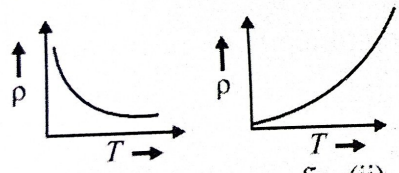
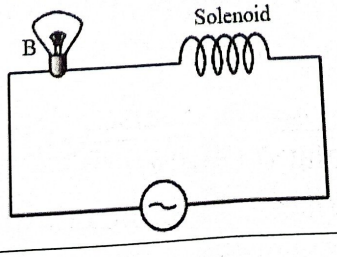
FIRST TERM EXAMINATION (2024-2025)
CLASS – XII
SUBJECT: PHYSICS

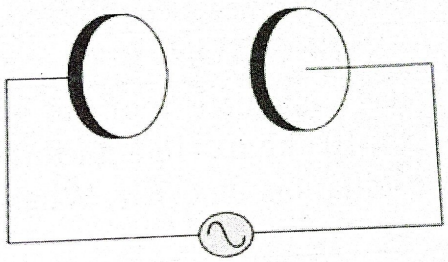
Time Allowed: 3 Hours **Maximum Marks: 70**

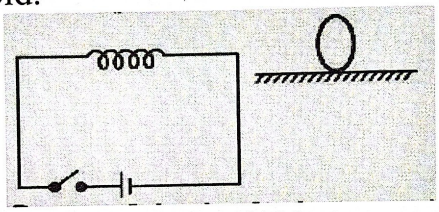
General Instructions:
(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study-based questions of four marks each and Section E contains three long answer questions of five marks each.
(5) Use of calculators is not allowed.

SECTION: A

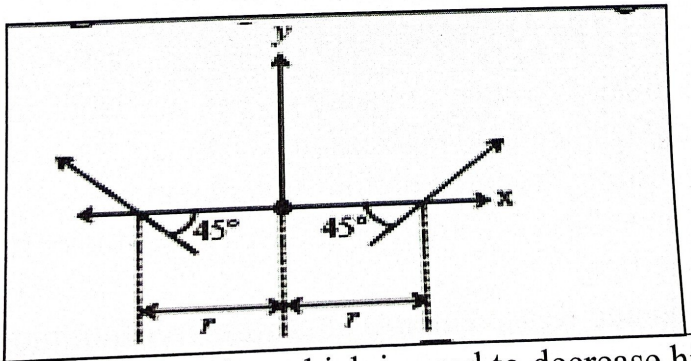
1	A proton and an electron are released from rest in the uniform electric field, then the correct Statement among the following is (a) The time required to fall through a certain distance is more for an electron (b) The force experienced by the proton will be more (c) The magnitude of acceleration experienced by the proton is more (d) KE gained by both charges in moving through the same distance are equal	1
2	Two points P and Q are maintained at the potentials of 10 V and – 4 V, respectively. The work done in moving 100 electrons from P to Q is: (a) 9.60×10^{-17} J (b) -2.24×10^{-16} J (c) 2.24×10^{-16} J (d) -9.60×10^{-17} J	1
3	When the current (i) is flowing through a conductor, the drift velocity is v. If 2i current flows through the same metal but has double the area of cross-section, then the drift velocity will be (a) v /4 (b) v / 2 (c) v (d) 4v	1
4	Coulomb's law of electrostatics for the force between two point charges most closely resembles (a) Law of conservation of charges	1

	(b) Law of conservation of energy (c) Newton's second law of motion (d) Newton's law of gravitation	
5	An ammeter of resistance 0.81 ohm reads up to 1 A. The value of the required shunt to increase the range to 10 A is (a) 0.9 ohm (b) 0.09 ohm (c) 0.03 ohm (d) 0.3 ohm	1
6	A capacitor of capacitance $C_1 = 1\ \mu F$ can withstand maximum voltage $V_1 = 6kV$ (kilo-volt) and another capacitor of capacitance $C_2 = 3\ \mu F$ can withstand maximum voltage $V_2 = 4kV$. When the two capacitors are connected in series, the combined system can withstand a maximum voltage of (a) 4kV (b) 6kV (c) 8kV (d) 10kV	1
7	An iron rod of 0.5 cm^2 area of cross-section is subjected to a magnetizing field of 1200 Am^{-1}. If the susceptibility of iron is 599,the permeability of the rod in TA^{-1} m is (a) $2.4\ \pi \times 10^{-4}$ (b) $2.4\ \pi \times 10^{-5}$ (c) 2.4×10^{-4} (d) 2.4×10^{-5}	1
8	The temperature (T) dependence of resistivity of materials A and material B is represented by Fig (i) and Fig (ii) respectively. Identify material A and material B.  fig. (i) fig. (ii) (a) material A is copper and material B is germanium (b) material A is germanium and material B is copper (c) material A is nichrome and material B is germanium (d) material A is copper and material B is nichrome	1
9	An iron cored coil is connected in series with an electric bulb with an AC source as shown in the figure. When an iron piece is taken out of the coil, the brightness of the bulb will  	1

