(English Version)

Instructions : 1. *All Parts A to D are compulsory. Part – E is only for visually challenged students.*

2. *For Part – A questions, first written answers will be considered for awarding marks.*

3. *Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.*

4. *Direct answers to numerical problems without relevant formula and detailed solutions will not carry any marks.*

PART – A

I. Pick the correct option among the four given options for **all** of the following questions : **(15 × 1 = 15)**

1) A point charge q_1 exerts a force F on another point charge q_2 when placed at a fixed distance. If another point charge q_3 is brought near q_2, the force on q_2 due to q_1 :

a) increases

b) decreases

c) may increase or decrease

d) does not change

2) Equipotential surfaces for an isolated point charge are _____ in shape.

a) spherical

b) planar

c) cylindrical

d) conical

3) Resistivity of a metal wire depends on its :

a) area of cross-section
b) length
c) material
d) volume

4) The following table lists magnetic fields due to different current configurations. Column – I lists the current configurations and Column – II lists expressions for magnetic fields. Symbols have usual meanings.

	Column – I		Column – II
i)	At a distance r from an infinitely long straight wire.	p)	$B = \mu_0 nI$
ii)	At the centre of a circular current loop of radius r.	q)	$B = \frac{\mu_0 I}{2r}$
iii)	At the centre of a current carrying solenoid.	r)	$B = \frac{\mu_0 I}{2\pi r}$

Match the current configurations in Column – I with the correct magnetic field expressions in Column – II.

a) (i) – (p), (ii) – (q), (iii) – (r)
b) (i) – (r), (ii) – (q), (iii) – (p)
c) (i) – (r), (ii) – (p), (iii) – (q)
d) (i) – (q), (ii) – (r), (iii) – (p)

5) 'The net magnetic flux through any closed surface is zero'. This law is called

a) Gauss' law in electrostatics
b) Gauss' law in magnetism
c) Ampere's circuital law
d) Faraday's law of electromagnetic induction

6) Consider the following statements :

Statement – 1: A.C. Generator works on the principle of electromagnetic induction

Statement – 2: In an A.C. Generator , as the armature is rotated in a uniform magnetic field , the magnetic flux linked with the coil changes which induces an emf in the coil.

Among the above two statements :

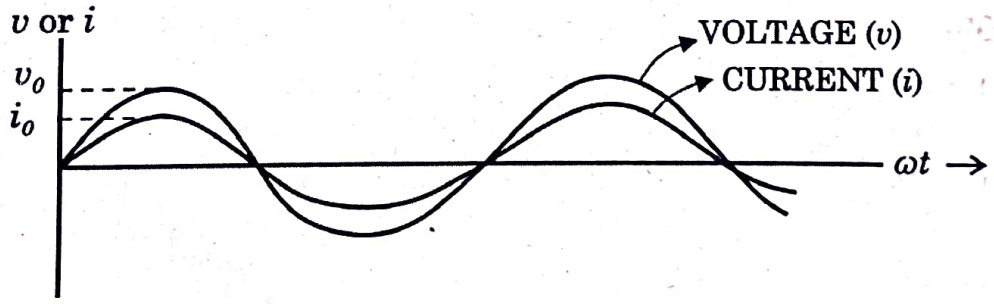
a) Both Statements are true

b) Both Statements are false

c) Statement-1 is true and Statement-2 is false

d) Statement-1 is false and Statement-2 is true

7) The variation of voltage and current through an a.c. circuit with time is as shown in the figure.



Along with the a.c. source, the circuit :

a) has a series combination of resistance and capacitance

b) has only inductance

c) has only capacitance

d) may have only resistance or may have a suitable series combination of inductance (L), capacitance (C) and resistance (R)

8) Transformer cores are usually laminated. This is to reduce energy loss due to

a) flux leakage
b) winding resistance
c) eddy currents
d) hysteresis

9) 'Ampere-Maxwell Law' is written as (symbols have usual meanings) :

a) $\oint \vec{B}.\vec{dl} = \mu_0 i + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$
b) $\oint \vec{B}.\vec{dl} = \mu_0 i + \varepsilon_0 \frac{d\phi_E}{dt}$
c) $\oint \vec{B}.\vec{dl} = \mu_0 i$
d) $\oint \vec{E}.\vec{dl} = -\frac{d\phi_B}{dt}$

10) Final image of a real object formed by a compound microscope is _____ with respect to the object.

a) real, inverted and magnified
b) virtual, erect and magnified
c) virtual, erect and diminished
d) virtual, inverted and magnified

11) Which one of the following statements is WRONG about interference of light?

a) Light waves of same wavelength coming from two independent sources can be coherent and can produce interference
b) When the path difference between two interfering waves in $n\lambda$, bright fringe is produced (Here $n = 0, 1, 2, ...$ and λ is the wavelength of light)
c) When the phase difference between two interfering waves is $(2n+1)\pi$, dark fringe is produced (Here $n = 0, 1, 2, ..$)
d) In Young's double slit experiment, dark and bright fringes are equally spaced

