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CHINMAYA VIDYALAYAS,CHENNAI

C0MMON EXAMINATION

I TERNIMAL EXAMINATION -AUGUST (2025 -26)

PHYSICS (THEORY)

Class: XII

Maximum Marks: 70 Time:3 Hours

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 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 in Section B, one question in **Section C**, one question in each CBQ in **Section D** and all three questions in **Section E**. You have to attempt only one of the choices in such questions.
6) Use of calculators is not allowed.
7) You may use the following values of physical constants where ever necessary.

i. $c = 3 \times 10^8$ m/s
ii. $m_e = 9.1 \times 10^{-31}$ kg
iii. $e = 1.6 \times 10^{-19}$ C
iv. $\mu_0 = 4\pi \times 10^{-7}$ Tm
v. $h = 6.63 \times 10^{-34}$ J s
vi. $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2 N^{-1} m^{-2}$
vii. Avogadro's number = 6.023×10^{23} gram per gram mole

SECTION A

I. Multiple choice questions:(MCQ)

1.Three charges of equal magnitude q are placed at the vertices of an equilateral triangle of side r. The magnitude of the electric field at any one vertex is

(A) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{r^2}$ (B) $\frac{1}{4\pi\varepsilon_0}\frac{\sqrt{3}q}{r^2}$ (C) $\frac{1}{4\pi\varepsilon_0}\frac{3q}{r^2}$ (D) zero

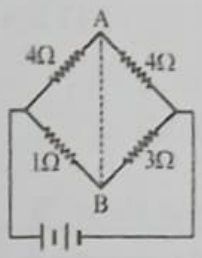
2. The electric field at a distance d from an electric dipole of dipole moment p along the axis is E. At a distance 2d from the dipole, the field is

A)E / 2 (B)E / 4 (C)E / 8 (D)E / 16

3. Capacitors A and B are identical. Capacitor A is charged so it stores 4 J of energy and capacitor B is uncharged. The capacitors are then connected in parallel. The total stored energy in the capacitors is now:

A) 16 J B) 8 J C) 4 J D) 2 J

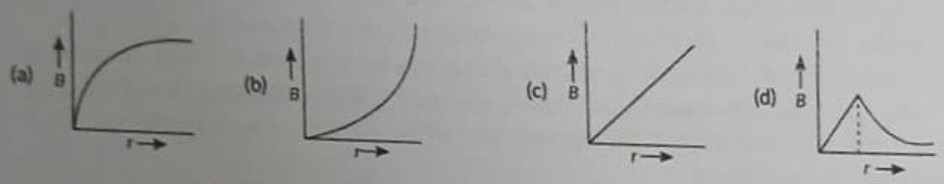
4.In the circuit shown, if a conducting wire is connected between points A and B, the current in this wire will



(A) flow in the direction which will be decided by the value of V
(B) be zero
(C) flow from B to A
(D) flow from A to B

5. A current of 2 mA was passed through an unknown resistor which dissipated a power of 4.4 W. Dissipated power when an ideal power supply of 11 V is connected across it is
(A) 11×10^{-4} W (B) 11×10^{-5} W (C) 11×10^{5} W (D) 11×10^{-3} W

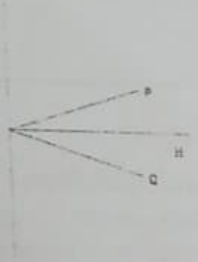
6. A thick current carrying cable of radius 'R' carries current 'I ' uniformly distributed across its cross- section. The variation of magnetic field B(r) due to the cable with the distance 'r' from the axis of the cable is represented by



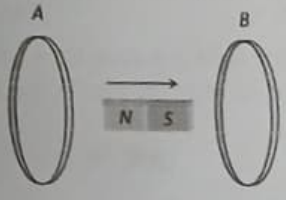
(A) a (B) b (C) c (D) d

7. The magnetic force acting on a charged particle of charge $-2\mu C$ in a magnetic field of 2T acting in y direction, when the particle velocity is $(2\hat{\imath} + \hat{\jmath}) \times 10^{6} ms^{-1}$, is
(A) 4 N in z direction
(B) 8 N in y direction
(C) 8 N in z direction
(D) 8 N in $-z$ direction

