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Please check that this question paper contains 33 question and 09 printed pages.

D.A.V. INSTITUTIONS, CHHATTISGARH

SAMPLE QUESTION PAPER IV – 2023-24

Class - XII

SUBJECT: PHYSICS

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

General Instruction

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. All the sections are compulsory.

4. SECTION A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of one mark each, SECTION Bcontains 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 Econtains 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. You may use the following values of physical constants wherever necessary.

$c = 3 \times 10^8 m/s$

$h = 6.63 \times 10^{-34} Js$

$e = 1.6 \times 10^{-19} C$

$\mu_0 = 4\pi \times 10^{-7} TmA^{-1}$

$\varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}$

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 Nm^2 C^{-2}$

$m_e = 9.1 \times 10^{-31} kg$

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

$mass\ of\ proton = 1.673 \times 10^{-27} kg$

Avogadro's number =*6.023*$\times 10^{23} per\ gram\ mole$

$Boltzmann\ constant = 1.38 \times 10^{-23} JK^{-1}$

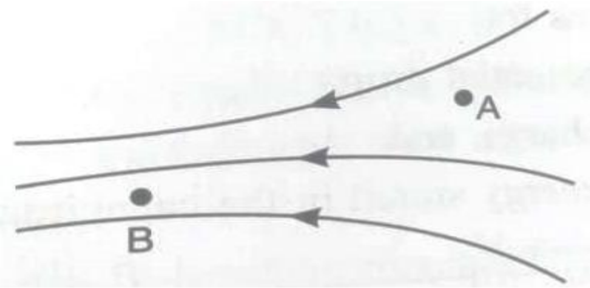
<u>Section –A</u>

Q.1. Two charges of equal magnitude and at a distance r exerts a force F on earth other. If the charges are halved and distance between them is doubled, then the new force acting on each charge is:

a) $F/8$ b) $F/4$

c) $4F$ d) $F/16$

Q.2. In below figure, two points A and B are located in a region of electric field. The potential difference $V_B - V_A$ is:



a) Positive
b) Negative
c) Zero
d) None of these

Q.3. Which is the correct relation in vector form of Ohm's Law?

a) $\vec{E} = \vec{J}\sigma$
b) $\vec{J} = \sigma\vec{E}$
c) $\sigma = \vec{E}\vec{J}$
d) $\sigma = \vec{J}/\vec{E}$

Q.4. A long straight wire carries a current of $20\ A$. What is the magnitude of the magnetic field at a point $10\ cm$ from the wire?

a) $4.6 \times 10^{-5}\ T$
b) $3.5 \times 10^{-9}\ T$
c) $6.4 \times 10^{-2}\ T$
d) $7.3 \times 10^{-4}\ T$

Q.5. What happens if a bar magnet is cut into two pieces along its length?

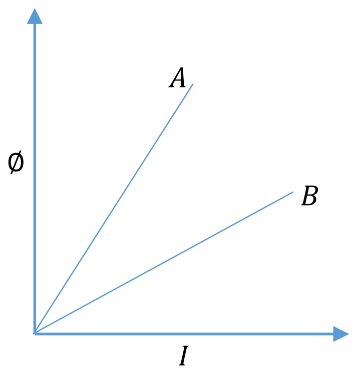
a) Both pieces will have the dipole moment equal to the original magnet.

b) The pieces will have their magnetic moments equal to the half of the original magnet.

c) The pieces will loose their magnetism.

d) None of these.

Q.6. A plot of magnetic flux $\emptyset$ versus current I is shown in the figure for two inductors A and B.



Which of the following statement is correct

a) A has smaller self-inductance than B

b) B has smaller self-inductance than A

c) B has greater self-inductance than A

d) A and B has same self-inductance.

Q.7. A pure inductor of $25.0\ mH$ is connected to a source of $220\ V$. Find the rms current in the circuit if the frequency of the source is $50\ Hz$.

a) $10\ A$ b) $15\ A$

c) $20\ A$ d) $28\ A$.

Q.8. Which radiation plays an important role in maintaining the earth's warmth or average temperature through the green house effect?

a) Visible b) Ultraviolet

c) Infrared d) Gamma

Q.9. We combine two lenses, one is convex and other is concave having focal lengths f_1 and f_2 and their combined focal length is F. Combination of the lenses will behave like concave lens, if

a) $f_1 > f_2$ b) $f_1 = f_2$

c) $f_1 < f_2$ d) $f_1 \leq f_2$.

