AMRITA VIDYALAYAM

AMRITA VIDYALAYAM
PUSHP VIHAR, NEW DELHI
SESSION 2023-24
PRE-BOARD 1

CLASS: - XII

SUBJECT: PHYSICS

TIME ALLOWED: -3 HOURS

MAX. MARKS: - 70

GENERAL INSTRUCTIONS: -

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 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 must 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) $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}
   (v) $h = 6.63 \times 10^{-34}$ J s
   (vi) $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N^{-1}m^{-2}$
   (vii) Avogadro's number = 6.023×10^{23} per gram mole

SECTION – A

1. An electric dipole placed in a non-uniform electric field will experience **1**
   (a) Only a force (b) only a torque
   (c) both force and torque (d) neither force nor torque

2. A point P lies at a distance x from the midpoint of an electric dipole on its axis. The electric potential at point P is proportional to **1**
   (a) $1/x^2$ (b) $1/x^3$ (c) $1/x$ (d) $1/x^{1/2}$

3. Two wires A and B, of the same material having length in the ratio 1:2 and diameter in the ratio 2:3 are connected in series with a battery. The ratio of the potential difference (V_A / V_B) across the two wires respectively is: **1**
   (a) 1/3 (b) 3/4 (c) 4/5 (d) 9/8

4. A current of 0.8A flows in a conductor of 40 Ω for 1minute. The heat produced in the conductor will be **1**
   (a) 1445 (b) 1536 (c) 1569 (d) 1640

5. An electron is projected with velocity $\vec{v}$ along the axis of a current carrying solenoid. Which one of the following statements is true? **1**

(a) The path of the electron will be circular about the axis.
(b) The electron will be accelerated along the axis.
(c) The path of the electron will be helical.
(d) The electron will continue to move with the same velocity $\vec{v}$ along the axis of the solenoid. 1

6. A current carrying closed loop of an irregular shape lying in more than one plane when placed in uniform magnetic field, the force acting on it
(a) will be more in the plane where its larger position is covered.
(b) is zero.
(c) is infinite.
(d) none of the above 1

7. The emf induced in a 10 H inductor in which current changes from 1A to 2A in 0.1s is 1
(a) 10^4 V (b) 10^3 V (c) 10^2 V (d) 10 V

8. A pure inductor of 318 mH and a pure resistor of 75 Ω are connected in series to an ac source of 50 Hz. The voltage across 75 Ω resistor is found to be 150 V. The source voltage is 1
(a) 150 V (b) 175 V (c) 220 V (d) 250 V

9. The phase difference between the current and voltage in series LCR circuit at resonance is 1
(a) π (b) π/2 (c) π/3 (d) zero

10. $\vec{E}$ and $\vec{B}$ represents electric and magnetic fields of an electromagnetic wave respectively. The direction of propagation of the wave is along 1
(a) $\vec{E}.\vec{B}$ (b) $\vec{B}.\vec{E}$ (c) $\vec{E} \times \vec{B}$ (d) $\vec{B} \times \vec{E}$

11. A bio-convex lens of focal length f is cut into two identical plano-convex lenses. The focal length of each part will be 1
(a) f (b) f/2 (c) 2f (d) 4f

12. If K.E of free electron is doubled, its de Broglie wavelength will change by factor 1
(a) $1/\sqrt{2}$ (b) $\sqrt{2}$ (c) 1/2 (d) 2

ASSERTION AND REASON BASED MCQs

Directions: In the following questions,
A statement of **Assertion (A)** is followed by a statement of **Reason (R)**. Mark the correct choice as.
(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 true **OR** Both A and R are false.

13. **Assertion:** A pure semiconductor has negative temperature coefficient of resistance. 1
Reason: On raising the temperature, more charge carriers are released, conductance increases and resistance decreases.

14. **Assertion:** Nuclei having mass number about 60 are most stable. 1
Reason: When two or more light nuclei are combined into a heavier nucleus, then the binding energy per nucleon will increase.

15. **Assertion:** Total energy of an electron in a hydrogen atom is negative. 1
Reason: Electron is bounded to the nucleus.

16. **Assertion:** Photoelectric effect demonstrates the wave nature of light. 1
Reason: The number of photoelectrons is proportional to the frequency of light.

