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(25)

GYAN BHARATI SCHOOL

Pre-Board-2 Examination (2023-2024)
Physics (042)
Class: SS2 A and B

Time: 3 Hours **M.M: 70**

General Instructions:

1. There are 33 questions and 7 printed pages 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 one mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains three long answer questions of five marks each and Section E contains two case-study based questions of four marks each
5. There is no overall choice. However, an internal choice has been provided in two questions in Section B, two questions in Section C, all three questions in Section D and one question in each case-based question 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.

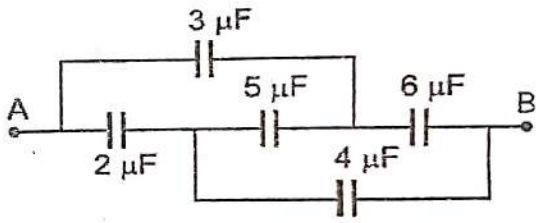
$c = 3 \times 10^8$ m/s, $m_e = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C, $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1},
$h = 6.63 \times 10^{-34}$ Js, $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N^{-1}m^{-2}$
Avogadro's number = 6.023×10^{23} per gram

SECTION A

1. A point charge +q is placed at the centre of the cube of side L. The electric flux emerging from the cube is 1

a) zero b) $\frac{qL^2}{\epsilon_o}$ c) $\frac{q}{6L^2\epsilon_o}$ d) $\frac{q}{\epsilon_o}$

2. In the circuit shown, the equivalent capacitance between the points A and B is 1



a) 10/3 μF
b) 15/4 μF
c) 12/5 μF
d) 25/6 μF

3. Match the Column I and Column II. 1

Column I	Column II
(A) Smaller the resistance greater the current applied	(i) If the same volt-age is and resistance are in series
(B) Greater or smaller the resistance the current is the same	(ii) If the same current is passed
(C) Greater the resistance smaller the power	(iii) When resistances are connected in series
(D) Greater the resistance greater the power	(iv) When resistances are connected in parallel

a) A - (ii), B - (i), C - (iv), D - (ii) b) A - (i), B - (iii), C - (ii), D - (iv)
c) A - (iii), B - (i), C - (ii), D - (iv) d) A - (iv), B - (iii), C - (i), D - (ii)

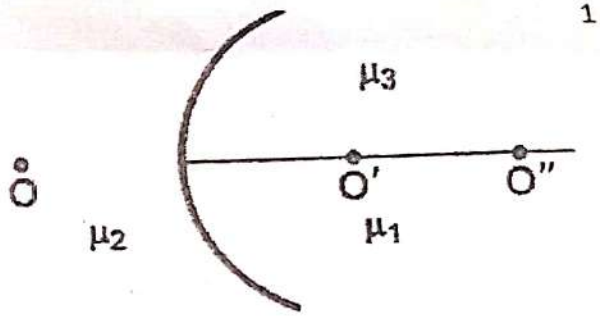
4. Two parallel beams of electrons moving in the opposite direction will:
   a) repel each other
   b) will not interact with each other
   c) attract each other
   d) be deflected normal to the plane containing the two beams 1

5. Unit of magnetic flux density (or magnetic induction) is
   a) Tesla
   b) Weber/ meter^2
   c) Newton/ampere meter
   d) All of the above 1

6. Ultraviolet radiation has a wavelength of 200 nm. The frequency of the radiation is
   a) 1.8×10^{15} Hz
   b) 1.7×10^{15} Hz
   c) 1.6×10^{15} Hz
   d) 1.5×10^{15} Hz 1

7. One requires 11eV of energy to dissociate a carbon monoxide molecule into carbon and oxygen atoms. The minimum frequency of the appropriate electromagnetic radiation to achieve the dissociation lies in
   a) microwave region
   b) visible region
   c) infrared region
   d) ultraviolet region 1