Q.10. In a Young's double slit experiment, the source is white light. One of the holes is covered by a red filter and another by a blue filter. In this case

a) There shall be alternate interference patterns of red and blue.

b) There shall be an interference patterns for red distinct from that for blue.

c) There shall be no interference fringes.

d) There shall be an interference patterns for red mixing with one for blue.

Q.11. In Bohr's model of an atom which of the following is an integral multiple of $h/_{2\pi}$?

a) Kinetic energy b) Radius of an atom

c) Potential energy d) Angular momentum

Q.12. Why the electric current flowing through a metallic wire is zero, in the absence of applied potential?

a) The electrons remain stationary.

b) The electrons are drifted in random direction with a speed of the order of $10^{-2} cm/s$.

c) The electrons move in random direction with the speed of the order close to that of velocity of light.

d) Electrons and ions move in opposite direction.

In Q.13. to Q.16., two statement are given one labeled Assertion (A) and other labeled Reason (R). Select the correct answer to these questions from the options as gives below.

(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 but Reason is false.

(d) If both Assertion and Reason are false.

Q.13. **Assertion (A):** Kirchhoff's current law is applicable at any junction or node in the circuit.
Reason (R): Kirchhoff's laws are general in nature.

Q.14. **Assertion (A):** All electrons that absorb a photon comeout as photoelectrons from a metal surface.

Reason (R): Most of the electrons emerge out of the surface of the metal and few are scattered into the metal.

Q.15. **Assertion (A):** Microwaves have more energy than the radio wave.

Reason (R): $E = hv$

Q.16. **Assertion (A):** The energy gap between the valenc0 eband and conduction band is smaller in silicon than in germanium

Reason (R): Thermal energy produces fewer minority carriers in silicon than in germanium.

Section –B

Q.17. In a region of space, the electric field strength $\overrightarrow{E}$ is given by $\overrightarrow{E} = 6\hat{\imath} + 5\hat{\jmath} + 3\hat{k}$. Calculate the electric flux through a surface area 100 unit in xy planes.

Q.18. From molecular view point, discuss the temperature dependence of susceptibility for diamagnetism, paramagnetism and ferromagnetism.

Q.19. Three capacitors each of capacitance 9 pF are connected in series.

a) What is total capacitance of the combination?

b) Determine the charge on each capacitor if the combination is connected to $120\ V$ supply.

Q.20. a) The electric field of an electromagnetic wave is represented as

$$E = E_0 \sin(\omega t + kx)$$

i) In which direction is the wave propagating?

ii) In which direction does the magnetic field oscillate?

b) Write two characteristics of electromagnetic waves.

Q.21. What does the slope of the line between stopping potentialand frequency represent? Two beams, one of red lightand the other of blue light, of the same intensity areincident on a metallic surface to emit photoelectrons. Which one of the two beams emits electrons of greater kinetic energy?

OR

The frequency of incident light on a metal surfaceis doubled. How will this affect the value of K.E. of emitted photoelectrons? Explain.

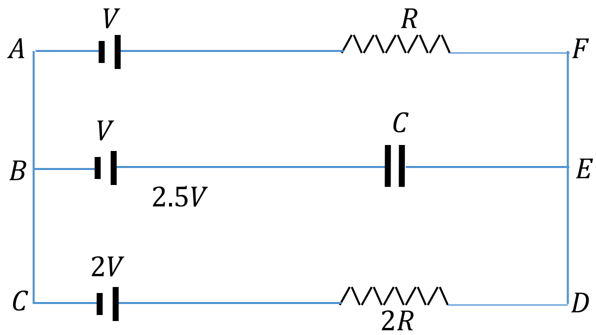
<u>Section – C</u>

Q.22. In the given circuit in the steady state, obtain the expressions for

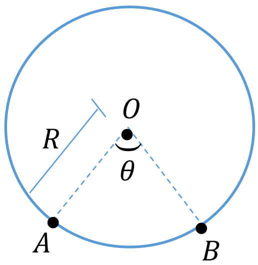
a) The potential drop,

b) The charge, and

c) The energy stored in the capacitor, C.



Q.23. A wire of uniform cross-section is bent into a circularloop of radius R. Consider two points A and B on the loop, such that $\angle AOB = \theta$ as shown. If now a battery is connected between A and B, show that the magnetic field at the centre of the loop will be zero irrespective of angle θ.