8. The graph below represents the variation of intensity of magnetisation (M) with magnetic field strength (H) for substances P and Q. Which of the two substances is most likely to be attracted when taken near a magnet?
(A) Only P
(B)Only Q
(C)Both P and Q
(D)Neither P nor Q



9. In the diagram shown if a bar magnet is moved along the common axis of two single turn coils A and B in the direction of arrow



(A) Current is induced only in A & not in B
(B) Induced currents in A & B are in the same direction
(C) Current is induced only in B and not in A
(D) Induced currents in A & B are in opposite directions

10. In an ideal transformer, the voltage and the current in the primary coil are 200 V and 2 A, respectively. If the voltage in the secondary coil is 2000 V, the value of current in the secondary coil will be

(A) 0.2 A (B) 2 A (C) 10 A (D) 20 A

11. Choose the INCORRECT options
(a) If the resonance is less sharp, not only is the maximum current less, the circuit is close to resonance for a larger range of frequencies and the tuning of the circuit will not be good.
(b) Less sharp the resonance less is the selectivity of the circuit or vice-versa
(c) If quality factor is large i.e. R is low or L is large the circuit is more selective
(d) None of the above
(A)a (B)b (C)c (D)d

12. Which of the following statement is NOT true about the properties of electromagnetic waves?
(a) These waves do not require any material medium for their propagation
(b) Both electric and magnetic field vectors attain the maxima and minima at the same time
(c) The energy in electromagnetic wave is divided equally between electric and magnetic fields
(d) Both electric and magnetic field vectors are parallel to each other.
(A) a (B)b (C)c (D)d

Questions number **13** to **16** are Assertion (A) and Reason(R) type questions. Two statements are given – one labelled Assertion (A) and the other labelled Reason (R).Select the correct answer from the codes (A),(B),(C) and (D) as 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 the assertion is true and the reason is false.
(D) If both assertion and reason are false.

13. **Assertion(A):** If a proton and an electron are placed in the uniform electric field, they experience different acceleration.
Reason(R): Electric force on an electric charge is independent of mass.
14.**Assertion(A):** The equatorial plane of a dipole is an equipotential surface.
Reason(R): The electric potential at any point on equatorial plane is zero.
15. **Assertion(A):** The induced e.m.f. will be same and current will be different in two identical loops of copper and aluminium, when rotated with same speed in the same magnetic field.
Reason(R) : Induced e.m.f. is proportional to rate of change of magnetic field while induced current depends on resistance of wire
16. **Assertion(A):** The average power dissipated through a pure inductor is zero.
Reason(R): The inductive reactance is directly proportional to the frequency of ac.

SECTION B

17. The variation of electric potential in a region is shown in the graph below. Find the magnitude and direction of the force on a particle having a charge of +2 μC just after it is released at a point x = 1 m in this region.

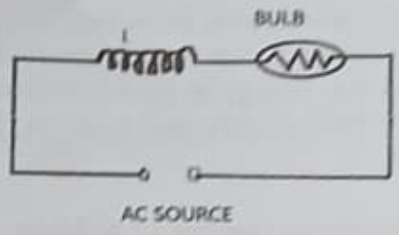
18. What is drift velocity of electrons? How do you explain the flow of current in a conductor based on this?

19.A galvanometer can be converted into a voltmeter to measure up to(i) V volt by connecting a resistance of 2kΩ in series with the galvanometer. (ii) 2 volt by connecting a resistance 5kΩ in series with the galvanometer. Calculate the resistance that should be connected in series with the galvanometer to convert it into a voltmeter to measure up to V/2 volt.

20.An alternating source of 220 V is connected to a circuit having a device "A", a current of 0.5 A flows, which lag behind the applied voltage in phase by $\pi/2$. If the same voltage is applied to another device "B", same current flows but now it is in phase with the applied voltage.
(i) Name the devices A and B
(ii) Draw the phasor diagram for device A

OR

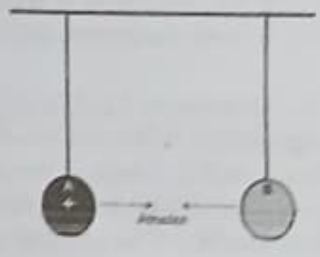
An inductor L of reactance XL is connected in series with a bulb B to an ac source as shown in figure. Explain briefly how does the brightness of the bulb change when (i) number of turns of the inductor is reduced (ii) an iron rod is inserted in the inductor.



