# CBSE EXAMINATION PAPER-2024

## PHYSICS

### (Solved)

Time allowed : 3 hours | Maximum Marks : 82

**General Instructions :**

Read the following instructions carefully and follow them :

i. This question paper contains **38 questions.** All questions are **compulsory.**

ii. This question paper is divided into **5 sections.**

iii. **Section A** – questions number **1 to 2** are case based questions

iv. **Section B** – questions number **3 to 18** are multiple choice questions

v. **Section C** – questions number **19 to 24** are very short answer

vi. **Section D** – questions number **25 to 32** are short answer

vii. **Section E** – questions number **33 to 38** are long answer

viii. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.

ix. Use of calculator is NOT allowed.

## Section A

**Question 1.** A lens is a transparent medium bounded by two surfaces, with one or both surfaces being spherical. The focal length of a lens is determined by the radii of curvature of its two surfaces and the refractive index of its medium with respect to that of the surrounding medium. The power of a lens is reciprocal of its focal length. If a number of lenses are kept in contact, the power of the combination is the algebraic sum of the powers of the individual lenses.

**(1)**

**A double-convex lens, with each face having the same radius of curvature R, is made of glass of refractive index n. Its power is :**

**(A) 2(n - 1)/R**

**(B) 2n-1/R**

**(C) n-1/2R**

**(D) 2n-1/2R**

[1 Marks]

**(2)**

**A double-convex lens of power P, with each face having the same radius of curvature, is cut into two equal parts perpendicular to its principal axis. The power of one part of the lens will be:**

**(A) 2P**

**(B) P**

**(C) 4P**

**(D) P/2**

[1 Marks]

**(3)**

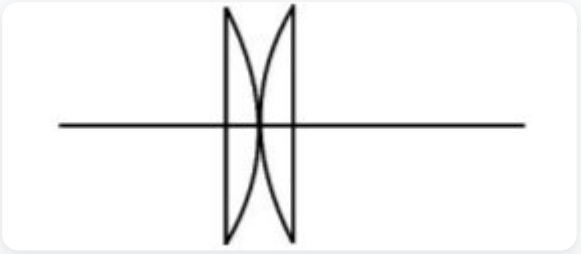
**The above two parts are kept in contact with each other as shown in the figure. The power of the combination will be :**

**(A) P/2**

**(B) P**

**(C) 2P**

**(D) P/4**



[1 Marks]

**(4)**

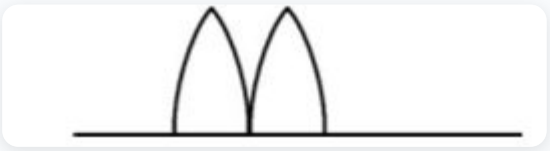
**A double-convex lens of power P, with each face having same radius of curvature, is cut along its principal axis. The two parts are arranged as shown in the figure. The power of the combination will be :**

**(A) Zero**

**(B) P**

**(C) 2P**

**(D) P/2**



[1 Marks]

**(5)**

**(b) Two convex lenses of focal lengths 60 cm and 20 cm are held coaxially in contact with each other. The power of the combination is :**

**(A) 6·6 D**

**(B) 15 D**

**(C) 1/15 D**

**(D) 1/80 D**

[1 Marks]

**Question 2.**

Junction Diode as a Rectifier:

The process of conversion of an ac voltage into a dc voltage is called rectification and the device which performs this conversion is called a rectifier. The characteristics of a p-n junction diode reveal that when a p-n junction diode is forward biased, it offers a low resistance and when it is reverse biased, it offers a high resistance. Hence, a p-n junction diode conducts only when it is forward biased. This property of a p-n junction diode makes it suitable for its use as a rectifier.

Thus, when an ac voltage is applied across a p-n junction, it conducts only during those alternate half cycles for which it is forward biased. A rectifier which rectifies only half cycle of an ac voltage is called a half-wave rectifier and one that rectifies both the half cycles is known as a full-wave rectifier.

**(1)**

**The root mean square value of an alternating voltage applied to a full-wave rectifier is $V_o/\sqrt{2}$. Then the root mean square value of the rectified output voltage is:**

**(A) $V_o/\sqrt{2}$**

**(B) $V_o^2/\sqrt{2}$**

**(C) $2V_o/\sqrt{2}$**

**(D) $V_o/2\sqrt{2}$**

[1 Marks]

**(2)**

**In a full-wave rectifier, the current in each of the diodes flows for :**

**(A) Complete cycle of the input signal**

**(B) Half cycle of the input signal**

**(C) Less than half cycle of the input signal**

**(D) Only for the positive half cycle of the input signal**

[1 Marks]

