# STUDENT SUPPORT MATERIAL

## (ASSERTION REASONING AND CASE BASED QUESTIONS)

## CLASS-XII

# PHYSICS

## Session 2020-21

## KENDRIYA VIDYALAYA SANGATHAN
## REGIONAL OFFICE
## LUCKNOW

# STUDENT SUPPORT MATERIAL

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# PHYSICS

## Class-XII

## INDEX

# SYLLABUS
# Session 2020-21
# PHYSICS
# CLASS-XII

| | | Marks |
|---|---|---|
| **Unit–I** | **Electrostatics** | **16** |
| | Chapter–1: Electric Charges and Fields | |
| | Chapter–2: Electrostatic Potential and Capacitance | |
| **Unit-II** | **Current Electricity** | |
| | Chapter–3: Current Electricity | |
| **Unit-III** | **Magnetic Effects of Current and Magnetism** | **17** |
| | Chapter–4: Moving Charges and Magnetism | |
| | Chapter–5: Magnetism and Matter | |
| **Unit-IV** | **Electromagnetic Induction and Alternating Currents** | |
| | Chapter–6: Electromagnetic Induction | |
| | Chapter–7: Alternating Current | |
| **Unit–V** | **Electromagnetic Waves** | **18** |
| | Chapter–8: Electromagnetic Waves | |
| **Unit–VI** | **Optics** | |
| | Chapter–9: Ray Optics and Optical Instruments | |
| | Chapter–10: Wave Optics | |
| **Unit–VII** | **Dual Nature of Radiation and Matter** | **12** |
| | Chapter–11: Dual Nature of Radiation and Matter | |
| **Unit–VIII** | **Atoms and Nuclei** | |
| | Chapter–12: Atoms | |
| | Chapter–13: Nuclei | |
| **Unit–IX** | **Electronic Devices** | **7** |
| | Chapter–14: Semiconductor Electronics: Materials, Devices and Simple Circuits | |
| **Total** | | **70** |

# DELETED TOPICS
## (for Session 2020-21)

## PHYSICS

## CLASS XII

| S.No | Name of the Chapter | Deleted Topics |
|---|---|---|
| 01 | **Electric charges and fields** | uniformly charged thin spherical shell (field inside and outside). |
| 02 | **Current Electricity** | Carbon resistors, colour code for carbon resistors; series and parallel combinations of resistors |
| 03 | **Moving Charges and Magnetism** | Cyclotron |
| 04 | **Magnetism and Matter** | magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis, torque on a magnetic dipole (bar magnet) in a uniform magnetic field;<br>Para-, dia- and ferro - magnetic substances, with examples. Electromagnets and factors affecting their strengths, permanent magnets. |
| 05 | **Alternating Current** | power factor, wattless current |
| 06 | **Electromagnetic Waves** | Basic idea of displacement current |
| 07 | **Ray Optics and Optical Instruments** | Reflection of light, spherical mirrors,(recapitulation) mirror formula ,<br><br>Scattering of light - blue colour of sky and reddish appearance of the sun at sunrise and sunset.<br>resolving power of microscope and astronomical telescope, polarisation, plane polarised light, Brewster's law, uses of plane polarised light and Polaroids. |
| 08 | **Dual Nature of radiation and matter** | Davisson-Germer experiment |
| 09 | **Nuclei** | Radioactivity, alpha, beta and gamma particles/rays and their properties; radioactive decay law, half life and mean life<br>binding energy per nucleon and its variation with mass number |
| 10 | **Semiconductor Electronics: Materials, Devices and Simple Circuits** | Zener diode and their characteristics, zener diode as a voltage regulator |

# UNIT-I ELECTROSTATISC
## Assertion (A) & Reason(R)

**For question numbers 1 to 20, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**
**a) Both A and R are true and R is the correct explanation of A**
**b) Both A and R are true but R is NOT the correct explanation of A**
**c) A is true but R is false**
**d) A is false and R is also false**

1. Assertion (A): The electrostatics force increases with decrease the distance between the charges.
   Reason (R): The electrostatic force of attraction or repulsion between any two stationary point charges is inversely proportional to the square of the distance between them.

   Answer: A

2. Assertion(A): The Coulomb force between two points charges depend upon the dielectric constant of the intervening medium.
   Reason(R): Coulomb's force varies inversely with the dielectric constant of medium.

   Answer: A

3. Assertion(A): The charge given to a metallic sphere does not depend on whether it is hollow or solid
   Reason(R): The charge resides only at the surface of conductor.

   Answer: A

4. Assertion (A): A comb run through one's dry hair attracts small bits of paper.
   Reason(R): Molecules in the paper gets polarized by the charged comb resulting in net force of attraction

   Answer: A

5. Assertion(A): A proton is placed in a uniform electric field, it tend to move along the direction of electric field.
   Reason(R): A proton is placed in a uniform electric field it experiences a force.

   Answer: B

6. Assertion(A): Electric field at the surface of a charged conductor is always normal to the surface at every point.
   Reason(R): Electric field gives the magnitude & direction of electric force $(\vec{F})$ experienced by any charge placed at any point.

   Answer: B

7. Assertion(A): The potential inside a hollow spherical charged conductor is zero.
   Reason(R): Inside the hollow spherical conductor electric field is constant.

   Answer: D

8. Assertion(A): Electric filed lines not form closed loops.
   Reason(R): Electric filed lines are always normal to the surface of a conductor.

   Answer: B

9. Assertion(A): No work is done in moving a test charge from one point to another over an equipotential surface.
   Reason(R): Electric field is always normal to the equipotential surface at every point

   Answer: B

10. Assertion(A): No work is done in moving a point charge $Q$ around a circular arc of radius $'r'$ at the Centre of which another point charge $'q'$ is located.
    Reason(R): No work is done in moving a test charge from one point to another over an equipotential surface.

    Answer: A

11. Assertion(A): A metal plate is introduced between the plates of a charged parallel plate capacitor, its capacitance increased.
    Reason(R): A metal plate is introduced between the plates of a charged parallel plate capacitor, the effective separation between the plates is decreased.

    Answer: A

12. Assertion(A): In the presence of external electric field the net electric field within the conductor becomes zero.
    Reason(R): In the presence of external electric field the free charge carriers move and charge distribution in the conductor adjusts itself.
    Answer: A

13. Assertion (A): Sensitive instruments can protect from outside electrical influence by enclosing them in a hollow conductor.
    Reason(R): Potential inside the cavity is zero.

    Answer: C

14. Assertion(A): Earthing provides a safety measure for electrical circuits and appliances.
    Reason(R): When we bring a charged body in contact with the earth, all the excess charge on the body disappears by causing a momentary current to pass to the ground through the connecting conductor.

    Answer: A

15. Assertion(A): The total amount of charge on a body equal to $4X10^{-19}$ C is not possible.
Reason(R): Experimentally it is established that all free charges are integral multiples of a basic unit of charge denoted by *e*. Thus, charge *q* on a body is always given by $q = ne$
Answer: A

16. Assertion(A): The net force on a dipole in a uniform electric dipole is zero.
Reason(R): Electric dipole moment is a vector directed from –q to +q.

Answer: B

17. Assertion(A): Electrostatic forces are conservative in nature.
Reason(R): Work done by electrostatic force is path dependent.

Answer: C

18. Assertion(A) The field intensity in between such sheets having equal and opposite uniform surface densities of charge become constant.
Reason(R): The field intensity does not depend upon the distance between the thin sheet.

Answer: A

19. Assertion(A): Work done by the electrostatic force in bringing the unit positive Charge form infinity to the point P is positive.
Reason(R): The force on a unit positive test charge is attractive, so that the electrostatic force and the displacement (from infinity to P) are in the same direction.

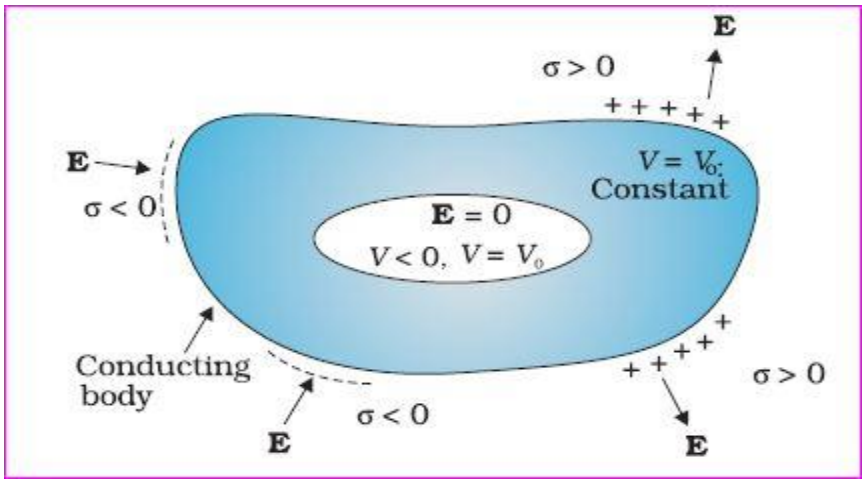
Answer: A

20. Assertion(A): The interior of a conductor can have no excess charge in the static situation
Reason(R): Electrostatic potential is constant throughout the volume of the conductor and has the same value (as inside) on its surface.

Answer: B

## CASE STUDY BASED QUESTIONS

Q.1 The electric field inside the cavity is zero, whatever be the size and shape of the cavity and whatever be the charge on the conductor and the external fields in which it might be placed. The electric field inside a charged spherical shell is zero. But the vanishing of electric field in the (charge-free) cavity of a conductor



is, as mentioned above, a very general result. A related result is that even if the conductor is charged or charges are induced on a neutral conductor by an external field, all charges reside only on the outer surface of a conductor with cavity.

The proofs of the results noted in Fig. are omitted here, but we note their important implication. Whatever be the charge and field configuration outside, any cavity in a conductor remains shielded from outside electric influence: the field inside the cavity is always zero. This is known as electrostatic shielding. The effect can be made use of in protecting sensitive instruments from outside electrical influence.

(1) A metallic shell having inner radius $R_1$ and outer radii $R_2$ has a point charge Q kept inside cavity. Electric field in the region $R_1 < r < R_2$ where r is the distance from the centre is given by
(a) depends on the value of r
(b) Zero
(c) Constant and nonzero everywhere
(d) None of the above

(2) The electric field inside the cavity is depend on
(a) Size of the cavity
(b) Shape of the cavity
(c) Charge on the conductor
(d) None of the above

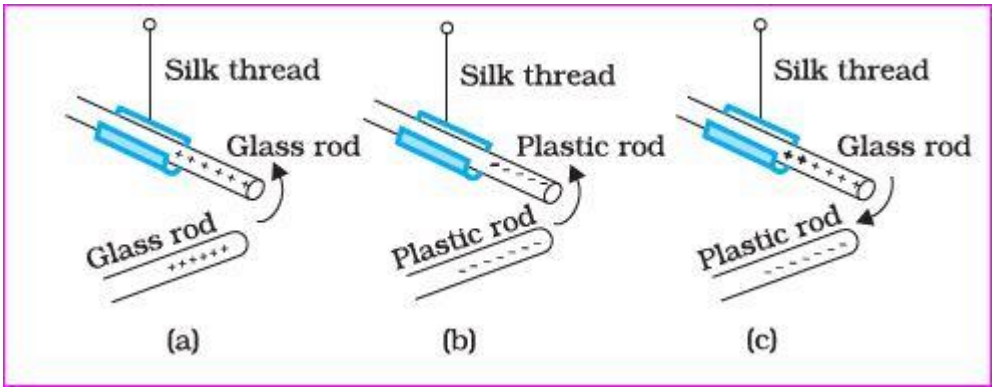
(3) Electrostatic shielding is based
(a) electric field inside the cavity of a conductor is less than zero
(b) electric field inside the cavity of a conductor is zero
(c ) electric field inside the cavity of a conductor is greater than zero
(d) electric field inside the cavity of a plastic is zero

(4) During the lightning thunderstorm, it is advised to stay
(a) inside the car
(b) under trees
(c) in the open ground
(d) on the car

(5) Which of the following material can be used to make a Faraday cage (based on electrostatic shielding)
(a) Plastic
(b) Glass
(c) Copper
(d) Wood

Answer: 1. b 2. d 3. b 4. a 5. c

2. When a glass rod is rubbed with silk, the rod acquires one kind of charge and the silk acquires the second kind of charge. This is true for any pair of objects that are rubbed to be electrified. Now if the electrified glass rod is brought in contact with silk, with which it was rubbed, they no longer attract each other. They also do not attract or repel other light objects as they did on being electrified.




Thus, the charges acquired after rubbing are lost when the charged bodies are brought in contact. What can you conclude from these observations? It just tells us that unlike charges acquired by the objects neutralise or nullify each other's effect. Therefore, the charges were named as positive and negative by the American scientist Benjamin Franklin. We know that when we add a positive number to a negative number of the same magnitude, the sum is zero. This might have been the philosophy in naming the charges as positive and negative. By convention, the charge on glass rod or cat's fur is called positive and that on plastic rod or silk is termed negative. If an object possesses an electric charge, it is said to be electrified or charged. When it has no charge it is said to be electrically neutral.

(1) When you charge a balloon by rubbing it on your hair this is an example of what method of charging?
(a)Friction
(b)Conduction
(c)Grounding
(d)Induction

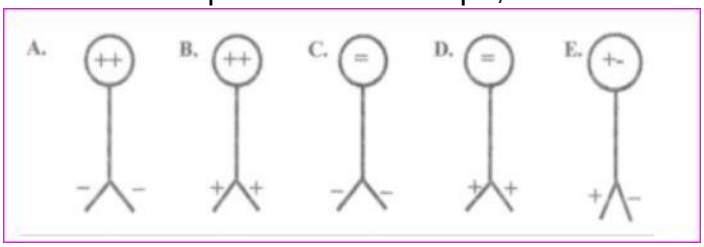
(2) Neutral atoms contain equal numbers of positive __ and negative __.
(a)Electrons and Protons
(b)Protons and Electrons
(c)Neutrons and Electrons
(d)Protons and Neutrons

(3) Which particle in an atom can you physically manipulate?
(a)protons
(b)electrons
(c)neutrons
(d)you can't manipulate any particle in an atom

(4) If a negatively charged rod touches a conductor, the conductor will be charged by what method?
(a) Friction
(b)Conduction
(c)Induction
(d)Convection

(5) A negatively charged rod is touched to the top of an electroscope, which on is correct in the given figure

(a) A
(b) B
(c) C
(d) D




Answer: 1. a 2. b 3. b 4. b 5. C

3. For electrostatics, the concept of electric field is convenient, but not really necessary. Electric field is an elegant way of characterizing the electrical environment of a system of charges. Electric field at a point in the space around a system of charges tells you the force a unit positive test charge would experience if placed at that point (without disturbing the system). Electric field is a characteristic of the system of charges and is independent of the test charge that you place at a point to determine the field. The term field in physics generally refers to a quantity that is defined at every point in space and may vary from point to point. Electric field is a vector field, since force is a vector quantity.

(1) Which of the following statement is correct? The electric field at a point is
(a) always continuous.
(b) continuous if there is a charge at that point.
(c) discontinuous only if there is a negative charge at that point.
(d) discontinuous if there is a charge at that point.

(2) The force per unit charge is known as
(a) electric flux
(b) electric field
(c) electric potential
(d) electric current

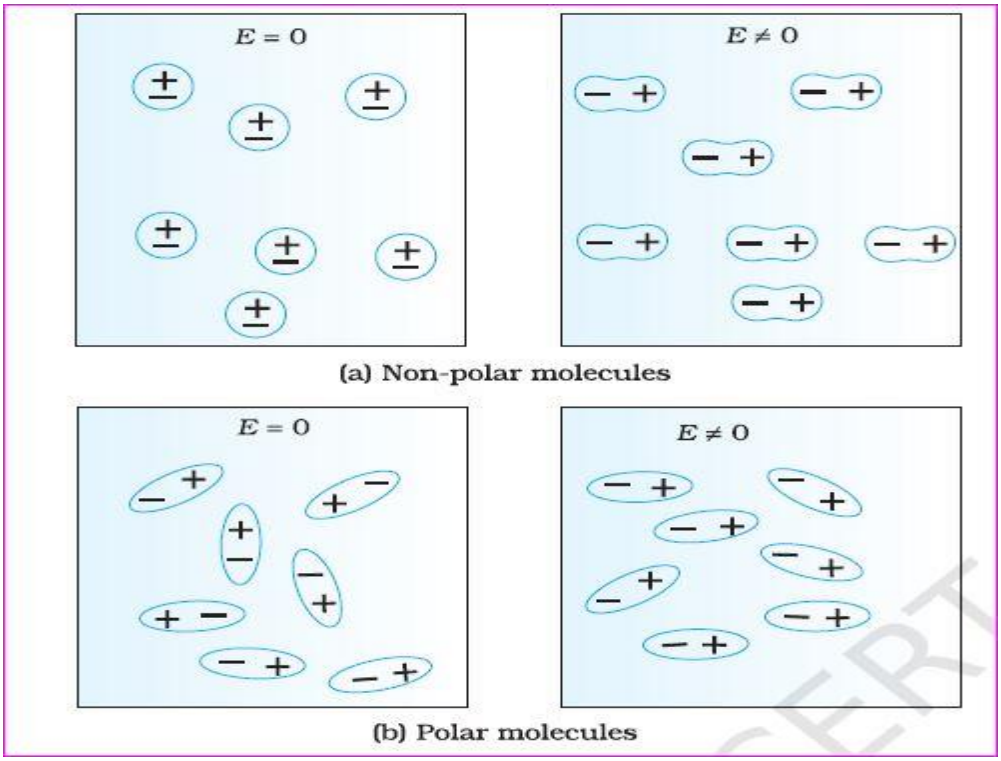
(3) The SI unit of electric field is
(a) N/m
(b) N-m
(c) N/C
(d) $N/C^2$

(4) The magnitude of electric field intensity E is such that, an electron placed in it would experience an electrical force equal to its weight is given by
(a) mge
(b) mg/e
(c) e/mg
(d) $e^2g/m^2$

(5) At a particular point, Electric field depends upon
(a) Source charge Q only
(b) Test Charge $q_0$ only.
(c)Both q and $q_0$
(d)Neither Q nor $q_0$

Answer: 1. b 2. b 3. c 4. b 5. a

4. Dielectric with polar molecules also develops a net dipole moment in an external field, but for a different reason. In the absence of any external field, the different permanent dipoles are oriented randomly due to thermal agitation; so the total dipole moment is zero. When an external field is applied, the individual dipole moments tend to alignwith the field. When summed overall the molecules, there is then a net dipole moment in the direction of the external field, i.e., the dielectric is polarised. The extent of polarisation depends on the relative strength of two factors: the dipole potential energy in the external field tending to align the dipoles mutually opposite with the field and thermal energy tending to disrupt the alignment. There may be, in addition, the 'induced dipole moment' effect as for non-polar molecules, but generally the alignment effect is more important for polar molecules. Thus in either case, whether polar or non-polar, a dielectric develops a net dipole moment in the presence of an external field. The dipole moment per unit volume is called polarization.




(1) The best definition of polarisation is
   (a) Orientation of dipoles in random direction
   (b) Electric dipole moment per unit volume
   (c) Orientation of dipole moments
   (d)Change in polarity of every dipole

(2) Calculate the polarisation vector of the material which has 100 dipoles per unit volume in a volume of 2 units.
   (a) 200
   (b) 50
   (c) 0.02
   (d) 100

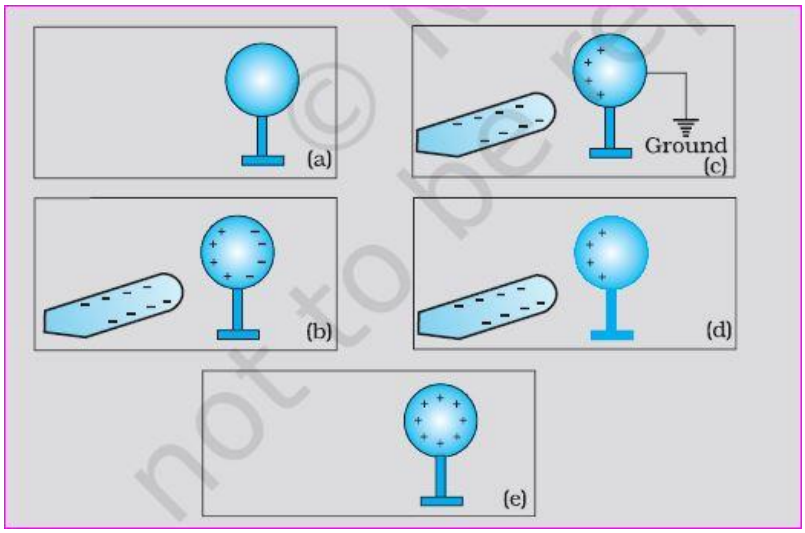
(3) The total polarisation of a material is the
   (a) Product of all types of polarisation
   (b) Sum of all types of polarisation
   (c)Orientation directions of the dipoles
   (d)Total dipole moments in the material

(4) Dipoles are created when dielectric is placed in _____
(a) Magnetic Field
(b) Electric field
(c) Vacuum
(d) Inert Environment

(5) Identify which type of polarisation depends on temperature.
(a)Electronic
(b)Ionic
(c)Orientational
(d) Interfacial

Answer: 1. b 2. a 3. b 4. b 5. C

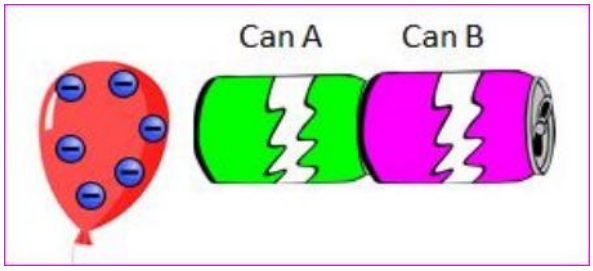
5. Figure (a) shows an uncharged metallic sphere on an insulating metal stand. If we Bring a negatively charged rod close to the metallic sphere, as shown in Fig. (b). As the rod is brought close to the sphere, the free electrons in the sphere move away due to repulsion and start piling up at the farther end. The near end becomes positively charged due to deficit of electrons.




This process of charge distribution stops when the net force on the free electrons inside the metal is zero. Now if we Connect the sphere to the ground by a conducting wire. The electrons will flow to the ground while the positive charges at the near end will remain held there due to the attractive force of the negative charges on the rod, as shown in Fig. (c). Disconnect the sphere from the ground. The positive charge continues to be held at the near end Fig.(d). if we remove the electrified rod. The positive charge will spread uniformly over the sphere as shown in Fig. (e). In this experiment, the metal sphere gets charged by the process of induction and the rod does not lose any of its charge.

(1) What do you call the process of charging a conductor by bringing it near another Charged object?
(a) Induction
(b) Polarisation
(c) neutralization
(d) conduction

(2) The negatively charged balloon is brought near the two cans. What happens?




