2022

PHYSICS

(Theory)

Full Marks : 70

Pass Marks : 21

Time : Three hours

All the Questions are compulsory.

The figures in the right margin indicate full marks for the questions.

Question Nos. 1 to 10 are "Very Short Answer" type questions carrying 1 mark each.

1. State Gauss's theorem in electrostatics. 1

2. Define Drift velocity of free electrons in a conductor. 1

3. State Ampere's circuital law. 1

4. What is displacement current ? 1

5. Write down the expression of de-Broglie wavelength λ associated with a particle of mass **m** when it is moving with a velocity **v**. 1

6. State Bohr's quantisation condition for angular momentum of an electron. 1

7. What is meant by half-life of a radioactive element ? 1

8. Semiconductors behave as conductors at very high temperature. Why ? 1

9. What are the charge carriers responsible for a very small current in a reversed bias p-n junction diode ? 1

10. Why is Zener diode fabricated by heavily doping of both p and n sides of the junction ? 1

*Question Nos. **11** to **20** are 'Short Answer Type-II' questions carrying **2** marks each.*

11. A parallel plate capacitor is charged to have a uniform electric field E in the space between the plates. If the distance between the plates is d and area of each plate is A, find the energy stored in the capacitor. 2

12. The e.m.f of a cell is 1.4 V. On connecting a load resistance of $10\,\Omega$, the terminal potential difference falls to 1.25 V. What is the internal resistance of the cell ? 2

13. A circular copper coil of radius **r** and **n** turns, is placed with its plane perpendicular to a magnetic field which varies with time as $B = B_0 \sin\omega t$. Obtain the expression for induced emf at the two ends of the coil. 2

14. Obtain the resonant frequency of a series L-C-R circuit with L= 2H, C = $32\,\mu$F, and R = $10\,\Omega$. 2

15. Identify the type of electromagnetic waves which are produced by the following ways and write one application of each :

    (i) Rapid acceleration and deceleration of electrons in aerials.

    (ii) Bombarding a metal target by high energy electrons. 2

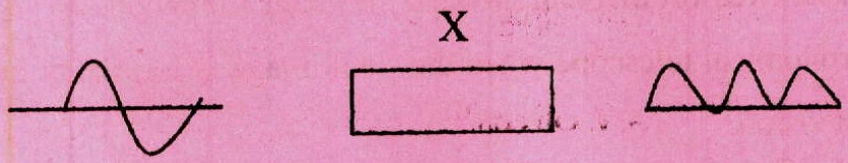
16. Write the distinguishing features between a diffraction patterns due to a single slit and interference fringes produced in young's double slit experiment. 2

17. Explain the reddish appearance of sun at sunrise and sunset. 2

18. The total energy of an electron in the first exited state of H-atom is –3.4 eV. What is the kinetic and potential energy of the electron in this state? 2

19. Explain the formation of depletion layer in a p-n junction. 2

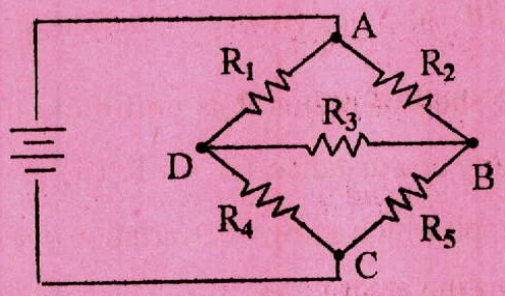
20. In the figure given below, the input waveform is converted into the output waveform by the device X. Name the device and draw the circuit diagram of the device. 2



Question Nos. 21 to 27 are 'Short Answer Type-I' questions carrying 3 marks each.

21. Find the current drawn from the battery of the circuit given below.

Where $R_1 = 10\ \Omega$, $R_2 = 20\ \Omega$, $R_4 = 20\ \Omega$, $R_5 = 40\ \Omega$, $R_3 = 5\ \Omega$ and e.m.f of the Battery, $E = 10$ V. 3



22. A particle of charge q and mass m is moving with a velocity v, it is subjected to a uniform magnetic field B directed perpendicular to its velocity. Show that the charge particle describes in a circular path. Find the radius of the circular path. 3

23. How much current is drawn by the primary coil of a transformer, which step- down 220 V to 44 V to operate a device with an impedance of 440 Ω. 3

24. Two polaroids A and B are kept in crossed position. How should a third polaroid C be placed between them so that the intensity of polarised light transmitted by polaroid B is maximum ? 3

25. Draw a labelled ray diagram showing the image formation of a distance object by an astronomical telescope when the final image is formed at least distance of distinct vision. 3

26. If V is the stopping potential of photoelectrons in a photo electric experiment, find the expression for maximum velocity of the emitted electrons. Does this value depends on the intensity of the incident light ? Justify your answer. 3

27. From the relation of radius of nucleus $R = R_0 A^{1/3}$ where R_0 is a constant and A is the mass number of the nucleus, show that the nuclear matter density is independent of A. 3

Question Nos. ***28*** *to* ***30*** *are 'Long Answer Type' questions carrying* ***5*** *marks each.*

28. A thin spherical shell of radius R is uniformly charged. Find the expression of electric intensity at a distance (i) $x > R$ (ii) $x < R$ if the charge on the shell is Q. Draw the graph which shows the variation of electric intensity with distance from the centre of the shell. 2+2+1=5

Or

Find the expression for work done in bringing a unit positive charge from infinity up to a point at a distance **x** from a point charge Q.

Give the relation between electric intensity and potential. 4+1=5

29. Derive the relation between distance of object, distance of image and radius of curvature of a convex spherical surface when refraction takes place from rarer medium of refractive index n_1 to a denser medium of refractive index n_2 and image is real. 5

Or

State Huygens' principle. With the help of of suitable diagram, prove the law of reflection of light using huygens' principle. 4+1=5

30. A rectangular coil of n turns and carrying a current I, is suspended in a uniform magnetic field of strength B . Find the torque acting on the coil when the plane of the coil makes an angle θ with the direction of the magnetic field. When will the torque be maximum? Find its value. 5

Or

An electron is revolving in a circular orbit of radius r around a nucleus. Obtain the expression for magnetic dipole moment produced by the electron in terms of its angular momentum and Bohr's quantum number. 5

Question Nos. ***31*** *to* ***34*** *are 'Multiple Choice Type' questions carrying* ***1*** *mark each. Choose the correct answer out of the four alternatives and* **rewrite** *the correct answer.*

31. The value smallest possible electric charge on a body is : 1

(A) 0.1×10^{-19} C

(B) 0.8×10^{-19} C

(C) 1.6×10^{-19} C

(D) 1 C

32. The colour code of a carbon resistor is given as red, black, orange and silver. Then the value of resistance is : 1

(A) $2 \times 10^4\ \Omega \pm 5\%$

(B) $2 \times 10^4\ \Omega \pm 10\%$

(C) $2 \times 10^3\ \Omega \pm 5\%$

(D) $2 \times 10^3\ \Omega \pm 10\%$

33. In an A.C circuit, the current flowing is $I = 5 \sin\left(100t - \frac{\pi}{2}\right)$ ampere and the potential different is $V = 200 \sin(100t)$ volt. The power consumption is equal to 1

(A) 1000 W

(B) 20 W

(C) 0 W

(D) 40 W

34. As the intensity of incident light increases 1

(A) photoelectric current decreases

(B) kinetic energy of the emitted photoelectrons increases

(C) photoelectric current increases

(D) kinetic energy of the emitted photoelectrons decreases
