S R SAMPLE PAPER 2

Class 12 - Physics

Time Allowed: 3 hours **Maximum Marks: 70**

General Instructions:

1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. All the sections are compulsory.
4. **Section A** contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, **Section B** contains five questions of two marks each, **Section C** contains seven questions of three marks each, **Section D** contains two case study based questions of four marks each and **Section E** contains three long answer questions of five marks each.
5. There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
6. Use of calculators is not allowed.

Section A

1. The potential barrier in the depletion layer is due to **[1]**

   a) Holes
   b) Forbidden gap
   c) Electrons
   d) Ions

2. Consider a current-carrying wire (current I) in the shape of a circle. Note that as the current progresses along the wire, the direction of j (current density) changes in an exact manner, while the current I remain unaffected. The agent that is essentially responsible for, is **[1]**

   a) the electric field produced by charges accumulated on the surface of the wire.
   b) the charges just behind a given segment of wire which push them just the right way by repulsion.
   c) source of emf.
   d) the charges ahead.

3. A telescope has an objective of focal length 100 cm and an eye-piece of focal length 5 cm. What is the magnifying power of the telescope when it is in normal adjustment? **[1]**

   a) 20.0
   b) 2.0
   c) 0.2
   d) 200

4. The arrangement fo two magnetic poles of equal and opposite strengths separated by a finite distance is called: **[1]**

   a) Magnetic dipole
   b) None of these

c) Magnetic field

d) Magnetic pole

5. Potential energy of two equal +ve charges 1μC each held 1 m apart in air is: **[1]**

a) $9 \times 10^{-3} eV$

b) $9 \times 10^{-3} J$

c) zero

d) 1 J

6. A particle having charge q and mass m starts moving from the origin under the action of an electric field $\vec{E} = E_0 \hat{i}$ and $\vec{B} = B_0 \hat{i}$ with a velocity $v = v_0 \hat{j}$. The speed of the particle will become $\frac{\sqrt{5}}{2} v_0$ after a time **[1]**

a) $\frac{\sqrt{3} m v_0}{2qE}$

b) $\frac{m v_0}{qE}$

c) $\frac{\sqrt{5} m v_0}{2qE}$

d) $\frac{m v_0}{2qE}$

7. A wire loop is rotated in a magnetic field. The frequency of change of direction of the induced emf is: **[1]**

a) four times per revolution

b) twice per revolution

c) six times per revolution

d) once per revolution

8. The susceptibility of a paramagnetic material is χ at 27° C. At what temperature will its susceptibility be $\frac{\chi}{2}$? **[1]**

a) 54° C

b) 327° C

c) 237° C

d) 1600° C

9. The shape of the wavefront of the portion of the wavefront of light from a distant star intercepted by the earth is **[1]**

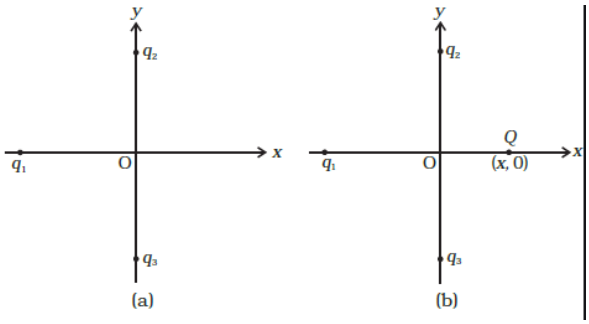
a) plane

b) spherical

c) conical

d) hyperboloid

10. In Fig, two positive charges q_2 and q_3 fixed along the y axis, exert a net electric force in the + x direction on a charge q_1 fixed along the x axis. If a positive charge Q is added at (x, 0), the force on q_1 **[1]**



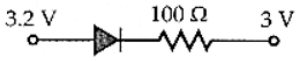
a) shall increase along the positive x-axis.

b) shall point along the negative x-axis.

c) shall decrease along the positive x-axis.

d) shall increase but the direction changes because of the intersection of Q with q_2 and q_3.

11. The current in the circuit shown in the figure considering ideal diode is **[1]**



a) 200 A

b) 2×10^{-4} A

c) 20 A

d) 2×10^{-3} A

12. The principal behind optical fibre is: **[1]**

a) Total internal reflection

b) Both Total external reflection and Total

internal reflection

c) Diffraction

d) Total external reflection

13. **Assertion (A):** The de Broglie wavelength of a molecule varies inversely as the square root of temperature. **[1]**
Reason (R): The root mean square velocity of the molecule depends on the temperature.

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.

14. **Assertion:** Capacitor is filled with same thickness of dielectric (t < d) and conducting sheet one after another, then capacitance are C_1 and C_2 respectively then $C_2 > C_1$. **[1]**

Reason: Capacitance is more in presence of metal sheet as $K_{metal} > K_{dielectric}$.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

15. **Assertion (A):** When Young's double-slit experiment is performed with a source of white light, only black and white fringes are observed. **[1]**
Reason (R): White light does not disperse in different colours in case of interference.