SECTION – B

17. Let N_1 be the number of electric field lines going out of an imaginary cube of side 'a' encloses an isolated point charge 2q and N_2 be the corresponding number for an imaginary sphere of radius 'a' that encloses an isolated point charge 3q. Calculate the ratio of N_1 / N_2. 2

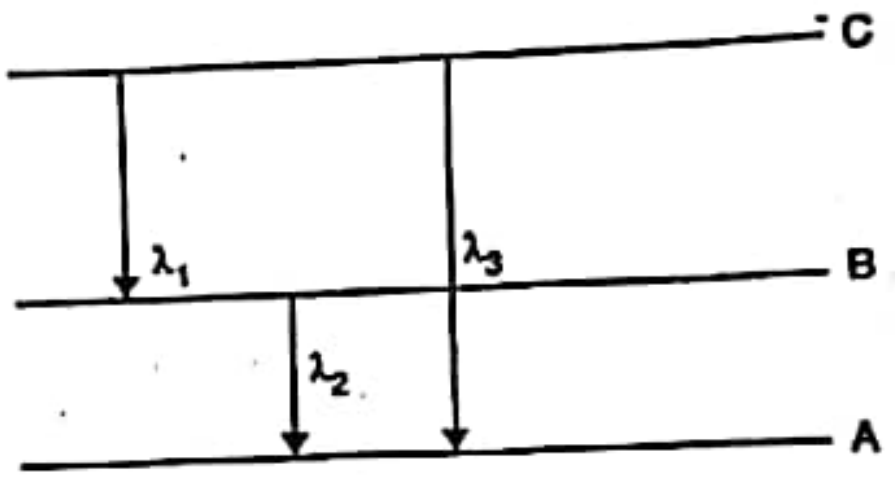
OR

Four charges +q, -q, +q and -q are to be arranged respectively at the four corners of a square A, B, C and D of side 'a'. Find the work required to put together this arrangement.

18. (a) The electric field of an electromagnetic wave is represented as $E_x = E_0 \sin(\omega t + kz)$. 2
    (i) In which direction is the wave propagating?
    (ii) In which direction does the magnetic field oscillate?
    (b) Write two characteristics of electromagnetic waves.

19. How would the angular width of central maximum of diffraction pattern be affected when (i) width of the slit is decreased, and (ii) monochromatic light is replaced by polychromatic light of smaller wavelength? Justify your answer. 2

20. Find the relation between the three wavelengths λ_1, λ_2 and λ_3 from the energy level diagram shown below. 2



21. (a) Name the device which utilizes unilateral action of a p-n diode to convert ac into dc. 2
    (b) Draw the circuit diagram of a full wave rectifier.

SECTION – C

22. Two identical circular coils, P and Q each of radius R, carrying currents 1 A and $\sqrt{3}$ A respectively, are placed concentrically and perpendicular to each other lying in the XY and YZ planes. Find the magnitude and direction of the net magnetic field at the center of the coils. 3

23. Draw a diagram to show the magnetic field lines produced by two parallel straight wires carrying currents in the same direction. Obtain an expression for the force per unit length between these wires and hence define the S.I unit of current. 3

24. A device X is connected across an ac source of voltage $V = V_0 \sin \omega t$. The current through X is given as $I = I_0 \sin(\omega t + \pi/2)$. 3
    (a) Identify the device X and write the expression for its reactance.
    (b) How does the reactance of the device X vary with frequency of the ac? Show this variation graphically..
    (c) Draw the phasor diagram for the device X.

25. The primary coil of an ideal step-up transformer has 100 turns and transformation ratio is also 100. The input voltage and power are respectively 220 V and 1100 W. Calculate 3
    (i) Number of turns in secondary,
    (ii) Current in primary,
    (iii) Voltage across secondary,
    (iv) Current in secondary.

26. In Young's doubles slit experiment, the two slits 0.15 mm apart are illuminated by monochromatic light of wavelength 450 nm. The screen in 1.0 m away from the slits. 3

(i) Find the distance of the second (i) bright fringe, (ii) dark fringe from the central maximum.

(ii) How will the fringe pattern change if the screen is moved away from the slits?

27. Define the term 'work function' of a metal. The threshold frequency of a metal is v_0. When the light of frequency $2v_0$ is incident on the metal plate, the maximum velocity of electrons emitted is v_1. When the frequency of the incident radiation is increased to $5v_0$, the maximum velocity of electrons emitted is v_2. Find the ratio of v_1 to v_2. 3

28. Draw a plot of the binding energy per nucleon as a function of mass number for a large number of nuclei, $2 \leq A \leq 240$. How do you explain the constancy of binding energy per nucleon in the range $30 < A < 170$ using the property that nuclear force is short-ranged? 3

OR

(a) Using Bohr's second postulate of quantization of orbital angular momentum show that the circumference of the electronic in the n^{th} orbital state in hydrogen atom in n times the dc Broglie wavelength associate with it.

