BANGALORE SAHODAYA SCHOOLS COMPLEX ASSOCIATION

QUESTION PAPER (2023-24) PHYSICS (Code – 042)

CLASS XII **SET 1**

Maximum Marks: 70 **Time allowed: 3 Hrs**

Date : _____

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.

(7) You may use the following values of physical constants where ever necessary

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

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

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

iv. $\mu_0 = 4\pi \times 10^{-7}$ Tm$\boldsymbol{A^{-1}}$

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

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

vii. Avogadro's number = 6.023 x $\mathbf{10^{23}}$ per gram mole

SECTION – A

1. Two point charges placed at a certain distance r in air exert a force F on each other. Then the distance r′ at which these charges will exert the same force in a medium of dielectric constant k is given by

(a) r

(b) r/k

(c) $r\sqrt{k}$

(d) $\sqrt{r}$/k

2. The electric potential in a certain region of space is given by $V=-8x^2+4x$, where V is in volt and x is in metre. In this region, the equipotential surfaces are

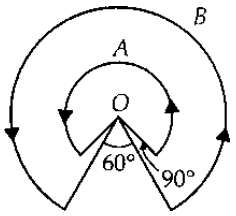
(a) planes parallel to y-z plane

(b) planes parallel to x-axis

(c) concentric circles centered at the origin

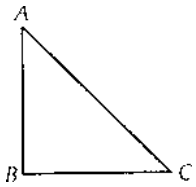
(d) concentric cylinders with axes parallel to y-axis

3. A wire A, bent in the shape of an arc of a circle, carrying a current of 2A and having radius 2cm and another wire B, also bent in the shape of an arc of a circle, carrying current of 3A and having radius of 4cm, are placed as shown in figure. The ratio of magnetic fields due to the wires A and B at the common centre 'O' is



(a) 4 : 6 (b) 6 : 4 (c) 6 : 5 (d) 2 : 5

4. A current carrying closed loop in the form of a right angle isosceles triangle ABC is placed in a uniform magnetic field acting along **AB**. If the magnetic force on the arm BC is $\vec{F}$, the force on the arm AC is



(a) $-\sqrt{2}\vec{F}$ (b) $-\vec{F}$ (c) $\vec{F}$ (d) $\sqrt{2}\vec{F}$

5. The dipole moment of a circular loop carrying a current I, is m and the magnetic field at the centre of the loop is B_1. When the dipole moment is doubled by keeping the current constant, the magnetic field at the centre of the loop is B_2. The ratio $\frac{B_1}{B_2}$ is

(a) 2 (b) $\sqrt{3}$ (c) $\sqrt{2}$ (d) $\frac{1}{\sqrt{2}}$

6. An iron rod of volume $10^{-3}\,m^3$ and relative permeability 1000 is placed as core in a solenoid with 10 turns /cm. If a current of 0.5A is passed through the solenoid, then the magnetic moment of the rod will be approximately

(a) $5\times10^2\,Am^2$ (b) $0.5\times10^2\,Am^2$ (c) $500\times10^2\,Am^2$ (d) $50\times10^2\,Am^2$

7. A long solenoid of diameter 0.1m has 2×10^4 turns per metre. At the centre of the solenoid, a coil of 100 turns and radius 0.01m is placed with its axis coinciding with the solenoid axis. The current in the solenoid reduces at a constant rate to 0A from 4A in 0.05s. If the resistance of the coil is $10\,\pi^2\,\Omega$, the total charge flowing through the coil during the time is

(a) $32\pi\mu C$ (b) $16\mu C$ (c) $32\mu C$ (d) $16\pi\mu C$

8. In a circuit L, C & R are connected in series with an alternating voltage source of frequency f. The current leads the voltage by 45°. The value of C is

(a) $\frac{1}{\pi f(2\pi fL - R)}$ (b) $\frac{1}{2\pi f(2\pi fL - R)}$ (c) $\frac{1}{\pi f(2\pi fL + R)}$ (d) $\frac{1}{2\pi f(2\pi fL + R)}$

9. The condition under which a microwave oven heats up a food item containing water molecules most efficiently, is

(a) The frequency of the microwaves must match the resonant frequency of the water molecules.

(b) The frequency of the microwaves has no relation with natural frequency of water molecules.