(a)The negative charges in Can B move towards the balloon
(b)The negative charges in Can A move away from the balloon
(c)The positive charges in Can B move towards the balloon
(d)The positive charges in Can A move away from the balloon

(3) Transferring a charge without touching is ___
(a)Conduction
(b)Induction
(c)Grounding
(d)Newtons 3rd law

(4) Due to electrostatic induction in aluminum rod due to charged plastic rod, the total charge on the aluminum rod is
(a)Zero
(b)Positive
(c) Negative
(d) Dual

(5) If we bring charged plastic rod near-neutral aluminum rod, then rods will
(a)Repel each other
(b)Attract each other
(c)Remain their position
(d)Exchange charges

Answer: 1. a 2. b 3. b 4. a 5. b

# UNIT-II CURRENT ELECTRICITY
## Assertion (A) & Reason(R)

Q1:

**Statement I:** A potentiometer is preferred over a voltmeter for the measurement of e.m.f. of a cell.

**Statement II:** A potentiometer is preferred, as it does not draw any current from the cell.

A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.
B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.
C) If Statement I is true but Statement II is false.
D) If the Statement I and Statement II both are false.
E) If Statement I is false but Statement II is true.

Answer: A

Q2:

**Statement I:** The wire of a potentiometer should be of uniform area of cross section.

**Statement II:** It satisfies the requirement of the principle of a potentiometer.

A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.
B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.
C) If Statement I is true but Statement II is false.
D) If the Statement I and Statement II both are false.
E) If Statement I is false but Statement II is true.

Answer: A

Q3:

**Statement I:** The higher the range, the greater is the resistance of an ammeter.

**Statement II:** To increase the range of an ammeter, additional shunt is needed to be used across it.

A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.
B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.

C) If Statement I is true but Statement II is false.
D) If the Statement I and Statement II both are false.
E) If Statement I is false but Statement II is true.
Answer: D

Q4:

**Statement I:** The resistance of an ideal voltmeter should be infinite.

**Statement II:** Lower resistance of voltmeters gives a reading lower than the actual potential difference across the terminals.

A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.
B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.
C) If Statement I is true but Statement II is false.
D) If the Statement I and Statement II both are false.
E) If Statement I is false but Statement II is true.

Answer: A

Q5:

**Statement I:** Voltmeter always gives e.m.f. of a cell if it is connected across the terminals of a cell.

**Statement II:** Terminal potential of a cell is given by

$V = E - ir$

A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.
B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.
C) If Statement I is true but Statement II is false.
D) If the Statement I and Statement II both are false.
E) If Statement I is false but Statement II is true.

Answer: D

**Statement I :** The e.m.f. of the driver cell in the potentiometer experiment should be greater than the e.m.f. of the cell to be determined.

**Statement II:** The fall of potential across the potentiometer wire should not be less than the e.m.f. of the cell to be determined.

A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.
B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.
C) If Statement I is true but Statement II is false.
D) If the Statement I and Statement II both are false.
E) If Statement I is false but Statement II is true.
Answer: A

Q7:

**Statement I:** In a metre bridge experiment, a high resistance is always connected in series with a galvanometer.

**Statement II:** As resistance increases, current through the circuit increases.

A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.
B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.
C) If Statement I is true but Statement II is false.
D) If the Statement I and Statement II both are false.
E) If Statement I is false but Statement II is true.
Answer: C

Q8:

**Statement I:** The wires supplying current to an electric heater are not heated appreciably.

**Statement II:** Resistance of connecting wires is very small and $H \propto R$.

A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.
B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.
C) If Statement I is true but Statement II is false.
D) If the Statement I and Statement II both are false.
E) If Statement I is false but Statement II is true.
Answer: A

Q9:

**Statement I:** If the current of a lamp increases by 20%, the percentage increase in the illumination of the lamp is 40%.

**Statement II:** Illumination of the lamp is directly proportional to the square of the current through the lamp.

A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.

B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.

C) If Statement I is true but Statement II is false.

D) If the Statement I and Statement II both are false.

E) If Statement I is false but Statement II is true.

Answer: D

Q10:

**Statement I:** Heater wire must have high resistance than connecting wires and high metallic point.

**Statement II:** If resistance is high, the electrical conductivity will be less.

A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.

B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.

C) If Statement I is true but Statement II is false.

D) If the Statement I and Statement II both are false.

E) If Statement I is false but Statement II is true.

Answer: B

Q11:

**Statement I:** In the circuit in Fig. 7.46, both cells are ideal and of fixed e.m.f., the resistor $R_1$ has fixed resistance and the resistance of resistor $R_2$ can be varied (but $R_2$ is always non-zero). Then the electric power delivered to resistor of the resistance $R_1$ is independent of the value of resistance $R_2$.

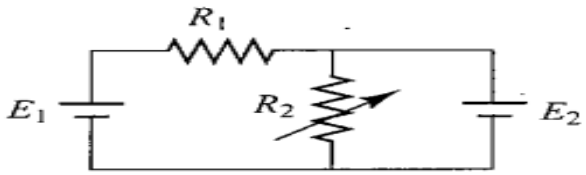



**Fig. 7.46**

**Statement II:** If potential difference across a fixed resistance is unchanged, the power delivered to the resistor remains constant.

A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.
B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.
C) If Statement I is true but Statement II is false.
D) If the Statement I and Statement II both are false.
E) If Statement I is false but Statement II is true.
Answer: A

Q12:
**Statement I:** Since all the current coming to our house returns to powerhouse (as current travels in a closed loop), there is no need to pay the electricity bill.
**Statement II:** The electricity bill is paid for the power used, not for the current used.
A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.
B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.
C) If Statement I is true but Statement II is false.
D) If the Statement I and Statement II both are false.
E) If Statement I is false but Statement II is true.
Answer: D

Q13:
**Statement I:** Internal resistance of a battery is drawn parallel to a battery in electrical circuit.
**Statement II:** Heat generated in a battery is due to internal resistance.
A) If both Statement I and Statement II are true and the statement II is the correct explanation of the statement I.
B) If both Statement I and Statement II are true but statement II is not the correct explanation of the statement I.
C) If Statement I is true but Statement II is false.
D) If the Statement I and Statement II both are false.
E) If Statement I is false but Statement II is true.
Answer: D

Q14:

Statement 1: The possibility of an electric bulb fusing is higher at the time of switching ON and OFF

Statement 2: Inductive effects produce a surge at the time of switch ON and OFF

A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.

B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.

C) If Statement 1 is true but Statement 2 is false.

D) If the Statement 1 and Statement 2 both are false.

E) If Statement 1 is false but Statement 2 is true.

Answer: A

Q15:

Statement 1: The 200 W bulbs glow with more brightness than 100 W bulbs.

Statement 2: A 100 W bulb has more resistance than a 200 W bulb.

A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.

B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.

C) If Statement 1 is true but Statement 2 is false.

D) If the Statement 1 and Statement 2 both are false.

E) If Statement 1 is false but Statement 2 is true.

Answer: A

Q16:

Statement 1: Fuse wire must have high resistance and low melting point.

Statement 2: Fuse is used for small current flow only.

A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.

B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.

C) If Statement 1 is true but Statement 2 is false.

D) If the Statement 1 and Statement 2 both are false.

E) If Statement 1 is false but Statement 2 is true.

Answer: C

Q17:

Statement 1: Two electric bulbs of 50 and 100 W are given. When connected in series 50 W bulb glows more but when connected parallel 100 W bulb glows more.

Statement 2: In series combination, power is directly proportional to the resistance of the circuit. But in parallel combination, power is inversely proportional to the resistance of the circuit.

A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: A

Q18:
Statement 1: Two bulbs of same wattage, one having a carbon filament and the other having a metallic filament are connected in series. Metallic bulbs will glow more brightly than a carbon filament bulb.
Statement 2: Carbon is a semiconductor.
A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: D

Q19:
Statement 1: An electric bulb is first connected to a dc source and then to an ac source having the same brightness in both cases.
Statement 2: The peak value of voltage for an A.C. source is $\sqrt{2}$ times the root mean square voltage.
A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: E

Q20:
Statement 1: Current is passed through a metallic wire, heating it red. When cold water is poured on half of its portion, then the rest of the half portion becomes hotter.
Statement 2: Resistances decrease due to a decrease in temperature and so current through wire increases.

A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: A

Q21:
Statement 1: Through the same current flows through the line wires and the filament of the bulb but the heat produced in the filament is much higher than that in line wires.
Statement 2: The filament of bulbs is made of a material of high resistance and a high melting point.

A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: A

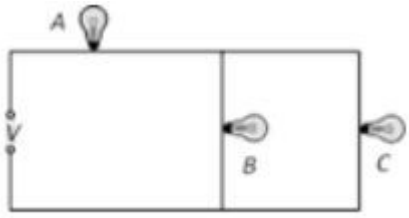
Q22:
Statement 1: In practical application, the power rating of resistance is not important.
Statement 2: Property of resistance remain the same even at high temperature.

A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: D

Q23:
Statement 1: Leclanche cell is used, when a constant supply of electric current is not required.
Statement 2: The e.m.f. of a Leclanche cell falls, if it is used continuously.

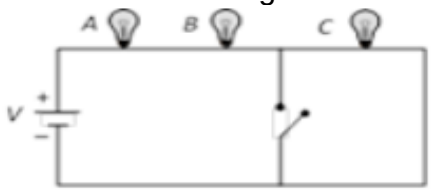
A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: A

Q24:
Statement 1: In the given circuit if lamp B or C fuses then the light emitted by lamp A decreases.
Statement 2: Voltage on A decreases.




A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: A

Q25:
Statement 1: If three identical bulbs are connected in series as shown in figure then on closing the switches. Bulb C short-circuited and hence illumination of bulbs A and B decreases.
Statement 2: Voltage on A and B decreases




A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: D

Q26:
Statement 1: Heat is generated continuously is an electric heater but its temperature becomes constant after some time.
Statement 2: At the stage when heat produced in the heater is equal to the heat dissipated to its surrounding the temperature of the heater becomes constant.

A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: A

Q27:
Statement 1: Electric appliances with a metallic body; e.g. heaters, presses, etc, have three-pin connections, whereas an electric bulb has a two pin connection.
Statement 2: Three-pin connections reduce the heating of connecting cables.

A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: C

Q28:
Statement 1: A domestic electrical appliance, working on a three-pin will continue working even if the top pin is removed.
Statement 2: The third pin is used only as a safety device.
A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.
B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.
C) If Statement 1 is true but Statement 2 is false.
D) If the Statement 1 and Statement 2 both are false.
E) If Statement 1 is false but Statement 2 is true.
Answer: A

Q29:

Statement 1: The presence of water molecules makes separation of ions easier in an electrolyte.

Statement 2: The presence of water molecules in electrolyte decreases the resistance of electrolyte.

A) If both Statement 1 and Statement 2 are true and the statement 2 is the correct explanation of the statement 1.

B) If both Statement 1 and Statement 2 are true but statement 2 is not the correct explanation of the statement 1.

C) If Statement 1 is true but Statement 2 is false.

D) If the Statement 1 and Statement 2 both are false.

E) If Statement 1 is false but Statement 2 is true.

Answer: B

## CASE BASED QUESTIONS

Q1:

Ram and Shyam purchased two electric tea kettles *A* and *B* of same size, same thickness and same volume of 0.4 litre. They studied the specification of kettles as under

Kettle *A*:
Specific heat capacity = 1680 J/kgK
Mass = 200 g
Cost = Rs. 400

Kettle *B*:
Specific heat capacity = 2450 J/kgK
Mass = 400 g
Cost = Rs. 400

When kettle *A* is switched on with constant potential source, the tea begins to boil in 6 min. When kettle *B* is switched on with the same source separately, then tea begins to boil in 8 min. The efficiency of kettle is defined as

$$\frac{\text{Energy used for liquid heating}}{\text{Total energy supplied}}$$

They made discussion on specification and efficiency of kettles and subsequently prepared a list of questions to draw the conclusions. Some of them are as under (Assume specific heat of tea liquid as 4200 J/kgK and density 1000 kg/m$^3$.)

A: Efficiency of kettle A is
1. 63.34%
2. 83.34%
3. 93.34%
4. 73.34%

B: Efficiency of kettle B is
1. 82.5%
2. 72.5%
3. 92.5%
4. 62.5%

C: Ratio of efficiency consumed charges for one time boiling of tea in kettle A to that in kettle B
1. 3:5
2. 2:3
3. 3:4
4. 1:1

D: If the resistance of the coil in kettle A and B is Ra and Rb then we can say
1. Ra>Rb
2. Ra=Rb
3. Ra<Rb
4. Data insufficient

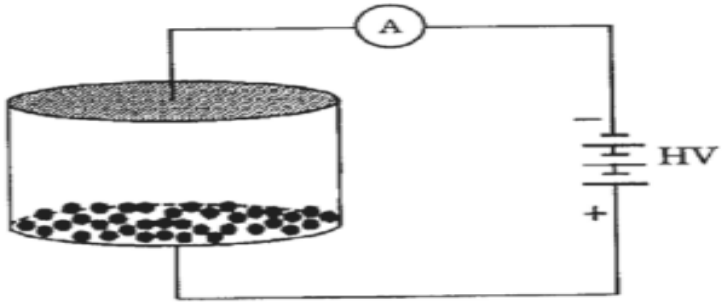
E: If both the kettles are joined with the same source in series one after another then boiling starts in kettle A and kettle B after
1. 4 times of their original time
2. Equal to their original time
3. 2 times of their original time
4. Data insufficient

**Answers:**

**A. 2**
**B. 4**
**C. 3**
**D. 2**
**E. 1**

Q2: Consider an evacuated cylindrical chamber of height *h* having rigid conducting plates at the ends and an insulating curved surface as shown in the figure. A number of spherical balls made of a light weight and soft material and coated with a conducting material are placed on the bottom plate. The balls have a radius *r«h.* Now a high voltage source (HV) is connected across the conducting plates such that the bottom plate is at + V, and the top plate at - Vo. Due to their conducting surface, the balls will get charged, will become equipotential with the plate and are repelled by it. The balls will eventually collide with the top plate, where the coefficient of restitution can be taken to be zero due to the soft nature of the material of the balls. The electric field in the chamber can be considered to be that of

a parallel plate capacitor, Assume that there are no collisions between the balls and the interaction between them is negligible. (Ignore gravity)




A: Which one of the following statements is correct?

1. The balls will stick to the top plate and remain there
2. The balls will bounce back to the bottom plate carrying the same charge they went up with
3. The balls will bounce back to the bottom plate carrying the opposite charge they went up with
4. The balls will execute simple harmonic motion between the two plates

B: The average current in the steady state registered by the ammeter in the circuit will be

1. zero
2. proportional to the potential V
3. proportional to the $\sqrt{V}$
4. Proportional to $V^2$

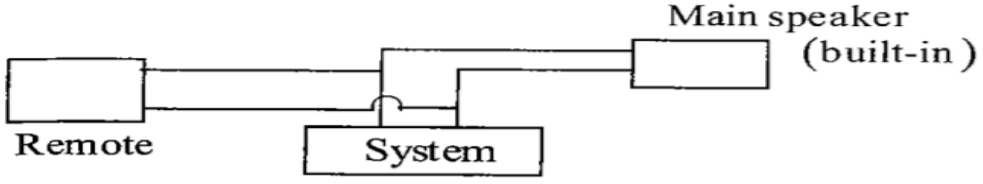
**Answers:**

**A. 3**
**B. 4**

Q3:

Most of the times we connect remote speakers to play music in another room along with the buit-in speakers. These speakers are connected in parallel with the music system.

At the instant represented in the picture, the voltage across the speakers is 6.00 V. The resistance of the main speaker is 8 Ω and the remote speaker has resistance 4 Ω.




A: Equivalent resistance of the speakers is

1. 12 ohm
2. 7/3 ohm
3. 8/3 ohm
4. 0.375 ohm

B: The total current supplied by music system

1. 2.25 A
2. 1 A
3. 16 A
4. 1.5 A

C: The power dissipated in the 4 ohm resistance is

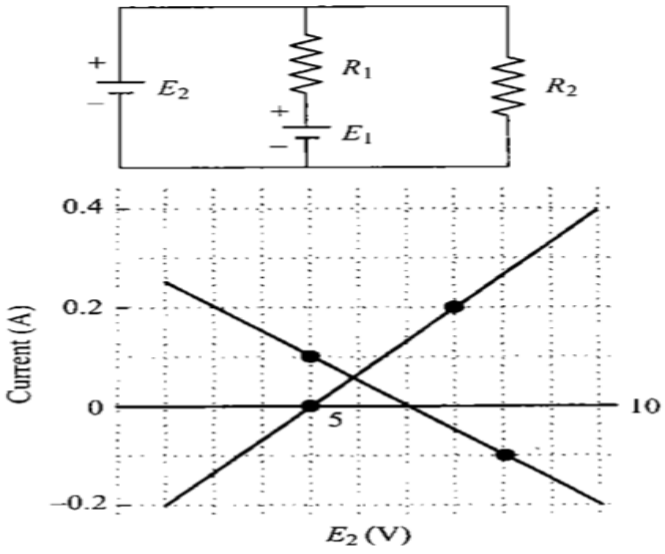
1. 9 W
2. 4.5 W
3. 13.5 W
4. 0

**Answers:**

**A. 3**
**B. 1**
**C. 1**

Q4

In the circuit given in the figure, both batteries are ideal. e.m.f. $E_1$ of battery 1 has a fixed value, but e.m.f. $E_2$ of battery 2 can be varied between 1.0 V and 10.0 V. The graph gives the currents through the two batteries as a function of $E_2$, but are not marked as which plot corresponds to which battery. But for both plots, current is assumed to be negative when the direction of the current through the battery is opposite to the direction of that battery's e.m.f. (direction of e.m.f. is from negative to positive).




A: The value of EMF $E_1$ is

1. 8 V
2. 6 V
3. 4 V
4. 2 V

B: The resistance $R_1$ has value

1. 10 ohm
2. 20 ohm
3. 30 ohm
4. 40 ohm

C: The resistance $R_2$ has value

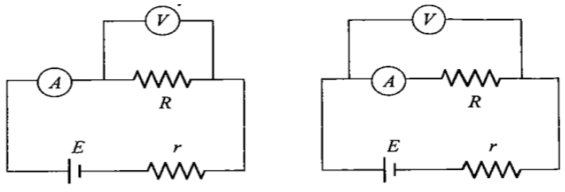
1. 10 ohm
2. 20 ohm
3. 30 ohm
4. 40 ohm

**Answers:**

**A. 3**
**B. 1**
**C. 1**

Q5

Resistance value of an unknown resistor is calculated using the formula $R = V/I$ where $V$ and $I$ are the readings of the voltmeter and the ammeter, respectively. Consider the circuits below. The internal resistances of the voltmeter and the ammeter ($R_V$ and $R_G$ respectively) are finite and non-zero.




Let $R_A$ and $R_B$ be the calculated values in the two cases A and B, respectively.

A: The relation between $R_A$ and the actual value of R is

1. R > $R_A$
2. R < $R_A$
3. R = $R_A$
4. Dependent on E and r

B: The relation between $R_B$ and the actual value of R is

1. R < $R_B$
2. R > $R_B$
3. R = $R_B$
4. Dependent upon E and r

C: If the resistance of the voltmeter is $R_V$ = 1 kilo ohm and that of ammeter is $R_G$ = 1 ohm , the magnitude of percentage error in the measurement of R (the value of

R is nearly 10 ohm ) is

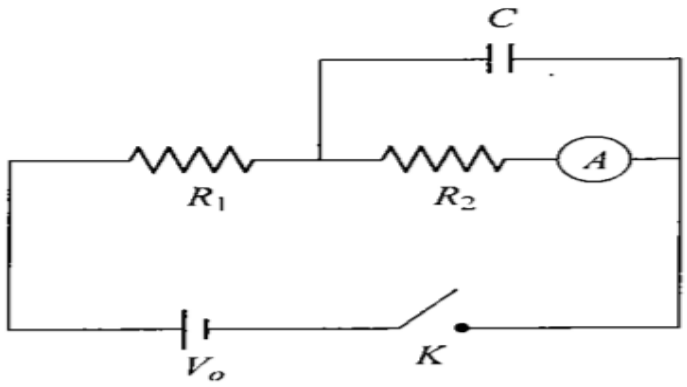
1. Zero in both cases
2. Non-zero but equal in both cases
3. More in circuit A
4. More in circuit B

**Answers:**

**A. 2**
**B. 2**
**C. 4**

Q6

In the connection shown in the figure, initially the switch $K$ is open and the capacitor is uncharged. Then the switch is closed and the capacitor is charged up to the steady state and the switch is opened again. Determine the values indicated by the ammeter. [Given: $V_0 = 30$ V, $R_1 = 10$ k$\Omega$, $R_2 = 5$ k$\Omega$]




A: Just after closing the switch

1. 2 mA
2. 3 mA
3. 0 mA
4. None of the above

B: Long time after the switch is closed

1. 2 mA
2. 3 mA
3. 6 mA
4. None of the above

C: Just after reopening the switch

1. 2 mA
2. 3 mA
3. 6 mA
4. None of the above

**Answers:**
**A. 3**
**B. 1**
**C. 1**

Q7.

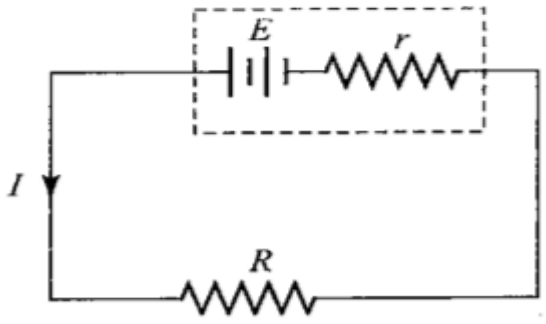
Electric fuse is a protective device used in series with an electric circuit or an electric appliance to save it from damage due to overheating produced by strong current in the circuit or application. Fuse wire is generally made from an alloy of lead and tin which has high resistance and low melting point. It is connected in series in an electric installation. If a circuit gets accidentally short-circuited, a large current flows, then fuse wire melts away which causes a break in the circuit. The power through fuse ($F'$) is equal to heat energy lost per unit area per unit time ($h$) (neglecting heat loses from ends of the wire).

$$P = I^2 R = h \times 2\pi rl \quad \left[ R = \frac{\rho l}{\pi r^2} \right]$$

where $r$ and $l$ are the length and radius of fuse wire, respectively.

A battery is described by its e.m.f. ($E$) and internal resistance ($r$). Efficiency of a battery ($\eta$) is defined as the ratio of the output power to the input power

$$\eta = \frac{\text{Output power}}{\text{Input power}} \times 100\%$$



but $I = \frac{E}{R+r}$, input power $= EI$

Output power $= EI - I^2r$

Then
$$\eta = \left(\frac{EI - I^2r}{EI}\right) \times 100 \left(1 - \frac{Ir}{E}\right) \times 100$$
$$= 1 - \left(\frac{E}{R+r}\right)\left(\frac{r}{E}\right) \times 100$$
$$\eta = \left(\frac{R}{R+r}\right) \times 100$$

We know that output power of a source is maximum when the external resistance is equal to internal resistance, i.e., $R = r$.

