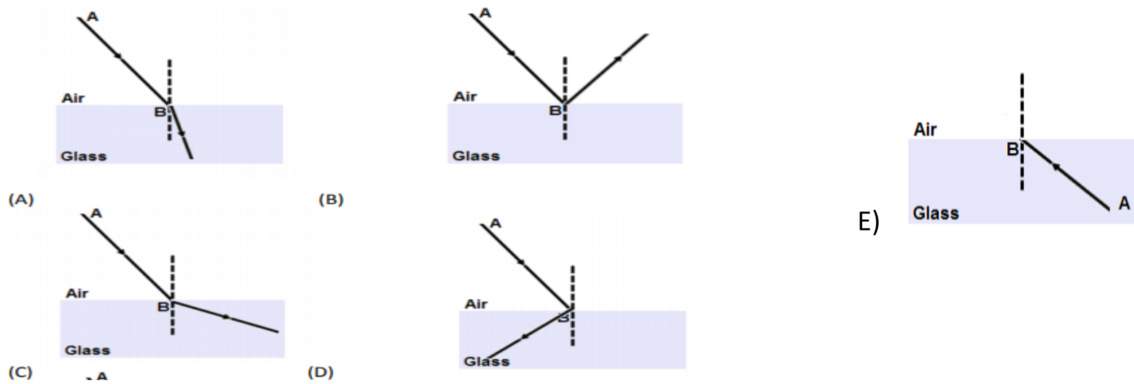
10. An upright object is located in front of a convex mirror a distance greater than the focal length. The image formed by the mirror is:

(a) real, inverted, and smaller than the object
(b) virtual, inverted, and larger than the object
(c) real, inverted, and larger than the object
(d) real, erect, and larger than the object
(e)virtual, erect, and smaller than the object

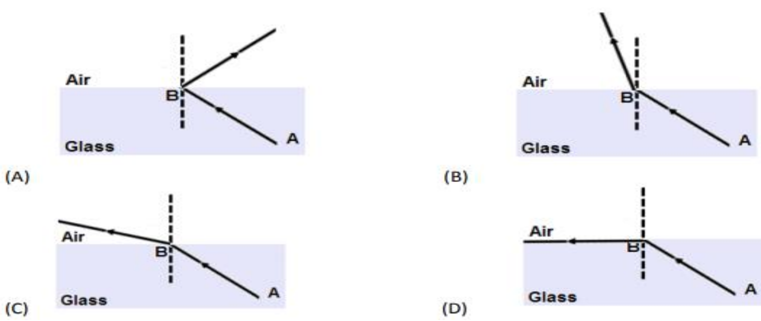
11. How does the angle of incidence compare with the angle of refraction when a light ray passes from air into glass at a nonzero angle?
12. How does the angle of incidence compare with the angle of refraction when a light ray leaves glass and enters air at a nonzero angle?
13. A movie camera with a (single) lens of focal length 75 mm takes a picture of a person standing 27 m away. lf the person is 180 cm tall, what is the height of the image on the film?
14. What are the sign conventions for thin lenses and spherical mirrors?
15. When an object is placed in front of a plane mirror the image is:
    (A) Upright, magnified and real
    (B) Upright, the same size and virtual
    (C) Inverted, demagnetized and real
    (D) Inverted, magnified and virtual
    (E) Upright, magnified and virtual

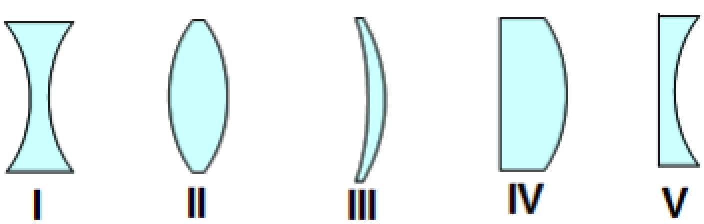


16.A light ray AB is incident obliquely on the surface of a glass block. Which of the following diagrams represents the refracted ray?



17.A light ray AB passes from glass into air at an angle less than the critical angle. Which of the following diagrams represents the refracted ray?



18. 

Which of the lens or lenses is the converging lens?

A. I and V (B) II, III and IV (C) II and III (D) III and IV

.

19.Which of the lens or lenses is the diverging lens?

(A) I and V (B) II, III and IV (C) II and III (D) III and IV

Use the information below to answer questions 20 & 21.

An 8.0 cm tall object is placed 20 cm away from a concave mirror that has a focal length of 5.0 cm.

20. Determine the distance separating the mirror from the image.
 a. 0.15 cm b. 6.7 cm c. 0.25 cm d. 4.0 cm
21. Determine the image size.
a. 2.7 cm b. 0.060 cm c. 0.10 cm d. 1.6 cm

Use the information below to answer questions 22 & 23.

A 10 cm tall object is placed 30 cm away from a concave lens that has a focal length of 6.0 cm.