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

16. **Assertion (A):** If the frequency of the applied AC is doubled, then the power factor of a series R-L circuit decreases. **[1]**
Reason (R): Power factor of series R-L circuit is given by $\cos\phi = \frac{2R}{R^2+\omega^2L^2}$.

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.

Section B

17. An e.m. wave is travelling in a medium with a velocity $v = v\hat{i}$. The electric field oscillations, of this e.m. wave, are along the y-axis. **[2]**
    a. Identify the direction in which the magnetic field oscillations are taking place, of the e.m. wave.
    b. How are the magnitudes of the electric field and magnetic fields in the electromagnetic wave related to each other?
18. What are magnetic lines of force? Sketch the magnetic field lines of a bar magnet. **[2]**
19. Name the type of bias that results in very high resistance of a p-n junction diode. In the given circuit, a voltmeter **V** is connected across bulb **B**. What changes would occur in bulb **B** and voltmeter **V**, if the resistor **R** is increased in value? Give reason for your answer. **[2]**
20. Calculate the ratio of the frequencies of the radiation emitted due to transition of the electron in a hydrogen atom from its (i) second permitted energy level to the first level and (ii) highest permitted energy level to the second **[2]**

permitted level.

21. Using Biot-Savart's law, deduce the expression for the magnetic field at a point (x) on the axis of a circular current-carrying loop of radius R. How is the direction of the magnetic field determined at this point? **[2]**

OR

A wire AB is carrying a steady current of 12 A and is lying on the table. Another wire CD carrying 5 A is held directly above AB at a height of 1 mm. Find the mass per unit length of the wire CD so that it remains suspended at its position when left free. Give the direction of the current flowing in CD with respect to that in AB.

Section C

22. Two batteries, each of emf ε and internal resistance r, are connected in parallel. If we take current from this combination in an external resistance R, then for what value of R maximum power will be obtained? What will be this power? **[3]**

23. Using the concept of electron and hole current, derive an expression for the electrical conductivity of a semiconductor. **[3]**

24. **[3]**
    a. Calculate the frequency of a photon of energy 6.5×10^{-19} J.
    b. Can this photon cause emission of an electron from the surface of Cs of work function 2.14 eV? If yes, what will be maximum kinetic energy of the photoelectron?

25. **[3]**
    i. Derive the mathematical expression for the radioactive decay for a sample of a radioactive nucleus.
    ii. How is the mean life of a given radioactive nucleus related to the decay constant?

26. In a Geiger-Marsden experiment, what is the distance of closest approach to the nucleus of a 7.7 MeV $\alpha-$particle before it comes momentarily to rest and reverses its direction? **[3]**

27. In single slit diffraction, explain why the maxima at $\theta = \left(\mathrm{n} + \frac{1}{2}\right)\left(\frac{\lambda}{\mathrm{a}}\right)$ becomes weaker and weaker as n increases. State two important differences between interference and diffraction pattern. **[3]**

28. **[3]**
    i. Define mutual inductance.
    ii. A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20 A in 0.5 s, what is the change of flux linkage with the other coil?

OR

A metallic rod of length l and resistance R is rotated with a frequency ν, with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius l, about an axis passing through the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field B parallel to the axis is present everywhere.

i. Derive the expression for the induced emf and the current in the rod.
ii. Due to the presence of the current in the rod and of the magnetic field, find the expression for the magnitude and direction of the force acting on this rod.
iii. Hence obtain the expression for the power required to rotate the rod.

Section D

29. **Read the text carefully and answer the questions:** **[4]**

In an electromagnetic wave both the electric and magnetic fields are perpendicular to the direction of propagation, that is why electromagnetic waves are transverse in nature. Electromagnetic waves carry energy as they travel through space and this energy is shared equally by the electric and magnetic fields. Energy density of an electromagnetic waves is the energy in unit volume of the space through which the wave travels.

(i) The electromagnetic waves propagated perpendicular to both $\vec{E}$ and $\vec{B}$. The electromagnetic waves travel

in the direction of

a) $\vec{E} \cdot \vec{B}$ b) $\vec{B} \cdot \vec{E}$

c) $\vec{E} \times \vec{B}$ d) $\vec{B} \times \vec{E}$

(ii) Fundamental particle in an electromagnetic wave is

a) photon b) phonon

c) electron d) proton

(iii) Electromagnetic waves are transverse in nature is evident by

a) diffraction b) interference

c) polarisation d) reflection

OR

The electric and magnetic fields of an electromagnetic waves are

a) in opposite phase and parallel to each other b) in phase and parallel to each other.

c) in phase and perpendicular to each other d) in opposite phase and perpendicular to each other

