MODEL QUESTION PAPER-1 (2020-21)

PHYSICS (THEORY)

MM: 70 Marks **Time : 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.

SECTION–A

All questions are compulsory. In case of internal choices, attempt any one of them.

1. Why electrostatics field lines do not form closed loop? **[1]**

2. Which part of the electromagnetic spectrum is used in RADAR? Give it's frequency range. **[1]**

OR

How are electromagnetic waves produced by accelerating charges?

3. Write the relation for the force acting on a charged particle q moving with velocity $\vec{v}$ in the presence of a magnetic field $\vec{B}$. **[1]**

4. Define 'quality factor' of resonance in series LCR circuit. What is it's SI unit ? **[1]**

5. Write the underlying principle of a moving coil galvanometer. **[1]**

6. What is the ratio of radii of the orbits corresponding to first excited state and ground state in a hydrogen atom? **[1]**

7. How is the radius of a nucleus related to its mass number? **[1]**

OR

Select the pairs of isobars from the following nuclei ? $_{11}Na^{22}$, $_{11}Na^{23}$, $_{10}Ne^{23}$.

8. Name one impurity each, which when added, to pure Si, produces **[1]**

(i) n-type, and (ii) p-type semiconductor.

OR

State the reason, why GaAs is most commonly used in making of a solar cell.

9. Draw a schematic diagram of a reflecting telescope. **[1]**

10. Define the term 'Coherent Source' which are required to produce interference pattern in Young's double slit experiment. **[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.

(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

11. **Assertion(A) :** Whenever magnetic flux linked with the coil changes with respect to time, then an emf is induced in it. **[1]**
Reason(R): According to Lenz law, the direction of induced emf in any coil in such a way that it always opposes the cause by which is it produced.

12. **Assertion :** Coluomb's law in electrostatics holds good for two point charges at rest. **[1]**
Reason : When the charges are in motion, the force is electromagnetic in nature.

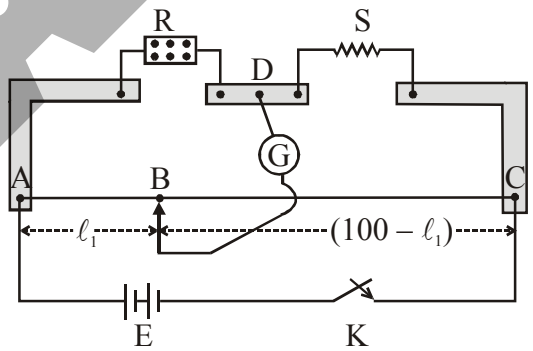
13. **Assertion :** For the scattering of α-particle at a large angles, only the nucleus of the atom is responsible.
Reason : Nucleus is very heavy in comparison to electrons. **[1]**

14. **Assertion(A) :** Conductivity of semiconductor increases on doping.
Reason(R): Doping raises the temperature of semi conductor. **[1]**

SECTION – B

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. **Meter Bridge :**
The meter bridge consists of a wire of length 1m and of uniform cross sectional area stretched taut and clamped between two thick metallic strips bent at right angles, as shown. The metallic strip has two gaps across which resistors can be connected. The end points where the wire is clamped are connected to a cell through a key. One end of a galvanometer is connected to the metallic strip midway between the two gaps. The other end of the galvanometer is connected to a 'jockey'. The jockey is essentially a metallic rod whose one end has a knife-edge which can slide over the wire to make electrical connection. If the jockey is moved along wire, then there will be one position where galvanometer will show no current (i.e. balanced condition). **[4]**



1. Resistance of the two gaps of a meter bridge are 10 ohm and 30 ohm respectively. It the resistances are inter changed, the balance point shift by :
(a) 33.3 cm (b) 66.67 cm (c) 25 cm (d) 50 cm

2. A galvanometer acting as a voltmeter will have :
(a) A low resistance in series with its coil (b) A low resistance in parallel with its coil
(c) A high resistance in series with its coil (d) A high resistance in parallel with its coil