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

SECTION – D

Case Study Based Questions

29. A telescope is an optical device used for observing celestial objects. Its object is at infinity. It forms image at infinity or at least distance of distinct vision depending on its adjustments, which can be done by rack and pinion arrangement. Celestial objects are generally viewed during night. 4

(i) Can a telescope produce image of size larger than that of object?

(a) Yes, it can produce only linear magnification.
(b) Yes, it can produce both linear and angular magnification.
(c) No, it can't produce both kind of magnification.
(d) No, it can produce only angular magnification.

(ii) The aperture of objective of telescope is large to

(a) Increase magnification
(b) Decrease magnification
(c) Increase brightness and resolution of image
(d) Increase the size of telescope

(iii) If the focal lengths of objective lens and eyepiece are 120 cm and 5 am respectively, then in normal adjustment, the length of the telescope will be

(a) 125 cm
(b) 24 cm
(c) 115 m
(d) 126.25 cm

(iv) In (iii) part, if the final image is seen at least distance of distinct of distinct vision, the tube length will be

(a) 125 cm
(b) 115 cm
(c) 124.25 cm
(d) 126.25 cm

OR

(iv) An astronomical telescope of ten-fold angular magnification has a length of 44 cm. The focal length of the object is

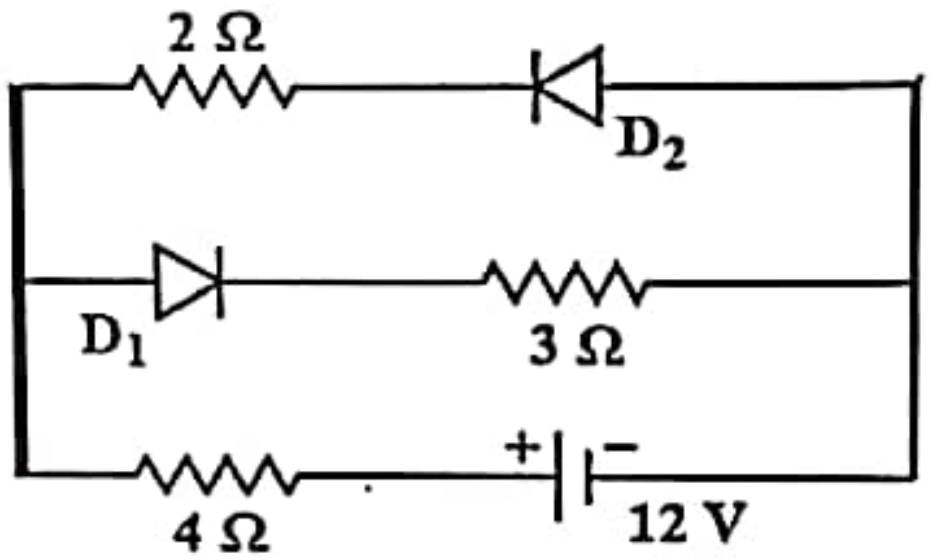
(a) 4 cm
(b) 40 cm
(c) 44 cm
(d) 440 cm

30. There are different techniques of fabrication of p-n junction. In one such technique, called junction techniques, an aluminium film is kept on the wafer of n-type semiconductor and the combination is then heated to a high temperature (about 600^0 C). As a result, aluminium fused into silicon and produces p-type semiconductor and in this way p-n junction is formed. 4

(i) When a p-n junction is reverse biased, then how does the height of potential barrier change?
(a) No current flows
(b) The depletion region is reduced
(c) Height of potential barrier is decreased
(d) Height of potential barrier is increased

(ii) The cause of potential barrier in p-n junction is
(a) Depletion of positive charge near the junction
(b) Concentration of negative charges near the junction
(c) Concentration of positive and negative charges near the junction
(d) Depletion of negative charges near the junction

(iii) The circuit has two oppositely connected ideal diodes in parallel. What is the current flowing in the circuit?



(a) 1.17 A
(b) 1.71 A
(c) 2.0 A
(d) 3.0 A

(iv) Carbon, germanium, and silicon all are fourteenth group elements.
(a) C and Ge are semiconductors.
(b) C and Si are semiconductors.
(c) All C, Si and Ge are semiconductors.
(d) Si and Ge are semiconductors.