**(3)**

**In a full-wave rectifier :**

**(A) Both diodes are forward biased at the same time.**

**(B) Both diodes are reverse biased at the same time.**

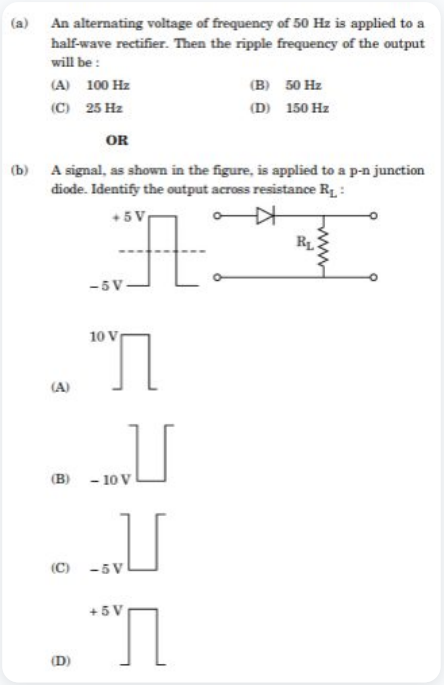
**(C) One is forward biased and the other is reverse biased at the same time.**

**(D) Both are forward biased in the first half of the cycle and reverse biased in the second half of the cycle.**

[1 Marks]

**(4)**

**A signal, as shown in the figure, is applied to a p-n junction diode. Identify the output across resistance R_L :**




[1 Marks]

**(5)**

**(a) An alternating voltage of frequency of 50 Hz is applied to a half-wave rectifier. Then the ripple frequency of the output will be :**

**(A) 100 Hz**

**(B) 50 Hz**

**(C) 25 Hz**

**(D) 150 Hz**

[1 Marks]

## Section B

**Question 3.**

A thin plastic rod is bent into a circular ring of radius R. It is uniformly charged with charge density . The magnitude of the electric field at its centre is:

[1 Marks]

(A) $\lambda/2\varepsilon_0 R$

(B) $\lambda/4\varepsilon_0 R$

(C) Zero

(D) $\lambda/4\pi\varepsilon_0 R$

**Question 4.**

Ten capacitors, each of capacitance 1 μF, are connected in parallel to a source of 100 V. The total energy stored in the system is equal to:

[1 Marks]

(A) $5.0 \times 10^{-2}$ J

(B) $10^{-3}$ J

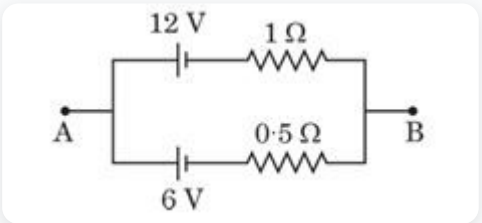
(C) $0.5 \times 10^{-3}$ J

(D) $10^{-2}$ J

**Question 5.**

Consider the circuit shown in the figure. The potential difference between points A and B is:

[1 Marks]




(A) 12 V

(B) 9 V

(C) 6 V

(D) 8 V

**Question 6.**

A loop carrying a current I clockwise is placed in x-y plane, in a uniform magnetic field directed along z-axis. The tendency of the loop will be to:

[1 Marks]

(A) move along y-axis

(B) shrink

(C) expand

(D) move along x-axis

**Question 7.**

A 10 cm long wire lies along y-axis. It carries a current of 1.0 A in positive y-direction. A magnetic field □□=(5 mT)$\hat{j}$−(8 mT)$\hat{k}$ exists in the region. The force on the wire is :

[1 Marks]

(A) -(0·8 mN) $\hat{i}$

(B) (80 mN) $\hat{i}$

(C) -(80 mN)$\hat{i}$

(D) (0·8 mN) $\hat{i}$

**Question 8.**

A galvanometer of resistance G ohm is converted into an ammeter of range 0 to I A. If the current through the galvanometer is 0.1% of I A, the resistance of the ammeter is :

[1 Marks]

(A) G/999Ω

(B) G/1000Ω

(C) G/100.1Ω

(D) G/1001Ω

**Question 9.**

The reactance of a capacitor of capacitance C connected to an ac source of frequency ω is 'X'. If the capacitance of the capacitor is doubled and the frequency of the source is tripled, the reactance will

become :

[1 Marks]

(A) X/6

(B) 2/3X

(C) 6X

(D) 3/2X

**Question 10.**

In the four regions, I, II, III and IV, the electric fields are described as : Region I : $Ex = E_0 \sin (kz - \omega t)$

Region II : $Ex = E_0$

Region III : $Ex = E_0 \sin kz$

Region IV : $Ex = E_0 \cos kz$

The displacement current will exist in the region :

[1 Marks]

(A) II

(B) IV

(C) I

(D) III

**Question 11.**

The transition of electron that gives rise to the formation of the second spectral line of the Balmer series in the spectrum of hydrogen atom corresponds to :

[1 Marks]

(A) n_f = 2 and n_i = 3

(B) n_f = 2 and n_i = 4

(C) n_f = 3 and n_i = 4

(D) n_f = 2 and n_i = ∞

**Question 12.**

Ge is doped with As. Due to doping,

[1 Marks]

(A) the structure of Ge lattice is distorted.

