Time : 3 Hours
Maximum Marks : 70

PHYSICS

CBSE
Sample Question Paper

Sample Question Paper (2020)

General Instructions :

1. All questions are compulsory. There are 37 questions in all.
2. This question paper has **four** sections : Section **A**, Section **B**, Section **C**, Section **D**.
3. Section **A** contains **twenty** questions of **one** mark each, Section **B** contains **seven** questions of **two** marks each, Section **C** contains **seven** questions of **three** marks each, Section **D** contains **three** questions of **five** marks each.
4. There is no overall choice. However, internal choices have been provided in **two** questions of **one** mark, **two** questions of **two** marks, **one** question of **three** marks and **three** questions of **five** marks weightage. You have to attempt only one of the choices in such questions.
5. You may use the following values of physical constants wherever necessary :

$c = 3 \times 10^8$ m/s, $h = 6.63 \times 10^{-34}$ Js

$e = 1.6 \times 10^{-19}$ C, $\mu_0 = 4\pi \times 10^{-7}$ T mA^{-1}

$\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1}m^{-2}, $\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ Nm^2 C^{-2}

mass of electron $= 9.1 \times 10^{-31}$ kg, Boltzmann constant $= 1.38 \times 10^{-23}$ JK^{-1}

mass of proton $= 1.673 \times 10^{-27}$ kg, Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

mass of neutron $= 1.675 \times 10^{-27}$ kg

Section 'A'

1. Consider the two idealized systems : **(i)** a parallel plate capacitor with large plates and small separation and **(ii)** a long solenoid of length $L >> R$, radius of cross-section. In (i) E is ideally treated as a constant between plates and zero outside. In (ii) magnetic field is constant inside the solenoid and zero outside. These idealized assumptions, however, contradict fundamental laws as below :

(a) case (i) contradicts Gauss's law for electrostatic fields.

(b) case (ii) contradicts Gauss's law for magnetic fields.

(c) case (i) agrees with $\oint \vec{E}.\vec{dl} = 0$

(d) case (ii) contradicts $\oint \vec{H}.\vec{dl} = I_{en}$ **1**

2. The phenomenon which is responsible for the bending of light around the sharp corners of an obstacle is :

(a) Interference

(b) Diffraction

(c) Polarization
(d) Dispersion **1**

3. Let $E_n = \dfrac{-1}{8\varepsilon_0^2}\dfrac{me^4}{n^2h^2}$

be the energy of the nth level of H-atom. If all the H-atoms are in the ground state and radiation of frequency $\dfrac{(E_2 - E_1)}{h}$ falls on it,

(a) it will not be absorbed at all.
(b) some of atoms will move to the first excited state.
(c) all atom will be excited to the $n = 2$ state.
(d) no atoms will make a transition to the $n = 3$ state. **1**

4. When an electric field is applied across a semiconductor :
(a) electrons move from lower energy level to higher energy level in the conduction band.
(b) electrons move from higher energy level to lower energy level in the conduction band.
(c) holes in the valence band move from higher energy level to lower energy level.
(d) holes in the valence band move from lower energy level to higher energy level. **1**

5. If the rms current in a 50 Hz AC circuit is 5 A, the value of the current $\left(\dfrac{1}{300}\right)$s after its value becomes zero is :

(a) $5\sqrt{2}$ A .
(b) $5\sqrt{\dfrac{3}{2}}$ A .
(c) $\dfrac{5}{6}$ A .
(d) $\dfrac{5}{\sqrt{2}}$ A . **1**

6. An electromagnetic wave travelling along z-axis is given as E = $E_0\cos(kz-\omega t)$. Choose the correct options from the following :

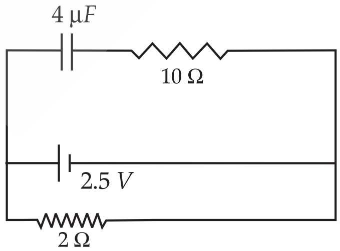
(a) The associated field is given as $\vec{B} = \dfrac{1}{c}(\hat{k}\times\vec{E}) = \dfrac{1}{\omega}(\hat{k}\times\vec{E})$.

