Aarushi Jaiswal

FIRST TERM EXAMINATION (2024-25)
CLASS - XII
PHYSICS (042)

Time allowed: 3 hours. **Max. Marks: 70**

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General Instructions:

1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, B, C, D and E.
3. All the sections are compulsory.
4. **Section A** contains sixteen questions, twelve MCQ 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. There is no overall choice. However, an internal choice has been provided in one question of Section B, one question of Section C, one question of each CBQ in Section D and all three questions in Section E. You must attempt only one of the choices in such questions.
6. Use of calculators is not allowed

SECTION A (1X 16=16marks)

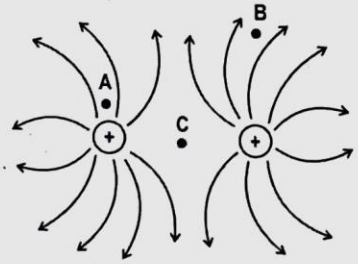
Q1. The electric potential V at any point (x,y,z), (in metre) in space is given by $V=(3x^2+3)$ volt. The magnitude of electric field at a point (2,0,1) will be

(a) 12 Vm^{-1}
(b) 15 Vm^{-1}
(c) 24 Vm^{-1}
(d) depends on the path connecting the initial and final positions.

Q2. The correct statement about electric dipole is

(a) The total charge of an electric dipole is non-zero.
(b) The electric field of an electric dipole at far-off distances (r) varies as $1/r^2$.
(c) The dipole moment vector of an electric dipole points from –q to +q.
(d) The electric dipole moment of CO2 molecule is non-zero in electric field free region.

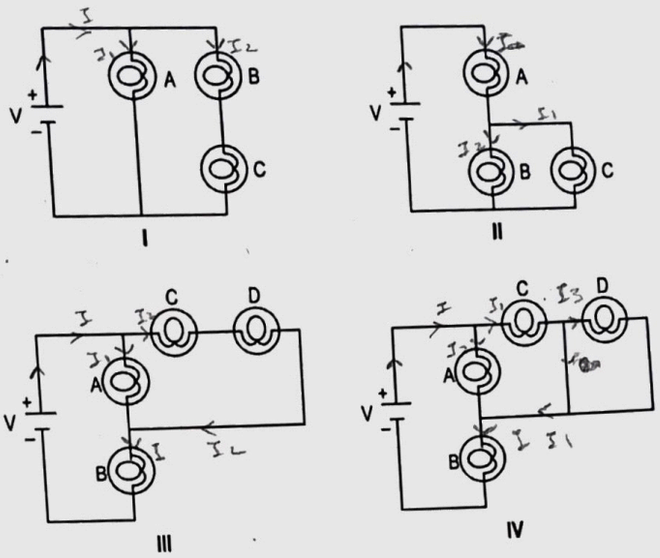
Q3. Electric field lines are pictorial representations of electric fields due to static charges on the plane of a paper



Study the given electric field representation and identify one INCORRECT statement.

A. The electric field at point A is stronger than at point B.
B. The electric field distribution is two-dimensional.
C. The electric field at point C is zero.
D. The electric field always points away from a positive charge.

Q4. Given below are four different electrical circuits with identical voltage sources. All the bulbs in each circuit are of the same voltage and power ratings.



Identify the brightest bulb in each circuit.

A. Bulb A in all circuits
B. Bulb B in all circuits
C. C. Bulb A in circuits I & II and bulb B in circuits III & IV
D. D. Bulb A in circuits I & II and bulb D in circuits III & IV

Q5 A parallel plate air capacitor has a capacitance C. When it is half filled with a dielectric of dielectric constant 5, the percentage increase in the capacitance will be

