BANGALORE SAHODAYA SCHOOLS COMPLEX ASSOCIATION

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

CLASS XII –SET 2

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 +3 μC and +8 μC repel each other with a force of 40 N. If a charge of −5 μC is added to each of them, then the force between them will become

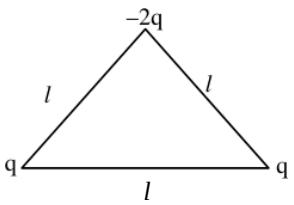
(a) −10 N (b) +10 N (c) +20 N (d) −20 N

2. The dipole moment of the given system is

(a)√3ql along perpendicular bisector of q-q line

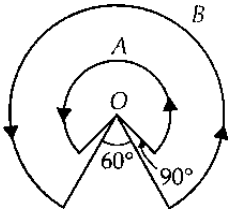
(b) 2ql along perpendicular bisector of q-q line

(c) ql/√2 along perpendicular bisector of q-q line



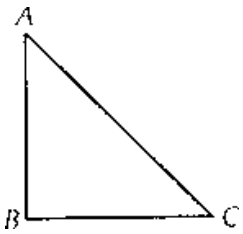
(d) Zero

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. If K_1 and K_2 are maximum kinetic energies of photoelectrons emitted when lights of wavelength λ_1 & λ_2 respectively incident on metallic surface and $\lambda_1 = 3\lambda_2$, then

(a) $K_1 > (K_2/3)$ (b) $K_1 < (K_2/3)$ (c) $K_1 = 2K_2$ (d) $K_2 = 2K_1$

11. The ratio of time taken by the electron to go once round the nucleus in orbits of radii r and 4r of a hydrogen atom is

(a) 1:4 (b) 1:8 (c) 4:1 (d) 8:1

12. In terms of Rydberg constant R, the shortest wavelength in Balmer series will have wavelength

(a) 1/R (b) 4/R (c) 3/2R (d) 9/R

- **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: Angular width of central maximum in Young's double slit experiment is independent of the distance between source and screen.

Reason : Fringe width of central maximum is double that of the first maximum inYDSE.

15. Assertion : In photoelectron emission, the velocity of electron ejected from near the surface is larger than that coming from interior of metal.

Reason : The velocity of ejected electron will be zero.

16. Assertion: In a p-n junction new holes and conduction electrons are produced continuously throughout the material.

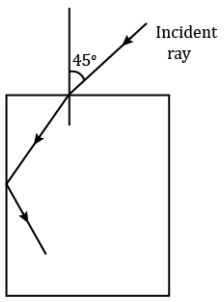
Reason : Holes and conduction electrons recombine continuously throughout the material.

SECTION - B

17. a) Define the temperature coefficient of material of a conductor

b) A metallic wire has a resistance of 120 Ω at 20°C. Find the temperature at which the resistance of same metallic wire rises to 240 Ω. The temperature coefficient of the wire is $2\times10^{-4}\ ^{\circ}C^{-1}$.

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.

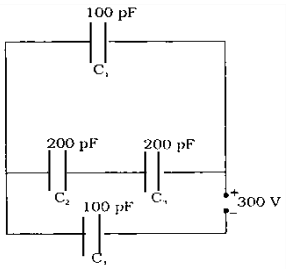
20. (a) An electron and a photon both have wavelength of 1nm. What is the ratio of energy of photon to kinetic energy of electron?

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

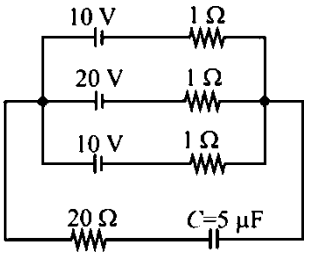
21. Explain briefly, with the help of circuit diagram, the working of a full wave rectifier.

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) (i) A particle of charge q and mass 'm' moving with velocity v is subjected to a uniform magnetic field $\vec{B}$ perpendicular to its velocity. Show that the particle describes a circular path. Obtain the expression for the radius of the circular path.

(ii) A proton, an electron and a helium nucleus, have the same energy. They are in circular orbits in a plane due to magnetic field perpendicular to the plane. If r_p, r_e and r_{He} are their respective radii, then find the relation between them.

OR

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

(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 its 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 ℓ. 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. (a) Show that the density of nucleus over a wide range of nuclei is constant, independent of mass number A.

(b) The nuclear radius of ^{27}Al is 3.6 fermi. What is the nuclear radius of ^{64}Cu?

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 mo 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 eyelens is decreased

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

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

(d) the focal length of both objective lens and of eyelens 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

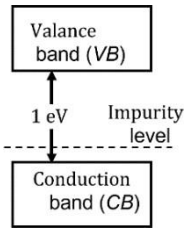
(b) Resistivity of semiconductors is in between conductors and insulators

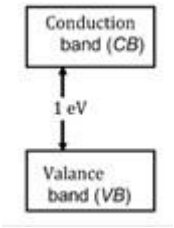
(c) Doping increases the resistivity of semiconductor

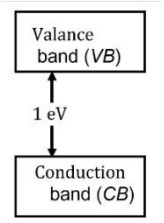
(d) at absolute zero intrinsic semiconductors behave as insulators.

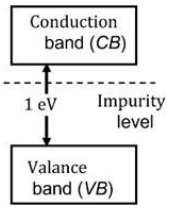
OR

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

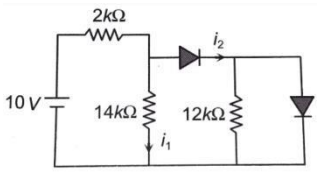
iii) A potential barrier of 0.4 V exist across a PN junction. A constant electric field of magnitude 10^6 V/m exists in the depletion region. The width of depletion region is

(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

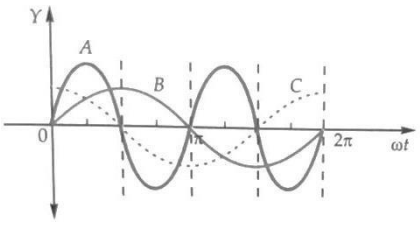
electrostatic potential at (0 , 0 , z) and (x, y , 0). (2) How much work is done in moving a small test charge from the point (5 , 0 , 0 ,) to (-7 , 0 , 0) along the x - axis ?

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 Ω .

(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 5cm 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.