(c) Microwaves are heat waves, so always produce heating.

(d) Infrared waves produce heating in a microwave oven.

10. A photo electric surface is illuminated successively by monochromatic light of wavelength λ and $\frac{\lambda}{2}$.

If the maximum kinetic energy of the emitted photoelectrons in the second case is 3 times that in the first case, the work function of the surface of the material is

(a) $\frac{hc}{3\lambda}$ (b) $\frac{hc}{2\lambda}$ (c) $\frac{hc}{\lambda}$ (d) $\frac{2hc}{\lambda}$

11. An α- particle accelerated through V volt is projected towards a nucleus. Its distance of closest approach is r. If a proton accelerated through the same potential is projected towards the same nucleus, the distance of closest approach of proton will be

(a) r (b) 2r (c) r/2 (d) r/4

12. The ratio of the longest wavelength of the Lyman series to the longest wavelength of the Balmer series of the hydrogen spectrum is

(a) 9:31 (b) 7:29 (c) 5:27 (d) 3:23

- **Directions: In the following questions (13-16), a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice 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 but reason is false

(d) If both assertion and reason are false.

13. Assertion: Within some range of electric field pure semiconductors obey Ohm's law.

Reason : At higher electric field, current doesn't vary linearly with potential difference.

14. Assertion : A lens of short focal length can be used as magnifying glass.

Reason : The angular magnification produced in relaxed eye viewing is one less than the maximum angular magnification produced by magnifying glass.

15. 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_s) versus frequency (ν) for different materials, has greater slope for metals with greater work functions.

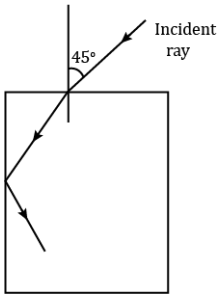
16. Assertion : The space-charge region on either side of the junction together is known as depletion region.

Reason : During the formation of p-n junction due to the concentration gradient across p and n-sides of the junction, holes diffuse from n-side to p-side and electrons diffuse from p-side to n-side.

SECTION - B

17. Two heaters are marked 200 V, 300 W and 200 V, 600 W. If the heaters are connected in series and the combination connected to a 200 V dc supply, which heater will produce more heat? Justify.

18. For the given incident ray as shown in figure, for the condition of total internal reflection of this ray, find the minimum refractive index of prism.



19. In a YDSE setup, the fringe pattern is seen on a screen placed at distance D. The slits are separated by a distance d and are illuminated by light of wavelength λ. Find the least distance from the central maximum where the intensity falls to half of the maximum intensity.

OR

A prism is set for minimum deviation for a light of wavelength λ_1. The angle of minimum deviation δ_m in this case is equal to the angle of prism. When the prism is set for minimum deviation for light of another wavelength λ_2, the angle of minimum deviation is 30^o. The refractive index of the prism for λ_1 is $\sqrt{3}$. Find the refractive index of the prism for light of wavelength λ_2.

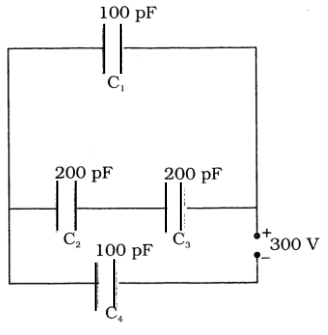
20. (a) An electron and a photon both have wavelength of 1nm. What is the ratio of energy of photon to kinetic energy of electron?

(b) Write any two characteristic features in photoelectric effect which cannot be explained on the basis of wave theory of light.

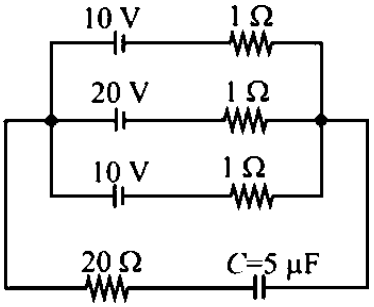
21. Explain briefly, with the help of circuit diagram, the working of a full wave rectifier.

SECTION - C

22. Obtain the equivalent capacitance of the network. For a 300V supply determine the charge and voltage across C_1 and C_2.



23. In the given network, find the charge on the capacitor.



24. (a) Derive an expression for the force per unit length between two infinitely long parallel current carrying conductors. Hence define one ampere.