Q.24. Draw the circuit diagram of a full wave rectifier and explain its working. Also, give the input and output wave forms.

Q.25. Explain with the help of a labelled diagram the principle, construction and working of a transformer.

OR

Show that average power transferred to an alternating current carrying circuit is in general given by $P = E_{rms}I_{rms}cos\emptyset$ where the symbols have their usual meaning.

Q.26. How does Huygen's principle used to obtain the diffraction pattern due to a single slit? Show the plotof variation of intensity with angle and state the reasonfor the reduction in intensity of secondary maxima compared to central maximum.

Q.27. a) When a voltage drop across a p-n junction diodeis increased from $0.70\ V$ to $0.71\ V$, the change inthe diode current is $10\ mA$. What is the dynamic resistance of diode?

b) Name two factors on which electrical conductivity of a pure semiconductor at a given temperature depends.

c) Sn, C, Si and Ge are all group 14 elements. Yet, Sn is a conductor, C is an insulator while Si and Ge are semiconductors. Why?

Q.28. a) State one property of nuclear forces. Prove that the density of matter in nuclei is independent of mass number A.

b) Two nuclei have mass numbers in the ratio $1:8$. What is the ratio of their nuclear radii?

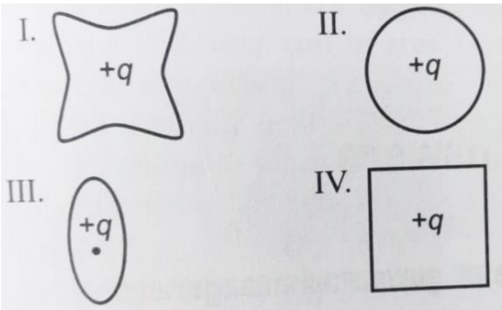
Section – D

Case Study Based Questions

Q.29. **Read the paragraph and answer the followingquestions.**

Electric flux through an area is defined as $\vec{E}.\vec{A}$. Gauss law is used to assess amount of enclosed charge. The concept of flux and Gauss law is very useful as in casesof non-planar area calculation of flux is not easy. Gauss law is also very important in calculating the electrostatic field. Flux due to charge is additive in nature. Gauss law does not depend on the shape of surface that encloses charges.

i) The electric flux through the surface



a) In figure (IV) is the largest.
b) In figure (III) is least.
c) In figure (II) is same as figure (III) but is smaller than figure (IV).
d) Is same for all the figures.

OR

i) Charge 'q' is first kept in a sphere of radius 5 cm and then it is kept in a cube of side 7 cm. The outgoing flux

a) Will be more is case of sphere.

b) Will be more in case of cube.

c) Will be same in both cases.

d) Cannot be determined.

ii) If $\int \vec{E}.\vec{d_s} = 0$, inside a surface, that means there is

a) Uniform electric field inside the surface.

b) Discontinuous field lines inside the surface.

c) No net charge present inside the surface.

d) Some charge present inside the surface.

iii) Which statement is true for Gauss's law?

a) All the charges whether inside or outside the Gaussian surface contribute to the electric flux.

b) Electric flux depends upon the geometry of the Gaussian surface.

c) Gauss's theorem can be applied to non-uniform electric field.

d) The electric field over the Gaussian surface remains continuous and uniform at every point.

iv) 5 electric dipoles having charges e are placed at the centre of a cube. The net flux coming out of the cube surface is

a) Zero

b) ${e}/{\varepsilon_0}$

c) ${8e}/{\varepsilon_0}$

d) ${16e}/{\varepsilon_0}$

Q.30. Coherent sources emit light waves with same frequency or same wavelength, with a phase difference which is either zero or constant on the other hand non-coherent sources do not emit light waves which have a constantor zero phase difference. Interference pattern can be produced only when the light emitting sources arecoherent. The intensity of pattern is maximum when phase difference is integral even multiple of π and minimum for odd multiple of π.

i) Two light sources are said to be coherent if they emit waves having

a) Same amplitude.

b) Same wavelength.

c) Constant phase difference.

d) Both (b) and (c).