8. Figure shows three transparent media of refractive indices μ_1 , μ_2 and μ_3 . A point object O is placed in the medium μ_2 . If the entire medium on the right of the spherical surface has refractive index μ_1 , the image forms at O' . If this entire medium has refractive index μ_3 , the image forms at O'' . In the situation shown in the figure given ahead:
   a) the image forms to the left of O'
   b) two images form, one at O' and the other at O''
   c) the image forms to the right of O''
   d) the image forms between O' and O''



1

9. Light appears to travel in a straight line, because
   a) it is not absorbed by surrounding
   b) its velocity is very large
   c) its wavelength is very small
   d) it is reflected by surrounding 1

10. In photoelectric effect, electrons are ejected from metals, if the incident light has a certain minimum:
   a) amplitude
   b) wavelength
   c) frequency
   d) angle of incidence 1

11. If an α-particle of mass m, charge q and velocity v is incident on a nucleus of charge Q and mass m, then the distance of closest approach is
   a) $\frac{Qq}{mv^2}$ b) $\frac{Qqmv^2}{2}$ c) $\frac{Qq}{4\pi\varepsilon_0 m^2v^2}$ d) $\frac{Qq}{2\pi\varepsilon_0 mv^2}$ 1

12. Heavy stable nuclei have more neutrons than protons. This is because of the fact that
   a) nuclear forces between neutrons are weaker than that between protons
   b) the electrostatic force between protons is repulsive
   c) neutrons decay into protons through beta decay 1

d) neutrons are heavier than protons

Questions 13 to 16 consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following four responses.

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.

13. **Assertion (A):** Capacitor blocks dc and offers an easy path to ac. 1
Reason (R): Capacitive reactance is inversely proportional to frequency.

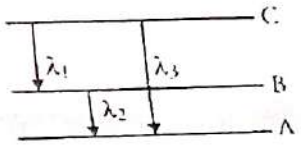
14. **Assertion (A):** Electromagnetic radiations exert pressure. 1
Reason (R): Electromagnetic waves carry both momentum and energy.

15. **Assertion (A):** Bohr had to postulate that the electrons in stationary orbits around the nucleus do not radiate. 1
Reason (R): According to classical physics all moving electrons radiate.

16. **Assertion (A):** Free electrons always keep on moving in a conductor even then no magnetic force act on them in magnetic field unless a current is passed through it. 1
Reason (R): The average velocity of free electron is zero.

SECTION B

17. Find the relation between the three wavelengths from the energy levels as shown in diagram. 2



18. A bar magnet has a length of 8 cm. The magnetic field at a point at a distance of 3 cm from the centre in the broad side on position is found to be 4×10^{-6} T. Calculate the pole strength of the magnet. 2

19. Prove the laws of reflection using wave optics. 2

20. Use de-Broglie's hypothesis to derive the relation for the radius of nth Bohr orbit in terms of Bohr's quantization condition of orbital angular momentum. 2

21. Calculate the energy release in Mev in the deuterium- tritium fusion reaction 2
${}_1^2H + {}_1^3H \longrightarrow {}_2^4He + n$, using the data m(${}_1^2$H) = 2.014102u, m(${}_1^3$H) = 3.016049u, m_α = m(${}_2^4$He) = 4.002604u and m_n = 1.008665 u,

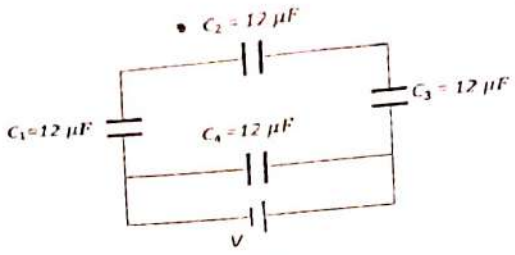
OR

How does the size of a nucleus depend on its mass number? Hence explain why the density of nuclear matter should be independent of the size of the nucleus.

SECTION C

22. Two free point charge 4e and e are at a distance 'a' apart. Where a third charge q should be placed between them so that the entire system is in equilibrium? What will be the nature and magnitude of q? 3

23. A network of four capacitors each of 12 μF capacitance is connected to a 500 V supply as shown in the figure. Determine (a) equivalent capacitance of the network and (b) charge on each capacitor.