OR

(b) (i) Explain how a galvanometer can be converted into an ammeter of a given range. Derive an expression for shunt resistance. Find the effective resistance of the ammeter.

(ii) To increase the current sensitivity of a galvanometer by 50%, its resistance is increased so that the new resistance becomes twice its initial resistance. By what factor does it's voltage sensitivity change?

25. Derive an expression for the mutual inductance of two long solenoids wound over one another, in terms of their number of turns N_1 , N_2 ; common cross sectional area A and common length . Prove that $M_{12}=M_{21}$.

26. (a) Electromagnetic waves with wavelength (i) λ_1 are used to treat muscular strain

(ii) λ_2 are used by FM radio station for broadcasting

(iii) λ_3 is used to detect fracture in bones.

Identify and name the part of electromagnetic spectrum to which these radiations belong.

Arrange these wavelengths in decreasing order of magnitude.

(b) Show graphically an electromagnetic wave propagating along positive X axis.

27. (a) State Bohr's postulate that gives the quantisation condition for stable orbits in hydrogen atom. Justify it using de Broglie's hypothesis.

(b) The electron in hydrogen atom is initially in the third excited state. What is the maximum number of spectral lines which can be emitted when it finally moves to the ground state ?

28. Draw a graph showing the variation of binding energy per nucleon with mass number for different nuclei. State with reason why light nuclei usually undergo nuclear fusion. What characteristic property of nuclear force explains the constancy of binding energy per nucleon in the range of mass number A lying between 30 and 170?

SECTION- D

Case Study Based Questions

Read the following paragraph and answer the questions that follow.

29. A compound microscope is an optical instrument used for observing highly magnified images of tiny objects. Magnifying power of a compound microscope is defined as the ratio of the angle subtended at the eye by the final image to the angle subtended at the eye by the object, when both the final image and the object are situated at the least distance of distinct vision from the eye. It is given as $m=m_e m_o$ where me is the magnification produced by the eye lens and m_o is the magnification produced by the objective lens.

Consider a compound microscope that consists of an objective lens of focal length 2.0 cm and an eyepiece of focal length 6.25 cm separated by a distance of 15 cm.

(i) The object distance for eye-piece, so that final image is formed at the least distance of distinct vision, will be

(a)3.45 cm (b) 5 cm (c) 1.29 cm (d) 2.59 cm

(ii)How far from the objective should an object be placed to obtain final image at the least distance of distinct vision?

(a) 4.5 cm (b) 2.5 cm (c) 1.5 cm (d) 3.0 cm

(iii) What is the magnifying power of microscope in this case?

(a) 20 (b) 30 (c) 40 (d) 50

(iv) The intermediate image formed by the objective of a compound microscope is

(a) real, inverted and magnified (b) real, erect and magnified

(c) virtual,erect and magnified (d) virtual, inverted and magnified

OR

The magnifying power of compound microscope increases with

(a) the focal length of objective lens is increased and that of eye lens is decreased

(b) the focal length of objective lens is decreased and that of eye lens is increased

(c) the focal length of both objective lens and of eye lens is increased

(d) the focal length of both objective lens and of eye lens is decreased

Read the following paragraph and answer the questions that follow.

30. Devices in which a controlled flow of electrons can be obtained are the basic building blocks of all the electronics circuits. Semiconductors are the materials whose conductivity intermediate to metals and insulators. Semiconductors could be elemental or compound. Commonly used elemental semiconductors are Silicon and Germanium.

Intrinsic semiconductors are pure form of semiconductors. The conductivity of intrinsic semiconductors can be altered by temperature and by doping. When a small amount of impurity is added to the pure semiconductor, the conductivity of the semiconductor is increased manifold. The deliberate addition of a desirable impurity is called doping and the impurity atoms are called dopants. Diodes and transistors are the important semiconductor devices.

(i) In case of a semiconductor, which of the following statement is wrong

(a) Temperature coefficient of resistance is negative

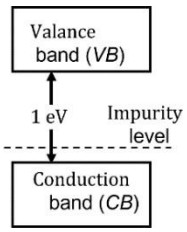
(b) Resistivity is in between conductors and insulators

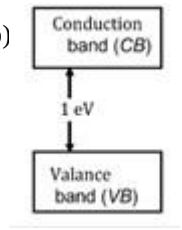
(c) Doping increases the resistivity of semiconductor

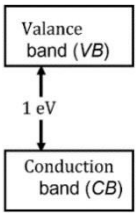
(d) at absolute zero intrinsic semiconductors behave as insulators.

