Bhavan's Tripura Vidyamandir

Pre-Board Test: (2024-2025)

Class:- 12 **Subject:- Physics**

Time:- 3 Hours Total :- 70 Marks

Name of the student : Roll: Stream:

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 twelve MCQ and four assertion-reason question of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section E contains two case study based questions of 4 marks each and section D contains three long questions of five 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.

SECTION-A [1X16=16]

Each of the following carries 1 mark:

1. The electric field intensity at a point due to a point charge is 20 N/C and the electric potential is 10 V. What is the distance of the point from the charge?

(a) 2 m (b) 0.5 m (c) 1 m (d) 4 m

2. In a uniform electric field, a dipole is placed with its dipole moment vector making an angle of 30^0 with the field. The net force acting on the dipole is:

(a) Zero (b) Along the direction of the field

(c) Perpendicular to the field (d) Opposite to the field

3. Which of the following is a unit of magnetic flux?

(a) Weber (b) Tesla (c) Ampere (d) Henry

4. According to Gauss's law, the net flux through a closed surface depends on:

(a) The shape of the surface (b) The volume of the surface

(c) The enclosed charge (d) The area of the surface

5. Two parallel wires carry currents 1A and 2A in opposite directions. The force between the wires will be:

(a) Attractive (b) Repulsive

(c) Zero (d) Cannot be determined

6. If a current of 5 A flows through a conductor for 2 minutes, the charge transferred through the conductor is:

(a) 300 C (b) 600 C (c) 10 C (d) 120 C

7. A transformer has 200 turns in its primary coil and 1000 turns in its secondary coil. If the input voltage is 240 V, the output voltage will be:

(a) 48 V (b) 1200 V (c) 240 V (d) 480 V

8. In Young's double-slit experiment, if the slit separation is halved, the fringe width will:

(a) Double (b) Halve (c) Remain the same (d) Become zero

9. Which of the following statements about the photoelectric effect is correct?

(a) Kinetic energy of photoelectrons depends on the intensity of incident light

(b) Photoelectric current depends on the frequency of incident light

(c) There is a threshold frequency below which photoelectric emission does not occur

(d) Increasing frequency increases the number of photoelectrons emitted

10. The focal length of a convex lens is 20 cm. When an object is placed at a distance of 40 cm from the lens, the image formed will be:

(a) Real and inverted (b) Virtual and upright

(c) Real and diminished (d) Virtual and magnified

11. Which among the following radiation has the longest wavelength?

(a) Infrared (b) X-rays (c) Ultraviolet (d) Gamma rays

12. Which of the following statements about nuclear fusion is true?

(a) It releases less energy than nuclear fission

(b) It requires extremely high temperature and pressure

(c) It splits a heavy nucleus into lighter nuclei

(d) It is commonly used in nuclear reactors

Question no. 13-16 are assertion-reason based question. These consist of two statements-Assertion (A) and Reason(R). Answer the question selecting the appropriate option given below:

(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 but R is true

13. Assertion : The alternating current lags behind the e.m.f. by a phase angle of $\frac{\pi}{2}$, when A.C. flows through an inductor.

Reason : The inductive reactance increases as the frequency of A.C. source decreases.

14. Assertion: Drift velocity of electrons is independent of time.

Reason: Electrons are accelerated in the presence of electric field.

15. Assertion : Kinetic energy of photo electrons emitted by a photosensitive surface depends upon the intensity of incident photon.

Reason : The ejection of electrons from metallic surface is possible with frequency of incident photon below the threshold frequency.

16. Assertion: Nuclear force between neutron-neutron, proton-neutron and proton-proton is approximately the same

Reason : The nuclear force does not depend on the electric charge

SECTION-B [2X5=10]

17. Explain the significance of the negative sign in the formula for the potential energy of two charges, $U=-kq_1q_2/r$.

OR

A parallel plate capacitor with plate area 500 cm^2 and plate separation of 1 mm is connected to a 100 V battery. Calculate the capacitance and the charge on the capacitor.