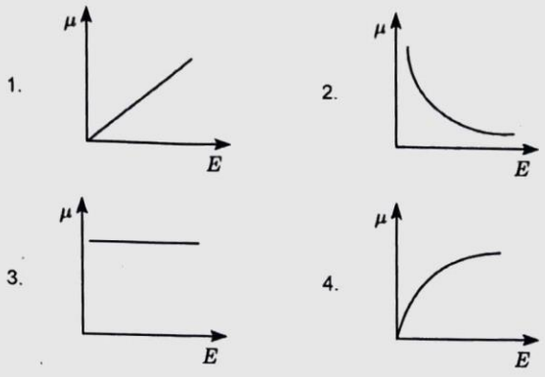
(a) 400%

(b) 66.6%

(c) 33.3%

(d) 200%

Q6. Which of the following graphs correctly shows variation of mobility of electrons with applie electric field in a metallic conductor?



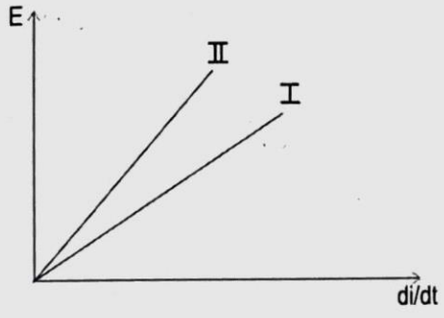
(a) 4
(b) 1
(c) 2
(d) 3

Q7. A wire of length L is bent to make a triangular coil. All the sides of the triangle are of the same length. If the triangular coil carries a current I, what is its magnetic dipole moment?

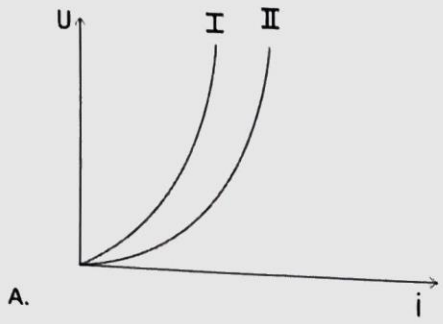
A. Zero
B. IL^2
C. $(\sqrt{3} \times IL^2)/4$
D. $(\sqrt{3} \times IL^2)/36$

Q8. Which of the following represents Waves in decreasing order of their wavelength are
(a) radio waves, ultraviolet rays, visible rays, X-rays
(b) radio waves, visible rays, infrared rays, X-rays
(c) radio waves, infrared rays, visible rays, X-rays
(d) X-rays, infrared rays, visible rays, radio waves

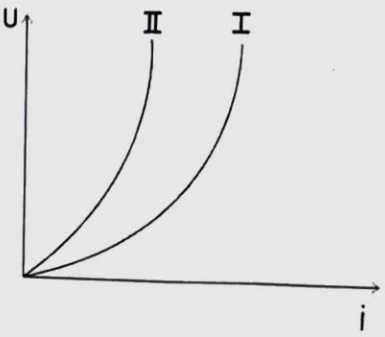
Q 9. The following graphs represent emf induced with the rate of change of current for two different inductors.



Which of the given options correctly represents the energy stored versus current through these inductors?



A.



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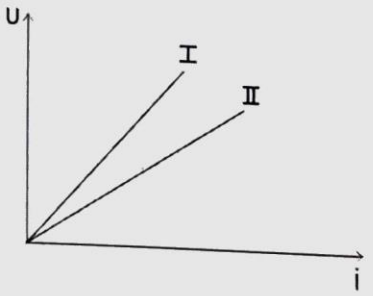

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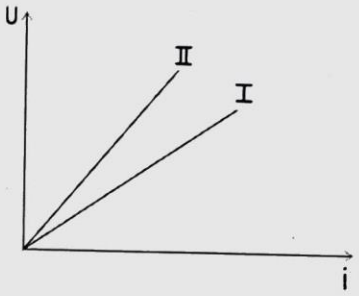


D.

Q10. With increase in frequency of an A.C. supply, the impedance of an L-C-R series circuit
(a) remains constant
(b) increases
(c) decreases
(d) decreases at first, becomes minimum and then increases.