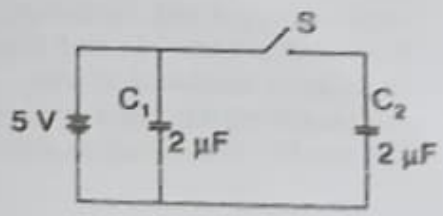
21.A parallel plate capacitor is being charged by a time varying current. Explain briefly how Ampere's circuital law is generalized to incorporate the effect due to displacement current. Give the expression also

SECTION C

22. A positively charged ball A hangs from a string. A non-conducting ball B is brought near ball A. Ball A is seen to be attracted to ball B. (a) Give reason why it is NOT possible to determine whether ball B is negatively charged or neutral for sure from the above experiment alone. (b) Suggest any ONE additional experiment with ball B required to determine whether ball B is negatively charged or neutral for sure.



23. Figure shows two identical capacitors C_1 and C_2, each of 2 μF capacitance, connected to a battery of 5 V. Initially switch 'S' is left open and dielectric slabs of dielectric constant K = 5 are inserted to fill completely the space between the plates of the two capacitors. (i) How will the charge and(ii) potential difference between the plates of the capacitors be affected after the slabs are inserted? Also find the values.



24.A battery of emf 12.0 V and internal resistance 0.5Ω is to be charged by a battery charger which supplies 110 V dc. How much resistance must be connected in series with the battery to limit the charging current to 5.0 A? What will be the potential difference across the terminals of the battery during charging?

25. Write the expression for Lorentz magnetic force on the particle of charge q moving with velocity v in a magnetic field B. Show that no work is done by this force on the charged particle.

26. Explain the following –
(a) Why are the field lines repelled when a diamagnetic material is placed in an external uniform magnetic field?
(b) Draw the magnetic field lines for a current carrying solenoid, when a rod made of – (i) Copper (ii) Aluminium are inserted within the solenoid.

27. What is mean by Self Induction. Derive an expression for self-inductance which shows that it is not depend upon emf and current induce in It.

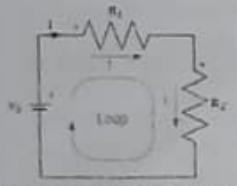
OR

The coil of an ac generator having N turns, each of area A, is rotated with a constant angular velocity ω. Deduce the expression for the alternating emf generated in the coil. What is the source of energy generation in this device?

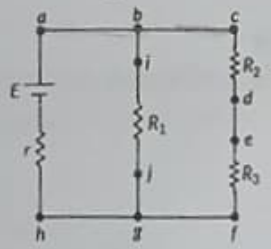
28. Electromagnetic waves with wavelength
(i) λ_1 is suitable for radar systems used in aircraft navigation.
(ii) λ_2 is used to kill germs in water purifiers.
(iii) λ_3 is used to improve visibility in runways during fog and mist conditions.
Identify and name the part of the electromagnetic spectrum to which these radiations belong. Also arrange these wavelengths in ascending order of their magnitude.

SECTION D

29. Electric circuits generally consist of a number of resistors and cells interconnected sometimes in a complicated way. The formulae we have derived earlier for series and parallel combinations of resistors are not always sufficient to determine all the currents and potential differences in the circuit. Two rules, called Kirchhoff's rules, are very useful for analysis of electric circuits. Given a circuit, we start by labelling currents in each resistor by a symbol, say I, and a directed arrow to indicate that a current I flows along the resistor in the direction indicated. If ultimately, I is determined to be positive, the actual current in the resistor is in the direction of the arrow. If I turn out to be negative, the current actually flows in a direction opposite to the arrow. Similarly, for each source (i.e., cell or some other source of electrical power) the positive and negative electrodes are labelled, as well as, a directed arrow with a symbol for the current flowing through the cell.



An experiment was set up with the circuit diagram shown in figure. Given that $R_1 = 10\ \Omega$, $R_2 = R_3 = 5\ \Omega$, $r = 0\ \Omega$ and E=5V.