18. Draw a labeled diagram of an AC generator. Mention its principle.

19. Explain why optical fibers use the principle of total internal reflection.

20. What is drift velocity? How does it depend on electric field and temperature?

21. Define the terms threshold frequency and work function in the context of photoelectric effect.

SECTION-C [3X7=21]

22. Using Huygens' principle, derive the laws of reflection of light.

OR

(a) The critical angle for light going from glass (refractive index n=1.5) to air is required. Calculate the critical angle.

(b) A ray of light is incident on an equilateral prism (refractive index 1.6) at an angle of 45°. Calculate the angle of deviation, given that the angle of the prism is 60°. (1+2)

23. (a) Explain the working of a p-n junction diode in forward and reverse bias.

(b) Sketch and explain the I-V characteristics of a p-n junction diode. (2+1)

24. (a)Write Einstein's photoelectric equations and explain the terms involved.
(b) The work function of a metal is 2 eV. Calculate the threshold wavelength for the metal.
(2+1)

25. Use Ampère's law to find the magnetic field inside a long straight solenoid.

26. In a circuit, three resistors R_1=5 Ω, R_2=10 Ω, and R_3=15 Ω are connected in series. A battery of 24 V is connected across the series combination. Calculate:
(a) The total current flowing through the circuit.
(b) The voltage drop across each resistor.

27. Using Bohr's postulates, derive the expression for the radius of the n-th orbit of an electron in a hydrogen atom.

28. Show that the nuclear density of a nucleus is independent of its mass number.

SECTION-D [4X2=8]

29. Case Study: Working Principle and Components of an Astronomical Telescope

An astronomical telescope is an optical instrument designed to observe distant celestial objects like stars and planets. It primarily consists of two lenses: the objective lens and the eyepiece. The objective lens, which has a large focal length and aperture, collects light from the distant object and forms a real, inverted, and diminished image at its focal point. This image serves as the object for the eyepiece lens, which has a shorter focal length. The eyepiece magnifies this image, allowing the observer to view a larger and inverted image of the distant object.

The total magnifying power (M) of the telescope, when the final image is formed at infinity, is given by: $M=\frac{fo}{fe}$

Where, f_o is the focal length of the objective and f_e is the focal length of the eyepiece.

For comfortable viewing, the telescope can be adjusted to form the final image at the near point of the observer, which results in a slightly different magnification and requires the tube length to be adjusted.

Specifications of an Astronomical Telescope:

- Focal length of the objective lens (f_o) = 100 cm
- Focal length of the eyepiece lens (f_e) = 5 cm
- The telescope is adjusted for normal viewing (final image at infinity).

Based on this information, answer the following questions:

i) For the given astronomical telescope, what is the magnifying power when the final image is formed at infinity?
(a) 5 (b) 10 (c) 15 (d) 20

ii) The length of the telescope tube when it is adjusted for viewing at infinity will be:
(a) 100 cm (b) 105 cm (c) 95 cm (d) 110 cm

iii) The primary purpose of using a large objective lens in an astronomical telescope is:
(a) To increase the magnifying power
(b) To collect more light from distant objects
(c) To reduce the weight of the telescope
(d) To reduce the length of the telescope

iv) If a telescope is modified to use an eyepiece with a focal length of 2.5 cm instead of 5cm, what will be the new magnifying power?
(a) 20 (b) 25 (c) 30 (d) 40

30. Case Study: LCR Circuit in Alternating Current

An AC circuit consists of a resistor (R), an inductor (L), and a capacitor (C) connected in series. When an alternating voltage $V=V_0\sin(\omega t)$ is applied across the series LCR circuit, the current in the circuit depends on the values of R, L, and C. The circuit exhibits different behaviors at different frequencies, particularly resonating when the inductive and capacitive reactances are equal. Key equations involved in analyzing an LCR series circuit are:

Impedance (Z) of the circuit:

$Z = \{R^2+(X_L-X_C)^2\}^{1/2}$ where $X_L= \omega L$ (inductive reactance) and $X_C=1/\omega C$ (capacitive reactance).