	(a) decrease (b) increase (c) remain unaffected (d) fluctuate	
10	Five cells each of emf E and internal resistance r send the same amount of current through an external resistance R whether the cells are connected in parallel or in series. Then the ratio R /r is (a) 2 (b) 1/2 (c) 1/5 (d) 1	1
11	The large-scale transmission of electrical energy over long distances is done with the use of transformers. The voltage output of the generator is stepped up because of (a) reduction of current (b) reduction of current and voltage both (c) power loss is cut down (d) (a) and (c) both	1
12	A parallel plate capacitor (fig) made of circular plates each of radius 6 cm has a capacitance C = 100 pF. The capacitor is connected to a 230 V AC supply with (angular) frequency of 300 rad s^{-1}. The value of displacement current is  (a) 6.9 μ A (b) 6.9 m A (c) 1.38 μ A (d) 1.38 m A	1
	For Questions 13 to 16, two statements are given –one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the options given below. a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion. b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion. c) If Assertion is true but Reason is false. d) If both Assertion and Reason are false	
13	**Assertion:** Current is a scalar quantity. **Reason:** Electric current arises due to the continuous flow of charged particles or ions.	1

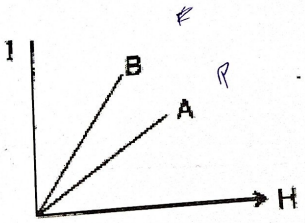
14	**Assertion:** A proton and an alpha particle having the same kinetic energy are moving in circular paths in a uniform magnetic field. The radii of their circular paths will be equal. **Reason:** Any two charged particles having equal kinetic energies and entering a region of uniform magnetic field B in a direction perpendicular to B, will describe circular trajectories of equal radii.	1
15	**Assertion**: Figure shows a horizontal solenoid connected to the battery and a switch. A copper ring is placed on a smooth surface, the axis of the ring being horizontal. As the switch is closed, the ring will move away from the solenoid.  **Reason:** Induced emf in the ring, e= $d\phi/dt$.	1
16	**Assertion**: Infrared radiation plays an important role in maintaining the average temperature of Earth. **Reason:** Infrared radiations are sometimes referred to as heat waves.	1

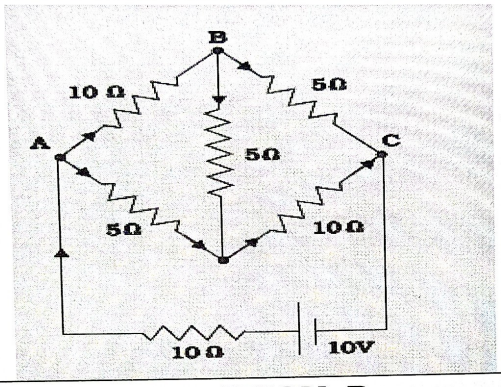
SECTION: B

17	A small magnetic needle has a magnetic moment of 6.7×10^{-2} Am^2 and a moment of inertia of 7.5×10^{-6} kg m^2. In a uniform magnetic field B, it performs 10 complete oscillations in 6.70s. What is the magnitude of the magnetic field?	2
18	Two identical electric dipoles are arranged on the x-axis as shown in the figure. Calculate the Electric field at the origin.  	2
19	Draw a diagram of a device which is used to decrease high a.c.Voltage to low a.c.Voltage and state its working principle. Write any 2 sources of energy loss in this device.	2
20	Calculate the potential at the centre of a square ABCD of each side $\sqrt{2}$ m, due to charges 2 μC, -2 μC, -3 μC, and 6 μC at four corners of it.	2