OR

(iv) When a p-n junction is forward biased, then
(a) Only diffusion current flows.
(b) Both diffusion current and drift current flow but diffusion is more than drift current.
(c) Only drift current flows.
(d) Both diffusion and drift current flow but drift current exceeds the diffusion current.

SECTION – E

31. (i) State Gauss' law. Using this law, obtain the expression for the electric field due to an infinitely long straight conductor of linear charge density λ. 5

(ii) A wire AB of length L has linear charge density $\lambda = kx$, where x is measured from the end A of the wire. The wire is enclosed by a Gaussian hollow surface. Find the expression for the electric flux through the surface.

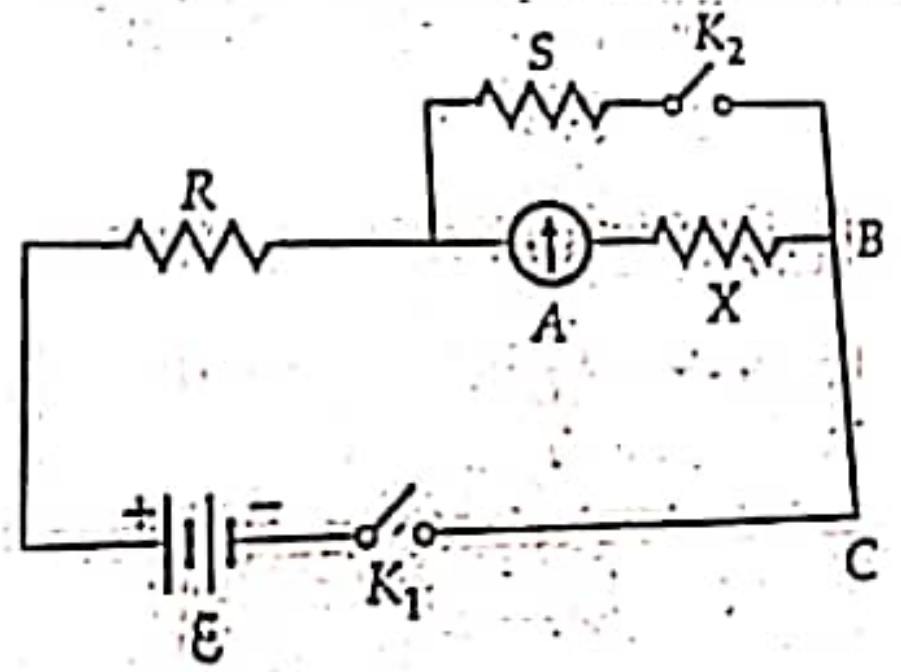
OR

(a) Derive the expression for the energy stored in a parallel plate capacitor. Hence, obtain the expression for the energy density of the electric field.

(b) The two plates of a parallel capacitor are 4 mm apart. A slab of dielectric constant 3 and thickness 3 mm is introduced between the plates with its faces parallel to them. The distance between the plates is so adjusted that the capacity of the capacitor becomes $2/3^{rd}$ of its original value. What is the new distance between the plates?

32. (a) State the two Kirchhoff's laws in electricity and mention their significance. 5

(b) The reading of an ideal ammeter, in the circuit shown below, equals (i) I when key K_1 is closed but key K_2 is open, (ii) I/2 when both keys K_1 and K_2 are closed. Find the expression for the resistance of X in terms of the resistance R and S.



OR

(a) Define electromotive force. Write four differences between emf and terminal potential.

(b) Deduce the equivalent emf and resistance in parallel combination of three cells.

33. (a) Draw a ray diagram to show the working of a compound microscope. Deduce an expression for the total magnification when the final image is formed at the near point. 5

(b) In a compound microscope, an object is placed at a distance of 1.5 cm from the objective piece of focal length 1.25 cm. If the eyepiece has a focal length of 5 cm and the final image is formed at the near point, estimate the magnifying power of the microscope.

OR

(a) A point object is placed on the principal axis of a convex spherical surface of radius of curvature R, which separates the two media of refractive indices n_1 and n_2 ($n_1 < n_2$). Draw the ray diagram and deduce the relation between the object distance (u), image distance (v) and the radius of curvature (R) for refraction to take place at the convex spherical surface from rarer to denser medium.

(b) A converging lens has a focal length of 20 cm in air. It is made of a material of refractive index 1.6. If it is immersed in a liquid of refraction index 1.3, find its new focal length