Q11. If an alpha particle projected towards the north is deflected towards the East by a magnetic field. What will be the direction of a magnetic field?

a. Upward
b. Towards East
c. Towards South
d. Downwards

Q12. When a metal conductor connected to left gap of a meter bridge is heated, the balancing point
(a) shifts towards right
(b) shifts towards left
(c) remains unchanged
(d) remains at zero

For Q13 to Q16, two statements are given below. One is labelled Assertion (A) and the other is labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements A and R.

A. Both assertion and reason are true and reason is the correct explanation for assertion.
B. Both assertion and reason are true but reason is not the correct explanation of assertion.

C. Assertion is true but reason is false.
D. Assertion is false but reason is true.
E. Both Assertion and Reason are false.

Q13. **Assertion (A)**: The resistivity of conductors increases with an increase in temperature.
Reason (R): The drift speed of electrons decreases with an increase in temperature

Q14. **Assertion(A):** Paramagnetic substances are weakly attracted to magnets.

Reason(R): The individual atoms of a paramagnetic substance do not possess a permanent magnetic dipole moment.

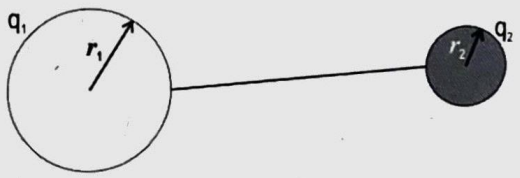
Q15. **Assertion (A):** The induced emf in a coil increases if the resistance of the coil is increased.
Reason (R): Higher the resistance, the less the current through a coil.

Q16. **Assertion (A):** For the same doping concentrations, n-type Si material has a higher conductivity than p-type Si material.

Reason (R): In a semiconductor the electrons are less tightly bounded than holes

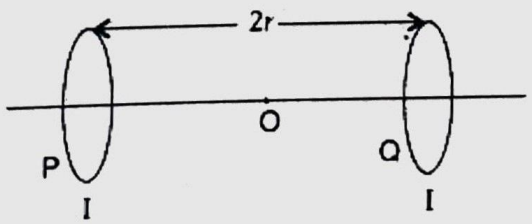
SECTION B (2X5=10 marks)

Q17. A conducting wire connects two charged conducting spheres such that they attain equilibrium with respect to each other. The distance of separation between the two spheres is very large as compared to either of their radii.



Find the ratio of the magnitudes of the electric fields at the surfaces of the two spheres.

Q18. Two identical circular loops, P and Q, each of radius r and carrying equal currents are kept in the parallel planes having a common axis passing through O. The direction of current in P is clockwise and in Q is anti-clockwise as seen from O which is equidistant from the loops P and Q. Find the magnitude of the net magnetic field at O.



Q19. An inductor of unknown value, a capacitor of 100 μF and a resistor of 10 Ω are connected in series to a 200 V. 50 Hz a.c. source. It is found that the power factor of the circuit is unity. Calculate the inductance of the inductor and the current amplitude

Q20. The oscillating electric field of an electromagnetic wave is given by :
$E = 30 \sin [2 \times 10^{11} t + 300 \pi x]$ Vm^{-1}
(a) Obtain the value of the wavelength of the electromagnetic wave.
(b) Write down the expression for the oscillating magnetic field.

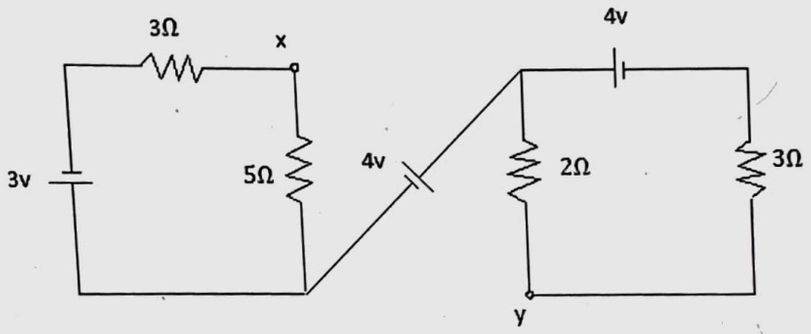
Q21. An electric dipole is placed in a uniform electric field E with its dipole moment p parallel to the field. Find
(i) the work done in turning the dipole till its dipole moments points in the direction opposite to E.
(ii) the orientation of the dipole for which the torque acting on it becomes maximum.