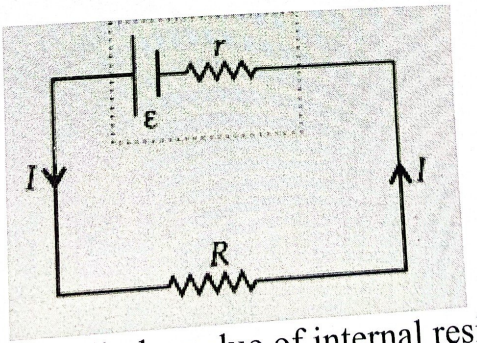
21	An EM wave travelling through a medium has an electric field vector. $E_y = 4 \times 10^5 \cos (3.14 \times 10^8 t - 1.57 x)$ N/C Here x is in m and t is in s. Find (i) wavelength and (ii)amplitude of the magnetic field	2

SECTION: C

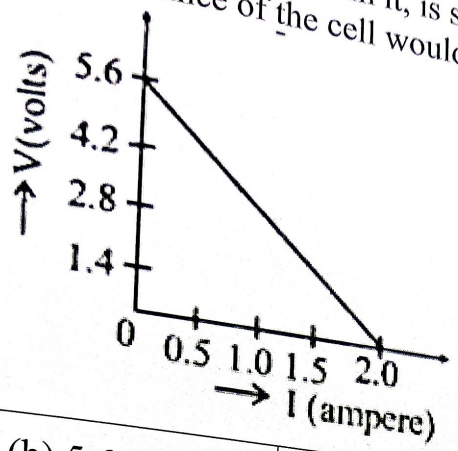
22	(a) State the two Kirchhoff's rules used in the analysis of electric circuits. (b) Derive the equation of the balanced state in a Wheatstone bridge using Kirchhoff's laws.	3
23	An electron travels in a circular path of radius 20 cm in a magnetic field of 2×10^{-3} T. Calculate the speed of the electron. What is the potential difference through which the electron must be accelerated to acquire this speed?The mass of electron is 9.1×10^{-31} kg	3
24	Draw equipotential surfaces : (i) in the case of a single-point charge and (ii) in a constant electric field in Z-direction. Whythe equipotential surfaces about a single charge are not equidistant? (iii) Can an electric field exist tangential to an equipotential surface? Give reason.	3
25	The figure shows the variation of intensity of magnetization versus the applied magnetic field intensity, H, for two magnetic materials A and B:  (a) Identify the materials A and B. (b) Why does the material B, has a larger susceptibility than A, for a given field at constant temperature? (c)) Write two characteristics of a material used for making permanent magnets.	3
26	Given a uniformelectric field $E = 2 \times 10^3$ i N/C, find the flux of this held through a square of side 20 cm, whose plane is parallel to the YZ-plane. What would be the flux through the same square if the plane	3

	makes an angle of 30° with the X-axis?	
27	Show diagrammatically a device which can generatean alternating emf by a loop of wire rotating in a magnetic field. Derive the expression for the instantaneous value of the emf induced in the rotating loop. State its underlying principle	3
28	Determine the current in each branch of the network shown in figure 	3

SECTION :D

29	Emf of a cell is the maximum potential difference between two electrodes of the cell when no current is drawn from the cell. Internal resistance is the resistance offered by the electrolyte of a cell when the electric current flows through it. The internal resistance of a cell depends upon the following factors; (1) distance between the electrodes (2) nature and temperature of the electrolyte (3) nature of electrodes (4) area of electrodes.  For a freshly prepared cell, the value of internal resistance is generally low and goes on increasing as the cell is put to more and more use. The potential difference between the two electrodes of a cell in a closed circuit is called terminal potential difference and its value is always less than the emf of the cell in a closed circuit. It can be written as V = E – I r.	4

(i) A straight line plot showing the terminal potential difference (V) of a cell as a function of current (I) drawn from it, is shown in the figure. The internal resistance of the cell would be then-



(a) 2.8 Ω	(b) 5.6 Ω	(c) 2 Ω	(d) 1.4 Ω

(ii) A cell of emf E and internal resistance r gives a current of 0.5 A with an external resistance of 12Ω and a current of 0.25 A with an external resistance of 25Ω . What is the value of the internal resistance of the cell?

(a) 5Ω	(b) 1Ω	(c) 7Ω	(d) 3Ω

(iii) Choose the wrong statement.

(a) Potential difference across the terminals of a cell in a closed circuit is less than its emf.
(b) Internal resistance of a cell decrease with the decrease in temperature of the electrolyte.
(c) Potential difference versus current graph for a cell is a straight line with a negative slope
(d) Terminal potential difference of the cell when it is being charged is given as V = E + Ir.

