COMMON PRE-BOARD EXAMINATION: 2022-23

Class-XII Subject: PHYSICS (042)

Date: 15/01/2023

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

General Instructions:

(1) There are 35 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. All the sections are compulsory.
(3) Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study-based questions of 4 marks each.
(4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
(5) Use of calculators is not allowed.

Q.No. Marks

SECTION A

1. A charge Q is placed at the centre of the line joining two point charges +q and +q as shown in the figure. The system is in equilibrium. The ratio of charges Q and q is: 1

(i) 4
(ii) 1/4
(iii) -4
(iv) -1/4

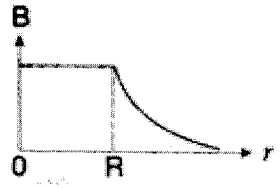
2. A hollow metal sphere of radius 5 cm is charged so that the potential on its surface is 10 V. The potential at the centre of the sphere is: 1

(i) 0 V
(ii) 10 V
(iii) Same as at point 5 cm away from the surface
(iv) Same as at point 25 cm away from the surface

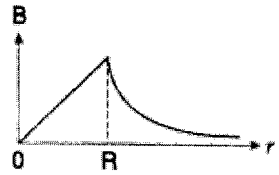
3. For a fixed potential difference applied across a conductor, the drift speed of free electrons does not depend upon: 1

(i) free electron density in the conductor
(ii) mass of the electrons.
(iii) length of the conductor
(iv) temperature of the conductor

4. The correct plot of the magnitude of magnetic field $\vec{B}$ vs distance r from centre of the wire is, if the radius of wire is R: 1



(i)



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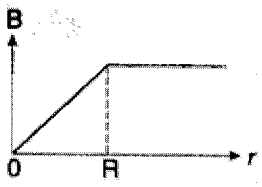

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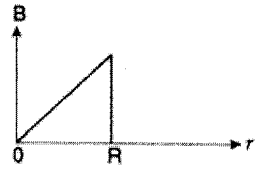


(iv)

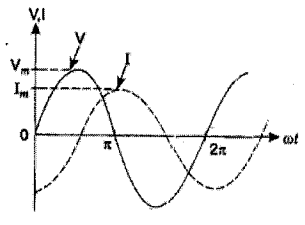
5. The conversion of a moving coil galvanometer into a voltmeter is done by: 1

(i) introducing a resistance of large value in series.
(ii) introducing a resistance of small value in parallel.
(iii) introducing a resistance of large value in parallel.
(iv) introducing a resistance of small value in series.

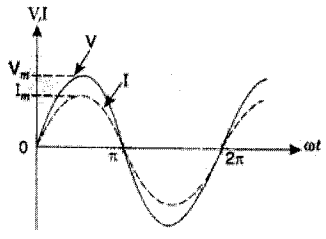
6. The force between two parallel wire 2×10^{-7} Nm^{-1}, placed 1 m apart to each other in vacuum. The electric current flowing through the wires is: 1

(i) 1 A
(ii) zero
(iii) 5×10^{6} A
(iv) 2×10^{-7} A

7. The phase relationship between current and voltage in a pure resistive circuit is best represented by: 1



(i)



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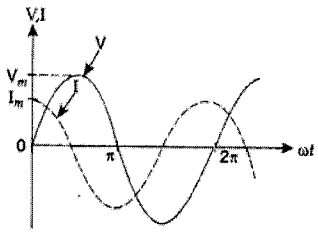

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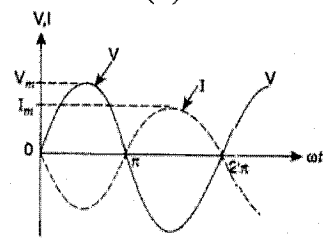
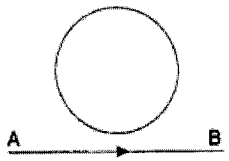


(iv)

8. In the given figure current from A to B in the straight wire is decreasing. The direction of induced current in the loop is: 1



(i) clockwise
(ii) anticlockwise
(iii) changing
(iv) nothing can be said

9. Lenz's law is a consequence of: 1

(i) law of conservation of charge
(ii) law of conservation of energy
(iii) law of conservation of momentum
(iv) none of the above

