APPENDIX: 2
CONTENT ANALYSIS

1. LAWS OF MOTION

Motion:

The change of position of a body in the course of time is called motion. It is a relative term.

Acceleration:

It refers to the increase in velocity of a body per second. Galileo was the first to infer that when a body moves, it will continue to move with the same velocity when no force acts on it.

Newton's Laws of Motion:

i) First Law:

"Every body continues in its state of rest or of uniform motion in a straight line, unless it is compelled to change that state by an external impressed force".

Inertia:-

It refers to the inability of a material body to change by itself its state of rest or of uniform motion in a straight line. Newton's first law is called as "law of inertia".

Force:-

'Force' is an external agency which changes or tends to change the state of rest or of uniform motion of the body along a straight line.

Momentum:-

Momentum of a body is defined as the product of its mass and velocity.

ii) Second Law:

The rate of change of momentum of a body is directly proportional to the force acting on it and takes place in the direction of force.

Impulse:-

The change in momentum is known as impulse and is the product of force and the time for which the force acts.

iii) Third Law:

"To every action there is always an equal and opposite reaction".
2. WAVE MOTION

Wave Motion:

It refers to transfer of energy from one particle to the succeeding particle.

Definition of Wave Motion:

Wave motion may be defined as the transfer of vibratory motion from one particle of the medium to the succeeding particle.

Characteristics of Wave Motion:

1. Wave motion is the disturbance produced in the medium by the repeated periodic motion of the particles of the medium.
2. Only the wave travels forward, whereas the particles of the medium vibrate about their mean position.
3. There is a regular phase change between the various particles of the medium. The particle ahead starts vibrating a little later than a particle just preceding it.
4. The velocity of the wave is different from the velocity with which the particles of the medium are vibrating about their mean positions.

Types of Wave Motion:

Mechanical wave can be classified into two types viz-Transverse wave and longitudinal wave.

i) Transverse wave:

In this type of wave motion, the particles of the medium vibrate at right angles to the direction of propagation of the wave.

Crests and Troughs:-

Transverse wave is propagated in an elastic medium in the form of crests and troughs. Crests are the position of maximum displacement in the positive direction whereas troughs are the position of minimum displacement in the negative direction.

Wave length ($\lambda$) :-

The distance between two consecutive crests or troughs is known as wave length ($\lambda$).

ii) Longitudinal Wave:

In longitudinal wave motion, every particle of the medium execute simple harmonically about their mean position along the direction of propagation of the wave.
Compressions and Rarefactions:-

Longitudinal wave in an elastic medium propagate in the form of compression and rarefaction. Compressions are the regions of maximum pressure whereas rarefactions are the regions of minimum pressure.

3. ELASTICITY

Solids:

A substance is usually called as a solid, if it retains the shape and volume.

Types of solids:

Solid substances are divided into two types viz-crystalline solids and amorphous solids. Crystalline solids are further divided into two categories viz mono crystals and poly crystals.

Stress and strain:

A change in size or shape or both in a body due to an external force is called as strain.

The restoring force is called as stress.

Strain = Change in dimension / Original dimension.

Elastic limit:

The maximum value of the stress within which a body completely regains its original condition when the deforming forces are removed is known as the elastic limit.

Hooke's law:

The ratio between the stress to the strain is a constant.

Stress/Strain=K (constant)

Modulus of Elasticity:

It is the constant ratio of the stress applied to the body to the strain caused in the body.

Modulus of elasticity = Stress / Strain

Three Moduli of Elasticity:

i) Young's Modulus:

It is the ratio of linear stress to the linear strain.

\[ Y = \frac{\text{Linear stress}}{\text{Linear strain}}. \]

Linear stress is equal to the stretching force divided by the area of cross-section. Linear strain is equal to the ratio of change in length to the original length of the body due to the stretching force.
ii) Bulk Modulus:

It is the ratio of bulk stress to bulk strain.

\[ K = \frac{\text{Bulk stress}}{\text{Bulk strain}}. \]

Bulk stress is equal to the force applied to the body over the volume divided by the area of cross-section. Bulk strain is equal to the change in volume of the body due to the force, to the original volume of the body.

iii) Rigidity Modulus:

It is the ratio of shearing stress to the angle of shear.

\[ N = \frac{\text{Shearing stress}}{\text{Angle of shear}}. \]

Shearing stress is equal to the force per area which tilts the body to an angle 'θ'. Angle of shear is the strain, caused by the shearing stress.