A: Two fuse wires of same potential material are having length ratio 1:2 and ratio 4:1 Then respective ratio of their current rating will be

1. 8:1
2. 2:1
3. 1:8
4. 4:1

B: The maximum power rating of a 20.0 ohm fuse wire is 2.0 kW,then this fuse wire can be connected safely to a DC source (negligible internal resistance) of

1. 300 volt
2. 190 volt
3. 250 volt
4. 220 volt

C: Efficiency of a battery when delivering maximum power is

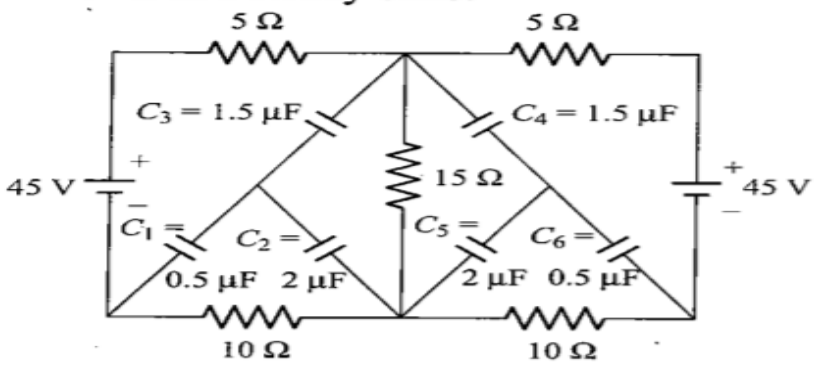
1. 100 %
2. 50 %
3. 90 %
4. 40 %

**Answers:**

**A. 1**
**B. 2**
**C. 4**

Q8

The circuit shown in a steady state:




A: The charge in capacitor C1 is

1. 20 μC
2. 30 μC
3. 40 μC
4. 10 μC

B: The charge in capacitor C2 is

1. 30 μC
2. 10 μC
3. 20 μC
4. 40 μC

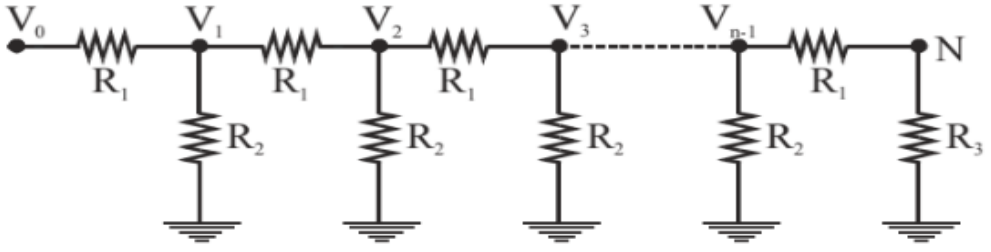
C: The charge on capacitor C3 is

1. 10 μC
2. 30 μC
3. 20 μC
4. 40 μC

**Answers:**

**A. 4**
**B. 3**
**C. 2**

Q9 A network of resistance is constructed with R1 and R2 as shown in figure. The potential at the points 1, 2, 3.... N are V1, V2, V3,.....VN, respectively, each having a potential k times smaller than the previous one.



A: The ratio of $\frac{R_1}{R_2}$ is

1. $k^2 - \frac{1}{k}$
2. $\frac{k}{k-1}$
3. $k - \frac{1}{k^2}$
4. $\frac{(k-1)^2}{k}$

B: The ratio of $\frac{R_2}{R_3}$ is

1. $\frac{(k-1)^2}{k}$
2. $k^2 - \frac{1}{k}$
3. $\frac{k}{k-1}$
4. $k - \frac{1}{k^2}$

C: The current that passes through the resistance R2 nearest to the V0 is

1. $\frac{(k-1)^2}{k}\frac{V_0}{R_3}$
2. $\frac{(k+1)^2}{k}\frac{V_0}{R_3}$
3. $\left(k + \frac{1}{k^2}\right)\frac{V_0}{R_3}$

4. $\left(k-\frac{1}{k^2}\right)\frac{V_0}{R_3}$

**Answers:**
**A. 4**
**B. 3**
**C. 4**

Q10 An ammeter and a voltmeter are connected in series to a battery with an emf of 10V. When a certain resistance is connected in parallel with the voltmeter, the reading of the voltmeter decreases three times, whereas the reading of the ammeter increases two times.

A: Find the voltmeter reading after the connection of the resistance.

1. 1 V
2. 2 V
3. 3 V
4. 4 V

B: If the resistance of the ammeter is 2 ohm, then the resistance of the voltmeter is:-

1. 1 ohm
2. 2 ohm
3. 3 ohm
4. 4 ohm

C: If the resistance of ammeter is 2 ohm ,then resistance of the resistor which is added in parallel to the voltmeter is

1. ⅗ ohm
2. 2/7 ohm
3. 3/7 ohm
4. None of the above

**Answers:**
**A. 2**
**B. 3**
**C. 1**

# UNIT-III MAGNETIC EFFECT OF ELECTRIC CURRENT AND MAGNETISM

## Assertion (A) & Reason(R)

**Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**

**(a) Both A and R are true and R is the correct explanation of A**
**(b) Both A and R are true but R is not the correct explanation of A**
**(c) A is true but R is false**
**(d) A is false and R is also false**

1. Assertion(A):
   The centripetal force on the test charge $q_o$ is $q_o\ vB$, where v is the velocity of a particle and B is the magnetic field.
   Reason (R):
   When a charged particle is fired at right angles to the magnetic field, the radius of its circular path is directly proportional to the kinetic energy of the particle.

2. Assertion (A):
   Magnetic field due to an infinite straight conductor varies inversely as the distance from it.
   Reason (R):
   The magnetic field due to a straight conductor is in the form of concentric circles.

3. Assertion (A):
   A rectangular current loop is in an arbitrary orientation in an external uniform magnetic field. No work is required to rotate the loop about an axis perpendicular to the plane of loop
   Reason (R):
   All positions represent the same level of energy.

4. Assertion (A):
   The magnitude of magnetic field in a region is equal to the number of magnetic field lines per unit area where area should be normal to the field.
   Reason (R):
   Magnetic field is tangential to a magnetic field line.

5. Assertion (A):
   If a proton and an α-particle enter a uniform magnetic field perpendicularly with the same speed, the time period of revolution of α-particle is double than that of proton.

Reason (R):
In a magnetic field, the period of revolution of a charged particle is directly proportional to the mass of the particle and inversely proportional to the charge of the particle.

6. Assertion (A):
A charged particle is moving in a circular path under the action of a uniform magnetic field. During the motion, kinetic energy of the charged particle is constant.
Reason (R):
During the motion, magnetic force acting on the particle is perpendicular to instantaneous velocity.

7. Assertion (A):
When radius of a circular loop carrying current is doubled, its magnetic moment becomes four times.
Reason (R):
Magnetic moment depends on the area of the loop.

8. Assertion (A):
The magnetic field at the ends of a very long current carrying solenoid is half of that at the centre.
Reason (R):
If the solenoid is sufficiently long, the field within it is uniform.

9. Assertion (A):
If an electron and proton enter a magnetic field with equal momentum, then the paths of both of them will be equally curved.
Reason (R):
The magnitude of charge on an electron is same as that on a proton.

10. Assertion (A):
The coils of a spring come close to each other, when current is passed through it.
Reason (R):
It is because, the coils of a spring carry current in the same direction and hence attract each other.

11. Assertion (A):
The range of a voltmeter can be both increased or decreased.
Reason (R):
The required resistance (to be connected in series) can be calculated by using the relation,

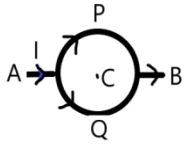
$R = \frac{V}{I_g} - G$

12. Assertion (A):
Both A $m^2$ and J $T^{-1}$ are the units of magnetic dipole moment.
Reason (R):
Both the units are equivalent to each other.

13. Assertion (A):
The true geographic north direction is found by using a compass needle.
Reason (R):
The magnetic meridian of the earth is along the axis of rotation of the earth.

14. Assertion (A):
If a compass needle is kept at magnetic north pole of the earth, the compass needle may stay in any direction.
Reason (R):
Dip needle will stay vertical at the north pole of the earth.

15. Assertion (A):
The magnetic field at the centre of the current carrying circular coil shown in the fig. is zero.




Reason (R):
The magnitudes of magnetic fields are equal and the directions of magnetic fields due to both the semicircles are opposite.

16. Assertion (A):
The voltage sensitivity may not necessarily increase on increasing the current sensitivity.
Reason (R):
Current sensitivity increases on increasing the number of turns of the coil.

17. Assertion (A):
The angle of dip is maximum at the poles of the earth.
Reason (R):
The magnetic field lines are parallel to the surface of the earth at the poles.

18. Assertion (A):
An electron projected parallel to the direction of magnetic force will experience maximum force.

Reason (R):
Magnetic force on a charge particle is given by F = (IL x B).

19. Assertion (A):
The torque acting on square and circular current carrying coils having equal areas, placed in uniform magnetic field, will be same.
Reason (R):
Torque acting on a current carrying coil placed in uniform magnetic field does not depend on the shape of the coil, if the areas of the coils are same.

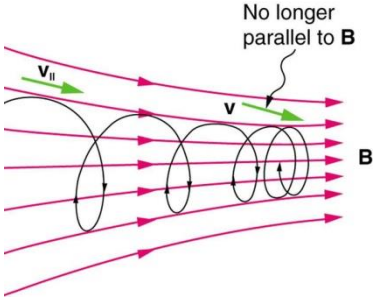
20. Assertion (A):
A phosphor bronze strip is used in a moving coil galvanometer.
Reason (A):
Phosphor bronze strip has the maximum value of torsional constant k.

**ANSWER KEY:**

| | |
|---|---|
| 1. c | 11. a |
| 2. b | 12. a |
| 3. a | 13. d |
| 4. b | 14. b |
| 5. a | 15. a |
| 6. a | 16. b |
| 7. a | 17. c |
| 8. b | 18. d |
| 9. a | 19. a |
| 10. a | 20. c |

## CASE BASED QUESTIONS

Case 1. FORCE ON A CHARGE IN ELECTRIC AND MAGNETIC FIELD




A point charge q (moving with a velocity v and located at r at a given time t) in the presence of both the electric field E and magnetic field B. The force on an electric charge q due to both of them can be written as
$F = q [ E + v \times B ] = F_{el} + F_{mag}$
It is called the 'Lorentz force'.

1. If the charge q is moving under a field, the force acting on the charge depends on the magnitude of field as well as the velocity of the charge particle, what kind of field is the charge moving in?
(a) Electric field
(b) Magnetic field
(c) Both electric and magnetic field perpendicular to each other
(d) None of these

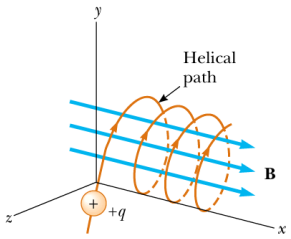
2. The magnetic force acting on the charge ‘q’ placed in a magnetic field will vanish if
(a) if v is small
(b) If v is perpendicular to B
(c) If v is parallel to B
(d) None of these

3. If an electron of charge -e is moving along + X direction and magnetic field is along + Z direction, then the magnetic force acting on the electron will be along
(a) + X axis
(b) - X axis
(c) - Y axis
(d) + Y axis

4. The vectors which are perpendicular to each other in the relation for magnetic force acting on a charge particle are
(a) F and v
(b) F and B
(c) v and B
(d) All of these

5. A particle moves in a region having a uniform magnetic field and a parallel, uniform electric field. At some instant, the velocity of the particle is perpendicular to the field direction. The path of the particle will be
(a) A straight line
(b) A circle
(c) A helix with uniform pitch
(d) A helix with non-uniform pitch

CASE 2: HELICAL MOTION OF A CHARGED PARTICLE IN A MAGNETIC FIELD




If velocity has a component along B, this component remains unchanged as the motion along the magnetic field will not be affected by the magnetic field. The motion in a plane perpendicular to magnetic field is a circular one, thereby producing a helical motion.

1. The radius of the charge particle, (when v is perpendicular to B) placed in a uniform magnetic field is given by

(a) R = mv/qB
(b) R = qB/mv
(c) R = Bqm/v
(d) R = vq/mB

2. An electron, proton, $He^{+}$ and $Li^{++}$ are projected with the same velocity perpendicular to a uniform magnetic field. Which one will experience maximum magnetic force?

(a) Electron
(b) Proton
(c) $He^{+}$
(d) $Li^{++}$

3. The work done by the magnetic field on the charge particle moving perpendicular to a uniform magnetic field is

(a) Zero
(b) q (v x B). S
(c) Maximum
(d) qBS/v

4. The distance moved by a charged particle along the magnetic field in one rotation, when v has a component parallel to B is

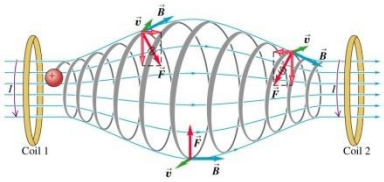
(a) $\frac{2\pi v\cos\theta}{qBm}$

(b) $\frac{2\pi mv\cos\theta}{qB}$

(c) $\frac{qBm}{2\pi v\cos\theta}$

(d) $\frac{Bq}{2\pi m}$

CASE 3: AURORA BOREALIS




During a solar flare, a large number of electrons and protons are ejected from the sun. Some of them get trapped in the earth's magnetic field and move in helical paths along the field lines. The field lines come closer to each other near the magnetic poles, hence the density of charges increases near the poles. The particles collide with atoms and molecules of the atmosphere. Excited oxygen atoms emit green light and excited nitrogen atoms emit pink light. This phenomenon is called 'Aurora Borealis'.

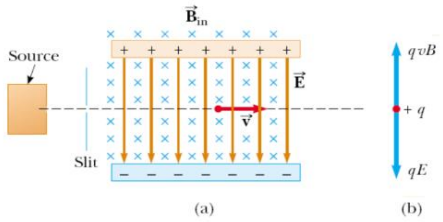
1. When will the path of the particle be helix, when it is moving in external magnetic field?
(a) When v has a component parallel to B
(b) When v has a component perpendicular to B
(c) When v is parallel to B
(d) None of these

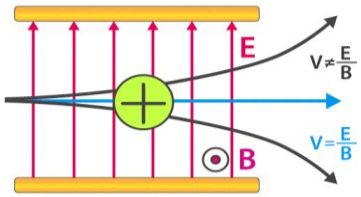
2. When the charged particle travelling in a helical path enters a region where the magnetic field is non-uniform, the pitch of helix of the charge particle will be
(a) Same as in uniform magnetic field
(b) Increases as the charge moves inside the magnetic field
(c) Decreases as the charge moves inside the magnetic field
(d) First increases then decreases as the charge moves inside the magnetic field

3. The colour of Aurora Borealis is due to
(a) Excited ozone, chromium atoms
(b) Excited Oxygen and Nitrogen atoms
(c) Due to presence of water vapours in the atmosphere
(d) Excited electrons and protons in the atmosphere

4. The density of magnetic field lines is greater_____ on the earth
(a) At the poles
(b) Near the equator
(c) Uniform everywhere on the surface
(d) None of these

CASE 4: VELOCITY SELECTOR




A charge q moving with a velocity v in presence of both electric and magnetic fields experience a force F = q [ E + v x B ]. If electric and magnetic fields are perpendicular to each other and also perpendicular to the velocity of the particle, the electric and magnetic forces are in opposite directions. If we adjust the value of electric and magnetic field such that magnitude of the two forces are equal. The total force on the charge is zero and the charge will move in the fields undeflected.
1.What will be the value of velocity of the charge particle, when it moves undeflected in a region where the electric field is perpendicular to the magnetic field and the charge particle enters at right angles to the fields.
(a) v = E/B
(b) v = B/E
(c) v = EB
(d) v = EB/q

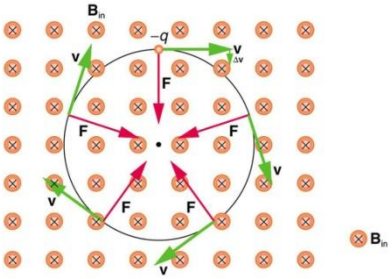
2. Proton, neutron, alpha particle and electron enter a region of uniform magnetic field with same velocities. The magnetic field is perpendicular to the velocity. Which particle will experience maximum force?
(a) proton
(b) electron
(c) alpha particle
(d) neutron

3. A charge particle moving with a constant velocity passing through a space without any change in the velocity. Which can be true about the region?
(a) E = 0, B = 0
(b) E ≠ 0, B ≠ 0
(c) E = 0, B ≠ 0
(d) All of these

4. Proton, electron and deuteron enter a region of uniform magnetic field with same electric potential-difference at right angles to the field. Which one has a more curved trajectory?

(a) electron
(b) proton
(c) deuteron
(d) all will have same radius of circular path

CASE 5: MOTION OF A CHARGED PARTICLE IN A UNIFORM MAGNETIC FIELD




A charged particle of mass m and charge q moves with a constant velocity along the positive X direction v = ai. It enters a region of magnetic field which is directed towards positive Z direction from x = a which is given by B = bk

1.The initial acceleration of the particle is

(a) a = $-\frac{qab}{m}$ i

(b) a = - $\frac{qam}{b}$ j

(c) a = - $\frac{qa}{mb}$ j

(d) none of these

2. The radius of the circular path which the particle moves is

(a) $\frac{mb}{qa}$

(b) $\frac{ma}{qb}$

(c) $\frac{mab}{q}$

(d) None of these

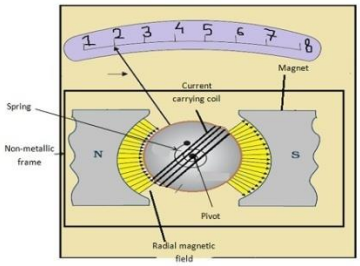
3. Which of the following is true about the motion of the particle in uniform magnetic field, where the charged particle enters at right angles to the field?

(a) Force will always be perpendicular to the velocity.
(b) Kinetic energy of the particle remains constant.
(c) Velocity vector and magnetic field vector remains perpendicular to each other during the motion.
(d) All of these.

4. The frequency of the rotation

(a) depends on the value of a
(b) depends on the value of b
(c) depends on the value of a and b both
(d) does not depend on a and b

CASE 6: MOVING COIL GALVANOMETER




The galvanometer is a device used to detect the current flowing in a circuit or a small potential difference applied to it. It consists of a coil with many turns, free to rotate about a fixed axis, in a uniform radial magnetic field formed by using concave pole pieces of a magnet. When a current flows through the coil, a torque acts on it.

1.What is the principle of moving coil galvanometer?

(a) Torque acting on a current carrying coil placed in a uniform magnetic field.
(b) Torque acting on a current carrying coil placed in a non-uniform magnetic field.
(c) Potential difference developed in the current carrying coil.
(d) None of these.

2. If the field is radial, then the angle between magnetic moment of galvanometer coil and the magnetic field will be

(a) 0°
(b) 30°
(c) 60°
(d)90°

3. Why pole pieces are made concave in the moving coil galvanometer?

(a) to make the magnetic field radial.
(b) to make the magnetic field uniform.
(c) to make the magnetic field non-uniform.
(d) none of these.

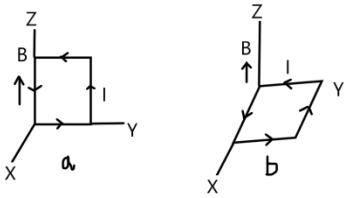
4. What is the function of radial field in the moving coil galvanometer?

(a) to make the torque acting on the coil maximum.
(b) to make the magnetic field strong.
(c) to make the current scale linear.
(d) all the above.

5. If the rectangular coil used in the moving coil galvanometer is made circular, then what will be the effect on the maximum torque acting on the coil in magnetic field for the same area of the coil?

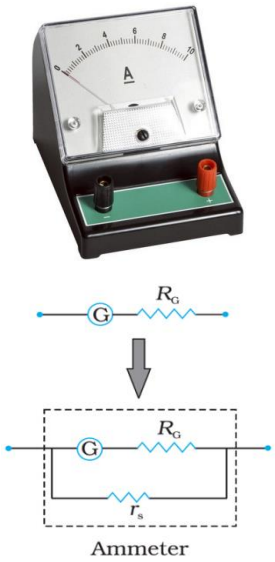
(a) remains the same
(b) becomes less in circular coil
(c) becomes greater in circular coil
(d) depends on the orientation of the coil

6.What is the torque and force in the two cases as shown in the fig.?




(a) $\tau_a < \tau_b$, $F_a \neq 0$, $F_b \neq 0$
(b) $\tau_a > \tau_b$, $F_a = F_b = 0$
(c) $\tau_a = \tau_b = 0$, $F_a = F_b = 0$
(d) $\tau_a = \tau_b$, $F_a = F_b = 0$

CASE 7: CONVERSION OF MOVING COIL GALVANOMETER INTO AN AMMETER



Ammeter

The galvanometer cannot be used as an ammeter to measure the value of the current directly as it is a very sensitive device. It gives a full-scale deflection for current of the order of μA. For measuring currents, the galvanometer has to be connected in series, and as it has a large resistance, this will change the value of current in the circuit.

1.How is a moving coil galvanometer converted into an ammeter of desired range?
(a)Connecting a shunt resistance in series.
(b)Connecting a shunt resistance in parallel.
(c)Connecting a large resistance in series.
(d)Connecting a large resistance in parallel.

2.A moving coil galvanometer of resistance G gives a full-scale deflection for a current Ig. It is converted into an ammeter of range 0- I ampere. What should be the value of shunt resistance to convert it into an ammeter of desired range?
(a)$S = \frac{I}{I - I_g} G$
(b)$S = \frac{I - I_g}{I} G$

(c)S = $\frac{I}{I_g}$ G

(d)S = $\frac{I_g}{I}$ G

3.Which one will have the greatest resistance – a micro-ammeter, a milli-ammeter, an ammeter?

(a)Micro-ammeter

(b)Milli-ammeter

(c)Ammeter

(d)All will have the same resistance

4.The resistance of the ammeter will be

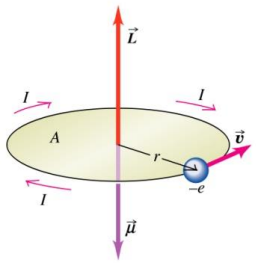
(a)$\frac{1}{R_A} = \frac{1}{G} + \frac{1}{S}$

(b)RA = G + S

(c)RA = $\frac{G+S}{GS}$

(d)None of these

CASE 8. MAGNETIC MOMENT OF ELECTRON




In the Bohr model of the Hydrogen atom, the electron revolves around a positively charged nucleus such as a planet revolves around the sun. The force which binds the electron-proton system is the electrostatic force. There will be a magnetic moment associated with this circulating current given by M = I A.

1.What will be the magnetic moment of the electron in the first orbit of H-atom?