(iv) An external resistance R is connected to a cell of internal resistance r, the maximum current flows in the external resistance, when

(a) R = r	(b) R < r	(c) R> r	(d) R=l/r

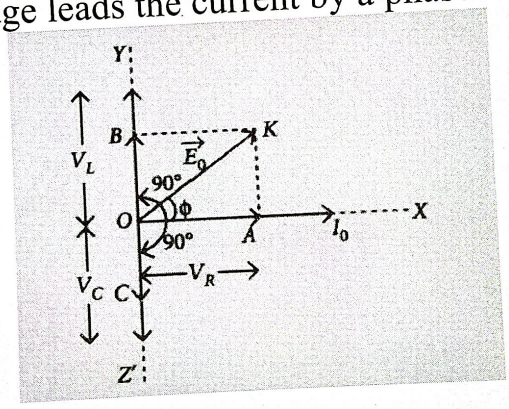
OR

(v) If external resistance connected to a cell has been increased to 5 times, the potential difference across the terminals of the cell increases from 10 V to 30 V. Then, the emf of the cell is

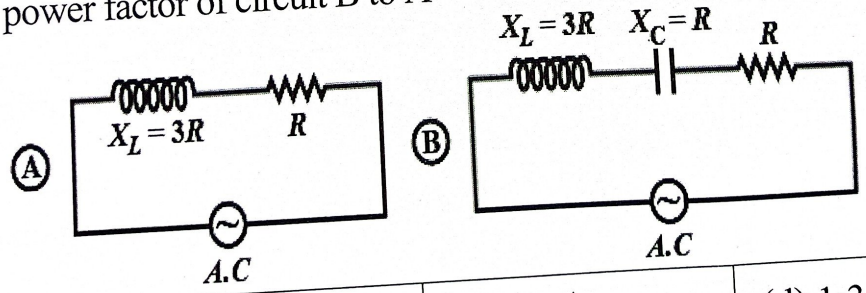
(a) 30 V	(b) 60V	(c) 50 V	(d) 40 V

30 When a pure resistance R, pure inductor L and an ideal capacitor of capacitance C is connected in series to a source of alternating e.m.f., then current at any instant through the three elements has the same amplitude and is represented as $I = I_0 \sin\omega t$. However, the voltage across each element has a different phase relationship with the current as shown in the graph. 4

The effective resistance of the RLC circuit is called impedance of the circuit and the voltage leads the current by a phase angle



(i) Give below are the two circuit A and B. Calculate the ratio of power factor of circuit B to A



(a) √2 :1	(b) 1:1	(c) 1 : √2	(d) 1:3

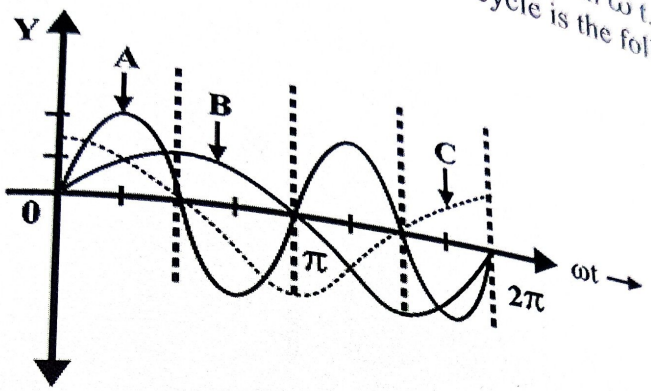
(ii)An inductor 200 mH , capacitor 500 μF and resistance 10 Ω are connected in series with a 100 V variable frequency ac source, the frequency at which power factor of the circuit is unity is

(a) 100 Hz	(b) 15.9 Hz	(c) 10 Hz	(d) 19.6 Hz

(iii) What is the value of current in the circuit of part (ii)?

(a) 5 A	(b) 15 A	(c) 10 A	(d) 9.46 A

(iv) A device 'X' is connected to an ac source $V = V_0 \sin \omega t$. The variation of Voltage , current , power in one cycle is the following graph



Identify the Device 'X'

(a) Capacitor	(b) Inductor	(c) Resistor	(d) LCR

OR

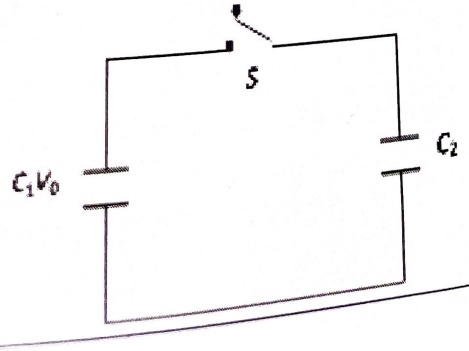
(v) The curve represent the voltage , current and power consumed in the circuit in the above graph of part (iv) is