(B) the number of conduction electrons decreases.

(C) the number of conduction electrons increases.

(D) the number of holes increases.

**Question 13.**

Two beams, A and B whose photon energies are 3·3 eV and 11·3 eV respectively, illuminate a metallic surface (work function 2·3 eV) successively. The ratio of maximum speed of electrons emitted due to beam A to that due to beam B is :

[1 Marks]

(A) 3

(B) 1/3

(C) 1/9

(D) 9

**Question 14.**

The waves associated with a moving electron and a moving proton have the same wavelength . It implies that they have the same

[1 Marks]

(A) momentum

(B) angular momentum

(C) speed

(D) energy

**Question 15.**

Assertion (A) : In photoelectric effect, the kinetic energy of the emitted photoelectrons increases with increase in the intensity of the incident light.

Reason (R) : Photoelectric current depends on the wavelength of the incident light.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

(E) Assertion (A) is false and Reason (R) is true..

**Question 16.**

Assertion (A) : The mutual inductance between two coils is maximum when the coils are wound on each other.

Reason (R) : The flux linkage between two coils is maximum when they are wound on each other.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(B) Assertion (A) is false and Reason (R) is also false.

(C) Assertion (A) is true, but Reason (R) is false.

(D) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

**Question 17.**

Assertion (A) : Two long parallel wires, freely suspended and connected in series to a battery, move apart.

Reason (R) : Two wires carrying current in opposite directions repel each other.

[1 Marks]

(A) Assertion (A) is false and Reason (R) is also false.

(B) Assertion (A) is true, but Reason (R) is false.

(C) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(D) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

**Question 18.**

Assertion (A) : Plane and convex mirrors cannot produce real images under any circumstance.

Reason (R) : A virtual image cannot serve as an object to produce a real image.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Assertion (A) is true, but Reason (R) is false.

(C) Assertion (A) is false and Reason (R) is also false.

(D) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

---

## Section C

**Question 19.**

Find the temperature at which the resistance of a wire made of silver will be twice its resistance at 20°C. Take 20°C as the reference temperature and temperature coefficient of resistance of silver at 20°C = $4{\cdot}0*10^{-3}\ K^{-1}$.

[2 Marks]

**Question 20.**

Monochromatic light of frequency $5.0 \times 10^{14}$ Hz passes from air into a medium of refractive index 1.5. Find the wavelength of the light (i)reflected and (ii) reflected at the interface of the two media.

[2 Marks]

**Question 21.**

An object is placed 30 cm in front of a concave mirror of radius of curvature 40 cm. Find the

(i) position of the image formed and

(ii) magnification of the image.

[2 Marks]

**Question 22.**

Consider a neutron (mass m) of kinetic energy E and a photon of the same energy. Let $\lambda_n$ and $\lambda_p$ be the de Broglie wavelength of neutron and the wavelength of photon respectively. Obtain an expression for $\lambda_n/\lambda_p$.

[2 Marks]

**Question 23.**

Plot a graph showing the variation of current with voltage for the material GaAs. On the graph, mark the region where :

a) resistance is negative, and

b) Ohm's law is obeyed.

[2 Marks]

**Question 24.**

A plano-convex lens of focal length 16 cm is made of a material of refractive index 1.4. Calculate the radius of the curved surface of the lens.

[2 Marks]

---

## Section D

**Question 25.**

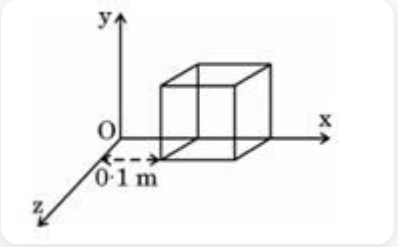
A cube of side 0.1 m is placed, as shown in the figure, in a region where electric field □□ = 500 x□̂ exists. Here x is in meters and E in $N/C^{-1}$.

Calculate:

(a) the flux passing through the cube, and

(b) the charge within the cube.

[3 Marks]




**Question 26.**

Define current density. Is it a scalar or a vector? An electric field □□ is maintained in a metallic conductor. If n be the number of electrons (mass m, charge -e) per unit volume in the conductor and ζ its relaxation time, show that the current density □□ = α□□, where $\alpha=(ne^2/m)\zeta$

[3 Marks]

**Question 27.**

A proton with kinetic energy $1.3384 \times 10^{-14}$ J moving horizontally from north to south, enters a uniform magnetic field B of 2.0 mT directed eastward. Calculate:

(a) the speed of the proton,

(b) the magnitude of acceleration of the proton,

(c) the radius of the path traced by the proton.