Current (I) in the circuit: $I=V/Z$

Resonance Condition: The circuit is in resonance when $X_L=X_C$, which gives the resonant angular frequency: $\omega_0=\frac{1}{\sqrt{LC}}$. At resonance, the impedance Z=R and the current reaches its maximum value.

Given Data for the RLC Circuit:

- Resistance, R=10 Ω
- Inductance, L=0.5 H
- Capacitance, C=50 μF
- Peak voltage of the AC source, V_0=100 V

Using this information, answer the following questions:

i) Calculate the angular frequency (ω) for resonance in this RLC circuit.

(a) 200 rad/s (b) 50 rad/s (c) 100 rad/s (d) 20 rad/s

ii) At the resonant frequency, the impedance of the circuit will be:

(a) 10 Ω (b) 20 Ω (c) 0 Ω (d) Infinite

iii) If the supply frequency is at resonance, the peak value of current in the circuit will be:

(a) 10 A (b) 5 A (c) 20 A (d) 15 A

iv)What will be the phase difference between the current and the voltage at the resonant frequency?

(a) 0° (b) 90° (c) 180° (d) 45°

SECTION-E

[5X3=15]

31. A compound microscope 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. How far from the objective should an object be placed in order to obtain the final image at-

a) The least distance of distinct vision (25 cm) and infinity?

b) What is the magnifying power of the microscope in each case?

c) Draw the ray diagram to represent the given question? [2+1.5+1.5]

OR

Draw a ray diagram of a compound microscope. Write the expression for its magnifying power.

a) A ray of light passing through an equilateral triangular glass prism from air undergoes minimum deviation when angle of incidence is 3/4th of the angle of prism. Calculate the speed of light in the prism.

b) A biconvex lens made of a transparent material of refractive index 1.5 is immersed in water of refractive index 1.33. Will the lens behave as a converging or a diverging lens? Give reason. [3+2]

32. a) With the help of a diagram, explain the principle of a device which changes a low ac voltage into a high voltage. Deduce the expression for the ratio of secondary voltage to the primary voltage in terms of the ratio of the number of turns of primary and secondary winding.

b) Write any two sources of the energy losses which occur in actual transformers.

c) A step-up transformer converts a low input voltage into a high output voltage. Does it violate law of conservation of energy? Explain. [2.5+1+1.5]

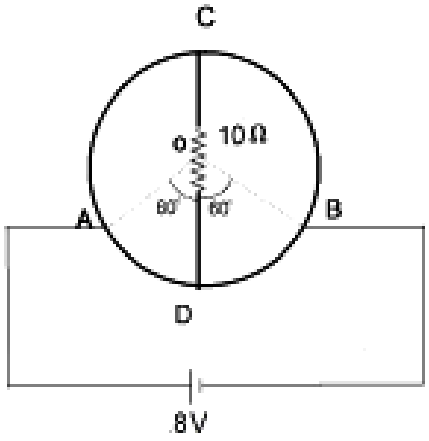
OR

When 5 V potential difference is applied across a wire of length 0.1 m the drift speed of electron is 2.5×10^{-4} m/s. If the electron density in the wire is 8×10^{28} m^3, calculate the resistivity of the wire.

What is the force between two small charged spheres having charges of 2×10^{-7} C and 3×10^{-7} C placed 30 cm apart in air. [3+2]

33. a)Using Kirchhoff's laws obtain the equation of the balanced state in Wheatstone bridge.

b) A wire of uniform cross-section and resistance of 12 ohm is bent in the shape of circle as shown in the figure. A resistance of 10 ohms is connected to diametrically opposite ends C and D. A battery of emf 8V is connected between A and B. Determine the current flowing through arm AD. [3+2]



OR

i) Find out capacitance of a capacitor with a dielectric slab of thickness 't' between the capacitor plates having separation 'd'.

ii) What happens when the dielectric slab is replaced by a conducting slab of same thickness?

[3+2]