(a)$\frac{evr}{2}$

(b)$\frac{ev}{2r}$

(c) $\frac{ev}{2rm}$

(d)$\frac{evr}{2m}$

2. The relation between magnetic moment and angular momentum for an electron revolving in the first orbit of H-atom is

(a) M = $\frac{e}{2m}$ L

(b) L = $\frac{e}{2m}$ M

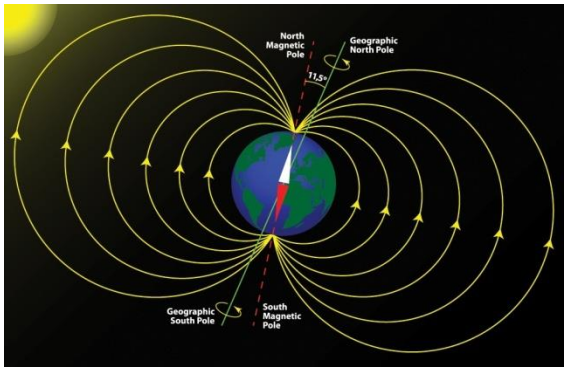
(c) M = $\frac{eB}{2m}$ L

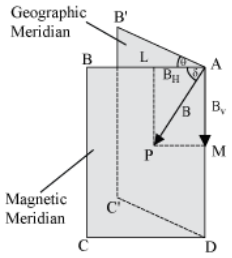
(d) L = $\frac{eB}{2m}$ M

3. The angle between magnetic moment vector and angular momentum vector is
(a) 0°
(b)45°
(c)90°
(d)180°

4. The value of gyroscopic ratio M/L
(a) depends on the value of charge
(b) is a constant quantity
(c) depends on mass of the particle
(d) depends on the axis of rotation.

CASE 9: EARTH'S MAGNETISM




The magnetic field lines of the earth resemble that of a hypothetical magnetic dipole located at the centre of the earth. The axis of the dipole does not coincide with the axis of rotation of the earth but is presently tilted by approximately 11.3° with respect to the later. If the magnetic needle is perfectly balanced about a horizontal axis so that it can swing in a plane of the magnetic meridian, the needle would make an angle with the horizontal. This is known as the angle of dip (also known as inclination).

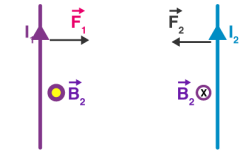
1.What is the angle of dip at the equator?
(a) 0°
(b) 45°
(c) 60°
(d) 90°

2. At the poles, the dip needle will
(a) stay horizontal
(b) stay vertical
(c) stays at 45° angle with the horizontal
(d) does not remain steady in any fixed position

3.The angle of dip where the vertical component of the earth's magnetic field is equal to the horizontal component of the earth's magnetic field will be
(a)0°
(b)45°
(c)60°
(d)90°

4. Which of the following independent quantities is not used to specify the earth's magnetic field?
(a) Magnetic declination (θ)
(b) Angle of dip (δ)
(c) Horizontal component of earth's magnetic field ($B_H$)
(d) Vertical component of earth's magnetic field ($B_V$)

CASE 10: FORCE BETWEEN TWO INFINITELY LONG PARALLEL CURRENT-CARRYING WIRES



Current carrying conductors

Two current-carrying conductors placed near each other will exert magnetic forces on each other. Ampere studied the nature of this magnetic force and its dependence on the product of magnitude of currents in both the conductors, on the shape and size of conductors as well as the distances between the conductors. Using Fleming's left hand rule, it is observed that currents flowing in the same direction attract each other and currents flowing in the opposite directions repel each other. Thus, force per unit length acting on a conductor of infinite length is given by

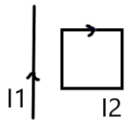
$$F = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d}$$

1.A vertical wire carries a current in upward direction. An electron beam sent horizontally towards the wire will be deflected
(a)towards right
(b)towards left
(c)upwards
(d)downwards

2. A current carrying, straight wire is kept along axis of a circular loop carrying a current. The straight wire
(a)will exert an inward force on the circular loop.
(b)will exert an outward force on the circular loop.
(c)will not exert any force on the circular loop.
(d)will exert a force on the circular loop parallel to itself.

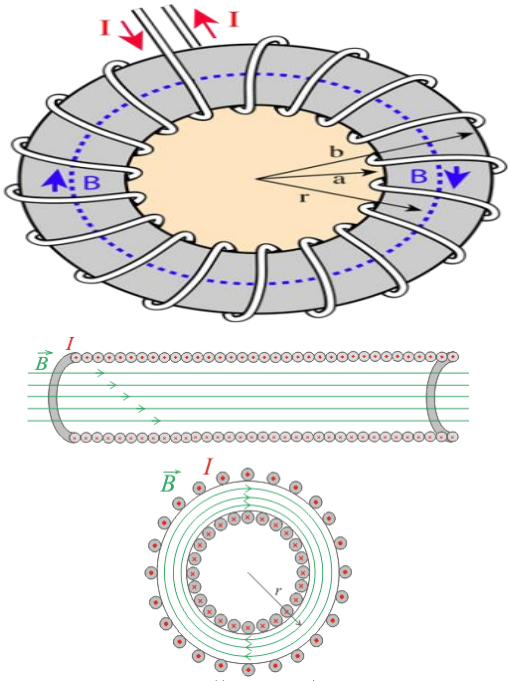
3. A proton beam is going from north to south and electron beam is going from south to north. Neglecting the earth's magnetic field, the electron beam will be deflected
(a)towards the proton beam
(b)away from the proton beam
(c)upwards
(d)downwards

4. Consider the situation shown in fig. The straight wire is fixed but the loop can move under magnetic force. The loop will




(a)remain stationary
(b)move towards the wire
(c)move away from the wire
(d) rotate about the wire.

CASE 11: TOROID
The toroid is a hollow circular ring on which a large number of turns of wire are closely wound. It can be viewed as a solenoid which has been bent into a circular shape to close on itself. The magnetic field vanishes in the open space inside and outside the toroid. The magnetic field inside the toroid is constant in magnitude and is given by $B = \mu_0 n I$, where n is the number of turns per unit length and I is the current flowing in the toriod, $\mu_0$ is the absolute permeability of the free space.



1.The magnetic field inside a toroid of radius R is B. If the current through it is doubled and its radius is also doubled keeping the number of turns per unit length the same, magnetic field produced by it will be

(a) B/2

(b) B/4

(c)B

(d)2B

2. What is the magnetic field in the empty space enclosed by the toroid of radius R?

(a)$\frac{\mu_0}{4\pi}\frac{2I}{R}$

(b) Infinity

(c) Zero

(d) $\frac{\mu_0}{4\pi}\frac{\pi I}{R}$

3. A toroid of 300 turns/m and radius 2 cm is carrying a current of 5 A. What is the magnitude of magnetic field intensity in the interior of the toriod?

(a) 1.9 T

(b) 1.9 x $10^{-6}$ T

(c) 1.9 x $10^{-3}$ T

(d) 1.9 x $10^{-7}$ T

4. Magnetic field due to a current carrying toroid is independent of

(a)Its number of turns

(b) Current

(c) Radius

(d) None of these

5. How can you increase the magnetic field inside a toroid?

(a)by increasing the radius

(a) by decreasing the current

(b) by introducing a soft iron core inside a toroid

(d)by decreasing the total number of turns

**ANSWER KEY OF CASE-BASED QUESTIONS**

| | | | | | |
|---|---|---|---|---|---|
| **CASE 1** | 1 (b) | 2 (c) | 3 (d) | 4 (d) | 5 (d) |
| **CASE 2** | 1 (a) | 2 (d) | 3 (a) | 4 (b) | 5 |
| **CASE 3** | 1 (a) | 2 | 3 (b) | 4 (a) | 5 |
| **CASE 4** | 1 (a) | 2 (c) | 3 (d) | 4 (a) | 5 |
| **CASE 5** | 1 (a) | 2 (b) | 3 (d) | 4 (b) | 5 |
| **CASE 6** | 1 (a) | 2 (d) | 3 (a) | 4 (d) | 5 (a) 6 (b) |
| **CASE 7** | 1 (b) | 2 (a) | 3 (a) | 4 (a) | 5 |
| **CASE 8** | 1 (a) | 2 (a) | 3 (d) | 4 (b) | 5 |
| **CASE 9** | 1 (a) | 2 (b) | 3 (b) | 4 (d) | 5 |
| **CASE 10** | 1 (c) | 2 (c) | 3 (a) | 4 (b) | 5 |
| **CASE 11** | 1 (d) | 2 (c) | 3 (c) | 4 (b) | 5 |

# UNIT-IV
# ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENT
# ASSERTION (A) & REASONING (R) QUESTIONS

Of the following statements, mark the correct Answers as-
A - if both **Assertion** and **Reason --** are true and **Reason --** is correct explanation of the Assertion.
B - if both **Assertion** and **Reason --** are true but **Reason --** is not correct explanation of Assertion.
C - if **Assertion** is true but **Reason --** is false.
D - if both **Assertion** and **Reason --** are false.
E - if **Assertion** is false but **Reason --** is true

1. Assertion-- The mutual induction of two coils is doubled, if the self-inductance of the primary or secondary coil is doubled
Reason -- Mutual induction is proportional to self-inductance of primary and secondary coils
Answer - C

2. Assertion- Making and breaking of current in a coil produce no momentary current in the neighboring coil of another circuit
Reason -- Momentary current in the neighboring coil of another circuit is an eddy current
Answer - D

3. Assertion- If primary coil is connected by voltmeter and secondary coil by ac source. If large copper sheet is placed between two coils, induced emf in primary coil is reduced
Reason -- Copper sheet between coils has no effect on induced emf in primary coil
Answer – A

4. Assertion- An electric motor will have maximum efficiency when back emf becomes equal to half of applied emf
Reason -- Efficiency of electric motor depends only on magnitude of back emf
Answer – C

5. Assertion- Armature current in DC motor is maximum when the motor has just started
Reason -- Armature current is given by I=E-e/R where e is back emf, R is resistance of armature
Answer – B

6. Assertion- Eddy current is produced in any metallic conductor when magnetic flux is changed around it
Reason -- Electric potential determine the flow of charge
Answer - B

7. Assertion -- The quantity L/R possesses dimensions of time
Reason -- to reduce the rate of increase of current through a solenoid should increase the time constant L/R
Answer - B

8. Assertion- Faraday laws are consequence of conservation of energy
Reason -- In a purely resistive AC circuit, the current lags behind the emf in phase
Answer - C

9. Assertion- Only a change in magnetic flux through a coil maintain a current in the coil if the current is continues
Reason -- The presence of large magnetic flux through a coil maintain a current in the coil if the current is continues
Answer - C

10. Assertion- magnetic flux can produce induced emf
Reason -- Faraday established induced emf experimentally
Answer - E

11. Assertion- Inductance coil are made of copper
Reason -- Induced current is more in wire having less resistance
Answer - A
12. Assertion- When two coils are wound on each other, the mutual induction between coil is maximum
Reason -- Mutual induction doesn't depends on the orientation of the coil s
Answer – C

13. Assertion- an aircraft flies along the meridian, the potential at the ends of its wings will be the same.
Reason -- Whenever there is change in magnetic flux emf induce
Answer – E

14. Assertion- A spark occur between the poles of a switch when the switch is opened
Reason -- Current flowing in the conductor produce magnetic field
Answer – B

15. In the phenomenon of mutual induction self-induction of each of coils persists
Reason -- Self-induction arises when strength of current in same coil change in the mutual induction, current is changing in both the individual
Answer – B

16. An induced emf is generated when magnet is withdrawn from the solenoid
Reason -- The relative motion between the magnet and solenoid induced emf
Answer - A

17. A transformer can't work on DC supply
Reason -- DC changes neither in magnitude nor in direction
Answer - A

18. Soft iron is used as a core of transformer
Reason -- Area of hysteresis is loop for soft iron is small
Answer - A

19. An AC generator is based on the phenomenon of self-induction
Reason -- in single coil we consider, self-induction only
Answer - E

20. An electric motor will maximum efficient, when back emf is equal to applied emf
Reason -- Efficiency of electric motor is depends only on magnitude of back emf
Answer - D

21. An AC doesn't show any magnetic effect
Reason -- AC doesn't vary with time
Answer - D

22. Assertion- A variable capacitor is connected in series with a bulb through AC source if the capacitance of variable capacitor is decrease the brightness of bulb is reduced
Reason -- The reactance of capacitor increase if capacitance is reduced
Answer - A

23. A capacitor of suitable capacitance can be used in AC circuit in the place of choke coil
Reason -- A capacitor blocks DC and allow only AC
Answer - B

24. An AC doesn't show any magnetic effect
Reason -- AC varies with time
Answer - B

25. The division are equally marked on the scale of AC ammeter
Reason -- heat produced is directly proportion to current
Answer - D

26. Average value of AC over a complete cycle is always zero
Reason -- Average value of AC is always defined over half cycle
Answer – B

27. Eddy current is produced in any metallic conductor when magnetic flux is changed around it
Reason -- electric potential determine the flow of charge
Answer – B

28. In LCR circuit resonance can take place
Reason -- resonance can take place if inductance and capacitive reactance are equal and opposite
Answer - A

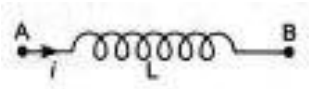
29. When capacitive reactance is smaller than the inductive reactance in LCR circuit, emf leads the current
Reason -- The phase angle is angle between alternating emf and alternating current of the circuit
Answer – B

30. The DC and AC both can be measured by a hot wire instrument
Reason -- The hot wire instrument is based on the principle of magnetic effect of current
Answer - C

# CASE STUDY QUESTIONS

## TOPIC: ELECTROMAGNETIC INDUCTION AND AC

Question 1: An inductor is simply a coil or a solenoid that has a fixed inductance. It is referred to as a choke. The usual circuit notation for an inductor is as shown.




Let a current i flows through the inductor from A to B. Whenever electric current changes through it, a back emf is generated. If the resistance of inductor is assumed to be zero (ideal inductor) then induced emf in it is given by

$$e=V_B-V_A = - L\, di / dt$$

Thus, potential drops across an inductor as we movein the direction of current. But potential also drops across a pure resistor when we move in the direction of the current.
The main difference between a resistor and an inductor is that while a resistor opposes the current through it, an inductor opposes the change in current through it.
Now answer the following questions.
(1) How does inductor behave when
(a) a steady current flow through it?
(b) a steadily increasing, current flows through it?
(c) a steadily decreasing current flows through it?
(d) Name the phenomenon in which change in current in a coil induces EMF in coil itself?

**ANS:** (i) **(a)** As electric current is steady therefore

$$di / dt = 0;$$

:: induced emf = e = 0 and the inductor behaves as short circuit.

**(b)** in the expression

$$e= - L\, di / dt$$

as di / dt is positive EMF is negative. that is $V_B < V_A$.
That is back EMF is genreted that opposses the increase in current.

**(c )** di / dt is negative, therefore EMF is positive. that is $V_B > V_A$. Forward EMF is generated that opposses fall in current.

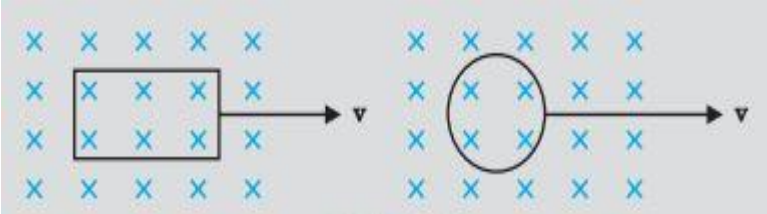
**(d)** Self induction.

**Question 2:**

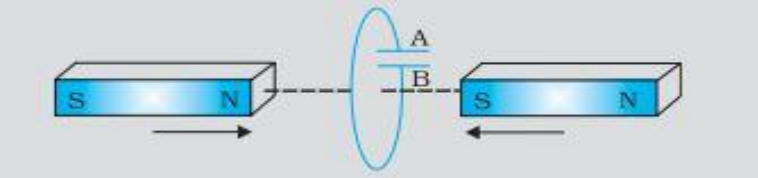
(a)A closed loop is held stationary in the magnetic field between the north and south poles of two permanent magnets held fixed. Can we hope to generate current in the loop by using very strong magnets?

(b) A closed loop moves normal to the constant electric field between the plates of a large capacitor. Is a current induced in the loop
(i) when it is wholly inside the region between the capacitor plates
(ii) when it is partially outside the plates of the capacitor? The electric field is normal to the plane of the loop.

(c) A rectangular loop and a circular loop are moving out of a uniform magnetic field region (Figure) to a field-free region with a constant velocity v. In which loop do you expect the induced emf to be constant during the passage out of the field region? The field is normal to the loops.




(d) Predict the polarity of the capacitor in the situation described by the figure




**Solution:**

(a) No. However strong the magnet may be current can be induced only by changing the magnetic flux through the loop.

(b) No current is induced in either case. Current can not be induced by changing the electric flux.

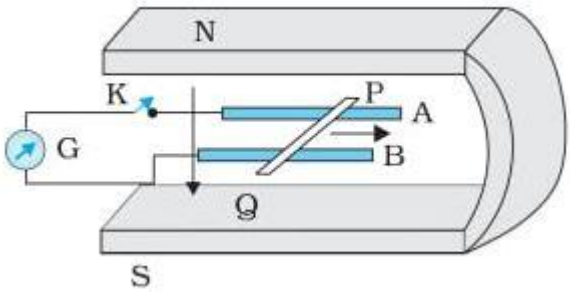
(c) The induced emf is expected to be constant only in the case of the rectangular loop. In the case of circular loop, the rate of change of area of the loop during its passage out of the field region is not constant, hence induced emf will vary accordingly,

(d) The polarity of plate 'A' will be positive with respect to plate 'B' in the capacitor.

**Question 3:**

Given figure shows a metal rod PQ resting on the smooth rails AB and positioned between the poles of a permanent magnet. The rails, the rod, and the magnetic field are in three mutual perpendicular directions. A galvanometer G connects the rails through a switch K. Length of the rod = 15 cm, B = 0.50 T, resistance of the closed loop containing the rod = 9.0 mΩ. Assume the field to be uniform.

(a) Suppose K is open and the rod is moved with a speed of 12 cm $s^{-1}$ in the direction shown. Give the polarity and magnitude of the induced emf.



(b) Is there an excess charge built up at the ends of the rods when K is open? What if K is closed?
(c) With K open and the rod moving uniformly, there is no net force on the electrons in the rod PQ even though they do experience magnetic force due to the motion of the rod. Explain.
(d) What is the retarding force on the rod when K is closed?
(e) How much power is required (by an external agent) to keep the rod moving at the same speed (=12 cm/ sec) when K is closed? How much power is required when K is open?
(f) How much power is dissipated as heat in the closed circuit? What is the source of this power?
(g) What is the induced emf in the moving rod if the magnetic field is parallel to the rails instead of being perpendicular?

**Answers:**
(a) EMF = vBL = 0.12 0.50 x 0.15 = 9.0 mV;
P positive end and Q negative end.
(b) Yes. When K is closed, the excess charge is maintained by the continuous flow of current.
(c) Magnetic force is cancelled by the electric force set-up due to the excess charge of opposite signs at the ends of the rod.
(d) Retarding force = IBL
9 mV / 9 mΩ x 0.5 T x 0.15 m
= 75 x $10^{-3}$ N
e) Power expended by an external agent against the above retarding
force to keep the rod moving uniformly at 12 cm s'
= 75 x $10^{-3}$ x 12 x $10^{-2}$ = 9.0 x $10^{-3}$ W
When K is open, no power is expended.

(f) $I^2$ R = 1x1x 9 x $10^{-3}$ = 9.0 x $10^{-3}$ W
The source of this power is the power provided by the external agent as calculated above.
g) Zero: motion of the rod does not cut across the field lines. [Note: length of Pg has been considered above to be equal to the spacing between the rails.]

**Question 3:**
A small town with a demand of 800 kW of electric power at 220 V is situated 15 km away from an electric plant generating power at 440 V. The resistance of the two wire line carrying power is 0.5Ω per km. The town gets power from the line through a 4000-220 V step-down transformer at a sub-station in the town.
(a) Estimate the line power loss in the form of heat.
(b) How much power must the plant supply, assuming there is negligible power loss due to leakage?
(c) Characterise the step up transformer at the plant.

**Answers:**
Line resistance = 30 X 0.5 = 15Ω
rms current in the line . 800 x 1000 W / 4000 V = 200 A

(a) Line power loss = $(200\ A)^2$ x 15 Ω = 600 kW.
(b) Power supply by the plant = 800 kW + 600 kW = 1400 kW.
(c) Voltage drop on the line = 200 A 15Ω = 3000 V.
The step-up transformer at the plant is 440 V - 7000 V.

**Question 4**. Electromagnetic induction is defined as the production of an electromotive force across an electric conductor in the changing magnetic field. The discovery of induction was done by Michael Faraday in the year 1831. Electromagnetic induction finds many applications such as in electrical components which includes transformers, inductors, and other devices such as electric motors and generators.
Alternating current is defined as an electric current which reverses in direction periodically. In most of the electric power circuits, the waveform of alternating current is the sine wave.