3

24. a) Define the current sensitivity of a galvanometer. Write its expression.
b) A galvanometer has resistance G and shows full-scale deflection for current I_g.
i. How can it be converted into an ammeter to measure current up to I_0 ($I_0 > I_g$)?
ii. What is the effective resistance of this ammeter?

25. One face of a prism of refracting angle 30° and refractive index 1.414 is silvered. At what angle must a ray of light fall on the other face so that after refracting into the prism and reflection at the silvered surface it retraces its path? 3

26. How will the interference pattern in Young's double - slit experiment be affected if: 3
a) The screen is moved away from the plane of the slits.
b) The source slit is moved away from the plane of the slits.
c) The phase difference between the light waves emanating from the two slits S_1 and S_2 changes from 0 to π.

OR

A slit of width 'a' is illuminated by red light of wavelength 6500$\mathring{A}$. For what value of 'a' will
a) the first minimum fall at an angle of diffraction of 30° and
b) the first maximum fall at an angle of diffraction of 30° ?

27. Radiations of frequency ν_1 and ν_2 are made to fall in turn, on a photosensitive surface. The stopping potential required for stopping the most energetic emitted photo-electrons in the two cases are V_1 and V_2 respectively. Obtain a formula for determining Planck's constant and the threshold frequency in terms of these parameters. 3

28. Explain with the help of a diagram, how a depletion layer and barrier potential are formed in a junction diode. And how the depletion region varies in forward and reverse biasing? 3

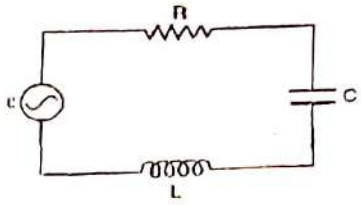
SECTION D

29. An air capacitor is first charged through a battery. The charging battery is then removed and a dielectric slab of dielectric constant K=4 is inserted between the plates. Simultaneously, the distance between the plates is reduced to half, then find change in the value of Charge, capacitance, electric field, electric potential and electric energy. 5

OR

a) Derive an expression for energy density stored in the capacitor.
b) An electrical technician requires capacitance of 2μF in a circuit across a potential difference of 1kV. A large number of 1 μF capacitors are available to him each of which can withstand a potential difference of not more than 300V. Suggest a possible arrangement that requires a minimum number of capacitors.

30. A series of LCR circuit is connected to a variable frequency 230 V source, L = 5.0 H, $C = 80\mu F$, $R =$ 5
40Ω



a) Determine the source frequency which drives the circuit in resonance.
b) Obtain the impedance of the circuit and the amplitude of current at the resonating frequency.
c) Determine the rms potential drops across the three elements of the circuit. Show that the potential drop across the LC combination is zero at the resonating frequency.

OR

A series LCR circuit with L = 0.12 H, C = 480 nF, R = 23Ω is connected to a 230 V variable frequency supply.

a) What is the source frequency for which the current amplitude is maximum? Obtain this maximum value
b) What is the source frequency for which average power absorbed by the circuit is maximum? Obtain the value of this maximum power.
c) For which frequencies of the source is the power transferred to the circuit half the power at resonant frequency? What is the current amplitude at these frequencies?

32. i. Draw a ray diagram showing the image formation by a compound microscope. Obtain the expression for total magnification when the image is formed at least distance of distinct vision. 5

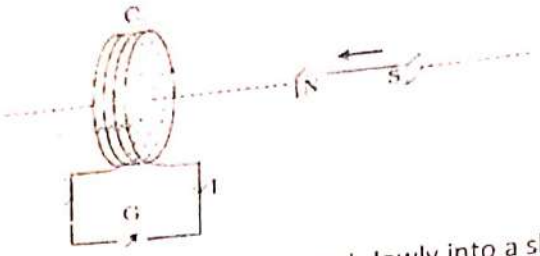
ii. The total magnification produced by a compound microscope is 20. The magnification produced by the eye piece is 5. The microscope is focused on a certain object. The distance between the objective and eyepiece is observed to be 14 cm. If least distance of distinct vision is 20 cm, calculate the focal length of the objective and the eye piece.