(b) The electromagnetic field can be written in terms of the associated magnetic field as $\vec{E} = c(\vec{B}\times\hat{k})$

(c) $\hat{k}\cdot\vec{E} = 0, \hat{k}\cdot\vec{B} = 0$

(d) $\hat{k}\times\vec{E} = \vec{0}, \hat{k}\times\vec{B} = \vec{0}$ **1**

7. A capacitor of 4 μF is connected as shown in the circuit figure. The internal resistance of the battery is 0.5 Ω. The amount of charge on the capacitor plates will be :



(a) 0 μC
(b) 4 μC
(c) 16 μC
(d) 8 μC **1**

8. Between the primary and secondary rainbows, there is a dark band known as Alexander's dark band. This is because :
(a) light scattered into this region interfere destructively.
(b) there is no light scattered into this region.

(c) light is absorbed in this region.

(d) angle made at the eye by the scattered rays with respect to the incident light of the sun lies between approximately 42° and 50°. **1**

9. Two identical current carrying coaxial loops, carry current I in an opposite sense. A simple amperian loop passes through both of them once. Calling the loop as C,

(a) $\oint B.dl = \mp 2\mu_o I$.

(b) the value of $\oint B.dl$ is independent of sense of C.

(c) there may be a point on C where B and dl are perpendicular.

(d) B vanishes everywhere on C. **1**

10. An electron (mass m) with an initial velocity $v = v_0\hat{i}$ $(v_0 > 0)$ is in an electric field $\vec{E} = -E_0\hat{\imath}$ (E_0= constant > 0). Its de Broglie wavelength at time t is given by :

(a) $\dfrac{\lambda_0}{\left[1+\dfrac{eE_0}{m}\cdot\dfrac{t}{v_0}\right]}$.

(b) $\lambda_0\left[1+\dfrac{eE_0 t}{mv_0}\right]$

(c) λ_0

(d) $\lambda_0 t$ **1**

11. Expression for speed of electromagnetic waves in a medium of electrical permittivity ε and magnetic permeability μ is **1**

OR

The electromagnetic radiations used for eye surgery are ....

12. Electric field lines are .... lines that extend from positive charge towards negative charge. **1**

13. Type of wave front generated from line sources is **1**

14. Energy gaps of silicon (14) and Germanium (32) are .... and respectively. **1**

15. Relation for binding energy (BE) (in MeV) of a nucleus of mass ${}^{A}_{Z}M$ atomic number (Z) and mass number (A) in terms of the masses of its constituents neutrons and protons is **1**

16. Why germanium is preferred over silicon for making semiconductor devices ? **1**

17. An object is placed in front of convex lens made of glass. How does the image distance vary if the refractive index of the medium is increased in such a way that still it remains less than the glass? **1**

18. Nichrome and copper wires of same length and same radius are connected in series. Current I is passed through them. Which wire gets heated up more ? Justify your answer. **1**

19. Why are elemental dopants for Silicon or Germanium usually chosen from group XIII or group XV ? **1**

20. Draw a plot showing variation of electric field with distance from centre of a solid conducting sphere of radius R having a charge of $+Q$ on its surface. **1**

OR

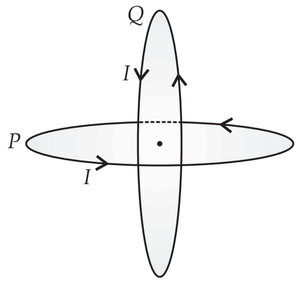
Draw the pattern of electric field lines, when a point charge $-Q$ is kept near an uncharged conducting plate.

Section 'B'

21. Using Rutherford model of the atom, derive the expression for the total energy of the electron in hydrogen atom. What is the significance of total negative energy possessed by the electron ? **2**

22. Write Einstein's photoelectric equation. Explain the terms **(i)** threshold frequency and **(ii)** stopping potential. **2**

23. Two identical circular wires P and Q each of radius R and carrying current I are kept in perpendicular planes such that they have a common centre as shown in the figure. Find the magnitude and direction of the net magnetic field at the common centre of the two coils. **2**



OR

A charged particle q is moving in the presence of a magnetic field B which is inclined to an angle 30° with the direction of motion of the particle. Draw the trajectory followed by the particle in the presence of the field and explain how the particle describes this path.