OR

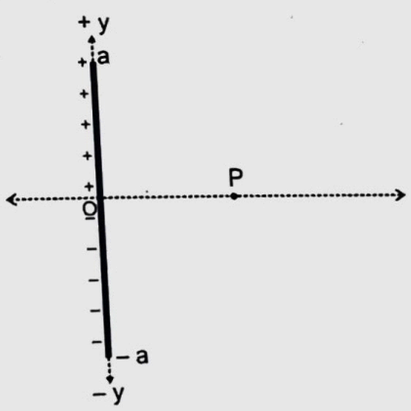
Deduce the expression for Electric field at an equatorial point of an electric dipole.

SECTION C(7X3=21 marks)

Q22. Kirchoff's loop rule is the result of conservation of energy in electrical circuits, Justify. Calculate potential difference between x and y.



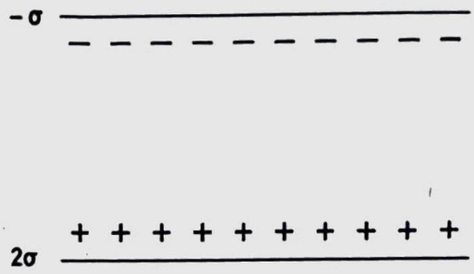
Q23. Given is a line of charge of uniform linear density. A charge +q is distributed uniformly between y = 0 and y = a and charge –q is distributed uniformly between y = 0 and y = -a.



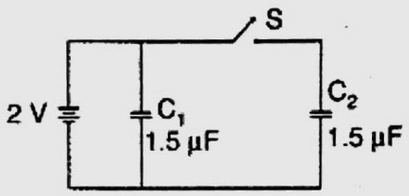
Explain how the direction of the resultant electric field at point P can be obtained. Represent using a vector diagram.

OR

Two charged sheets having charge density 2σ and -σ are placed parallel and close to each other in a vertical plane as shown in the figure. A particle having positive charge q and mass m is placed between these sheets and released from rest under gravity. What is the acceleration of this particle?



Q24. Figure shows two identical capacitors C^1 and C^2 each of 1.5 μF capacitance, connected to a battery of 2 V. Initially switch 'S' is closed. After sometime 'S' is left open and dielectric slabs of dielectric constant K = 2 are inserted to fill completely the space between the plates of the two capacitors. How will the
(i) charge and
(ii) potential difference between the plates of the capacitors be affected after the slabs are inserted?



Q25. (a) Define SI unit of current in terms of the force between two parallel current carrying conductors.
(b) Two long straight parallel conductors carrying steady currents I_a and I_b along the same directions are separated by a distance d. How does one explain the force of attraction between them? If a third conductor carrying a current I_c in the opposite direction is placed just in the middle of these conductors, find the resultant force acting on the third conductor.

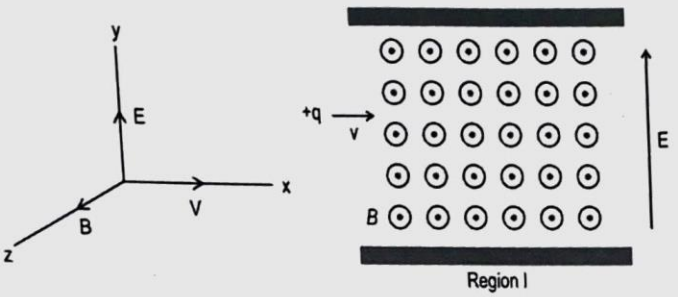
Q26. (a) Describe a simple experiment (or activity) to show that the polarity of emf induced in . a coil is always such that it tends to produce a current which opposes the change of magnetic flux that produces it.
(b) The current flowing through an inductor of self inductance L is continuously increasing. Plot a graph showing the variation of
(i) Magnetic flux versus the current
(ii) Induced emf versus dI/dt.