1. How to increase the energy stored in an inductor by four times?
   (a) By doubling the current
   (b) This is not possible
   (c) By doubling the inductance
   (d) By making current 2–√ times

   **Answer:** (a) By doubling the current
2. Consider an inductor whose linear dimensions are tripled and the total number of turns per unit length is kept constant, what happens to the self-inductance?
   (a) 9 times
   (b) 3 times
   (c) 27 times
   (d) 13 times

   **Answer:** (b) 3 times
3. Lenz law is based on which of the following conservation>
   (a) Charge
   (b) Mass
   (c) Momentum
   (d) Energy
   **Answer:** (d) Energy

4. What will be the acceleration of the falling bar magnet which passes through the ring such that the ring is held horizontally and the bar magnet is dropped along the axis of the ring?
   (a) It depends on the diameter of the ring and the length of the magnet
   (b) It is equal due to gravity
   (c) It is less than due to gravity
   (d) It is more than due to gravity
   **Answer:** (c) It is less than due to gravity

# UNIT-V
# ELECTROMAGNETIC WAVES
# ASSERTION (A) AND REASONING (R) QUESTIONS

**A. Both assertion and reason are True, *and* reason is the correct explaination .**

**B. Both assertion and reason are True, *but* reason is not the correct explaination .**

**C. Assertion is True , but reason is False .**

**D. Both assertion and reason are False .**

Assertion: Electromagnetic waves do not require medium for their propagation.
Reason: They can't travel in a medium.
Answer: C

Assertion: A changing electric field produces a magnetic field.
Reason: A changing magnetic field produces an electric field.
Answer: B

Assertion: X-rays travel with the speed of light.
Reason: X-rays are electromagnetic rays.
Answer: A

Assertion: Environmental damage has increased amount of Ozone in atmosphere.
Reason: Increase of ozone increases amount of ultraviolet radiation on earth
Answer: D

Assertion: Electromagnetic radiation exert pressure.
Reason: Electromagnetic waves carry both - Momentum & Energy.
Answer: B

Assertion: During discharging, there is magnetic field between plates of capacitor.
Reason: Time varying electric field produces magnetic field.
Answer: A

Assertion: In electromagnetic waves, electric and magnetic Field are perpendicular to each other.
Reason: E and B are self-sustaining.
Answer: B

Assertion: The earth without its atmosphere would be inhospitably Cold.
Reason: All heat would escape in the absence of atmosphere.
Answer: A

Assertion: The EM waves of shorter wavelength can travel longer distances on earth's surface than those of longer wavelengths.
Reason: Shorter the wavelength, the larger is the Velocity of propagation.
Answer: C

Assertion: EM waves follow Superposition principle.
Reason: Differential expression of EM wave is linear.
Answer: A

Assertion: Sound waves cannot travel in vacuum, but light waves can.
Reason: Light is an electromagnetic wave - but sound is a Mechanical wave.
Answer: A

Assertion: The Microwaves are better carriers of signals than radio waves.
Reason: The electromagnetic waves do not require any medium to propagate.
Answer: B

Assertion: Transverse waves are not produced in liquids and gases.
Reason: Shorter the wavelength, the larger is the Velocity of propagation.
Answer: B

Assertion: The energy contained in a small volume through which an em wave is passing, oscillates with the frequency of the wave.
Reason: Energy density of the wave is given by : ½ $e_0 E^2$ .
Answer: D

Assertion : Like Light radiation, thermal radiations are also e.m. radiations .
Reason: Thermal radiations require no medium for propagation .
Answer: B

Assertion : X-rays cannot be deflected by electric or magnetic fields .
Reason: These are electromagnetic waves .
Answer: A

Assertion : EM waves are transverse in nature .
Reason : Waves of wavelength 10mm are radiowave and microwave .
Answer: C

Assertion : Dipole oscillations produce em waves.
Reason: Accelerated charge produces em waves.
Answer: A

Assertion : In an electromagnetic wave, magnitude of magnetic field vector B is much smaller than the magnitude of vector E .
Reason: This is because in an electromagnetic wave $E/B = c = 3x10^8$.
Answer: A

Assertion : The gyrating electron can be a source of EM wave .
Reason: The electron in circular motion is accelerated motion .
Answer: A

Assertion : EM waves interacts with matter and set up oscillations .
Reason: Interaction is independent of em wave's Wavelength .
Answer: C

Assertion : When an em wave going through vacuum is described as :
$E = E0 . \sin (kx-wt)$ , then w/k is independent of wavelength.
Reason: w / k is speed of the wave.
Answer: A

Assertion : Ozone layer is essential for sustaining life on earth .
Reason: Ozone layer absorbs UV radiation, hence preventing it to reach on earth .
Answer: A

Assertion : Microwaves are considered suitable for radar ,used in navigation
Reason: Microwaves have wavelength of few millimeters. Due to this reason, they ] suffer very small diffraction .
Answer: A

Assertion : Ratio of speed of uv rays & infrared waves (in vacuum) is 1.
Reason: Both; infrared and uv rays are electromagnetic waves .
Answer: A

Assertion : Welders wear face mask,goggles during welding - on eyes.
Reason: 'Gamma' rays are produced by welding, is harmful for eyes.
Answer: C

Assertion : Infrared radiation are referred as Heat wave.
Reason: they get readily absorb ny molecules in most material .
Answer: A

Assertion : Ratio of frequencies of ultraviolet waves to infrared waves - is greater than 1.
Reason: Frequency of u.v. rays is more than infrared rays .
Answer: A

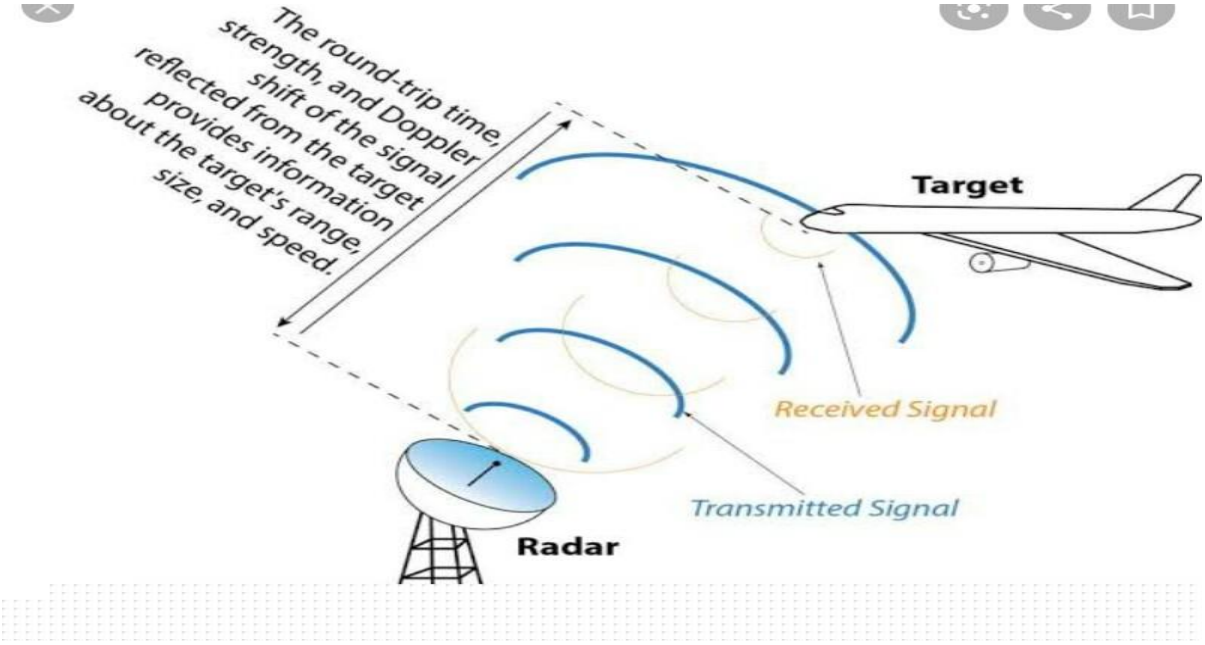
Assertion : Gamma rays are more energetic than X-rays.
Reason : Gamma rays are of nuclear origin- but X-rays are produced to sudden deceleration of high energy electrons while falling on a metal of high atomic number .
Answer: B

Assertion : The velocity of em wave depends on Electric and Magnetic properties of medium .
Reason: Velocity of em waves in free space is constant.
Answer: B

## CASE STUDY QUESTIONS
## TOPIC: ELECTROMAGNETIC WAVES

Q1)Microwave in aircraft navigation

Microwave are used in aircraft navigation. A radar guns out short bursts of microwave and it reflect back from oncoming aircraft and are detected by receiver in gun. The frequency of reflected wave used to compute speed of aircraft




1 Q) How are microwave produced?
a) klystron and magnetron valve
b) sudden deceleration of electron in x- ray tube
c)accelerated motion of charge in conducting wire
d)hot bodies and molecules

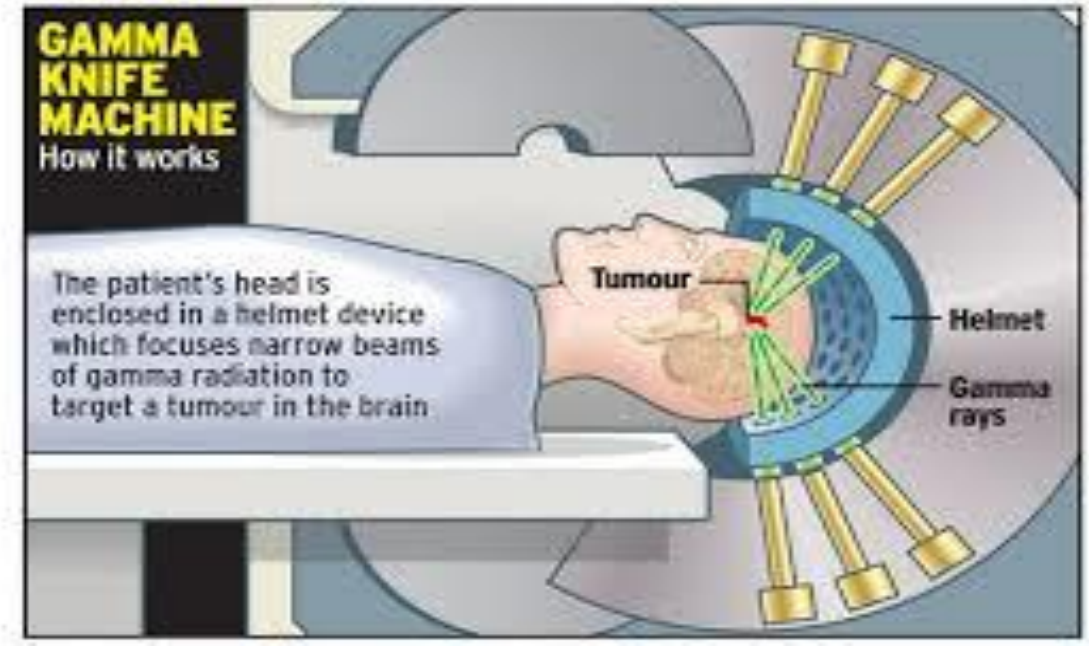
2 Q) why microwave use for aircraft navigation?
A) due to high wavelength
B) due to low wavelength
c) due to low frequency
d)due to their frequency modulation power

3 Q) which is use of microwave?
a) in treatment of cancer
b) to observe changing blood flow
c)used to kill microbes
d)studying details of atoms and molecule

4 Q) where do microwave fall in electromagnetic spectrum?
a) between u.v region and infrared
b) between gamma and u.v
c)between infrared and radio wave
d)between gamma and infrared

ANSWER KEY
1)a 3)d
2)b 4)c

Q 2) GAMMA RAYS IN TREATMENT OF CANCER
Gamma rays are used in radiotherapy to Treat cancer. They are used to spot tumors. they kill the living cells and damage malignant tumor.



1 Q) what is the source of gamma rays?
a) radioactive decay of nucleus
b) accelerated motion of charges in conducting wire
c) hot bodies and molecule
d) klystron valve

2 Q) how is wavelength of gamma rays
a) low
b) high
c) infinite
d) zero

3 Q)choose the one with correct radiation order?
a) alpha>beta>gamma
b) beta>alpha>gamma
c) gamma>beta>alpha
d) gamma>alpha>beta

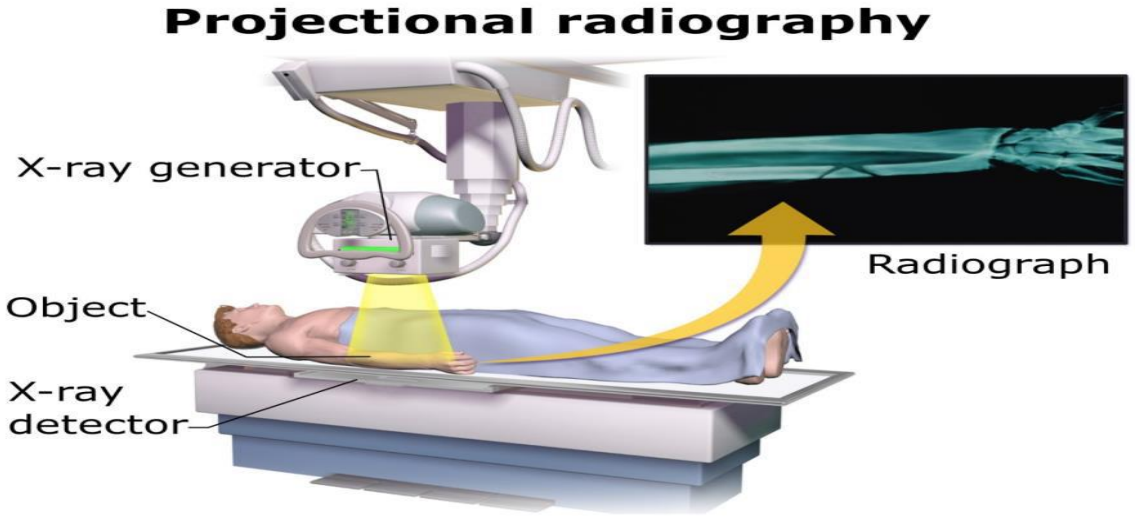
4 Q) what is other use of gamma rays?
a) used to change white topaz to blue topaz
b) used in aircraft navigation
c) used in kill microbes
d) checking fractures of bone

ANSWER KEY

1)a 3)c
2)b 4)a

Q3) X- Rays

X-rays are a form of electromagnetic radiation, similar to visible light. Unlike light, however, x-rays have higher energy and can pass through most objects, including the body. Medical x-rays are used to generate images of tissues and structures inside the body.



Q1. What is the most common method of preparation of X rays ?
a) magnetron valve
b) vibration of atoms and molecules
c) bombardment of metal by high energy electrons
d) radioactive decay of nucleus

Q2) which of the following set of instrument /equipment can detect X- rays
a) Photocells ,photographic film
b) Thermopiles ,bolometer
c) Photographic film ,Geiger tube
d) Geiger tube ,human eye

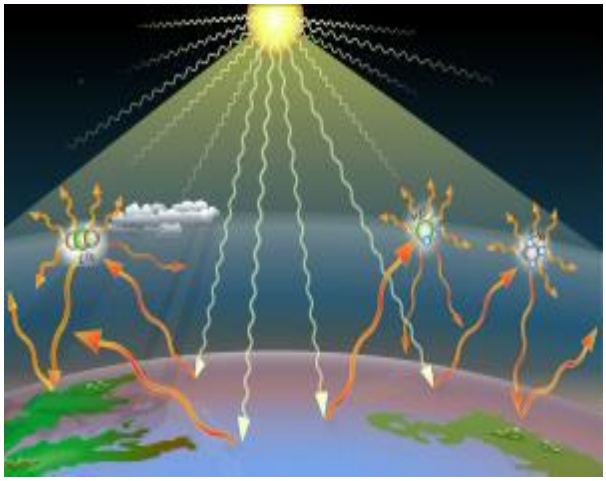
Q3) where do X rays fall on the electromagnetic spectrum?
a) Between UV region and infrared region
b) Between gamma rays and UV region
c) Between infrared and microwaves
d) Between microwaves and radio waves

Q4) what is the use of rays lying beyond X ray region in electromagnetic spectrum
a) used to kill microbes
b) used to detect heat loss in insulated systems
c) used in standard broadcast radio and television
d) used In oncology, to kill cancerous cells.

ANSWER KEY

Q1 c  Q2 c
Q3 b  Q4 d

Q4). Green house effect
The greenhouse effect is a natural process that warms the Earth's surface. When the Sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases. The absorbed energy warms the atmosphere and the surface of the Earth



Q1 The one which is not considered as naturally occurring greenhouse gas is
(a) methane
(b) CFCs
(c) carbon dioxide
(d) nitrous oxide

Q2) Which of the following is not a use of infrared waves
a) Used in treatment for certain forms of cancer
b) in military and civilian applications include target acquisition, surveillance, night vision, homing, and tracking.
c) to observe changing blood flow in the skin
d) In imaging cameras, used to detect heat loss in insulated systems

Q3) which of the following is the best method for production of infrared waves
a) bombardment of metal by high energy electrons
b) radioactive decay of nucleus
c) magnetron valve
d) vibration of atoms and molecules

Q4) Wavelength of infrared radiations is
(a) shorter (b) longer (c) infinite (d) zero

(ANSWER KEY)
Q1 b Q2 a
Q3 d Q4 b

**Q5 ) ELECTROMAGNETIC (EM) SPECTRUM**

- The electromagnetic (EM) spectrum is the range of all types of EM radiation. Radiation is energy that travels and spreads out as it goes – the visible light that comes from a lamp in your house and the radio waves that come from a radio station are two types of electromagnetic radiation. The other types of EM radiation that make up the electromagnetic spectrum are microwaves, infrared light, ultraviolet rays, X- rays and gamma rays.

Q1. The classification is roughly based on?
I) Wavelength and frequency of waves.
II) Production and detection of waves.
III) The way of travelling of waves.
IV) Year discovered.

Q2. Which of the following is NOT an example of EM RAYS.
I) Radiotherapy(medicine).
II) Checking fractures.
III) Sterilisation.
IV) Explosives.

Q3. Identify the pair having highest frequency and highest wavelength EM WAVES.

I) UV rays and X- rays
II) Gamma rays and Microwaves.
III) Gamma rays and Radio waves.
IV) Radio waves and UV rays.

Q4. What physical quantity is the same for X rays of wavelength $10^{-10}$m, red light of wavelength 6800 $A^o$ and radiowaves of wavelength 500m?

I) Speed in vacuum (c)
II) frequency (f)
III) Scattering
IV) Energy (e)

**ANSWER KEY**

1. II) PRODUCTION AND DETECTION OF WAYS
2. IV) EXPLOSIVES
3. III) GAMMA RAYS AND RADIO WAVES
4. I) SPEED IN VACUUM

# UNIT-VI
# OPTICS

**Instructions:**
**Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**
**a) Both A and R are true and R is the correct explanation of A**
**b) Both A and R are true but R is NOT the correct explanation of A**
**c) A is true but R is false**
**d) A is false and R is also false**

1) Assertion : The stars twinkle while the planets do not.
Reason : The stars are much bigger in size than the planets.
Correct Answer: B
Solution : The stars twinkle while the planets do not. It is due to variation in density of atmospheric layer. As the stars are very far and giving light continuously to us. So, the light coming from stars is found to change their intensity continuously. Hence they are seen twinkling. Also stars are much bigger in size than planets but it has nothing to deal with twinkling phenomenon.

2) Assertion : The air bubble shines in water.
Reason : Air bubble in water shines due to refraction of light
Correct Answer: C
Solution : Shining of air bubble in water is on account of total internal reflection.

3) Assertion : A double convex lens ($\mu_m = 1.5$) has focal length 10 cm. When the lens is immersed in water ($\mu_l = 4/3$) its focal length becomes 40 cm.
Reason : $1/f = [(\mu_l - \mu_m)/\mu_m](1/R_1 - 1/R_2)$
Correct Answer: A
Solution : Focal length of lens immersed in water is four times the focal length of lens in air. It means

$$f_w = 4fa = 4 \times 10 = 40 \text{ cm}$$

4) Assertion : The colour of the green flower seen through red glass appears to be dark.
Reason : Red glass transmits only red light.
Correct Answer: A

Solution : The red glass absorbs the radiations emitted by green flowers; so flower appears black.

5) Assertion : The mirrors used in search lights are parabolic and not concave spherical.
Reason : In a concave spherical mirror the image formed is always virtual.
Correct Answer: C

Solution : In search lights, we need an intense parallel beam of light. If a source is placed at the focus of a concave spherical mirror, only paraxial rays are rendered parallel. Due to large aperture of mirror, marginal rays give a divergent beam. But in case of parabolic mirror, when source is at the focus, beam of light produced over the entire cross-section of the mirror is a parallel beam.

6) Assertion : The size of the mirror affect the nature of the image.
Reason : Small mirrors always forms a virtual image.
Correct Answer: D
Solution : The size of the mirror does not affect the nature of the image except that a bigger mirror forms a brighter image.

7) Assertion : Within a glass slab, a double convex air bubble is formed. This air bubble behaves like a converging lens.
Reason : Refractive index of air is more than the refractive index of glass.
Correct Answer: D
Solution : The air bubble would behave as a diverging lens, because refractive index of air is less than refractive index of glass. However, the geometrical shape of the air bubble shall resemble a double convex lens.

8) Assertion : The focal length of lens does not change when red light is replaced by blue light.
Reason : The focal length of lens does not depends on colour of light used.
Correct Answer: D
Solution : Focal length of the lens depends upon it's refractive index as $1/f \propto (\mu - 1)$. Since $\mu_b > \mu_r$ so $f_b < f_r$ . Therefore, the focal length of a lens decreases when red light is replaced by blue light.

9) Assertion : There is no dispersion of light refracted through a rectangular glass slab.
Reason : Dispersion of light is the phenomenon of splitting of a beam of white light into its constituent colours.
Correct Answer: B
Solution : After refraction at two parallel faces of a glass slab, a ray of light emerges in a direction parallel to the direction of incidence of white light on the slab. As rays of all colours emerge in the same direction (of incidence of white light), hence there is no dispersion, but only lateral displacement.

10) Assertion : A beam of white light gives a spectrum on passing through a hollow prism.
Reason : Speed of light outside the prism is different from the speed of light inside the prism.
Correct Answer: D

Solution : Dispersion of light cannot occur on passing through air contained in a hollow prism. Dispersion take place because the refractive index of medium for different colour is different. Therefore when white light travels from air to air, refractive index remains same and no dispersion occurs.

11) Assertion : If objective and eye lenses of a microscope are interchanged then it can work as telescope. Reason : The objective of telescope has small focal length.
Correct Answer: D
Solution : We cannot interchange the objective and eye lens of a microscope to make a telescope. The reason is that the focal length of lenses in microscope are very small, of the order of mm or a few cm and the difference (fo & fe) is very small, while the telescope objective have a very large focal length as compared to eye lens of microscope.

12) Assertion : Although the surfaces of a goggle lens are curved, it does not have any power.
Reason : In case of goggles, both the curved surfaces have equal radii of curvature.
Correct Answer: A
Solution : The focal length of a lens is given by $1/f=(\mu-1)(1/R_1-1/R_2)$ For, goggle, $R_1 = R_2$ $1/f= (\mu-1)(1/R_1-1/R_2) = 0$. Therefore, $P = 1/f = 0$.

13) Assertion : If the angles of the base of the prism are equal, then in the position of minimum deviation, the refracted ray will pass parallel to the base of prism.
Reason : In the case of minimum deviation, the angle of incidence is equal to the angle of emergence.
Correct Answer: A
Solution : In case of minimum deviation of a prism $\angle i=\angle e$. so, $\angle r_1=\angle r_2$

14) Assertion : An empty test tube dipped into water in a beaker appears silver, when viewed from a suitable direction.
Reason : Due to refraction of light, the substance in water appears silvery.
Correct Answer: C
Solution : The ray of light incident on the water air interface suffers total internal reflections, in that case the angle of incidence is greater than the critical angle. Therefore, if the tube is viewed from suitable direction (so that the angle of incidence is greater than the critical angle), the rays of light incident on the tube undergoes total internal reflection. As a result, the test tube appears as highly polished i.e. silvery.

15) Assertion : Spherical aberration occur in lenses of larger aperture.
Reason : The two rays, paraxial and marginal rays focus at different points.
Correct Answer: A
Solution : In wide beam of light, the light rays of light which travel close to the principal axis are called paraxial rays, while the rays which travel quite away from the principal axis

is called marginal rays. In case of lens having large aperture, the behaviour of the paraxial and marginal rays are markedly different from each other. The two types of rays come to focus at different points on the principal axis of the lens, thus the spherical aberration occur. However in case of a lens with small aperture, the two types of rays come to focus quite close to each other.

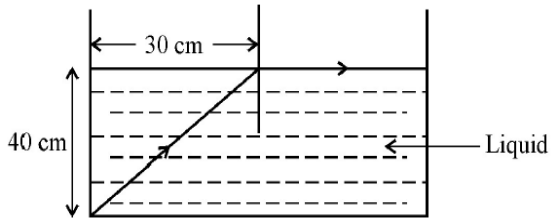
16) Assertion : The frequencies of incident, reflected and refracted beam of monochromatic light incident from one medium to another are same
Reason : The incident, reflected and refracted rays are coplanar.
Correct Answer: B
Solution : If both assertion and reason are true but reason is not the correct explanation of the assertion.

17) Assertion : By roughening the surface of a glass sheet its transparency can be reduced.
Reason : Glass sheet with rough surface absorbs more light.
Correct Answer: C
Solution : When glass surface is made rough then the light falling on it is scattered in different direction due to which its transparency decreases.

18) Assertion : Diamond glitters brilliantly.
Reason : Diamond does not absorb sunlight.
Correct Answer: B
Solution : Diamond glitters brilliantly because light enters in diamond suffers total internal reflection. All the light entering in it comes out of diamond after number of reflections and no light is absorb by it.