10. The intensity of light emerging from the two slits, in Young's experiment is in the ratio 1:4. The ratio of the intensity of the minimum to that of the consecutive maximum will be: 1

(i) 1 : 4
(ii) 2 : 3
(iii) 1 : 16
(iv) 1 : 9

11. What is the de-Broglie wavelength of an electron accelerated from rest through a potential difference of 100 volts? 1

(i) 12.3 Å
(ii) 0.123 Å
(iii) 1.23 Å
(iv) None of these

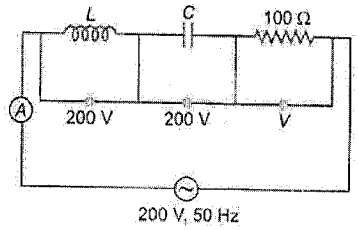
12 In Bohr's model of hydrogen atom, the total energy of the electron in n^{th} discrete orbit is proportional to: 1

(i) n
(ii) 1/n
(iii) n^2
(iv) $1/n^2$

13. Heavy stable nuclei have more neutrons than protons. This is because of the fact that 1

(i) neutrons are heavier than protons
(ii) electrostatic force between protons are repulsive
(iii) neutrons decay into protons through beta decay
(iv) nuclear force between neutrons are weaker than that between protons

14. The reading of ammeter and voltmeter in the following circuit are respectively 1



(i) 2A, 200V
(ii) 1.5A, 200V
(iii) 2A, 100V
(iv) none of these

15. Two capacitors of capacitance C_1 and C_2, are connected in parallel. If a charge Q is given to the combination, the charge gets shared. The ratio of the charge on the capacitor C_1 to the charge on the capacitor C_2 is: 1

(i) $C_1 C_2$
(ii) $C_1 + C_2$
(iii) C_1 / C_2
(iv) None of the above

16. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** 1
a) Both A and R are true and R is the correct explanation of A
b) Both A and R are true and R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false

ASSERTION(A):
A pure semiconductor has negative temperature coefficient of resistance.
REASON(R):
In a semiconductor on raising the temperature, more charge carriers are released, conductance increases and resistance decreases.

17. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** 1
a) Both A and R are true and R is the correct explanation of A
b) Both A and R are true and R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false

ASSERTION(A):
Diffraction takes places for all types of waves mechanical or non-mechanical, transverse or longitudinal.
REASON(R):
Diffraction effects are perceptible only if wavelength of wave is comparable to dimensions of diffracting device.

18. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** 1

a) Both A and R are true and R is the correct explanation of A
b) Both A and R are true and R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false

ASSERTION(A):
Photoelectric saturation current increases with the increase in frequency of incident light.
REASON(R):
Energy of incident photons increases with increase in frequency and as a result photoelectric current increases.

SECTION B

19. Which segment of electromagnetic waves has highest frequency? How are these waves produced? Give one use of these waves. 2

20. Show diagrammatically the behaviour of magnetic field lines in the presence of (i) paramagnetic and (ii) diamagnetic substances. How does one explain this distinguishing feature? 2

21. Calculate the de Broglie wavelength of the electron orbiting in the n=2 state of hydrogen atom. 2

OR

The total energy of an electron in the first excited state of the hydrogen atom is about –3.4 eV.
(a) What is the kinetic energy of the electron in this state?
(b) What is the potential energy of the electron in this state?
(c) Which of the answers above would change if the choice of the zero of potential energy is changed?

22. A ray of light incident on face AB of an equilateral glass prism, shows minimum deviation of 30°. Calculate the speed of light through the prism. 2

23. Explain, with the help of a circuit diagram, the working of a p-n junction diode as a half-wave rectifier. 2

OR

Draw the necessary energy band diagrams to distinguish between conductors and semiconductors.

24. State two conditions for sustained interference of light in Young's Double Slit experiment. Draw the variation of intensity with position in the interference pattern of Young's double slit experiment. 2

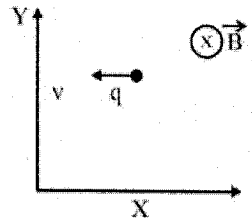
25. Two point charges $q_A = 3\mu C$ and $q_B = -3\ \mu C$ are located 20 cm apart in vacuum. What is the electric field at the midpoint O of the line AB joining the two charges? 2

SECTION C

26. (a) A point charge q moving with speed v enters a uniform magnetic field **B** that is acting into the plane of the paper as shown. What is the path followed by the charge q and in which plane does it move? 3

(b) How does the path followed by the charge get affected if its velocity has a component parallel to **B**?