[Take (q /m) for proton = $1{\cdot}0 * 10^8$ C/kg]

[3 Marks]

**Question 28.**

An inductor, a capacitor and a resistor are connected in series with an ac source $v = V_m \sin(\omega t)$. Derive an expression for the average power dissipated in the circuit. Also obtain the expression for the resonant frequency of the circuit.

[3 Marks]

**Question 29.**

a) The wavelength of the electromagnetic wave is often correlated with the characteristic size of the system that radiates. Give two examples to justify this statement.

b) (i) Long distance radio broadcasts use short-wave bands. Why ?

(ii) Optical and radio telescopes are built on the ground, but X-ray astronomy is possible only from satellites orbiting the Earth. Why ?

[3 Marks]

**Question 30.**

Write the drawbacks of Rutherford's atomic model. How did Bohr remove them? Show that different orbits in Bohr's atom are not equally spaced.

[3 Marks]

**Question 31.**

(a) State any two properties of a nucleus.

(b) Why is the density of a nucleus much more than that of an atom ?

(c) Show that the density of the nuclear matter is the same for all nuclei.

[3 Marks]

**Question 32.**

What is a Wheatstone bridge ? Obtain the necessary conditions under which the Wheatstone bridge is balanced.

[3 Marks]

---

## Section E

**Question 33.**

(i) Derive an expression for potential energy of an electric dipole □□ an external uniform electric field □□ When is the potential energy of the dipole (1) maximum, and (2) minimum?

(ii) An electric dipole consists of point charges - 1.0 PC and + 1.0 pC located at (0, 0) and (3 mm, 4 mm) respectively in x - y plane. An electric field □□ = ((1000V)/m) $\hat{i}$ is switched on in the region. Find the torque □□ acting on the dipole.

[5 Marks]

**Question 34.**

(i) A resistor and a capacitor are connected in series to an ac source v = $v_m$ sin t. Derive an expression for the impedance of the circuit.

(ii) When does an inductor act as a conductor in a circuit ? Give reason for it.

(iii) An electric lamp is designed to operate at 110 V dc and 11 A current. If the lamp is operated on 220 V, 50 Hz ac source with a coil in series, then find the inductance of the coil.

[5 Marks]

**Question 35.**

(i) A ray of light passes through a triangular prism. Show graphically, how the angle of deviation varies with the angle of incidence ? Hence define the angle of minimum deviation.

(ii) A ray of light is incident normally on a refracting face of a prism of prism angle A and suffers a deviation of angle δ. Prove that the refractive index n of the material of the prism is given by n=sin (A+δ)/ sin A.

(iii) The refractive index of the material of a prism is √2. If the refracting angle of the prism is 60 degree find the

1.Angle of minimum deviation, and

2.Angle of incidence.

[5 Marks]

**Question 36.**

i) An electric dipole (dipole moment □□ =□□ hat hat i ) consisting of charges q and q, separated by distance 2a, is placed along the x-axis, with its centre at the origin. Show that the potential V, due to this dipole, at a point x, (x >>a) is equal to $1/4\pi\varepsilon_0$**.** □□. $\hat{i}$ /$x^2$

(ii) Two isolated metallic spheres $S_1$ and $S_2$ of radii 1 cm and 3 cm respectively are charged such that both have the same charge density ($2/\pi \times 10^{-9}$) C / $m^2$. They are placed far away from each other and connected by a thin wire. Calculate the new charge on sphere $S_1$.

[5 Marks]

**Question 37.**

(i) Draw a labelled diagram of a step-up transformer and describe its working principle. Explain any three causes for energy losses in a real transformer.

(ii) A step-up transformer converts a low voltage into high voltage. Does it violate the principle of conservation of energy ? Explain.

(iii) A step-up transformer has 200 and 3000 turns in its primary and secondary coils respectively. The input voltage given to the primary coil is 90 V. Calculate :

- The output voltage across the secondary coil
- The current in the primary coil if the current in the secondary coil is 2·0 A.

[5 Marks]

**Question 38.**

(i) State Huygens' principle. A plane wave is incident at an angle i on a reflecting surface. Construct the corresponding reflected wavefront. Using this diagram, prove that the angle of reflection is equal to the angle of incidence.

(ii) What are the coherent sources of light ? Can two independent sodium lamps act like coherent sources ? Explain.

(iii) A beam of light consisting of a known wavelength 520 nm and an unknown wavelength λ, used in Young's double slit experiment produces two interference patterns such that the fourth bright fringe of unknown wavelength coincides with the fifth bright fringe of known wavelength. Find the value of λ.

[5 Marks]