19) Assertion : The cloud in sky generally appear to be whitish.
Reason : Diffraction due to cloud is efficient in equal measure at all wavelengths.
Correct Answer: C
Solution : The clouds consist of dust particles and water droplets. Their size is very large as compared to the wavelength of the incident light from the sun. So there is very little scattering of light. Hence the light which we receive through the clouds has all the colours of light. As a result of this, we receive almost white light. Therefore, the cloud are generally white.

Case based Questions (Ray optics)
1) Total internal reflection.



(i) What is refractive index of a medium(in terms of speed of light)
a) Speed of light in medium/speed of light in vacuum
b) Speed of light in vacuum/speed of light in medium
c) Speed of light in medium × speed of light in vacuum
d) None of the above.

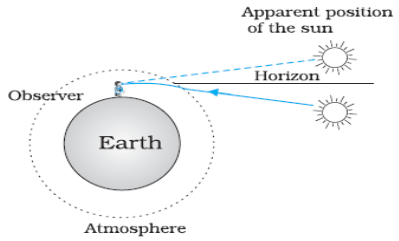
(ii) In the above diagram, calculate the speed of light in the liquid of unknown refractive index.
a) $1.2 \times 10^8$ m/$s$
b) $1.4 \times 10^8$ m/$s$
c) $1.6 \times 10^8$ m/$s$
d) $1.8 \times 10^8$ m/$s$

(iii) What is refractive index of a medium(in terms of real and apparent depth).
a) Real depth/ App depth
b) App/ Real depth
c) App × Real depth
d) Real + App depth

(iv) What is the relation between refractive index and critical angle for a medium.
a) $n = 1/\sin i_c$
b) $n = \sin i_c$
c) $1 = n/\sin i_c$
d) None of the above

**Answer:**
**i) (b)**
**ii) (d)**
**iii) (a)**
**iv) (a)**

2) Advance sunrise and delayed sunset




(i) What is the principal behind Advance sunrise and delayed sunset.
(a) Reflection.
(b) Refraction.
c) Dispersion
d) Total internal reflection.

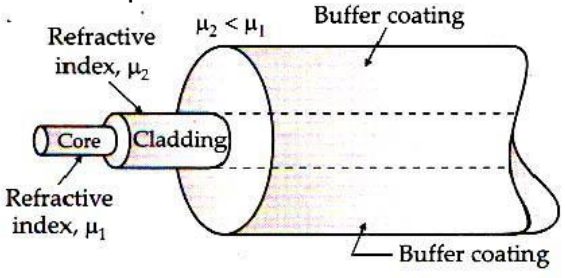
(ii) For how much time the sun is visible apparently after sunset.
(a) Approx. 5 minutes
b) Approx. 10 minutes

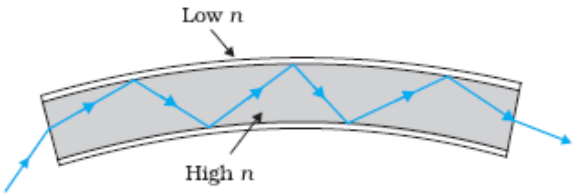
c) Approx. 2 minutes
d) None of the above

(iii) The Sun looks reddish while sunset or sunrise, because.
a) red colour is highly scattered.
b) red colour is least scattered.
c) of refraction of light.
d) of dispersion of light.
iv) The above given phenomenon cannot be observed on the moon because
a) total internal reflection could not take place on the moon
b) there is no atmosphere
c) Sun is not visible from the moon
d) None of the above

**Answers**
**i) (b)**
**ii) (c)**
**iii) (b)**
**iv) (b)**

3) Optical fibres: Now-a-days optical fibres are extensively used for transmitting audio and video signals through long distances. Optical fibres too make use of the phenomenon of total internal reflection. Optical fibres are fabricated with high quality composite glass/quartz fibres. Each fibre consists of a core and cladding. The refractive index of the material of the core is higher than that of the cladding. When a signal in the form of light is directed at one end of the fibre at a suitable angle, it undergoes repeated total internal reflections along the length of the fibre and
finally comes out at the other end. Since light undergoes total internal reflection at each stage, there is no appreciable loss in the intensity of the light signal. Optical fibres are fabricated such that light reflected at one side of inner surface strikes the other at an angle larger than the critical angle. Even if the fibre is bent, light can easily travel along its length. Thus, an optical fibre can be used to act as an optical pipe.




i) Which of the following statement is not true.
a) Optical fibres is based on the principle of total internal reflection.
b) The refractive index of the material of the core is less than that of the cladding.
c) an optical fibre can be used to act as an optical pipe.
d) there is no appreciable loss in the intensity of the light signal while propagating through an optical fibre.

ii) What is the condition for total internal reflection to occur?
a) angle of incidence must be equal to the critical angle.
b) angle of incidence must be less than the critical angle.
c) angle of incidence must be greater than the critical angle.
d) None of the above.

iii) Which of the following is not an application of total internal reflection?
a) Mirage
b) Sparkling of diamond
c) Splitting of white light through a prism.
d) Totally reflecting prism.

iv) Optical fibres are used extensively to transmit
a) Optical Signal
b) current
c) Sound waves
d) None of the above

**Answers**
**i) (b)**
**ii) (c)**
**iii) (c)**
**iv) (a)**

PART - B
Wave Optics (Assertion and Reasoning Based Questions)
1) Assertion : When a light wave travels from a rarer to a denser medium, it loses speed. The reduction in speed imply a reduction in energy carried by the light wave.
Reason : The energy of a wave is proportional to velocity of wave.
Correct Answer: D
Solution : When a light wave travel from a rarer to a denser medium it loses speed, but energy carried by the wave does not depend on its speed. Instead, it depends on the amplitude of wave.

2) Assertion : No interference pattern is detected when two coherent sources are infinitely close to each other.
Reason : The fringe width is inversely proportional to the distance between the two slits.
Correct Answer: A
Solution : When d is negligibly small, fringe width β which is proportional to 1/d may become too large. Even a single fringe may occupy the whole screen. Hence the pattern cannot be detected.

3) Assertion : For best contrast between maxima and minima in the interference pattern of Young's double slit experiment, the intensity of light emerging out of the two slits should be equal.

Reason : The intensity of interference pattern is proportional to square of amplitude.
Correct Answer: B
Solution : When intensity of light emerging from two slits is equal, the intensity at minima, $I_{min} = (\sqrt{I_a} - \sqrt{I_b})^2 = 0$, or absolute dark. It provides a better contrast.

4) Assertion: In Young's experiment, the fringe width for dark fringes is different from that for white fringes.
Reason : In Young's double slit experiment the fringes are performed with a source of white light, then only black and bright fringes are observed.
Correct Answer: D
Solution : In Young's experiments fringe width for dark and white fringes are same while in Young's double slit experiment when a white light as a source is used, the central fringe is white around which few coloured fringes are observed on either side.

5) Assertion : When a tiny circular obstacle is placed in the path of light from some distance, a bright spot is seen at the centre of shadow of the obstacle.
Reason : Destructive interference occurs at the centre of the shadow.
Correct Answer: C
Solution : As the waves diffracted from the edges of circular obstacle, placed in the path of light interfere constructively at the centre of the shadow resulting in the formation of a bright spot.

6) Assertion : Interference pattern is made by using blue light instead of red light, the fringes becomes narrower.
Reason : In Young?s double slit experiment, fringe width is given by relation $\beta = \lambda D/d$.
Correct Answer: A
Solution : $\beta = \lambda D/d$.
7) Assertion: Diffraction is common in sound but not common in light waves.
Reason : Wavelength of light is more than the wavelength of sound.
Answer (c)
Solution: If assertion is true but reason is false

8) Assertion : In Young's double slit experiment if wavelength of incident monochromatic light is just doubled, number of bright fringe on the screen will increase.
Reason : Maximum number of bright fringe on the screen is directly proportional to the wavelength of light used.
Answer: (d)
Solution: Wavelength is inversely proportional to the number of fringes, hence by doubling the wavelength the number of fringes decreases. Hence Assertion and reason are false.

9) Assertion : In interference and diffraction, light energy is redistributed.
Reason :There is no gain or loss of energy, which is consistent with the principle of conservation of energy.
Answer: (a)

Solution: In interference and diffraction, light energy is redistributed. If it reduces in one region, producing a dark fringe, it increases in another region, producing a bright fringe. There is no gain or loss of energy, which is consistent with the principle of conservation of energy.

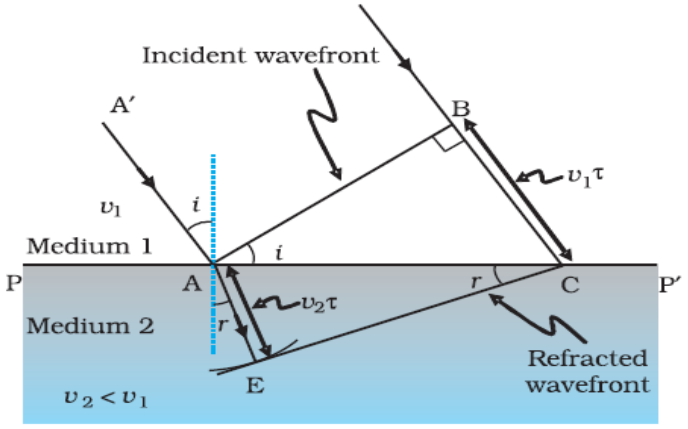
10) Assertion : If complete YDSE (Young's Double Slit Experiment) is dipped in the liquid from the air, then fringe width decreases.
Reason : Wavelength of light decreases, when we move from air to liquid.
Answer: (a)

11) Assertion: No sustained interference pattern is obtained when two electric bulbs of the same power are taken.
Reason: Phase difference between waves coming out of electric bulbs is not constant.
Answer: (a)

12) Assertion: The maximum intensity in YDSE (Young's Double Slit Experiment) is four times the intensity due to each slit when they are identical.
Reason: The phase difference between the interfering waves is $2n\pi$ at the position of maxima where n = 0, 1, 2, .....
Answer: (a)

## CASE BASED QUESTIONS (WAVE OPTICS)

1) Refraction of a plane wave



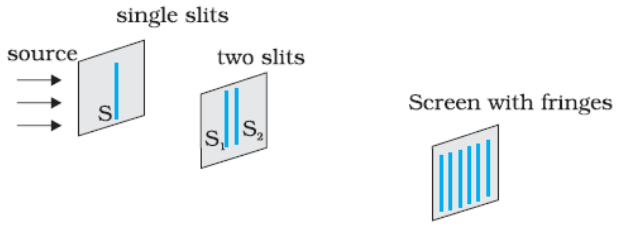

i) What is the angle made by the ray of light on the wavefront?
a) 90˚
b) 0˚
c) 45˚
d) None of the above

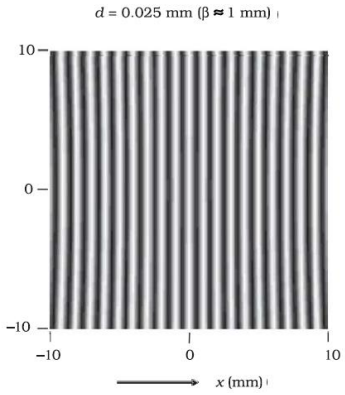
ii) Which parameter remains unchanged while a ray of light propagates from one medium to another?
a) velocity
b) Wave length
c) frequency
d) None of the above
iii) According to the above given fig., identify the correct expression for Snell's law.
a) $n_1 \sin i = n_2 \sin r$
b) $n_2 \sin i = n_1 \sin r$
c) $n_{21} = \sin r / \sin i$
d) None of the above

iv) When a ray of light travels from a denser to a rarer medium, it
a) it bends towards the normal
b) it travels in a straight line irrespective of angle of incidence.
c) it bends away from the normal
d) None of the above

**Answers:**
**i) (a)**
**ii) (c)**
**iii) (a)**
**iv) (c)**

2) Interference (Young's Double slit experiment)



i) What is the path difference between the two light waves coming from coherent sources, which produces 3rd maxima.

a) λ

b) 2λ

c) 3λ

d 0

ii) What is the correct expression for fringe width(β).

a) λd/D

(b) λdD

(c) d/λD

(d) λD/d

iii) what is the phase diff. between two interfering waves producing 1st dark fringe.

a) π

b) 2π

c) 3π

d) 4π

iv) The ratio of the widths of two slits in Young's double slit experiment is 4 : 1. Evaluate the ratio of intensities at maxima and minima in the interference pattern.

a) 1:1

b) 1:4

c) 3:1

d) 9:1

v) In a Young's double slit experiment, the separation between the slits is 0.1 mm, the wavelength of light used is 600 nm and the interference pattern is observed on a screen 1m away. Find the separation between bright fringes.

(a) 6.6 mm

(b) 6.0 mm

(c) 6 m

(d) 60cm

Answers:

i) (c)

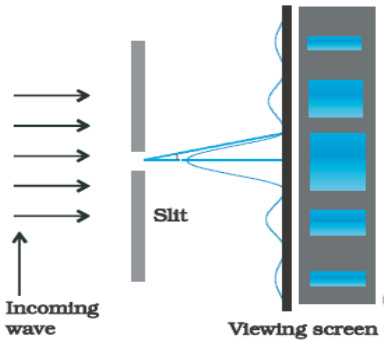
ii) (d)

iii) (a)

iv) (d)

v) (b)

3) Diffraction at a single slit




(i) In the phenomena of Diffraction of light when the violet light is used in the experiment is used instead of red light then,

(a) Fringe width increases
(b) No change in fridge width
(c) Fringe width decreases
(d) Colour pattern is formed

(ii) Diffraction aspect is easier to notice in case of the sound waves then in case of the light waves because sound waves

(a) Have longer wavelength
(b) Shorter wavelength
(c) Longitudinal wave
(d) Transverse waves

(iii) Diffraction effects show that light does not travel in straight lines. Under what condition the concepts of ray optics are valid. ( D = distance of screen from the slit).

(a) $D < Z_f$
(b) $D = Z_f$
(c) $D > Z_f$
(d) $D << Z_f$

(iv) when $2^{nd}$ secondary maxima is obtained in case of single slit diffraction pattern, the angular position is given by

(a) $\lambda$
(b) $\lambda/2$
(c) $3\lambda/2$
(d) $5\lambda/2$

**Answers:**
**(i) (c)**
**(ii) (a)**
**(iii) (d)**
**(iv) (d)**

# UNIT-VII
# DUAL NATURE OF RADIATION AND MATTER

**Directions: In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements, mark the correct answer as:**

**(A)If both assertion and reason are true and reason is the correct explanation of assertion**

**(B)If both assertion and reason are true but reason is not the correct explanation of assertion**

**(C)If assertion is true and reason is false**

**(D)If both assertion and reason are false**

1. Assertion: A photon has no rest mass , yet it carries definite momentum.
Reason: Momentum of photon is due to its energy and hence its equivalent mass.
(a)A (b)B (c)C (d)D

2.Assertion: Mass of moving photon varies inversely as the wavelength.
Reason: Energy of the particle = mass x (speed of light)$^2$
(a)A (b)B (c)C (d)D

3.Assertion: In photoelectron emission, the velocity of electron ejected from near the surface is larger than that coming from interior of metal.
Reason. The velocity of ejected electron will be zero.
(a)A (b)B (c)C (d)D

4.Assertion: A photocell is called an electric eye.
Reason. When light is incident on some semiconductor, its electrical resistance is reduced .
(a)A (b)B (c)C (d)D

5.Assertion: The de Broglie equation has significance for any microscopic or sub-microscopic particle.
Reason: The de Broglie wavelength is inversely proportional to the mass of the object if velocity is constant.
(a)A (b)B (c)C (d)D

6.Assertion : A particle of mass M at rest decay into particles of masses $m_1$ and $m_2$,having non-zero
velocities will have ratio of de-Broglie wavelengths unity.
Reason. Here we cannot apply conservation of linear momentum.
(a)A (b)B (c)C (d)D

7.Assertion: Photoelectric effect demonstrates the wave nature of light.
Reason. The number of photoelectrons is proportional to the frequency of light.
(a)A (b)B (c)C (d)D

8.Assertion:When acertain wavelength of light falls on a metal surface it ejects electron.
Reason. Light has wave nature.
(a)A (b)B (c)C (d)D

9.Assertion: As work function of a material increases by some mechanism, it requires greater energy to excite the electrons from its surface.

Reason. A plot of stopping potential ($V_2$) versus frequency (v) for different materials,has greater slope for metals with greater work functions.

(a)A (b)B (c)C (d)D

10.Assertion : Light of frequency 1.5 times the threshold frequency is incident on photo-sensitive material.If the frequency is halved and intensity is doubled the photo current remains unchanged.

Reason.The photo electric current varies directly with the intensity of light and frequency of light.

(a)A (b)B (c)C (d) D

11. Assertion. The de-Broglie wavelength of a neutron when its kinetic energy is k is λ. Its wavelength is 2 λ when its kinetic energy is 4k.

Reason. The de - Broglie wavelength λ is proportional to square root of the kinetic energy.

(a)A (b)B (c)C (d)D

12. Assertion. The de – Broglie wavelength of a molecule varies inversely as the square root of temperature.

Reason. The root mean square velocity of the molecule depends on the temperature.

(a)A (b)B (c)C (d)D

Answers

| | | | | |
|---|---|---|---|---|
| Q1. (a) | Q2. (a) | Q3. (c) | Q4. (c) | Q5. (a) |
| Q6. (a) | Q7. (d) | Q8. (b) | Q9. (c) | Q10. (d) |
| Q11. (d) | Q12. (a) | Q13. (b) | | |

## CASE BASED QUESTIONS
## DUAL NATURE OF RADIATION AND MATTER

**1.** The photoelectric emission is possible only if the incident light is in the form of packets of energy, each having a definite value, more than the work function of the metal. This shows that light is not of wave nature but of particle nature. It is due to this reason that photoelectric emission was accounted by quantum theory of light.

Q1. Packet of energy are called

(a)electron

(b)quanta

(c)frequency

(d)neutron

Q2. One quantum of radiation is called
(a)meter
(b)meson
(c) photon
(d)quark
Q3. Energy associated with each photon
(a)hc
(b)mc
(c)hv
(d)hk

Q4. Which of the following waves can produce photo electric effect
(a). UV radiation
(b). Infrared radiation
(c). Radio waves
(d) .Microwaves

Q5. Work function of alkali metals is
(a)less than zero
(b)just equal to other metals
(c) greater than other metals
(d) quite less than other metals

Answer
Q1.(b) Q2.(c) Q3.(c) Q4.(a) Q5.(d)

Q2. According to de-Broglie a moving material particle sometimes acts as a wave and sometimes as a particle or a wave is associated with moving material particle which controls the particle in every respect. The wave associated with moving material particle is called matter wave or de-Broglie wave whose wavelength called de-Broglie wavelength, is given by $\lambda = h/mv$
1.The dual nature of light is exhibited by
(a) diffraction and photo electric effect
(b) photoelectric effect
(c) refraction and interference
(d)diffraction and reflection.
2. If the momentum of a particle is doubled , then its de-Broglie wavelength will
(a)remain unchanged (b)become four times
(c) become two times (d)become half

3. If an electron and proton are propagating in the form of waves having the same $\lambda$ , it implies that they have the same

(a)energy (b)momentum

(c)velocity (d)angular momentum

4. Velocity of a body of mass m, having de-Broglie wavelength $\lambda$ , is given by relation

(a) $v = \lambda h/m$ (b) $v = \lambda m/h$

(c) $v = \lambda/hm$ (d) $v = h/\lambda m$

5. Moving with the same velocity , which of the following has the longest de Broglie wavelength?

(a)$\beta$ -particle (b) $\alpha$ -particle

(c) proton (d) neutron.

Answer

Q1.(a) Q2.(d) Q3.(b) Q4.(d) Q5.(a)

# UNIT-VIII
# ATOM AND NUCLEUS

Instructions:

**A) If both assertion and reason are true and the reason is the correct explanation of the assertion.**

**B) If both assertion and reason are true but reason is not the correct explanation of the assertion.**

**C) If assertion is true but reason is false.**

**D) If the assertion and reason both are false.**

**E) If assertion is false but reason is true.**

1.

Assertion: It is not possible to use $^{35}Cl$ as the fuel for fusion energy.

Reason: The binding energy of $^{35}Cl$ is too small.

Correct Answer: C

Solution : In fusion, lighter nuclei are used so, fusion is not possible with $^{35}Cl$. Also binding energy of $^{35}Cl$ is not too small.

2.

Assertion : $^{90}Sr$ from the radioactive fall out from a nuclear bomb ends up in the bones of human beings through the milk consumed by them. It causes impairment of the production of red blood cells.

Reason : The energetics b-particles emitted in the decay of $^{90}Sr$ damage the bone marrow.

Correct Answer: A

Solution : $^{90}Sr_{38}$ decays to $^{90}Y_{39}$ by the emission of $\beta^-$ rays. Sr gets absorbed in bones along with calcium. Reason is also true.

3.

Assertion : Neutrons penetrate matter more readily as compared to protons.

Reason : Neutrons are slightly more massive than protons.

Correct Answer: B

Solution : Neutron is about 0.1 more massive than proton. But the unique thing about the neutron is that while it is heavy, it has no charge (it is neutral). This lack of charge gives it the ability to penetrate matter without interacting as quickly as the beta particles or alpha particles.

4.
Assertion : Neutrons penetrate matter more readily as compared to protons.
Reason : Neutrons are slightly more massive than protons.

Correct Answer: B

Solution : Neutron is about 0.1 more massive than proton. But the unique thing about the neutron is that while it is heavy, it has no charge (it is neutral). This lack of charge gives it the ability to penetrate matter without interacting as quickly as the beta particles or alpha particles.

5.
Assertion : Radioactive nuclei emit $\beta^{-1}$ particles.
Reason : Electrons exist inside the nucleus.

Correct Answer: C

Solution : Nuclear stability depends upon the ratio of neutron to proton. If the n/p ratio is more than the critical value, then a neutron gets converted into a proton forming a $\beta^-$ particle in the process. So electrons do not exist in the nucleus but they result in some nuclear transformation.

6.
Assertion : ${}_{Z}X^{A}$ undergoes 2α decays $2\beta^-$ decays and 2γ decays and the daughter product is ${}_{Z-2}Y^{A-8}$.
Reason : In a-decay the mass number decreases by 4 and atomic number decreases by 2. In b- decay the mass number remains unchanged, but atomic number increases by 1 only.

Correct Answer: A

Solution : ${}_{Z}X^{A} \rightarrow 2({}_{2}He^{4}) + 2({}_{-1}e^{0}) + 2\gamma + {}_{Z-2}X^{A-8}$

7.
Assertion : Density of all the nuclei is same.
Reason : Radius of nucleus is directly proportional to the cube root of mass number.

Correct Answer: A

Solution : Experimentally it is found that the average radius of a nucleus is given by $R = R_0A^{1/3}$ where $R_0 = 1.1\times10^{-15}$m = 1.1 fm and A = mass number.

8.
Assertion : Isobars are the element having same mass number but different atomic number.
Reason : Neutrons and protons are present inside nucleus.

Correct Answer: B

9.
Assertion : The force of repulsion between atomic nucleus and a-particle varies with distance according to inverse square law.
Reason : Rutherford did a-particle scattering experiment.