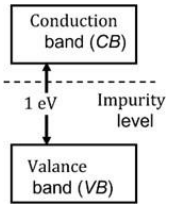
OR

Which of the following energy band diagram shows the n type semiconductor?

(a) 

(b) 

(c) 

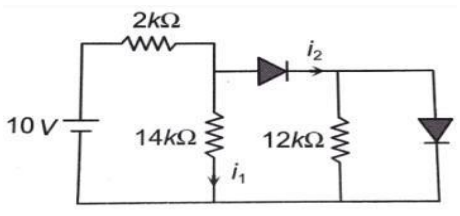
(d) 

(ii) The band gap for a pure semiconductor is 2.1 eV. The maximum wavelength of a photon which is able to create electron- hole pair is

(a) 620 nm (b) 589 nm (c) 598 nm (d) 489 nm

(iii) A potential barrier of 0.4 V exists across a PN junction. A constant electric field of magnitude 10^6 V/m exists in the depletion region. The width of depletion region is

(a) 4×10^{-7}m (b) 0.1mm (c) 5×10^{-7}m (d) 2mm

(iv) In the following circuit I_1 and I_2 are 

(a) 0 mA, 0 mA (b) 5 mA, 5 mA (c) 0 mA, 5 mA (d) 5 mA, 0 mA

SECTION - E

31. (a) (i) Derive an expression for electric field at any point on the axial line of an electric dipole.

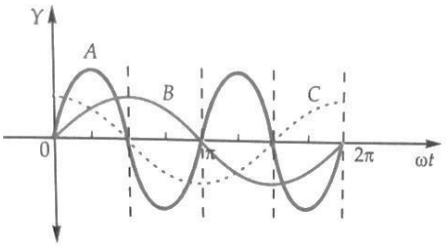
(ii) Two point charges q and - q are located at points (0 , 0 , - a) and (0 , 0 , a) respectively (1) Find the electrostatic potential at (0 , 0 , z) and (x, y , 0). (2) How much work is done in moving a small test charge from the point (5 , 0 , 0 ,) to (-7 , 0 , 0) along the x - axis ?

OR

(b)(i) Apply Gauss theorem to calculate the electric field due to an infinitely charged plane sheet

(ii) The bob of a simple pendulum has a mass of 40 g and a positive charge of 4.0×10^{-6}C. It makes 20 oscillations in 45 s. A vertical electric field pointing upward and of magnitude 2.5×10^{4} NC^{-1} is switched on. How much time will it now take to complete 25 oscillations?

32. (a) A device 'X' is connected to an ac source $V = V_o$ sin wt. The variation of voltage, current and power in one cycle is shown in the following graph:



(i) Identify the device X.

(ii) Which of the curves A, B and C represent the voltage, current and power consumed in the circuit? Justify your answer.

(iii) How does its impedance vary with frequency of ac source? Show graphically.

(iv) Obtain an expression for the current in the circuit and its phase relation with ac voltage.

OR

(b) (i) Explain the principle and working of the device, which is used to provide electricity at the proper voltage for household purposes.

(ii) Calculate the current drawn by the primary of a 90% efficient transformer which steps down 220 V to 22 V, if the output resistance is $440\,\Omega$.

(iii) Why don't transformers work with DC?

33. (a) (i)With the help of a suitable ray diagram, derive a relation between the object distance(u), image distance (v) and radius of curvature (R) for a convex spherical surface, when a ray of light travels from rarer to denser medium.

(ii) A solid glass sphere of radius 5 cm has a small air bubble O trapped at 2cm from the centre C. The refractive index of the material of glass is 1.5. Find the apparent position of the bubble where it will appear , when seen through the surface of sphere from an outside point E that is closest to the bubble.

OR

(b) State Huygen 's principle. Show, with the help of suitable diagram, how the principle is used to obtain the diffraction pattern by a single slit. Draw a plot of intensity distribution and explain clearly why the secondary maxima become weaker with increasing order (n) of the secondary maxima.