12) A ball is dropped from a certain height and it falls freely under gravity. During the fall, the de Broglie wavelength associated with it :

a) keeps increasing
b) keeps decreasing
c) is zero
d) may increase or decrease

13) In Rutherford's α-ray scattering experiment, α-particles of specific energy are projected towards a thin gold foil. If the impact parameter for the α-particles is zero, the angle of scattering is

a) $\theta = 0^\circ$ b) $\theta = 90^\circ$

c) $\theta = 180^\circ$ d) $\theta = 45^\circ$

14) Binding energy per nucleon of a nucleus is a measure of its

a) radius b) mass

c) volume d) stability

15) The energy gap for silicon is :

a) 0.72 eV b) 1.1 eV

c) 3 eV d) 5 eV

II. Fill in the blanks by choosing appropriate answer given in the bracket for **all** of the following questions : **(5 × 1 = 5)**

(diamagnetic, ferromagnetic, instantaneous, transverse, force, torque)

16) An electric dipole placed in a uniform electric field experiences a net _____.

17) Water is an example for _____ material.

18) When a _____ rod is inserted into a coil, its self-inductance increases.

19) Polarization of light shows that light is a _____ wave.

20) Photoelectric effect is a/an _____ effect.

PART – B

III. Answer **any five** of the following questions : **(5 × 2 = 10)**

21) Define electric potential energy of a system of charges.
What happens to the potential energy of a system of two unlike charges when the distance between them is increased (assume there is no external electric field)?

22) List any two limitations of Ohm's law.

23) Write the expression for Lorentz force and explain the terms.

24) State Lenz's law. What is its significance?

25) Give any two uses of microwaves.

26) How are focal length (f) and radius of curvature (R) of a spherical mirror related? What is the sign of focal length of a convex mirror?

27) Mention the conditions for total internal reflection.

28) An intrinsic semi conductor crystal is doped with pentavalent atoms has an electron concentration of $5\times10^{22}m^{-3}$. If, at thermal equilibrium, the intrinsic concentration $n_i = 1.5\times10^{16}m^{-3}$, find the hole concentration.

PART – C

IV. Answer **any five** of the following questions : **(5 × 3 = 15)**

29) Mention three properties of electric field lines.

30) Derive the expression for the equivalent capacitance of two capacitors connected in parallel.

31) Explain with a circuit diagram, how a galvanometer can be converted into voltmeter.

32) Define the terms :

a) Magnetization

b) Magnetic permeability and

c) Magnetic susceptibility.

33) Derive the expression for motional emf induced in a rod moving in a uniform magnetic field.

34) When a light radiation of energy 3 eV falls on a metal surface, photoelectrons with a maximum kinetic energy 1 eV are emitted from the surface. Find the threshold frequency for the metal surface. (Given : Planck's constant, $h = 6.63 \times 10^{-34} Js$; Charge on the electron $e = 1.6 \times 10^{-19} C$).

35) State the postulates of Bohr's hydrogen atom model.

36) Write any three properties of nuclear force.

PART – D

V. Answer **any three** of the following questions : **(3 × 5 = 15)**

37) Derive the expression for the electric potential at a point due to a point charge.

38) Arrive at the condition for balance of a Wheatstone's network using Kirchhoff's rules.

39) Obtain the expression for the force per unit length between two infinitely long straight parallel current carrying conductors placed in vacuum. Hence define the unit 'ampere'.

40) a) State Huygen's principle. **(1)**

b) Prove Snell's law of refraction using Huygen's principle by considering refraction of a plane wave by a surface. **(4)**

41) a) What is a rectifier? **(1)**

b) With the help of a circuit diagram, input and output waveforms, explain the working of a full wave rectifier. **(4)**

VI. Answer **any two** of the following questions : **(2 × 5 = 10)**

42) A uniformly charged spherical shell of radius 10 cm has a surface charge density of 16 μ cm^{-2}. Find the electric field due to the shell at a distance of

a) 20 cm from the centre of the shell.

b) 5 cm from the centre of the shell.

43) Two identical cells each of emf 15 V either connected in series or connected in parallel across an external resistance of 5Ω produce the same current through the resistor.

a) Calculate the value of internal resistance of the cell.

b) Find the current through the external resistor in either case.

44) A series LCR circuit with $L = 0.5\,H$ and $R = 100\,\Omega$ is connected to a 200 V, 50 Hz a.c. supply.

a) Calculate the value of capacitance of the capacitor that drives the circuit into resonance.

b) Find the value of voltage across the inductor at resonance.

45) An object of height 1 mm is kept perpendicular to the axis of a thin convex lens of power +10 D. The distance between the object and the lens is 15 cm. Find the position and height of the image formed.

PART – E

VII. **(For Visually Challenged Students only)**

7) When a.c. is passed through an a.c. circuit, it is observed that the voltage and the current are in phase. Along with the a.c. source, the circuit :

a) has a series combination of resistance and capacitance.

b) has only inductance.

c) has only capacitance.

d) may have only resistance or may have a suitable series combination of inductance (L), capacitance (C) and resistance (R).