(c) If an electric field **E** is also applied such that the particle continues moving along the original straight line path, what should be the magnitude and direction of the electric field **E**?



27. A metallic rod of 'L' length is rotated with angular frequency of 'ω' with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius L, about an axis passing through the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field B parallel to the axis is present everywhere. Deduce the expression for the emf between the centre and the metallic ring. 3

28. When a circuit element 'X' is connected across an AC source, a current of $\sqrt{2}$A flows through it and this current is in phase with the applied voltage. When another element 'Y' is connected across the same AC source, the same current flows in the circuit but it leads the voltage by $\pi/2$ radians. 3

i. Name the circuit elements X & Y.

ii. Find the current that flows in the circuit when the series combination of X & Y is connected across the same AC voltage.

iii. Plot a graph showing the variation of net impedance of this series combination of X & Y as a function of the frequency of the applied voltage.

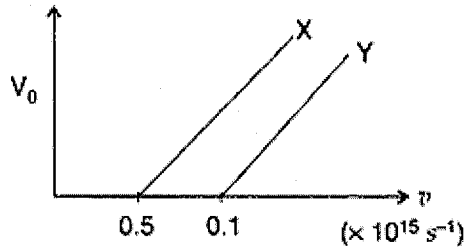
OR

A sinusoidal voltage of peak value 10 V is applied to a series LCR circuit in which resistance, capacitance and inductance have values of 10 Ω, 1μF and 1H respectively. Find (i) the peak voltage across the inductor at resonance and (ii) quality factor of the circuit.

29. Write three basic properties of photons which are used to obtain Einstein's photoelectric equation. 3

OR

The following graph shows the variation of stopping potential V_0 with the frequency v of the incident radiation for two photosensitive metals X and Y:



(i) Which of the metals has larger threshold wavelength? Give reason.

(ii) Explain, giving reason, which metal gives out electrons, having larger kinetic energy, for the same wavelength of the incident radiation.

(iii) If the distance between the light source and metal X is halved, how will the kinetic energy of electrons emitted from it change? Give reason.

30. What is the nuclear radius of ^{125}Fe, if that of ^{27}Al is 3.6 fermi? Draw a plot of potential energy of a pair of nucleons as a function of their separation. Write two important conclusions which you can draw regarding the nature of nuclear forces. 3

SECTION D

31. (a) Find the expression for the potential energy of a system of two point charges q_1 and q_2 located at $\mathbf{r}_1$ and $\mathbf{r}_2$, respectively in an external electric field $\mathbf{E}$. 5

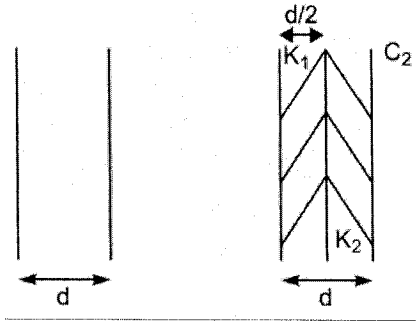
(b) Draw equipotential surfaces due to an isolated point charge (– q) and depict the electric field lines.

(c) Three point charges + 1 μC, – 1 μC and + 2 μC are initially infinite distance apart. Calculate the work done in assembling these charges at the vertices of an equilateral triangle of side 10 cm.

OR

(a) Derive an expression for the capacitance of a parallel plate capacitor. If a dielectric medium is introduced between the plates of the capacitor, how will the capacitance of the capacitor change?

(b) You are given an air filled parallel plate capacitor C_1. The space between its plates is now filled with slabs of dielectric constants K_1 and K_2 as shown in C_2. Find the capacitances of the capacitor C_2 if area of the plates is A distance between the plates is d.



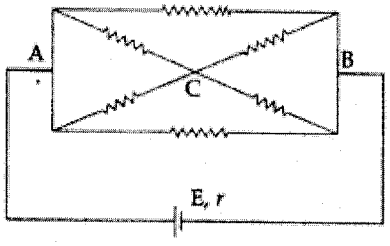
32. (a) Define the term drift velocity. On the basis of electron drift, derive an expression for resistivity of a conductor in terms of number density of free electrons and relaxation time. On what factors does resistivity of a conductor depend? 5

(b) Why alloys like constantan and manganin are used for making standard resistors?