3. An unknown resistance is placed on the left gap and known resistance of 60Ω in right gap of meter bridge. The null point is obtained at 40 cm from left end of the bridge. Select the value of unknown resistance :

(a) 60Ω (b) 30Ω (c) 40Ω (d) 20Ω

4. The principle of meter bridge is based on the balanced condition of :-

(a) Potentiometer (b) Wheatstone bridge

(c) Transformer (d) Galvanometer

5. In meter bridge experiment balanced point adjusted at the middle of the bridge because of :

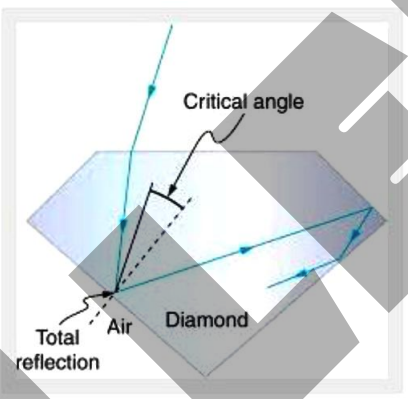
(a) The percentage error in determination of unknown resistance can be minimised

(b) Range can be increased

(c) Sensitivity can be minimised

(d) Range can be decreased

16. Sparking Brilliance of Diamond: **[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°. 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

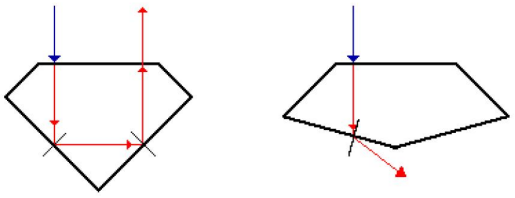
(c) It has high refractive index (d) It is very hard

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.



The brilliance of diamond in the second diamond will be:

(a) less than the first (b) greater than first

(c) same as first (d) will depend on the intensity of light

SECTION–C

All questions are compulsory. In case of internal choices, attempt anyone.

17. Find the condition under which the charged particles moving with different speeds in the presence of electric and magnetic field vectors can be used to select charged particles of a particular speed. **[2]**

18. Give any two differences between fringes formed in single slit diffraction and Young's double slit experiment. **[2]**

OR

State Huygens's principle for constructing wave fronts.

19. Explain the terms: **[2]**

(i) quantization of charge

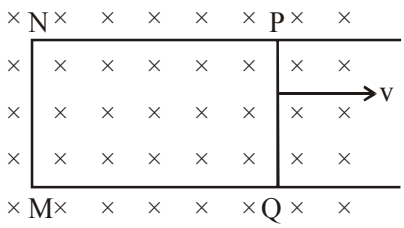
(ii) conservation of charge

OR

Electric field intensity within a conductor is always zero. Why? **[2]**

20. Current in a circuit falls from 5.0 A to 0.0 A in 0.1 s. If an average emf of 200 V induced, give an estimate of the self-inductance of the circuit. **[2]**

21. A rectangular loop PQMN with movable arm PQ of length 10 cm and resistance 2Ω is placed in a uniform magnetic field of 0.1 T acting perpendicular to the plane of the loop as is shown in the figure. The resistances of the arms MN, NP and MQ are negligible. Calculate the (i) emf induced in the arm PQ and (ii) current induced in the loop when arm PQ is moved with velocity 20 m/s. **[2]**



22. A double convex lens is made of a glass of refractive index 1·55, with both faces of the same radius of curvature. Find the radius of curvature required, if the focal length is 20 cm. **[2]**

23. Explain with the help of a diagram the formation of depletion region and barrier potential in a p-n junction. **[2]**

24. Name the elements of the earth's magnetic field. Define any two of them. **[2]**

OR

In the magnetic meridian of a certain place, the horizontal component of the earth's magnetic field is 0.26G and the dip angle is 60°. What is the magnetic field of the earth at this location?