22. Determine the distance separating the lens from the image.
a. 0.20 cm b. 5.0 cm c. 0.13 cm d. 7.5 cm
23. Determine the image size.
a. 0.067 cm b. 0.043 cm c. 1.7 cm d. 2.5 cm
24. A student conducts an investigation to determine the focal length of a convex lens. She holds the lens in front of her and looks through it at a distant object. She slowly moves the lens towards her eye. She knows she is holding it a the focal length when the image
 a. is inverted b. is upright c. is real d. disappears
25. A lens is used to produce a virtual image that is smaller than the object the lens must be a__ lens.
a. converging b. diverging c. convex d. positive
26. Identify the list below that contains items that diverge light rays.
 a. Convex mirror and concave lens
 b. Convex lens and concave mirror
 c. Convex mirror and concave mirror
 d. Convex lens and concave lens
27. The focal length of a lens is dependent on the
a. radius of curvature of the lens
b. material the lens is made from
c. shape of the lens and the material it is made from
d. location of the object used
28. A lens has a focal length of –10 cm. The image produced from this lens is
 a. real and smaller than the object
 b. virtual and smaller than the object
 c. real and larger than the object
 d. virtual and larger than the object
29. Light in air enters a diamond (n = 2.42) facet at 45.0°. What is the angle of refraction?
30. If a lens is submerged in water, what happens to its focal length?
 A) It decreases. B) It stays the same. C) It becomes negative.
 D) It increases.
31. An object is placed 10 cm from a convex lens of focal length 20 cm. What is the magnification? A) 1.0 B) 1.5 C) 2.0 D) 2.5
32. An object is placed 16 cm from a concave lens of focal length 20 cm. What is the magnification? A) -0.56 B) 0.56 C) -0.22 D) 0.22

33. A person wishes to buy the smallest possible mirror that allows her to see her entire reflection. How high must this mirror be?

A) Three-quarters of the person's height

B) Equal to the person's height

C) One-third of the person's height

D) One-half of the person's height

34. You wish to obtain a magnification of -2 from a convex lens of focal length f. The only possible solution is to

A) Place a virtual object at a distance 3f/2 from the lens.

B) Place a real object at a distance 3f/2 from the lens.

C) Place a virtual object at a distance 2f/3 from the lens.

D) Place a real object at a distance 2f/3 from the lens.

35. A convex lens is known as a diverging lens and a concave lens is known as a converging lens. A) True B) False

36. When an object is placed 30 cm from a converging lens, the image formed is positioned 60 cm from the lens. If the object is moved 5 cm closer to the lens, the position of the image changes by 40 cm. What is the focal length of the lens?

A) 20 cm B) 30 cm C) 10 cm D) 45 cm

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

The answer key to the above three chapters' problems

Chapter-4: Electromagnetism

1. -Electromagnetic Induction occurs when an emf is induced in a coil due to a changing magnetic flux.
2. -Faraday's Law states that the size of the induced emf is proportional to the rate of change of flux.

-Lenz's Law states that the direction of the induced emf is always such as to oppose the change producing it.

3. -Magnetic flux is the product of magnetic flux density and area. $\Phi = BA$
4. $A = (0.05)^2 = 0.0025$

$\Phi = BA = (4)(0.0025) = 0.01$ Wb.

5. -Eddy currents are induced in the iron core of an inductor or transformer.
   -Eddy currents raise the temperature of the core.Wasted power is dissipated as heat.
   -Losses increase with frequency

6. **A solenoid is a coil of wire used to produce a magnetic field.**
7. **A, left b, into page c, up d, no force e, right f, down**
8. B 9. B 10. B 11. C 12. A 13. A 14.C

15. d
16. B and C
17. C
18. B
19. D
20. D
21. D
22. A
23. C
24. B
25. A
26. D
27. D
28. D
29. B
30. E
31. C
32. A
33. C
34. A
35. E
36. C
37. C
38. E

Answer to Chapter:-5 Introduction to electronics

1. Allows current to flow in one direction only.
2. It converts a.c. to d.c.
3. It is a region with no charge carriers / high resistance.
4. p-type: doped with an element with fewer outer electrons / boron
   n-type: doped with an element with more outer electrons / phosphorus
5. Intrinsic: pure semiconductor with equal number of electrons & holes.
   Extrinsic: doped semiconductor with unequal number of electrons & holes
6. Resistivity/conductivity between that of a conductor and an insulator
7. The carrier concentration of intrinsic semiconductors (SC), at room temperature, is very small and hence intrinsic SCs have too low conductivity for practical use.

   - The conductivity of intrinsic SC can be increased by a process called Doping.

   Doping: The process of deliberate addition of controlled quantities of impurities to an intrinsic SC is called doping.

   ♣ Doping markedly increases the conductivity of a semiconductor

   ♣ A doped semiconductor is called an extrinsic semiconductor.