24. Plot a graph showing variation of de-Broglie wavelength λ versus $\frac{1}{\sqrt{V}}$, where, V is accelerating potential for two particles A and B carrying same charge but of masses m_1, m_2 ($m_1 > m_2$). Which one of the two represents a particle of smaller mass and why ? **2**

25. A capacitor of capacitance 'C' is being charged by connecting it across a dc source along with an ammeter. Will the ammeter show a momentary deflection during the process of charging ? If so, how would you explain this momentary deflection and the resulting continuity of current in the circuit ? Write the expression for the current inside the capacitor. **2**

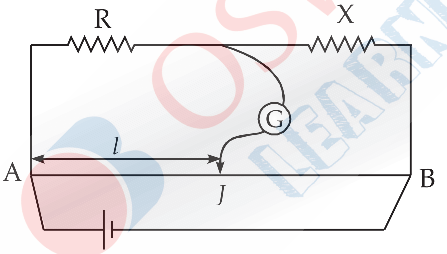
OR

Considering the case of a parallel plate capacitor being charged, show how one is required to generalize Ampere's circuital law to include the term due to displacement current.

26. In the metre bridge experiment, balance point was observed at J with AJ = l.

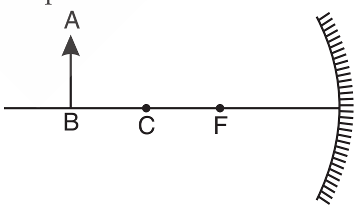
(i) The values of R and X were doubled and then interchanged. What would be the new position of the balance point ?

(ii) If the galvanometer and battery are interchanged at the balance position, how will the balance point get affected ?



2

27. An object AB is kept in front of a concave mirror as shown in the figure :



(i) Complete the ray diagram showing the image formation of the object.

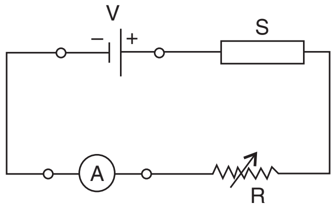
(ii) How will the position and intensity of the image be affected if the lower half of the mirror's reflecting surface is painted black ? **2**

Section 'C'

28. (i) Obtain the expression for the torque $\vec{\tau}$ experienced by an electric dipole of dipole moment $\vec{p}$ in a uniform electric field, $\vec{E}$.

(ii) What will happen if the field were not uniform? **3**

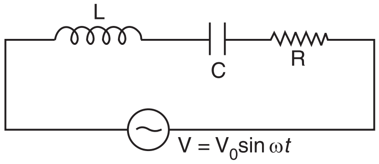
29. (i) In the following diagram 'S' is a semiconductor. Would you increase or decrease the value of R to keep the reading of the ammeter A constant when S is heated ? Give reason for your answer.



(ii) Draw the circuit diagram of a photodiode and explain its working. Draw its *I*/*V* characteristics. **3**

30. The current, in the LCR circuit shown in the figure is observed to lead the voltage in phase. Without making any other change in the circuit, a capacitor, of capacitance C_0, is (appropriately) joined to the capacitor *C*. This results in making the current, in the 'modified' circuit, flow in phase with the applied voltage.

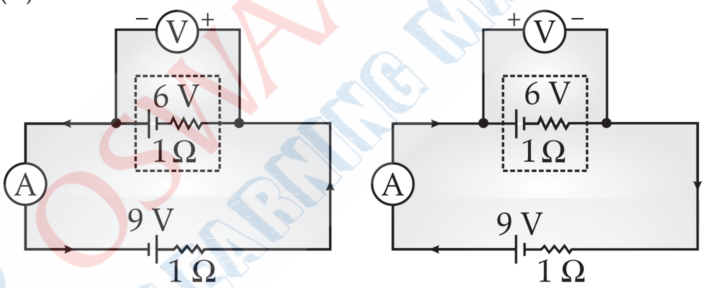
Draw a diagram of the 'modified' circuit and obtain an expression for C_0 in terms of ω, *L* and *C*. **3**



31. (a) Identify the part of electromagnetic spectrum used in **(i)** radar and **(ii)** eye surgery. Write their frequency range.

(b) Prove that the average energy density of the oscillating electric field is equal to that of the oscillating magnetic field. **3**

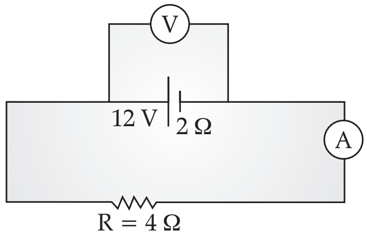
32. In the two electric circuits shown in the figure, determine the readings of ideal ammeter (A) and the ideal voltmeter (V).



OR

(i) The potential difference applied across a given resistor is altered so that the heat produced per second increases by a factor of 9. By what factor does the applied potential difference change ?