Q27. (a)State the principle of working of a galvanometer.
(b)A galvanometer of resistance G is converted into a voltmeter to measure upto V volts by connecting a resistance R_1 in series with the coil. If a resistance R_2 is connected in series with it, then it can measure upto V/2 volts. Find the resistance, in terms of R_1 and R_2, required to be connected to convert it into a voltmeter that can read upto 2V. Also find the resistance G of the galvanometer in terms of R_1 and R_2.

OR

Deduce the expression for the magnetic dipole moment of an electron orbiting around the central nucleus.

Q28. A charged particle '+q' moving with a velocity 'v' enters region I of crossed electric and magnetic field as shown below.



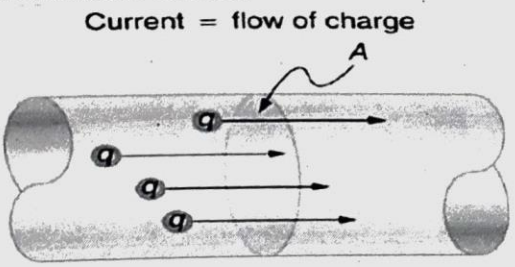
Represent the various paths diagrammatically that can be described by the particle in the region I. Also, specify the condition under which it describes each path. (Neglect the effect of gravity acting on the particle).

SECTION D(2 X4=8marks)

Case Study based questions:

For Q29 and Q30, read the following paragraph and answers the questions:

Q29. The rate of flow of charge through any cross-section of a wire is called electric current flowing through it. Electric current (I) =q/t . Its SI unit is ampere (A). The conventional direction of t electric current is the direction of motion of positive charge. The current is the same for all cross-sections of a conductor of the non-uniform cross-section. Resistance is a measure of the opposition to current flow in an electrical circuit.



(i)An example of non-ohmic resistance is:
A. tungsten wire
B. carbon resistance
C. diode
D. copper wire

(ii) Current is a :
A .scalar quantity
B. vector quantity.
C. both scalar and vector quantity

D. none of the above

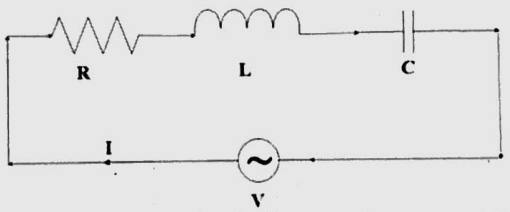
(iii) In a current-carrying conductor, the net charge is:
A 1.6×10^{-19} coulomb
B . 6.25×10^{-18} coulomb
C . zero
D . infinite

(iv) The current which is assumed to be flowing in a circuit from the positive terminal to negative is called:
A. direct current
B. pulsating current
C. conventional current
D. none of these.

OR

A current passes through a wire of non-uniform cross-section. Which of the following quantities are independent of the cross-section?
A. The charge crossing
B. drift velocity.
C. current density
D. free electron density.

Q30. A circuit containing a series combination of a resistance R, a coil of inductance Land a capacitor of capacitance C connected with a source of alternating emf of peak value of E_0 as shown in the figure



Let in series, LCR circuit applied alternating emf is $E = E_0 \sin \omega t$. As L, Cand R are joined in series, therefore current at any instant through the three elements has the same amplitude and phase. However voltage across each element bears a different phase relationship with the current.