Correct Answer: B

Solution : Rutherford confirmed the repulsive force on a-particle due to nucleus varies with distance according to inverse square law and that the positive charges are concentrated at the centre and not distributed throughout the atom.

10.
Assertion : The positively charged nucleus of an atom has a radius of almost 10−15m.
Reason : In a-particle scattering experiment, the distance of closest approach for a-particles is $\simeq$ 10−15m.

Correct Answer: A

Solution : In a-particle scattering experiment, Rutherford found a small number of a-particles which were scattered back through an angle approaching to 180∘. This is possible only if the positive charges are concentrated at the centre or nucleus of the atom.

11.
Assertion : According to classical theory, the proposed path of an electron in Rutherford atom model will be parabolic.
Reason : According to electromagnetic theory an accelerated particle continuously emits radiation.

Correct Answer: E

Solution : According to classical electromagnetic theory, an accelerated charge continuously emits radiation. As electrons revolving in circular paths are constantly experiencing centripetal acceleration, hence they will be losing their energy

continuously and the orbital radius will go on decreasing and form spiral and finally the electron will fall on the nucleus.

12.
Assertion : Electrons in the atom are held due to coulomb forces.
Reason : The atom is stable only because the centripetal force due to Coulomb?s law is balanced by the centrifugal force.

Correct Answer: C

Solution : According to postulates of Bohr?s atom model, the electron revolve round the nucleus in fixed orbit of definite radii. As long as the electron is in a certain orbits it does not radiate any energy.

13.
Assertion : The electron in the hydrogen atom passes from energy level n=4 to the n=1 level. The maximum and minimum number of photon that can be emitted are six and one respectively.
Reason : The photons are emitted when electron make a transition from the higher energy state to the lower energy state.

Correct Answer: B

Solution : Maximum number of photon is given by all the transitions possible $={}_4C^2$ = 6. Minimum number of transition = 1, that is directly jump from 4 to 1.

14.
Assertion : Hydrogen atom consists of only one electron but its emission spectrum has many lines.
Reason : Only Lyman series is found in the absorption spectrum of hydrogen atom whereas in the emission spectrum, all the series are found.

Correct Answer: B

Solution : When the atom gets appropriate energy from outside, then this electron rises to some higher energy level. Now it can return either directly to the lower energy level or come to the lowest energy level after passing through other lower energy lends, hence all possible transitions take place in the source and many lines are seen in the spectrum.

15.
Assertion : It is essential that all the lines available in the emission spectrum will also be available in the absorption spectrum.
Reason : The spectrum of hydrogen atom is only absorption spectrum.

Correct Answer: D

Solution : Emission transitions can take place between any higher energy level and any energy level below it while absorption transitions start from the lowest energy level only and may end at any higher energy level. Hence number of absorptions transitions between two given energy levels is always less than the number of emission transitions between same two levels.

16.
Assertion : For the scattering of a-particles at a large angles, only the nucleus of the atom is responsible.
Reason : Nucleus is very heavy in comparison to α particle.

Correct Answer: A

Solution : We know that an electron is very light particle as compared to an a-particle. Hence electron cannot scatter the a-particle at large angles, according to law of conservation of momentum. On the other hand, mass of nucleus is comparable with the mass of a-particle, hence only the nucleus of atom is responsible for scattering of a-particles.

17.
Assertion : All the radioactive elements are ultimately converted in lead.
Reason : All the elements above lead are unstable.

Correct Answer: C

Solution : All those elements which are heavier than lead are radioactive. This is because in the nuclei of heavy atoms, besides the nuclear attractive forces, repulsive forces between the protons are also effective and these forces reduce the stability of the nucleus. Hence, the nuclei of heavier elements are being converted into lighter and lighter elements by emission of radioactive radiation. When they are converted into lead, the emission is stopped because the nucleus of lead is stable (or lead is most stable elements in radioactive series).

18.
Assertion : Amongst alpha, beta and gamma rays, a-particle has maximum penetrating power.
Reason : The alpha particle is heavier than beta and gamma rays.

Correct Answer: D

Solution : The penetrating power is maximum in case of gamma rays because gamma rays are an electromagnetic radiation of very small wavelength.

19.
Assertion : The ionising power of β-particle is less compared to a-particles but their penetrating power is more.
Reason : The mass of β-particle is less than the mass of a-particle.

Correct Answer: B

Solution : β particles, being emitted with very high speed compared to α particles, pass very little time near the atoms of the medium. So the probability of the atoms being ionised is comparatively less. But due to this reason, their loss of energy is very slow and they can penetrate the medium through a sufficient depth.

20.
Assertion : The mass of b-particles when they are emitted is higher than the mass of electrons obtained by other means.
Reason : β-particle and electron, both are similar particles.

Correct Answer: B

Solution : β-particles are emitted with very high velocity (up to 0.99 c). So, according to Einstein?s theory of relatively, the mass of a β -particle is much higher compared to is` its rest mass ($m_0$). The velocity of electrons obtained by other means is very small compared to c (Velocity of light). So its mass remains nearly $m_0$. But b-particle and electron both are similar particles.

21. Assertion : Radioactivity of 108 un-decayed radioactive nuclei of half-life of 50 days is equal to that of 1.2×108 number of un-decayed nuclei of some other material with half-life of 60 days.
Reason : Radioactivity is proportional to half-life.

Correct Answer : C

Solution : Radioactivity $-dN/dt = \lambda N = 0.693/T_{1/2}$ Radioactivity is proportional to $1/T_{1/2}$ and not to $T_{1/2}$.

22.
Assertion : Fragments produced in the fission of $U^{235}$ are radioactive.
Reason : The fragments have abnormally high proton to neutron ratio.

Correct Answer: C

Solution : Fragments produced in the fission of $U^{235}$ are radioactive. When uranium undergoes fission, barium and krypton are not the only products. Over 100 different isotopes of more than 20 different elements have been detected among fission products. All of these atoms are, however, in the middle of the periodic table, with atomic numbers ranging from 34 to 58. Because the neutron-proton ratio needed for stability in this range is much smaller than that of the original uranium nucleus, the residual nuclei called fission fragments, always have too many neutrons for stability. A few free neutrons are liberated during fission and the fission fragments undergo a series of beta decays (each of which increases Z by one and decreases N by one) until a stable nucleus is reached. During decay of the fission fragments, an average of 15 MeV of additional energy is liberated.

23.
Assertion : The mass of a nucleus can be either less than or more than the sum of the masses of nucleons present in it.
Reason : The whole mass of the atom is considered in the nucleus.

Correct Answer: E

Solution : The whole mass of the atom is concentrated at nucleus and M(nucleus) < (Sum of the masses of nucleus) because, when nucleous combines, some energy is wasted.

24.
Assertion : Only those nuclei which are heavier than lead are radioactive.
Reason : Nuclei of elements heavier than lead are unstable.

Correct Answer : D
Solution : Some lighter nuclei are also radioactive.

25.
Assertion : In one half-life of a radioactive substance more number of nuclei are decayed than in one average life.
Reason : Average life = Half -life/Ln (2)

Correct Answer : D)

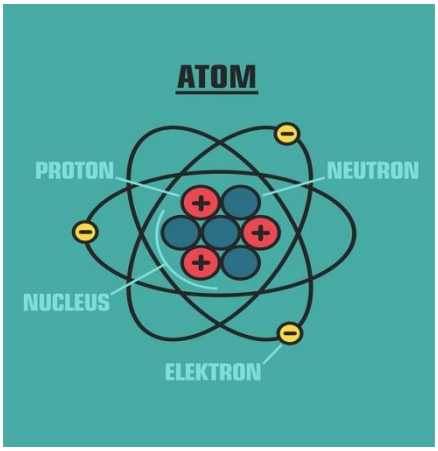
Solution : Average life is more Hence more nuclei decay in one average life .

26.
Assertion : Nucleus of the atom does not contain electrons, yet it emits β−particles in the form of electrons.
Reason : In the nucleus, protons and neutrons exchange mesons frequently.

Correct Answer D

Solution : Nucleus of the atom does not contain electrons, yet it emits β− particles in the form of electrons. The nucleus contains only protons and neutrons but In the nucleus, protons and neutrons do not exchange mesons frequently.

## CASE BASED QUESTIONS (ATOMS AND NUCLEI)




Everything around us which has mass and occupies space is matter. An atom is the basic unit of matter. It cannot be broken down further using any chemical means because it is the basic building block of an element. Every state of matter solid, liquid, gas, and plasma is composed of either atom either it is neutral (un-ionized), or ionized atoms. An atom is made up of three particles known as protons, neutrons, and electrons. And these particles are also made up from sub-particles. Among these three particles, protons have a positive charge while electrons carry a negative charge and the third particle neutrons have no electrical charge. And the charge of atoms depends on the number of protons and electrons, i.e an atom is electrically neutral if the number of protons and electrons are equal. If an atom has more or fewer electrons than protons, then it has an overall negative or positive charge, respectively. These atoms are extremely small or you can say their typical sizes are around 100 picometers. So the dense region consisting of protons and neutrons at the center of an atom is known as the atomic nucleus of an atom. Every atom is composed of such nucleus and some elections will be surrounding it. Studying these atoms and Nuclei will help us to have a thorough understanding of matter. Studying about the nucleus and its reactions will help us to understand more about nuclear energy, which is a very useful renewable energy. That's why it is very important to study about Atoms and Nuclei.

Q1. What is the basic unit of matter?

a) Atom
b) Electron
c) Proton
d) Neutron

Q2. Which particle is responsible for the ionization of the atom?

a) Positron
b) Electron
c) Proton
d) Neutron

Q3. If number of protons in an atom is equal to (number of electrons + 2). Then the atom is said to be

a) Single ionized positive ion
b) Single ionized positive atom
c) Double ionized positive ion
d) Double ionized positive atom

Q4. Which is the most dense part of an atom?

a) The exact central part of the atom.
b) The region at the center of atom containing neutrons and protons.
c) Outer edge of the atom
d) None of the above

Answer : Q1 – a; Q2 – b; Q3 – c; Q4 – b

## Bohr's Atomic Model

To study about atom various scientists perform various experiments and suggest various models of an atom with some explanation. For example, Thomson gives the "plum pudding" model in which he said the atom consists of a positive material known as "pudding" with some negative materials ("plums") distributed throughout. Later, famous scientist, Rutherford gives Rutherford's model of the atom after performing an Alpha Particle scattering experiment.

This model is a modification of the earlier Rutherford Model. According to this model, an atom consists of a small, positively-charged nucleus and negatively-charged electrons orbiting around it in an orbital. These orbital can have different sizes, energy, etc. And the energy of the orbit is also related to its size, I.e The lowest energy is found in the smallest orbit. So if the electron is orbiting in nth orbit then we will study about its Velocity in nth orbital, Radius of nth orbital, Energy of electron in nth orbit, etc. Energy is also emitted due to the transition of electrons from one orbit to another orbit. This energy is emitted in the form of photons with different wavelengths. This wavelength is given by the Rydberg formula. When electrons make transitions between two energy levels in an atom various spectral lines are obtained. The emission spectrum of the hydrogen atom has been divided into various spectral series like Lyman series, Balmer series, Paschen series Etc.

Q1. The formula which gives the wavelength of emitted photon when electron jumps from higher nergy state to lower was given by

a) Balmer
b) Paschen
c) Lymen
d) Rydberg

Q2. What is true about Bohr's atomic Model
a) His model was unique totally different from other
b) His model is a modification of Rutherford atomic model.
c) His model is a modification of Thomson atomic model.
d) None of the above

Q3. Bohr's atomic model is applicable for
a) All types of atoms
b) Only for hydrogen atom
c) For hydrogen like atoms
d) For $H_2$ gas.

Q4. The cause of rejection of Rutherford atomic model was
a) It was totally wrong
b) It could not justify its stability
c) Rutherford was unable to explain it
d) None of the above.

Answer : Q1 – d; Q2 – b; Q3 – c; Q4 – b

## SIZE OF THE NUCLEUS

Rutherford was the pioneer who postulated and established the existence of the atomic nucleus. At Rutherford's suggestion, Geiger and Marsden performed their classic experiment: on the scattering of α-particles from thin gold foils. Their experiments revealed that the distance of closest approach to a gold nucleus of an α-particle of kinetic energy 5.5 MeV is about $4.0 \times 10^{-14}$ m. The scattering of α-particle by the gold sheet could be understood by Rutherford by assuming that the coulomb repulsive force was solely responsible for scattering. Since the positive charge is confined to the nucleus, the actual size of the nucleus has to be less than $4.0 \times 10^{-14}$ m. If we use α-particles of higher energies than 5.5 MeV, the distance of closest approach to the gold nucleus will be smaller and at some point the scattering will begin to be affected by the short range nuclear forces, and differ from Rutherford's calculations. Rutherford's calculations are based on pure coulomb repulsion between the positive charges of the α particle and the gold nucleus. From the distance at which deviations set in, nuclear sizes can be inferred. By performing scattering experiments in which fast electrons, instead of α-particles, are projectiles that bombard targets made up of various elements, the sizes of nuclei of various elements have been accurately measured. It has been found that a nucleus of mass number A has a radius $R = R_0 A^{1/3}$, where $R_0 = 1.2 \times 10^{-15}$ m. This means the volume of the nucleus, which is proportional to $R^3$ is proportional to A. Thus the density of nucleus is a constant, independent of A, for all nuclei. Different nuclei are likes drop of liquid of constant density. The density of nuclear matter is approximately $2.3 \times 10^{17}$ kgm$^{-3}$. This density is very large compared to ordinary matter, say water, which is $10^3$ kg m$^{-3}$. This is understandable, as we have already seen that most of the atom is empty. Ordinary matter consisting of atoms has a large amount of empty space.

Q1. Relative density of nucleus with respect to water is

a) $2.3 \times 10^{17}$ kgm$^{-3}$
b) $2.3 \times 10^{14}$ kgm$^{-3}$
c) $23 \times 10^{17}$ kgm$^{-3}$
d) $.23 \times 10^{17}$ kgm$^{-3}$

Q2. From $R = R_0 A^{1/3}$ how can we conclude that density of almost all the nucleus is same

a) Volume being proportional to square of R density becomes independent of mass number A
b) Volume being proportional to cube of R density becomes independent of mass number A
c) Volume being proportional to R density becomes independent of mass number A
d) Density has no relation with R

Q3. What is the kinetic energy of α-particles bombarded towards the gold nucleus in Geiger and Marsden classic experiment?

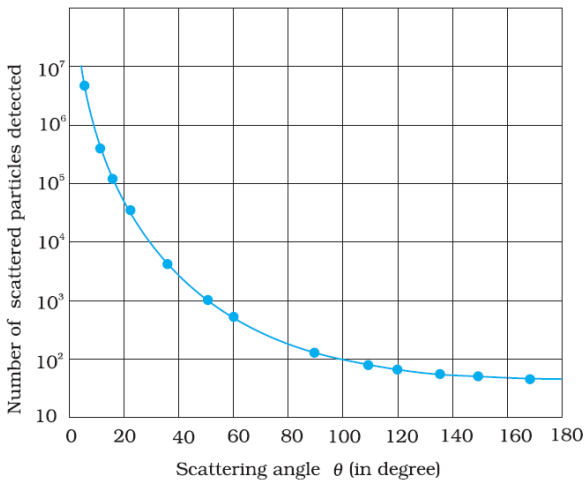
a) $8.8 \times 10^{-13}$ Joule
b) $8.8 \times 10^{-15}$ Joule
c) $8.8 \times 10^{-13}$ Joule
d) □□□ x $10^{-13}$ Joule
e) $8.5 \times 10^{-13}$ Joule

Q4. What is the range of volume of hydrogen nucleus?

a) $10^{-45}$m.
b) $10^{-30}$m.
c) $10^{-15}$m.
d) $10^{-60}$m.

Answer : Q1 – b; Q2 – b; Q3 – a; Q4 – a

## Graphical representation Of Scattering of α Particles By Gold Nucleus




A typical graph of the total number of α-particles scattered at different angles, in a given interval of time, is shown in Fig. The dots in this figure represent the data points and the solid curve is the theoretical prediction based on the assumption that the target atom has a small, dense, positively charged nucleus. Many of the α-particles pass through the foil. It means that they do not suffer any collisions. Only about 0.14% of the incident α-particles scatter by more than 1º; and about 1 in 8000 deflect by more than 90º. Rutherford argued that, to deflect the α-particle backwards, it must experience a large repulsive force. This force could be provided if the greater part of the mass of the atom and its positive charge were concentrated tightly at its centre. Then the incoming α-

particle could get very close to the positive charge without penetrating it, and such a close encounter would result in a large deflection. This agreement supported the hypothesis of the nuclear atom. This is why Rutherford is credited with the *discovery* of the nucleus.

In Rutherford's nuclear model of the atom, the entire positive charge and most of the mass of the atom are concentrated in the nucleus with the electrons some distance away. The electrons would be moving in orbits about the nucleus just as the planets do around the sun. Rutherford's experiments suggested the size of the nucleus to be about $10^{-15}$ m to $10^{-14}$ m. From kinetic theory, the size of an atom was known to be $10^{-10}$ m, about 10,000 to 100,000 times larger than the size of the nucleus. Thus, the electrons would seem to be at a distance from the nucleus of about 10,000 to 100,000 times the size of the nucleus itself. Thus, most of an atom is empty space. With the atom being largely empty space, it is easy to see why most α -particles go right through a thin metal foil. However, when α-particle happens to come near a nucleus, the intense electric field there scatters it through a large angle. The atomic electrons, being so light, do not appreciably affect the α-particles. The scattering data shown in Fig. can be analysed by employing Rutherford's nuclear model of the atom. As the gold foil is very thin, it can be assumed that α-particles will suffer not more than one scattering during their passage through it. Therefore, computation of the trajectory of an alpha-particle scattered by a single nucleus is enough. Alpha particles are nuclei of helium atoms and, therefore, carry two units,2*e*, of positive charge and have the mass of the helium atom. The charge of the gold nucleus is *Ze*, where *Z* is the atomic number of the atom; for gold *Z* = 79. Since the nucleus of gold is about 50 times heavier than α-particle, it is reasonable to assume that it remains stationary throughout the scattering process. Under these assumptions, the trajectory of an alpha-particle can be computed employing Newton's second law of motion and the Coulomb's law for electrostatic force of repulsion between the alpha-particle and the positively charged nucleus.

Q1. What percentage of α particle scattered at an angle more than 90º?

a) .0125%
b) .125%
c) 1.25%
d) 12.5%

Q2. Why the nucleus of gold is about remains stationary throughout the scattering process?

a) Because its mass is 100 times the mass of proton.
b) Because its mass is 50 times the mass of proton.
c) Because its mass is 150 times the mass of proton.
d) Because its mass is 200 times the mass of proton.

Q3. Why electrons around the gold nucleus were unable to deflect α particles?

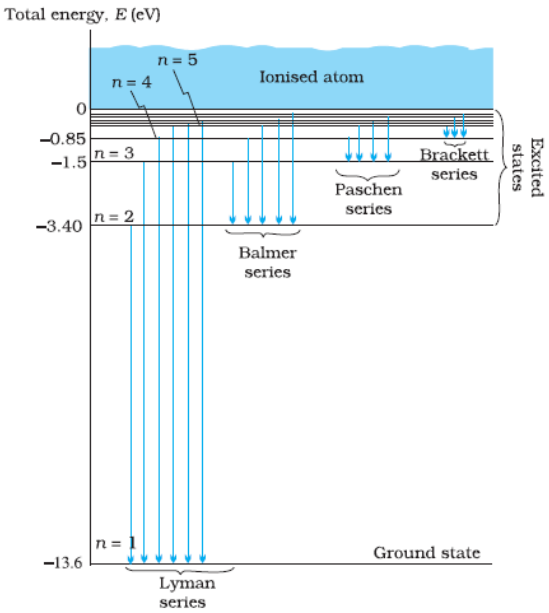
a) Size of α particle is much greater than that of electron.
b) Number of electrons around gold nucleus is very small
c) α particles is much heavier than electron.
d) Electrons are negatively charged.

Q4. What is the ratio of charge on α particle and gold nucleus?

a) .025
b) .25
c) .2
d) .5

Answer : Q1 – a; Q2 – d; Q3 – c; Q4 – a

## THE LINE SPECTRA OF THE HYDROGEN ATOM




According to the third postulate of Bohr's model, when an atom makes a transition from the higher energy state with quantum number *ni* to the lower energy state with quantum number *nf* (*nf* < *ni*), the difference of energy is carried away by a photon of frequency *v* such that *hv* = *Eni* – *Enf.* Since both *nf* and *ni* are integers, this immediately shows that in transitions between different atomic levels, light is radiated in various discrete frequencies. For hydrogen spectrum, the Balmer formula corresponds to *nf* = 2 and *ni* = 3, 4, 5 etc. The results of the Bohr's model suggested the presence of other series spectra for hydrogen atom–those corresponding to transitions resulting from *nf* = 1 and *ni* = 2, 3, etc; *nf* = 3 and *ni* = 4, 5, etc. and so on. Such series were identified in the course of spectroscopic investigations and are known as the Lyman, Balmer, Paschen, Brackett, and Pfund series. The electronic transitions corresponding to these series are shown in Fig. The various lines in the atomic spectra are produced when electrons jump from higher energy state to a lower energy state and photons are emitted. These spectral lines are called emission lines. But when an atom absorbs a photon that has precisely the same energy needed by the electron in a lower energy state to make transitions to a higher energy state, the process is called absorption. Thus if photons with a continuous range of frequencies pass through a rarefied gas and then are analysed with a spectrometer, a series of dark spectral absorption lines appear in the continuous spectrum. The dark lines indicate the frequencies that have been absorbed by the atoms of the gas. The explanation of the hydrogen atom spectrum provided by Bohr's model was a brilliant achievement, which greatly stimulated progress towards the modern quantum theory.

Q1. The series of spectrum when electron jumps from n = 5 to n = 3 is

a) Lymen
b) Balmer
c) Paschen
d) Bracket

Q2. Balmer series is obtained when electron transits from

a) n = 1,2,3, … to n = 5
b) n = 3,4,5 … to n = 2
c) n = 1,2,3, … to n = 4
d) n = 1,2,3, … to n = 6

Q3. From Fig. shown predict which series has waves of maximum frequency

a) Lymen
b) Balmer
c) Paschen
d) Bracket

Q4. What is the maximum energy of photon in emission spectrum of hydrogen atom

a) 13.6 eV
b) 1.36 eV
c) 1.5 eV
d) 1eV

Answer : Q1 – c; Q2 – b; Q3 – a; Q4 – a

# UNIT-IX
# ELECTRONIC DEVICES

**Two statements are given – One labeled assertion (A) and other labeled reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:**

**a) Both A and R are true and R is the correct explanation of A**
**b) Both A and R are true but R is not the correct explanation of A.**
**c) A is true but R is false.**
**d) A is false but R is true.**

1. Assertion (A): A Pure semiconductor has negative temperature coefficient of resistance.
   Reason (R): On raising the temperature, more charge carriers are released, conductance increases and resistance decreases.
2. Assertion (A): At a fix temperature, silicon will have a minimum conductivity when it has a smaller accepter doping.
   Reason (R): The conductivity of and intrinsic semiconductor is slightly higher than of a lightly doped p-type.
3. Assertion (A): The electrons in the conduction band have higher energy than those in the valance band of a semi-conductor.
   Reason (R): The conduction band lies above the energy gap and valance band lies below the energy gap.
4. Assertion (A): The energy gap between the valance band and conduction band is greater in silicon than a germanium.
   Reason (R): Thermal energy produces fewer minority carriers in silicon than in germanium.
5. Assertion (A): p- n junction diode can be used even at ultra-high frequencies.
   Reason (R): Capacitative reactance p- n junction diode increases as frequency increases.
6. Assertion (A): The colour of light emitted by LED depends on its forward biasing.
   Reason (R): The reverse biasing of p-n junction will lower the width of depletion layer.
7. Assertion (A): Two p-n junction diodes placed back to back will work as n-p-n transistor.
   Reason (R): The p- reasons of two p-n junction diodes placed back to back will form the base of n-p-n transistor.
8. Assertion ( A) : The number of electrons in a p- type silicon semi-conductor is less than the number of electrons in a pure silicon semiconductor at room temperature.
   Reason (R): It is due to law of mass action.
9. Assertion (A): Electron has higher mobility than hole in a semiconductor.
   Reason (R): Mass of electron is less than the mass of hole.
10. Assertion (A): An n type semiconductor has a large number of electrons but still it is electrically neutral.