(a) A,B,C	(b)B,A,C	(c) B,C,A	(d)A,C,B

SECTION : E

31 (i) A dielectric slab of thickness 't' is kept between the plates of a parallel plate capacitor with plate separation 'd' ($t < d$). Derive the expression for the capacitance of the capacitor. 5

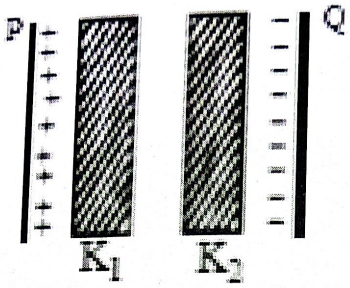
(ii) A capacitor of capacity $C1$ is charged to the potential of Vo. On disconnecting with the battery, it is connected with an uncharged capacitor of capacity $C2$ as shown in the adjoining figure. Find the ratio of energies before and after the connection of switch S.



OR

(i)Two point charges q_1 and q_2 initially at infinity, are brought one by one to points P_1 and P_2 specified by position vectors r_1 and r_2 relative to same origin. Derive the potential energy of this charge configuration? Write the expression of potential energy in case of two charges system placed in the presence of external electric field.

(ii) Two thin dielectric slabs of dielectric constants K1 and K2 (K1 < K2) are inserted between plates of a parallel plate capacitor, as shown in the figure. Plot the variation of electric field 'E' between the plates with distance 'd' as measured from plate P.



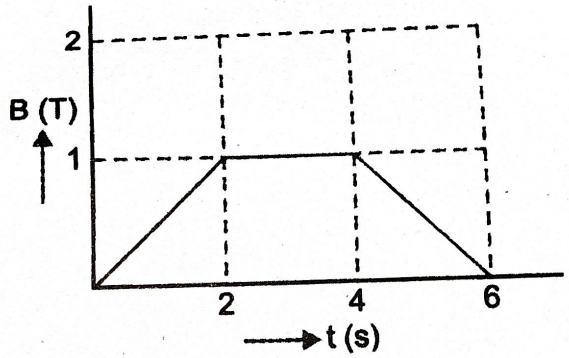
32	(i) Two long straight parallel current carrying conductors are kept 'a' distant apart in air. The direction of current in both the conductors is same. Find the magnitude of force per unit length and direction of the force between them. Hence define one ampere. (ii) A current of 200 microampere deflect the coil of a moving coil galvanometer through 60 degree. What should be the current to cause the rotation through π /10 Radian? Also find the current sensitivity of galvanometer?	5
	OR	
	(i)Derive the expression for the torque experienced by a rectangular loop carrying current I and placed in uniform magnetic field B. Indicate the direction of the torque acting on the loop. (ii) A beam of proton passes undeflected with a horizontal velocity v,through a region of electric and magnetic field, mutually perpendicular to each other and normal to the direction of beam.If the magnitudes of electric and magnetic field are 100KV/m and 50 m T respectively, calculate (i) the velocity v of the beam.(ii) force with which it strikes a target on a screen, if proton beam current is equal to 0.80 mA.	
33	(i) A short solenoid of length 4 cm , radius 2 cm and 100 turns is placed inside and on the axis of a long solenoid of length 80	5

cm and 1500 turns. What is the flux through the long solenoid if a current of 3 A flows through the short soleniod? Also obtain mutual induction of the two solenoid.

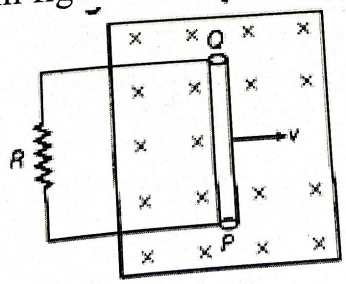
(ii) Derive an expression for the mutual inductance of two long solenoid of same length wounded one over the other.

OR

(i) The magnetic field through a circular loop of wire 12 cm in radius and 8.5 ohm resistance, changes with time as shown in Fig. The magnetic field is perpendicular to the plane of loop. Calculate the induced current in the loop and plot it as a function of time



(ii) A conducting rod PQ , of length l , connected to a resistor R, is moved at a uniform speed v normal to uniform magnetic field as shown in figure



(a) Derive an expression for the EMF induced in the conductor
(b) What is the force required to move the rod in the magnetic field?
(c) Mark the direction of the induced current in the rod.