OR

(a) State the two Kirchhoff's laws. Explain briefly how these rules are justified.

(b) The current is drawn from a cell of emf E and internal resistance r connected to the network of resistors each of resistance r as shown in the figure. Obtain the expression for the current drawn from the cell and the power consumed in the network.



33. (a) A plane wave front is incident at an angle of incidence i on a reflecting surface. Draw a diagram showing incident wave front, reflected wave front and verify the laws of reflection on the basis of Huygen's wave theory. 5

(b) 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 eye piece is observed to be 14cm. If least distance of distinct vision is 20cm, calculate the focal length of objective and eye piece.

OR

(a) An object is placed in front of a concave mirror. It is observed that a virtual image is formed. Draw the ray diagram to show the image formation and hence derive the mirror equation, $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$.

(b) In a single slit diffraction experiment, the width of the slit is made double the original width. How does this affect the size and intensity of the central diffraction band? Explain.

SECTION E

34. **Case Study:** 4
Read the following paragraph and answer the questions.

The lens maker's formula relates the focal length of a lens to the refractive index of the lens material and the radii of curvature of its two surfaces. This formula is

called so because it is used by manufacturers to design lenses of required focal length from a glass of given refractive index. If the object is placed at infinity, the image will be formed at focus for both double convex lens and double concave lens. Lens maker's formula is,

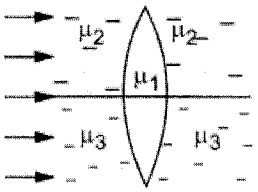
$$\frac{1}{f} = (\frac{\mu 2 - \mu 1}{\mu 1})(\frac{1}{R1} - \frac{1}{R2})$$

When lens is placed in air, $\mu_1 = 1$ and $\mu_2 = \mu$. The lens maker's formula takes the form, $\frac{1}{f} = (\mu - 1)(\frac{1}{R1} - \frac{1}{R2})$.

The thin lens formula is, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, where v is the image distance and u is the object distance.

(i) A converging lens of refractive index 1.5 is kept in a liquid medium having same refractive index. What would be the focal length of the lens in this medium?

(ii) A double convex lens, made of a material of refractive index μ_1 is placed inside two liquids of refractive indices μ_2 and μ_3, as shown $\mu_2 > \mu_1 > \mu_3$. A wide, parallel beam of light is incident on the lens from the left as shown. How will be the emergent beam?



(iii) What change in the focal length of a convex lens occurs, when the incident violet light on them is replaced with red light? Why?

OR

(iii) The focal length of an equiconvex lens is equal to the radius of curvature of either face. What is the refractive index of the material of the lens?

35. **Case Study:** 4

Read the following paragraph and answer the questions.

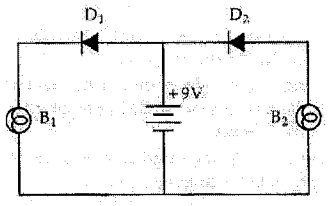
A diode (PN junction) in an electrical circuit allows current to flow more easily in one direction than another. If positive terminal of dc Voltage Source is connected to p side of diode and negative terminal is connected to n side then diode is said to be Forward Biased. When the diode is forward biased, it is found that beyond forward voltage $V = V_k$, called knee voltage, the conductivity is very high. At this value of battery biasing for p-n junction, the potential barrier is overcome and the current increases rapidly with increase in forward voltage.

If negative terminal of dc Voltage Source is connected to p side of diode and positive terminal is connected to n side then diode is said to be Reverse Biased. When the diode is reverse biased, the reverse bias voltage produces a very small current about a few microamperes which almost remains constant with bias. This small current is reverse saturation current.

(i) What happens to the width of depletion layer of a p-n junction when it is forward biased and reverse biased?

(ii) Draw the circuit diagram for studying the V-I characteristics of a p-n junction diode in forward bias.

(iii) In the following diagram, which bulb out of B_1 and B_2 will glow and why?



OR

(iii) In the following diagram 'S' is a semiconductor. Would you increase or decrease the value of R to keep the reading of the ammeter A constant when S is heated? Give reason for your answer.