Reason (R): A n type semiconductor is obtained by doping an intrinsic semiconductor with a penta valent impurity.

11. Assertion (A): V-I characteristic of p-n junction diode is same as that of any other conductor.
    Reason (R): p-n junction diode behave as conductor at room temperature.
12. Assertion (A): At 0K germanium is a super conductor.
    Reason (R): At 0K germanium offers zero resistance.
13. Assertion (A): Semiconductor do not obey's Om's Law.
    Reason (R): Current is determined by the rate of flow of charge carriers.
14. Assertion (A): Silicon is preferred over germanium for making semiconductors device.
    Reason (R): The energy gap for germanium is more than the energy gap of silicon.

## CASE STUDY BASED QUESTIONS
## ELECTRONIC DEVICES

**1. SEMICONDUCTOR :**

A pure semiconductor germanium or silicon, free of every impurity is called intrinsic semiconductor. At room temperature, a pure semiconductor has very small number of current carriers (electrons and holes) .Hence its conductivity is low.

When the impurity atoms of valance five or three are doped in a pure semiconductor, we get respectively n- type or p- type extrinsic semiconductor. In case of doped semiconductor $n_e\, n_h = n_i 2$. Where $n_e$ and $n_h$ are the number density of electron and hole charge carriers in a pure semiconductor. The conductivity of extrinsic semiconductor is much higher than that of intrinsic semiconductor.

Answer the following questions:

Q (1). Which of the following statements is not true?

a. The resistance of intrinsic semiconductor decreases with increase of temperature.

b. Doping pures Si with trivalent impurities gives p- type semiconductors.

c. The majority charges in n- type semiconductors are holes.

d. A p-n junction can act as semiconductor diode.

Q (2). The impurity atoms with which pure Si should be doped to make a p- type semiconductor is

a. Phosphorus
b. Boron
c. Arsenic
d. Antimony

Q (3). Holes are majority charge carriers in

**a.** Intrinsic semiconductors.
**b.** Ionic Solids
**c.** p- type semiconductors
**d.** Metals

Q (4). At absolute zero, Si acts as

**a.** Non- metal
**b.** Metal
**c.** Insulator
**d.** None of these

**Answers**

1. (c) The majority Charge carriers in n-type semiconduch as holes
2. (b) BORON
3. (c) p-type semiconductors
4. (c) Insulators

**2.** p-n junction diode :

p-n junction is a semiconductor diode. It is obtained by bringing p-type semiconductor in close contact with n- type semiconductor. A thin layer is developed at the p- n junction which is devoid of any charge carrier but has immobile ions. It is called depletion layer. At the junction a potential barrier appears, which does not allow the movement of majority charge carriers across the junction in the absence of any biasing of the junction. p-n junction offers low resistance when forward biased and high resistance when reverse biased.

Q (1). In the middle of depletion layer of reverse biased p- n junction, the

**a.** Electric field is zero
**b.** Potential is zero
**c.** Potential is maximum
**d.** Electric field is maximum

Q (2). The energy band gap is maximum in

**a.** Metals
**b.** Superconductors
**c.** Insulators
**d.** Semiconductors

Q (3). The number of majority carriers crossing the junction of diode depends primarily on the

a. Concentration of doping impurities
b. Magnitude of potential barriers
c. Magnitude of the forward bias voltage
d. Rate of thermal generation of electron –hole pairs

Q (4). Hole is

a. Antiparticle of electron
b. A vacancy created when an electron leaves covalent bond
c. Absence of free electrons
d. An artificially created particle.

**Answers:**

1. (c) potential is maximum
2. (c) Insulators
3. (d) Rate of thermal Generation of eleeton-holepair

4. (b) A Vacancy created when an electon leaves covalent bond

**3.** Rectifiers :

A semiconductor device is used as a rectifier that allows the voltage to flow in positive direction and very small value in the reverse direction. Now a days, there is a problem of supply of less voltage that damages the household appliances.

Q (1). In the depletion region of a diode

a. There are no mobile charges

b. Equal number of holes and electrons exist, making the region neutral.

c. Recombination of holes and electrons has taken place.

d. Immobile charge ions exist.

Q(2).When a p-n junction diode is reverse biased then

a. No Current flows

b. The depletion reason is increased

c. The depletion reason is reduced

d. Height of potential barrier is reduced

Q(3). Diode is used as

**a.** Oscillator

**b.** Amplifier

**c.** Rectifier

**d.** Modulator

Q(4).Which one statement is incorrect?

**a.** Diode is used as rectifier

**b.** Diode is used as half wave rectifier

**c.** Diode is used as Amplifier

**d.** Diode is used as full wave rectifier

**Answers:**

1. **(d)**
2. **(b)**
3. **(c)**
4. **(c)**

**4.** Zener diode :

Zener diode is a specially designed p-n junction diode in which both p- side and n- side of p-n junction are heavily dopped. The zener diode is designed specially to operate in the reverse break down voltage region continuously without being damaged. Zener diode is used to remove the fluctuations from given voltage and thereby provides a voltage of constant magnitude (i.e. zener diode is used as voltage regulator).

Q (1). Zener diode is mostly used as

a. Half wave rectifier

b. Full wave rectifier

c. Voltage regulator

d. LED

Q (2). Zener diode is designed to specially work in which region without getting damaged ?

a. Active region
b. Break down region
c. Forward Biased
d. Reverse biased

Q (3). The depletion region of the zener diode is

a. Thick
b. Normal
c. Very thin
d. Very thick

Q (4). What is the level of dopping in zener diode?

a. Lightly dopped
b. Heavily dopped
c. Moderately dopped
d. No dopping

**Answers:**

1. **(c)**
2. **(b)**
3. **(c)**
4. **(b)**

# Class: XII Session: 2020-2021

# Subject: Physics

# Sample Question Paper (Theory)

Maximum Marks: 70 Marks Time Allowed: 3 hours

**General Instructions:**

(1) All questions are compulsory. There are 33 questions in all.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) Section A contains ten very short answer questions and four assertion reasoning MCQs of 1 mark each, Section B has two case based questions of 4 marks each, Section C contains nine short answer questions of 2 marks each, Section D contains five short answer questions of 3 marks each and Section E contains three long answer questions of 5 marks each.
(4) There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.

| Sr. No. | | Marks |
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| | **Section – A**<br>**All questions are compulsory. In case of internal choices, attempt any one of them.** | |
| 1 | Name the physical quantity having unit J/T. | 1 |
| 2 | Mention one use of part of electromagnetic spectrum to which a wavelength of 21 cm (emitted by hydrogen in interstellar space) belongs.<br><br>**OR**<br><br>Give the ratio of velocity of the two light waves of wavelengths 4000Å and 8000Å travelling in vacuum. | 1 |
| 3 | An electron with charge -e and mass m travels at a speed v in a plane perpendicular to a magnetic field of magnitude B. The electron follows a circular path of radius R. In a time, t, the electron travels halfway around the circle. What is the amount of work done by the magnetic field? | 1 |

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| 4 | A solenoid with **N** loops of wire tightly wrapped around an iron-core is carrying an electric current **I.** If the current through this solenoid is reduced to half, then what change would you expect in inductance **L** of the solenoid.<br>**OR**<br>An alternating current from a source is given by **i**=10sin314t. What is the effective value of current and frequency of source? | 1 |
| 5 | What is the value of angular momentum of electron in the second orbit of Bohr's model of hydrogen atom? | 1 |
| 6 | In a photoelectric experiment, the potential required to stop the ejection of electrons from cathode is 4V. What is the value of maximum kinetic energy of emitted Photoelectrons? | 1 |
| 7 | In decay of free neutron, name the elementary particle emitted along with proton and electron in nuclear reaction.<br>**OR**<br>In the following nuclear reaction, Identify unknown labelled X.<br>$^{22}_{11}Na + X \rightarrow {}^{22}_{10}Ne + \nu_e$ | 1 |
| 8 | How does the width of a depletion region of a pn junction vary if doping concentration is increased?<br>**OR**<br>In half wave rectification, what is the output frequency if input frequency is 25 Hz. | 1 |
| 9 | When a voltage drop across a pn junction diode is increased from 0.70 V to 0.71V, the change in the diode current is 10 mA .What is the dynamic resistance of diode? | 1 |
| 10 | Which specially fabricated pn junction diode is used for detecting light intensity? | 1 |
| | **For question numbers 11, 12, 13 and 14, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**<br>**a) Both A and R are true and R is the correct explanation of A**<br>**b) Both A and R are true but R is NOT the correct explanation of A**<br>**c) A is true but R is false**<br>**d) A is false and R is also false** | |

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| 11 | **Assertion(A) :**<br>In a nonuniform electric field, a dipole will have translatory as well as rotatory motion.<br>**Reason(R):**<br>In a nonuniform electric field, a dipole experiences a force as well as torque. | 1 |
| 12 | **Assertion(A):**<br>Electric field is always normal to equipotential surfaces and along the direction of decreasing order of potential<br>**Reason(R):**<br>Negative gradient of electric potential is electric field. | 1 |
| 13 | **Assertion (A):**<br>A convex mirror cannot form real images.<br>**Reason (R):**<br>Convex mirror converges the parallel rays that are incident on it. | 1 |
| 14 | **Assertion(A):**<br>A convex lens of focal length 30 cm can't be used as a simple microscope in normal setting.<br>**Reason (R):**<br>For normal setting, the angular magnification of simple microscope is M=D/f | 1 |
| | **Section – B**<br>**Questions 15 and 16 are Case Study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.** | |
| 15 | **Faraday Cage:**<br><br>A Faraday cage or Faraday shield is an enclosure made of a conducting material. The fields within a conductor cancel out with any external fields, so the electric field within the enclosure is zero. These Faraday cages act as big hollow conductors you can put things in to shield them from electrical fields. Any electrical shocks the cage receives, pass harmlessly around the outside of the cage.<br><br>  | 4 |

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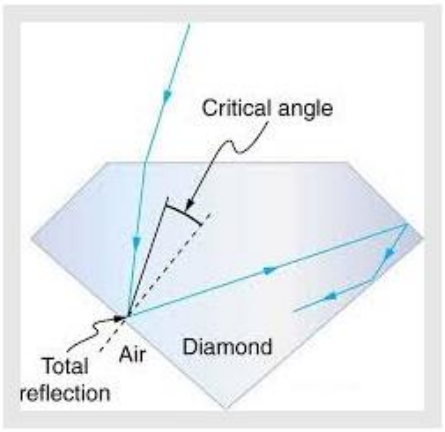
| | 1. Which of the following material can be used to make a Faraday cage?<br><br>a) Plastic<br>b) Glass<br>c) Copper<br>d) Wood<br><br>2. Example of a real-world Faraday cage is<br>a) car<br>b) plastic box<br>c) lightning rod<br>d) metal rod<br><br>3. What is the electrical force inside a Faraday cage when it is struck by lightning?<br>a) The same as the lightning<br>b) Half that of the lightning<br>c) Zero<br>d) A quarter of the lightning<br><br>4. An isolated point charge +q is placed inside the Faraday cage. Its surface must have charge equal to-<br>a) Zero<br>b) +q<br>c) –q<br>d) +2q<br><br>5. A point charge of 2C is placed at centre of Faraday cage in the shape of cube with surface of 9 cm edge. The number of electric field lines passing through the cube normally will be-<br><br>a) 1.9105 $Nm^2/C$ entering the surface<br>b) 1.9105 $Nm^2/C$ leaving the surface<br>c) 2.0105 $Nm^2/C$ leaving the surface<br>d) 2.0105 $Nm^2/C$ entering the surface | |
| 16 | **Sparking Brilliance of Diamond:**<br><br>  <br> | 4 |

The total internal reflection of the light is used in polishing diamonds to create a sparking brilliance. By polishing the diamond with specific cuts, it is adjusted the most of the light rays approaching the surface are incident with an angle of incidence more than critical angle. Hence, they suffer multiple reflections and ultimately come out of diamond from the top. This gives the diamond a sparking brilliance.

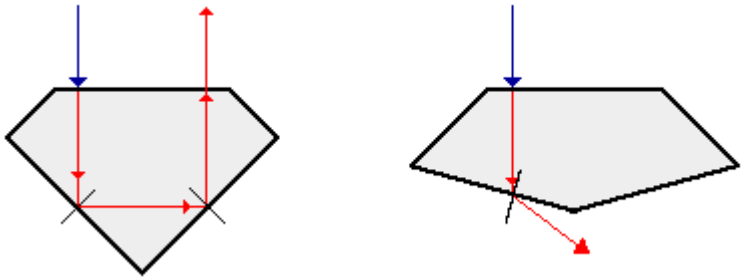
1. Light cannot easily escape a diamond without multiple internal reflections. This is because:
   a) Its critical angle with reference to air is too large
   b) Its critical angle with reference to air is too small
   c) The diamond is transparent
   d) Rays always enter at angle greater than critical angle

2. The critical angle for a diamond is 24.4$^{o}$. Then its refractive index is-
   a) 2.42
   b) 0.413
   c) 1
   d) 1.413

3. The basic reason for the extraordinary sparkle of **suitably cut** diamond is that
   a) It has low refractive index
   b) It has high transparency
   c) It has high refractive index
   d) It is very hard

4. A diamond is immersed in a liquid with a refractive index greater than water. Then the critical angle for total internal reflection will
   a) will depend on the nature of the liquid
   b) decrease
   c) remains the same
   d) increase

5. The following diagram shows same diamond cut in two different shapes.



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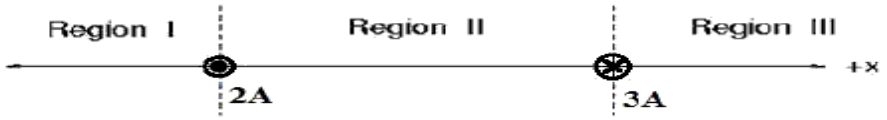
| | The brilliance of diamond in the second diamond will be:<br><br>a) less than the first<br>b) greater than first<br>c) same as first<br>d) will depend on the intensity of light | |
| | **Section – C**<br>**All questions are compulsory. In case of internal choices, attempt anyone.** | |
| 17 | Two straight infinitely long wires are fixed in space so that the current in the left wire is 2 A and directed out of the plane of the page and the current in the right wire is 3 A and directed into the plane of the page. In which region(s) is/are there a point on the x-axis, at which the magnetic field is equal to zero due to these currents carrying wires? Justify your answer.<br>  <br> | 2 |
| 18 | Draw the graph showing intensity distribution of fringes with phase angle due to diffraction through single slit.<br><br>**OR**<br><br>What should be the width of each slit to obtain **n** maxima of double slit pattern within the central maxima of single slit pattern? | 2 |
| 19 | Deduce an expression for the potential energy of a system of two point charges $q_1$ and $q_2$ located at positions $r_1$ and $r_2$ respectively in an external field $(\vec{E})$<br><br>**OR**<br><br>Establish the relation between electric field and electric potential at a point.<br>Draw the equipotential surface for an electric field pointing in +Z direction with its magnitude increasing at constant rate along –Z direction | 2 |
| 20 | Explain with help of circuit diagram, the action of a forward biased p-n junction diode which emits spontaneous radiation. State the least band gap energy of this diode to have emission in visible region. | 2 |

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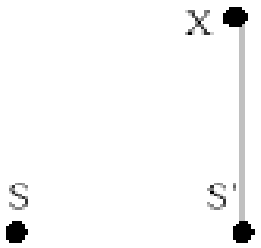
| 21 | A coil of wire enclosing an area 100 $cm^2$ is placed with its plane making an angle $60^0$ with the magnetic field of strength $10^{-1}$T. What is the flux through the coil? If magnetic field is reduced to zero in $10^{-3}$ s, then find the induced emf? | 2 |
| 22 | Two waves from two coherent sources S and S' superimpose at X as shown in the figure. If X is a point on the second minima and SX – S'X is 4.5 cm. Calculate the wavelength of the waves.<br>  <br> | 2 |
| 23 | Draw the energy band diagram when intrinsic semiconductor (Ge) is doped with impurity atoms of Antimony (Sb). Name the extrinsic semiconductor so obtained and majority charge carriers in it. | 2 |
| 24 | Define the terms magnetic inclination and horizontal component of earth's magnetic field at a place. Establish the relationship between the two with help of a diagram.<br>**OR**<br>Horizontal component of earth's magnetic field at a place is $\sqrt{3}$ times the vertical component. What is the value of inclination at that place? | 2 |
| 25 | Write two characteristics of image formed when an object is placed between the optical centre and focus of a thin convex lens. Draw the graph showing variation of image distance v with object distance u in this case. | 2 |
| | **Section -D**<br>**All questions are compulsory. In case of internal choices, attempt any one.** | |
| 26 | A rectangular loop which was initially inside the region of uniform and time - independent magnetic field, is pulled out with constant velocity $v$ as shown in the figure. | 3 |

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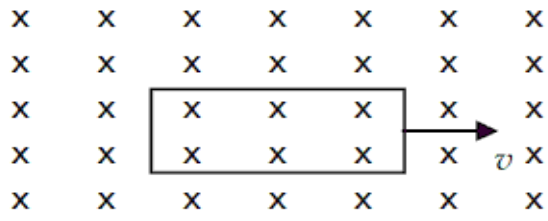
| |  <br>(a)<br><br>a) Sketch the variation of magnetic flux, the induced current, and power dissipated as Joule heat as function of time.<br><br>b) If instead of rectangular loop, circular loop is pulled out; do you expect the same value of induced current? Justify your answer. Sketch the variation of flux in this case with time. | |
| 27 | A variable resistor R is connected across a cell of emf E and internal resistance r.<br><br>a) Draw the circuit diagram.<br>b) Plot the graph showing variation of potential drop across R as function of R.<br>c) At what value of R current in circuit will be maximum.<br><br>**OR**<br><br>A storage battery is of emf 8V and internal resistance 0.5 ohm is being charged by d.c supply of 120 V using a resistor of 15.5 ohm<br><br>a) Draw the circuit diagram.<br>b) Calculate the potential difference across the battery.<br>c) What is the purpose of having series resistance in this circuit? | 3 |
| 28 | a) Explain de-Broglie argument to propose his hypothesis. Show that de-Broglie wavelength of photon equals electromagnetic radiation.<br><br>b) If, deuterons and alpha particle are accelerated through same potential, find the ratio of the associated de-Broglie wavelengths of two.<br><br>**OR**<br><br>State the main implications of observations obtained from various photoelectric experiments. Can these implications be explained by wave nature of light? Justify your answer. | 3 |

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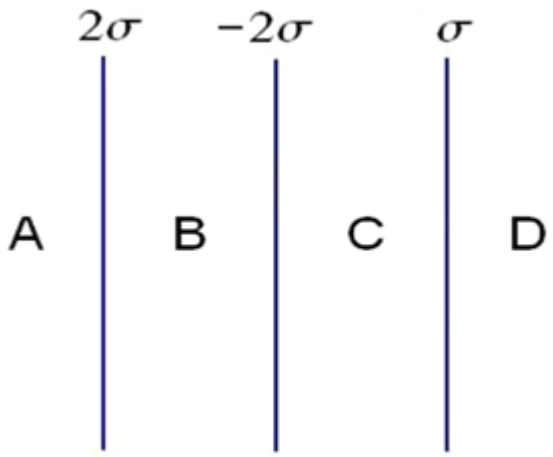
| 29 | Derive an expression for the frequency of radiation emitted when a hydrogen atom de-excites from level n to level (n – 1). Also show that for large values of n, this frequency equals to classical frequency of revolution of an electron. | 3 |
| 30 | a) Give one point of difference between nuclear fission and nuclear fusion.<br><br>b) Suppose we consider fission of a $^{56}_{26}Fe$ into two equal fragments of $^{28}_{13}Al$ nucleus. Is the fission energetically possible? Justify your answer by working out Q value of the process.<br>Given $(m)^{56}_{26}Fe$ = 55.93494 u and $(m)^{28}_{13}Al$ = 27.98191 | 3 |
| | **Section – E**<br>**All questions are compulsory. In case of internal choices, attempt any one.** | |
| 31 | a) State Gauss's law in electrostatics. Show that with help of suitable figure that outward flux due to a point charge Q, in vacuum within gaussian surface, is independent of its size and shape.<br><br>b) In the figure there are three infinite long thin sheets having surface charge density $+2\sigma$, $-2\sigma$ and $+\sigma$ respectively. Give the magnitude and direction of electric field at a point to the left of sheet of charge density $+2\sigma$ and to the right of sheet of charge density $+\sigma$.<br><br>  <br> | 5 |

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| | **OR**<br><br>a) Define an ideal electric dipole. Give an example.<br>b) Derive an expression for the torque experienced by an electric dipole in a uniform electric field. What is net force acting on this dipole.<br>c) An electric dipole of length 2cm is placed with its axis making an angle of $60^0$ with respect to uniform electric field of $10^5$N/C.<br>If it experiences a torque of $8\sqrt{3}$ Nm, calculate the (i) magnitude of charge on the dipole, and its potential energy. | |
| 32 | a) Derive the expression for the current flowing in an ideal capacitor and its reactance when connected to an ac source of voltage V**=$V_0$sinωt.**<br>b) Draw its phasor diagram.<br>c) If resistance is added in series to capacitor what changes will occur in the current flowing in the circuit and phase angle between voltage and current.<br>**OR**<br><br>a) State the principle of ac generator.<br>b) Explain with the help of a well labelled diagram, its working and obtain the expression for the emf generated in the coil.<br>c) Is it possible to generate emf without rotating the coil? Explain | 5 |
| 33 | a) Define a wave front.<br>b) Draw the diagram to show the shape of plane wave front as they pass through (i) a thin prism and (ii) a thin convex lens. State the nature of refracted wave front.<br>c) Verify Snell's law of refraction using Huygens's principle.<br>**OR**<br><br>a) State two main considerations taken into account while choosing the objective of astronomical telescope.<br>b) Draw a ray diagram of reflecting type telescope. State its magnifying power.<br>c) State the advantages of reflecting type telescope over the refracting type? | 5 |