   ♣The concentration of added impurity is normally one part in one million, i.e., 1 impurity atom for every 10^6 intrinsic atoms

   ♣ The impurity atoms are called dopants

8. Less than
9. Greater than
10. The anode is made positive with respect to the cathode
11. Exhibit a very low resistance
12. On both positive and negative half-cycles of the supply.
13. n material
14. . two p-regions and one n-region
15. The EB junction is the forward biased for active operation.
16. holes, electrons
17. Anode is referred as collector and cathode also referred as emitter.
18. Diode, Transistor and Integrated circuit are active components. Integrated circuit – is a small semiconductor chip on which millions of electronic components such as resistors, capacitors and transistors are fabricated.
19. I= 1.5 A
20. I = 1A
21. To increase the conductivity of a material

22. For p-n junction diode – is the type of semiconductor diode that made up from by connecting the p-type and n-type semiconductor.

-for an extrinsic semiconductor- is doped semiconductor that has a p-type and n-type semiconductor in separate.

23.

Input a	Input b	$\bar{a}$	$\bar{b}$	a.b	$\overline{a.b}$
0	0	1	1	1	0
1	0	0	1	0	1
0	1	1	0	0	1
1	1	0	0	0	1

24.The universal logic gates:

- NAND and NOR gates.
- Used to construct another type of logic gate circuits.

25.False

26.

Input a	Input b	$\bar{a}$	$\bar{b}$	$\overline{a.b}$
0	0	1	1	1
1	0	0	1	0
0	1	1	0	0
1	1	0	0	0

27.D 28. A 29. D 30. C 31. A and C

32. Band D 33. A 34. A 35. B 36. D 37. B 38. B 39. B 40. C

41.D 42. A

Answer to Chapter:-6 Electromagnetic waves and geometrical optics

1.
- ✓ Wavelength- the distance between two successive in-phase points; symbol is λ and SI unit is meters
- ✓ Amplitude- maximum displacement of wave; measure of wave's energy
- ✓ Frequency -the number of waves passing a point per second; symbol is f and SI unit is Hertz (Hz)
- ✓ Period time for one wave; symbol is T and SI unit is second

-T = 1/f

- f = 1/T

- ✓ Speed- the speed with which the wave moves through the medium is the product of the wavelength and the frequency; SI unit is m/s

- $v = \lambda f$

2.
• They continue to travel after the source is turned off.
• They travel through empty space.
• They always travel at the same constant speed.
• The electric field is always perpendicular to the magnetic field.
• The velocity is perpendicular to both the electric field and the magnetic field.

3.
1. Mechanical wave
- ✓ Examples -- sound waves, water waves, etc.
- ✓ Require medium for transfer; cannot be transferred through a vacuum
- ✓ The speed of the wave depends upon the mechanical properties of the medium.
- ✓ Some waves are periodic (particles undergo back and forth displacement as in a sound wave.)
- ✓ Some waves are sinusoidal (particles undergo up and down displacement as in a wave on a string.)

2. Electromagnetic
- ✓ Examples -- light waves, radio waves, microwaves, X-rays, etc.
- ✓ Do not require a medium for transfer; can be transferred through a vacuum Transverse and Longitudinal waves.
  - Transverse waves cause the medium to move perpendicular to the direction of the wave.
  - Longitudinal waves cause the medium to move parallel to the direction of the wave.

4. What is the difference between refraction and reflection?
   1. Refraction is the "bending of waves".
      - A wave passing from one medium to another medium of different density changes its speed causing the wave to bend
      - The speed of the wave is greatest in the less dense medium
   2. Reflection "bouncing back" of a wave

Laws of Reflection - The angle of incidence equals the angle of reflection (or it can be stated $\theta_1 = \theta_2$);
   i. The incident wave, the reflected wave, and the normal all lie in the same plane
   ii. Angle of incidence and angle of reflection are always drawn relative to the normal.

Example of reflection: echo.

5. Diffraction- is the ability of waves to bend around the edge of an obstacle in their path.
6.

Answer
Speed of light $v = f\lambda$
$f = v/\lambda = 3x10^8/7x10^{-9} = 4.29\ x10^{16}$ Hz.

7. D 8. E 9. C 10. E

11. - The angle of incidence is larger than the angle of refraction, because air has a smaller index of refraction.
12. - The angle of incidence is smaller than the angle of refraction, because glass has a larger index of refraction.
13. Student’s task.
14.
- f is + for a concave mirror or converging lens
- f is - for a convex mirror or diverging lens
- so is + if the object is real
- so is - if the object is virtual (only possible with multiple lens/mirror systems)
- si is + if the image is real
- si is - if the image is virtual
- m is + for an image that is upright with respect to the object
- m is - for an image that is inverted with respect to the object

15.B 31. C
16. A 32. B
17. C 33. D
18. B 34. B
19. A 35. False
20. B 36. A
21. A
22. B
23. C .
24. D
25. B
26. A
27. A
28.B
29.$\theta 2 = \sin^{-1} \frac{0.7}{2.42}$ = 17º
30.D

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The end