OR

i) Two coherent sources have wavelength λ_A and λ_B then

a) $\lambda_A > \lambda_B$

b) $\lambda_A = \lambda_B$

c) $\lambda_A < \lambda_B$

d) None of these.

ii) For constructive interference to take place between two monochromatic light waves of wavelength λ, the path difference should be

a) $(2n - 1)\lambda/4$

b) $(2n - 1)\lambda/2$

c) $n\lambda$ d) $(2n+1)\lambda/2$

iii) The Young's double slit experiment if one of the slits is covered by a thick black paper, then

a) Fringe width increases.

b) Fringes become fainter.

c) Fringe width decreases.

d) Diffraction pattern is obtained on the screen.

iv) In double slit experiment, for light of which colour, the fringe width will be minimum?

a) Violet

b) Red

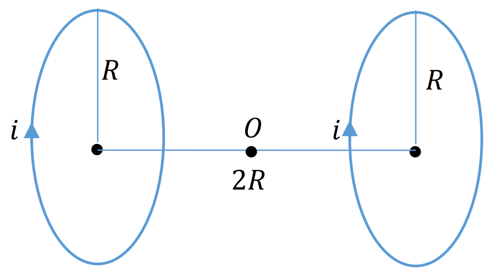
c) Green

d) Yellow

Section – E

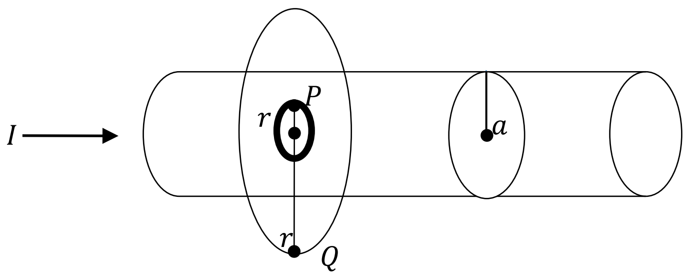
Q.31. a) With the help of a labelled diagram, explainthe principle and working of a moving coil galvanometer.

b) Two parallel coaxial circular coils of equal radius R and equal number of turns N, carry equal current i in the same direction and are separated by a distance $2R$. Find the magnitude and direction ofthe net magnetic field produced at the mid-pointof the line joining their centres.



OR

a) A long straight wire of a circular cross-section of radius $\boldsymbol{a}$ carries a steady current I. The current is uniformly distributed across the cross-section. Apply Ampere's circuital law to calculate the magnetic field at a point r in the region for i) $r < a$ and (ii) $r > a$. Plot a graph showing the nature of this variation.



b) Calculate the ratio of magnetic field at a point $\frac{a}{2}$ above the surface of the wire to that at a point $a/2$ below its surface. What is the maximum value of the field of this wire?

Q.32. a) Obtain the conditions for the bright and darkfringes in diffraction pattern due to a single narrow slit illuminated by a monochromatic source.

b) Find the intensity at a point on a screen in Young's double slit experiment where the interfering waves of equal intensity have a path difference of $(i)\ {}^{\lambda}/_{4}$, and $(ii)\ {}^{\lambda}/_{3}$.

OR

a) A thin convex lens having two surfaces of radii of curvature $R_1$and R_2 is made of a material of refractive index μ_2. It is kept in a medium of refractive index μ_1. Derive, with the help of a ray diagram, the lens maker's formula when a point object placed on the principal axis in front of the radius of curvature R_1 produces an image I on the other side of lens.

b) A beam of light converges at a point P. A concave lens of focal length $16cm$ is placed in the path of this beam $12cm$ from P. Draw a ray diagram and find the location of the point at which the beam would now converge.

Q.33. a) Using postulates of Bohr's theory of hydrogenatom, show that

i) The radii of orbits increase as n^2, and

ii) The total energy of the electron increasesas $1/n^2$, where n is the principal quantum number of the atom.

b) Calculate the longest wavelength of Balmer series of hydrogen atom, given Rydberg's constant $R = 1.0947\ \times\ 10^7 m^{-1}$.

OR

The electron in a given Bohr orbit has a total energy of 1.5 eV. Calculate its

a) Kinetic energy,

b) Potential energy and

c) Wavelength of radiation emitted, when this electron makes a transition to the ground state.

[Given: Energy in the ground state $= -13.6\ eV$ and Rydberg's constant $=\ 1.09\ x \times\ 10^7 m^{-1}$]

d) It is found experimentally that $13.6\ eV$ energy isrequired to separate a hydrogen atom into a proton and an electron. Compute the orbital radius andthe velocity of the electron in a hydrogen atom.