(ii) In the figure shown, an ammeter A and a resistor of 4 Ω are connected to the terminals of the source. The emf of the source is 12 V having an internal resistance of 2 Ω. Calculate the voltmeter and ammeter readings.



33. A radioactive nucleus 'A' undergoes a series of given below :

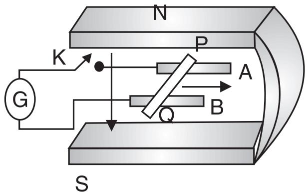
$$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$$

The mass number and atomic number of A_2 are 176 and 71 respectively.

(i) Determine the mass and atomic numbers of A_4 and A.

(ii) Write the basic nuclear processes underlying β^+ and β^- decays.

34. Figure shows a metallic rod PQ of length l, resting on the smooth horizontal rails AB 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. Assume the magnetic field to be uniform. Given the resistance of the closed loop containing the rod is R.



(i) Suppose K is open and the rod is moved with a speed v in the direction shown. Find the polarity and magnitude of induced emf.

(ii) 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 motion of the rod. Explain.

(iii) What is the induced emf in the moving rod if the magnetic field is parallel to the rails instead of being perpendicular ? **3**

Section 'D'

35. **(a)** Derive an expression for the electric field at any point on the equatorial line of an electric dipole.

(b) Two identical point charges, q each, are kept 2 m apart in air. A third point charge Q of unknown magnitude and sign is placed on the line joining the charges such that the system remains in equilibrium. Find the position and nature of Q. **5**

OR

(i) Compare the individual dipole moment and the specimen dipole moment for H_2O molecule and O_2 molecule when placed in

(a) absence of external electric field.

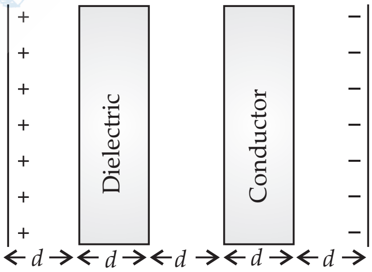
(b) presence of external electric field.

Justify your answer.

(ii) Given two parallel conducting plates of area A and charge densities $+\sigma$ and $-\sigma$. A dielectric slab of constant k and a conducting slab of thickness d each are inserted in between them as shown.

(a) Find the potential difference between the plates.

(b) Plot E versus x graph, taking $x = 0$ at positive plate and $x = 5d$ at negative plate.



36. **(i)** With the help of a diagram, explain the principle and working of a device which produces current that reverses its direction after regular intervals of time.

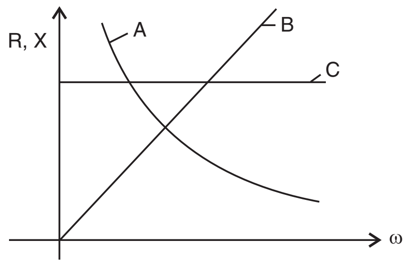
(ii) If a charged capacitor C is short circuited through an inductor L, the charge and current in the circuit oscillate simple harmonically.

(a) In what form the capacitor and the inductor store energy ?

(b) Write two reasons due to which the oscillations become damped. **5**

OR

(i) Figure shows the variation of resistance and reactance versus angular frequency. Identify the curve which corresponds to inductive reactance and resistance.



(ii) Show that series LCR circuit at resonance behaves as a purely resistive circuit. Compare the phase relation between current and voltage in series LCR circuit for (i) $X_L > X_C$, (ii) $X_L = X_C$ using phasor diagrams.

(iii) What is an acceptor circuit and where it is used ?

37. When a parallel beam of monochromatic source of light of wavelength λ is incident on a single slit of width a, show how the diffraction pattern is formed at the screen by the interference of the wavelets from the slit.

Show that, besides the central maxima at $\theta = 0$, secondary maxima are observed at

$$\theta = \left(n + \frac{1}{2}\right)\frac{\lambda}{a}$$

and the minima at $\theta = \frac{n\lambda}{a}$.

Why do secondary maxima get weaker in intensity with increasing n ? **5**

OR

(a) Define a wavefront. Using Huygens' principle, verify the laws of reflection at a plane surface.

(b) In a single slit diffraction experiment, the width of the slit is made double the original width. How does this affect the size and intensity of the central diffraction band ? Explain.

(c) When a tiny circular obstacle is placed in the path of light from a distant source, a bright spot is seen at the centre of the obstacle. Explain why.

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