(i)If an LCR series circuit is connected to an ac source then at resonance the voltage across.
(a) R is zero
(b) R equal to the applied voltage
(c) C is zero
(d) L equal to the applied voltage

(ii)At resonant frequency the amplitude of current in series LCR circuit is

(a) Maximum
(b) minimum
(c) zero
(d) infinity

(iii) Resonance frequency of LCR series a.c. circuit is f_o. Now the capacitance is made 4 times, then the new resonance frequency will become
(a) $f_o/4$ (b) $2f_o$ (c) f_o (d) $f_o/2$

(iv) In a series LCR circuit at resonance, impedance of the circuit is
(a) Maximum
(b) Minimum
(c) Zero
(d) Infinity

OR

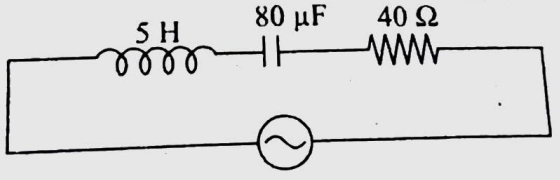
If frequency is less than resonating frequency in a series LCR circuit, then circuit will be
(a) More inductive
(b) More capacitive
(c) Pure resistive
(d) None of these

SECTION E(3X5=15 marks)

Q31. (i)With the help of a labelled diagram, describe briefly the underlying principle, construction and working of a step-down transformer.
(ii) Write any two energy losses in a transformer.
(i)A step-up transformer converts a low input voltage into a high output voltage. Does it violate the law of conservation of energy? Explain.

OR

(i) Derive an expression for the impedance of a series LCR circuit connected to an ac supply of variable frequency.
(ii) Plot a graph showing variation of current with the frequency of the applied voltage.
(iii) Figure shows a series LCR circuit connected to an ac supply of 230 V.



(a) Determine the source frequency which drives the circuit at resonance.
(b) Calculate the amplitude of current at resonance.
(c) Find the total potential drop across the circuit at resonance.

Q32.(i) Derive an expression for torque on a current carrying loop in a magnetic field. Name the device that works on this concept. For what orientation of the coil is this torque (a) maximum and (b) minimum? Hence define magnetic dipole moment of the coil.

(ii) Two wires of equal lengths are bent into the form of two loops. One of the loops is square shaped whereas the other loop is circular. These are suspended in a uniform magnetic field and the same current is passed through them. Which loop will experience greater torque? Justify your answer.

OR

(i)On a smooth plane inclined at 30^0 with the horizontal, a thin current carrying metallic rod is placed parallel to the horizontal ground. The plane is located in a uniform magnetic field of 0.15 T in the vertical direction. For what value of current can the rod remain stationary? The mass per unit length of rod is 0.03 kgm^{-1}.

(ii)A long wire carries a steady current I. It is at first bent into a circular loop and magnetic field at its centre is found to be B_0. Then the same wire is bent into a circular coil of n turns. Find the magnetic field at the centre point now.

Q33. (i) State Gauss's law.

A thin straight infinitely long conducting wire of linear charge density 'λ' is enclosed by a cylindrical surface of radius r and length 'l'—its axis coinciding with the length of the wire. Obtain the expression for the electric field, indicating its direction, at a point on the surface of the cylinder.

(ii) Two-point charges $q_A = 3\mu C$ and $q_B = -3\ \mu C$ are located 20 cm apart in vacuum. What is the electric field and its direction at the mid-point O of the line AB joining the two charges?

OR

(i) If dielectric strength of air is 3MV/m, can a metal sphere of radius 1 cm hold a charge of 1 Coulomb?

(ii) A parallel plate capacitor, with air between its plates having plate separation 3mm and plate area of 6 x 10-3 m2, is connected to a 100V supply. Calculate the charge on each plate of the capacitor.

(iii) Explain what would be the potential difference and charge across the plates of capacitor when a 3mm thick mica sheet (dielectric constant = 6) is inserted between its plate

(a) while the supply voltage remains connected

(b) after the supply is disconnected.