OR

Draw a ray diagram to show the formation of the image of an object placed on the axis of a convex refracting surface of radius of curvature 'R', separating the two media of refractive indices 'μ_1' and 'μ_2' ($\mu_2 > \mu_1$). Use this diagram to deduce the relation $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$, where u and v represent respectively the distance of the object and the image formed and hence derive the expression for Lens maker formula.

SECTION E

33. **Read the text carefully and answer the questions:** In year 1820 Oersted discovered the magnetic effect of current. Faraday gave the thought that reverse of this phenomenon is also possible i.e., current can also be produced by magnetic field. Faraday showed that when we move a magnet towards the coil which is connected by a sensitive galvanometer. The galvanometer gives instantaneous deflection showing that there is an electric current in the loop Whenever relative motion between coil and magnet takes place an emf induced in coil. If coil is in closed circuit then current is also induced in the circuit. This phenomenon is called electromagnetic induction. 4



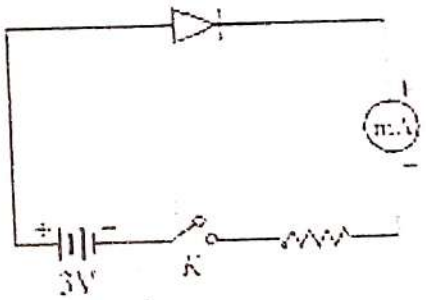
i. The north pole of a long bar magnet was pushed slowly into a short solenoid connected to a galvanometer. The magnet was held stationary for a few seconds with the north pole in the middle of the solenoid and then withdrawn rapidly. The maximum deflection of the galvanometer was observed when the magnet was
   a) at rest inside the solenoid
   b) moving into the solenoid
   c) moving towards the solenoid
   d) moving out of the solenoid.

ii. Two similar circular loops carry equal currents in the same direction. On moving the coils further apart, the electric current will
   a) remain unaltered
   b) decrease in both
   c) increases in one and decreases in the second
   d) increase in both

iii. A closed iron ring is held horizontally and a bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet is.
   a) equal to g
   b) more than g
   c) less than g
   d) depends on the diameter of the ring and length of magnet

iv. Whenever there is a relative motion between a coil and a magnet, the magnitude of induced emf set up in the coil does not depend upon the
   a) magnetic moment of the coil
   b) number of turns in the coil
   c) resistance of the coil
   d) relative speed between the coil and magnet

33. **Read the text carefully and answer the questions:** The potential barrier in the p - n junction diode is the barrier in which the charge requires additional force for crossing the region. In other words, the barrier in which the charge carrier stopped by the obstructive force is known as the potential barrier. When a p - type semiconductor is brought into close contact with n - type semiconductor, we get a p - n junction with a barrier potential 0.4 V and the width of the depletion region is 4.0×10^{-7} m. This p - n junction is forward biased with a battery of voltage 3 V and negligible internal resistance, in series with a resistor of resistance R, ideal millimeter and key K as shown in the figure. When the key is pressed, a current of 20 mA passes through the diode. 4



i. The intensity of the electric field in the depletion region when p - n junction is unbiased is
   a) 1.5×10^{6} V m^{-1}
   b) 1.0×10^{6} Vm^{-1}

c) 2.0×10^6 V m^{-1}
d) 0.5×10^6 Vm^{-1}

ii. The resistance of resistor R is
a) 300Ω
b) 130Ω
c) 150Ω
d) 180Ω

iii. In a p - n junction, the potential barrier is due to the charges on either side of the junction, these charges are
a) minority carriers
b) both majority carriers and minority carriers
c) majority carriers
d) fixed donor and acceptor ions

iv. If the voltage of the potential barrier is V_0 . A voltage V is applied to the input, at what moment will the barrier disappear?
a) $V << V_0$
b) $V < V_0$
c) $V > V_0$
d) $V = V_0$