25. State two properties of electromagnetic waves. How can we show that EM waves carry momentum? **[2]**

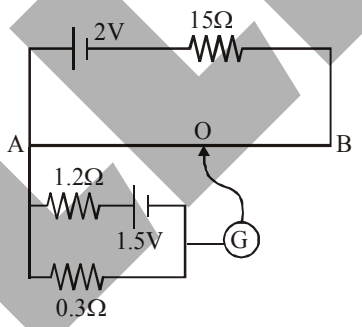
SECTION -D

All questions are compulsory. In case of internal choices, attempt any one.

26. (a) Derive, with the help of a diagram, the expression for the magnetic field inside a very long solenoid having n turns per unit length carrying a current I. **[3]**

(b) How is a toroid different from a solenoid?

27. In the following potentiometer circuit AB is a uniform wire of length 1 m and resistance 10 Ω Calculate the potential gradient along the wire and balance length AO (= ℓ). **[3]**



OR

Two identical cells of emf 1.5 V each joined in parallel to supply energy to an external circuit consisting of two resistances of 7 Ω each joined in parallel. A very high resistance voltmeter reads the terminal voltage of cells to be 1.4 V. Calculate the internal resistance of each cell.

28. (a) Show that the de-Broglie wavelength of the electrons of energy E is given by the relation

$$\lambda = \frac{h}{\sqrt{2mE}}.$$ **[3]**

(b) What is the de-Broglie wavelength of an atom at absolute temperature T ?

OR

(a) Write Einstein photoelectric equation and use it to explain:

(i) Independence of maximum energy of emitted photoelectrons from intensity of incident light,

(ii) Existence of threshold frequency for emission of photoelectrons.

29. The fission properties of $_{94}Pu^{239}$ are very similar to those of $_{92}U^{235}$. The average energy released per fission is 180 MeV. How much energy,in MeV, is released if all the atoms in 1 kg of pure $_{94}Pu^{239}$ undergo fission? **[3]**

30. When is H_α line in the emission spectrum of hydrogen atom obtained ? Calculate the frequency of the photon emitted during this transition. **[3]**

SECTION – E

All questions are compulsory. In case of internal choices, attempt any one.

31. (i) Use Gauss' law to find the electric field due to a uniformly charged infinite plane sheet. What is the direction of field for positive and negative charge densities ? **[5]**

(ii) Find the ratio of the potential differences that must be applied across the series and parallel combination of two capacitors C_1 and C_2 with their capacitances in the ratio 1 : 2 so that the energy stored in the two cases becomes the same.

OR

(a) Derive an expression for the electric field E due to a dipole of length '2a' at a point distant r from the centre of the dipole on the axial line.

(b) Draw a graph of E versus r for r >> a.

(c) If this dipole were kept in a uniform external electric field E_0, diagrammatically represent the position of the dipole in stable and unstable equilibrium and write the expressions for the torque acting on the dipole in both the cases.

32. A 2 μF capacitor, 100 Ω resistor and 8 H inductor are connected in series with an AC source.

(i) What should be the frequency of the source such that current drawn in the circuit is maximum, What is this frequency called ? **[5]**

(ii) If the peak value of e.m.f. of the source is 200 V, find the maximum current.

(iii) Draw a graph showing variation of amplitude of circuit current with changing frequency of applied voltage in a series LCR circuit for two different values of resistance R_1 and R_2 ($R_1 > R_2$).

OR

In a series LCR circuit connected to an a.c. source of voltage $V = V_m \sin\omega t$, use phasor diagram to derive an expression for the current in the circuit. Hence obtain the expression for the power dissipated in the circuit. Show that power dissipated at resonance is maximum.

33. What do you mean by diffraction of light? Explain diffraction at a single slit and deduce expression for width of its central maxima. **[5]**

OR

Define wavefront. Use Huygens' principle to verify the laws of refraction.