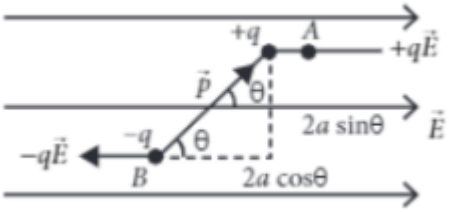
(iv) For a wave propagating in a medium, Name the property that is independent of the others.

a) frequency b) wavelength

c) velocity d) all these depend on each other

30. **Read the text carefully and answer the questions:** **[4]**

When electric dipole is placed in uniform electric field, its two charges experience equal and opposite forces, which cancel each other and hence net force on electric dipole in uniform electric field is zero. However these forces are not collinear, so they give rise to some torque on the dipole. Since net force on electric dipole in uniform electric field is zero. so no work is done in moving the electric dipole in uniform electric field. However some work is done in rotating the dipole against the torque acting on it.



(i) The dipole moment of a dipole in a uniform external field $\vec{E}$ is $\vec{P}$. Then the torque $\vec{\tau}$ acting on the dipole is

a) $\vec{\tau} = 2(\vec{P} + \vec{E})$ b) $\vec{\tau} = \vec{P} \cdot \vec{E}$

c) $\vec{\tau} = (\vec{P} + \vec{E})$ d) $\vec{\tau} = \vec{P} \times \vec{E}$

(ii) An electric dipole consists of two opposite charges, each of magnitude 1.0 μC separated by a distance of 2.0 cm. The dipole is placed in an external field of 10^5 NC^{-1}. The maximum torque on the dipole is

a) 4×10^{-3} Nm b) 2×10^{-3} Nm

c) 1×10^{-3} Nm d) 0.2×10^{-3} Nm

(iii) Torque on a dipole in uniform electric field is minimum when θ is equal to

a) 0^o b) 90^o

c) 180^o d) Both 0^o and 180^o

(iv) When an electric dipole is held at an angle in a uniform electric field, the net force F and torque τ on the dipole are

a) F = 0, τ = 0 b) $F \neq 0, \tau \neq 0$

c) F $\neq$ 0, τ = 0 d) F = 0, $\tau \neq 0$

OR

An electric dipole of moment p is placed in an electric field of intensity E. The dipole acquires a position such that the axis of the dipole makes an angle θ with the direction of the field. Assuming that the potential energy of the dipole to be zero when $\theta = 90^o$, the torque and the potential energy of the dipole will respectively be

a) pE sin θ, - pE cos θ b) pE cos θ, -pE sin θ

c) pE sin θ, 2pE cos θ d) pE sin θ, -2pE cos θ

Section E

31. i. Draw a labelled ray diagram to obtain the real image formed by an astronomical telescope in normal adjustment position. Define its magnifying power. **[5]**

ii. You are given three lenses of power 0.5 D, 4D and 10 D to design a telescope.

a. Which lenses should be used as objective and eyepiece? Justify your answer.

b. Why is the aperture of the objective preferred to be large?

OR

Describe Young's double slit experiment to produce an interference pattern due to a monochromatic source of light. Deduce the expression for the fringe width.

32. Two charges -q and +q are located at points (0, 0, -a) and (0, 0, a), respectively. **[5]**

a. What is the electrostatic potential at the points (0, 0, z) and (x, y, 0)?

b. Obtain the dependence of potential on the distance r of a point from the origin when r/a >> 1.

c. How much work is done in moving a small test charge from the point (5, 0, 0) to (-7, 0, 0) along the x-axis? Does the answer change if the path of the test charge between the same points is not along the x-axis?

OR

a. If two similar large plates, each of area A having surface charge densities +σ and - σ are separated by a distance d in air, then find the expression for

i. the field at points between the two plates and on the outer side of the plates. Specify the direction of the field in each case.

ii. the potential difference between the plates.

iii. the capacitance of the capacitor so formed.

b. Two metallic spheres of radii R and 2R are charged so that both of these have the same surface charge density σ. If they are connected to each other with a conducting wire, in which direction will the charge flow and why?

33. i. An ac source generating a voltage V = V_0 sin ωt is connected to a capacitor of capacitance C. Find the expression of the current I flowing through it. Plot a graph of V and I versus ωt to show that the current is $\frac{\pi}{2}$ **[5]**

ahead of the voltage.

ii. A resistor of 200 Ω and a capacitor of 15 μF are connected in series to a 220 V, 50 Hz ac source. Calculate the current in the circuit and the rms voltage across the resistor and the capacitor. Why the algebraic sum of these voltages is more than the source voltage?

OR

i. Draw a labelled diagram of a step-down transformer. State the principle of its working.

ii. Express the turn ratio in terms of voltages.

iii. Find the ratio of primary and secondary currents in terms of turn ratio in an ideal transformer.

iv. How much current is drawn by the primary of a transformer connected to 220 V supply when it delivers power to a 110 V - 550 W refrigerator?