Relation between the three Moduli of Elasticity:

The Young's modulus 'Y', Bulk modulus 'K' and Rigidity modulus 'N' is connected by the relation,

\[ \frac{9}{Y} = \frac{3}{N} + \frac{1}{K}. \]

4. SEMICONDUCTORS

Pauli's exclusion principle:

In any atom, no two electrons can have the same set of the four quantum numbers.

Energy band in solids:

In an isolated atom the electrons are influenced only by its nucleus. But, in a solid as a whole, these electrons are also influenced by the nucleus of neighbouring atoms and their electrons. So, the energy levels of an atom is changed into energy band in a solid.

Valence band:

The electrons in the outer most orbit, which is not fully filled are called as valence electrons. These valence electrons constitute the valence band.

Conduction band:

It is formed at the next permissible higher energy level (next to valence band) with a difference equal to \( \Delta E \) above the valence band. A completely filled band cannot contribute to electric current.
Forbidden energy gap:

There is an energy gap $\Delta E$ which exists between the valence band and conduction band. This energy gap is called as forbidden energy gap.

An electron can be lifted from valence band to conduction band by adding some energy to the material. This energy may be greater than forbidden energy gap $\Delta E$.

Conductors, insulators and semiconductors:

If the forbidden energy gap $\Delta E = 0$, then, there is a maximum chance for the electric flow and hence, these type of materials are known as conductors.

If $\Delta E \geq 5$ ev then, there is no chance for electric flow, and these type of materials are known as insulators.

If $\Delta E \leq 2$ ev, then, the extra energy is provided by heat at room temperature and hence the material begins to conduct electric current. These type of materials are known as semiconductors.

Intrinsic semiconductor:

A semiconductor in its purest form is called as an intrinsic semiconductor. It has only four electrons in its outermost orbit.

Extrinsic semiconductor:

It is formed by adding specified types of impurities to the intrinsic semiconductors. The process of adding impurities is called as “doping”. Hence, a doped semiconductor is called as extrinsic semiconductor. There are two kinds of extrinsic semiconductors viz. N-type and P-type.

(i) N-type Semiconductor

When a penta - valent impurity is added to a sample of intrinsic semiconductor, the N-type semiconductor is formed. In the N-type semiconductor, the majority charge carriers are "electrons" and the minority charge carriers are "holes".

(ii) P-type Semiconductor

When a tri - valent impurity is added to a sample of intrinsic semiconductor, the P-type semiconductor is formed. In a P-type semiconductor the majority charge carriers are "holes" and the minority charge carriers are "electrons".
5. SEMICONDUCTOR DIODE

Doping:

The process of adding impurities to a semiconductor is called as "doping".

Donor and Acceptor impurity:

In a N-type semiconductor the majority charge carriers are "electrons" where as in P-type the majority charge carriers are "holes". The N-type impurity is called as "donor impurity", since it donates electrons. The P-type impurity is called as "acceptor impurity" since, it accepts electrons.

PN-Junction:

When a P-type material and N-type material are joined such that the crystal structure is continuous, a PN-junction is said to be formed.

PN-Junction with no external voltage:

When the PN-Junction is not biased, there is no change in the action of the diode.

PN-Junction with forward bias:

The P-side of the diode is connected to positive and N-side is connected to negative of the battery, then the diode is said to be forward biased. Now, the diode conducts and the current flow is in the order of several milliamperes.

PN-Junction with reverse bias:

The P-side of the diode is connected to negative and N-side is connected to positive of the battery, then the diode is said to be reverse biased. Now, the diode current is very small and almost constant for all voltage till the "break - down voltage". When the applied voltage is equal to or greater than the break down voltage, the diode conducts more current and hence the current increases rapidly. Hence, the ideal diode can be used as an automatic switch.

Applications of Diodes:

1. Diodes can be used as a half-wave and full-wave rectifiers to convert a.c. into d.c.
2. Diodes can be used as a switch in computer circuits.
3. Diodes can be used as detectors in radios to detect audio signals from carrier waves.

LED

LED is known as Light Emitting Diodes which emit visible light in different colours. It is used in displays, calculators, intercoms, telephones etc.