(i) The points with the same potential are
(A) b, c, d (B) f, h, j (C) d, e, f (D) a, b, j

(ii) The current through branch bg is
(A) 1 A (B) 1/3 A (C) 1/2A (D) 2/3 A

(iii) The potential difference across R_3 is
(A) 2 V (B) 4.5 V (C) 3V (D)2.5W

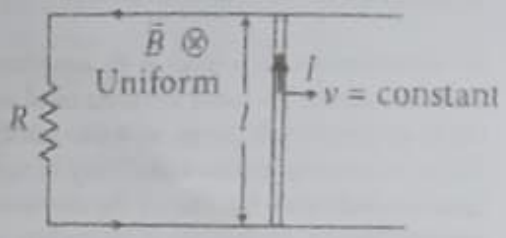
(iv) Kirchhoff's Voltage Law is the conservation of

(A) Energy (B) Charge (C) Current (D) Momentum

OR

Kirchhoff's First Law is conservation of
(A) Potential (B) Energy (C) Charge (D) Momentum

30.The emf induced across the ends of a conductor due to its motion in a magnetic field is called motional emf. It is produced due to the magnetic Lorentz force acting on the free electrons of the conductor. For a circuit shown in figure, if a conductor of length I moves with velocity v in a magnetic field B perpendicular to both its length and the direction of the magnetic field, then all the induced parametres are possible in the circuit.



i) Direction of current induced in a wire moving in a magnetic field is found using
A) Fleming left hand rule B) Fleming right hand rule
C) Amperes law D) Right hand thumb rule

ii) The magnitude of induce emf when the conductor of length l is moved with velocity v does not depends on- on
A) magnetic field B) velocity
C) resistance D) length of conductor l

iii) The current in the primary coil of pair of coils changes from 7 A to 3 A in 0.04s. The mutual inductance between the two coils is 0.5 H. the induced emf in the secondary coil is
A) 50 V B) 75 V C) 100 V D) 220 V

iv) A cylindrical bar magnet is kept along the axis of a circular coil. On rotating the magnet about its axis, the coil will have induced in it
(A) a current
(B) no current
(C) only an e.m.f.
(D) both an e.m.f. and a current

OR

Two identical coaxial coils P and Q carrying equal amount of current in the same direction are brought nearer. The current in
(A) P increases while in Q decreases
(B) Q increases while in P decreases
(C) both P and Q increases
(D) both P and Q decreases

SECTION E

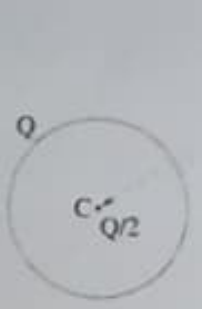
31.a)Use Gauss' law to obtain an expression for an electric field due to an infinitely long thin straight wire with uniform linear charge density λ.

a) An infinitely long positively charged straight wire has a linear charge density λ. An electron is revolving with a constant speed v such that the wire passes through the centre, and is perpendicular to the plane, of the circle. Find the kinetic energy of the electron in term of magnitudes of its charge and linear charge density λ *on the wire.* (b) Plot a graph of the kinetic energy as a function of charge density λ.c) ~~Draw a graph of kinetic energy as a function of linear charge density~~.

OR

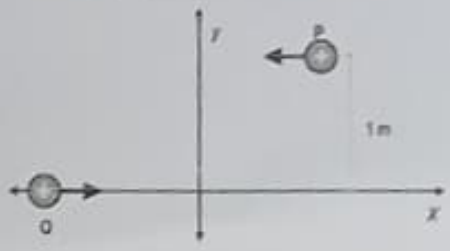
a) Define electric dipole. Is this a vector or scalar quantity? Derive an expression for the electric field intensity at a point on the equatorial line of electric diploe of dipole moment p and length 2a. What is the direction of this field?

b) A thin metallic spherical shell of radius R carries charge Q on its surface. A point charge Q/2 is placed at the centre C and another charge 2Q is placed outside the shell at A at a distance x from centre as shown in the figure. i) Find the electric flux through the shell. ii)Find the force on the charges at the centre C of the cell and at a point A.



32.a) Write, using Biot-Savart law, the expression for the magnetic field **B** due to an element **dl** carrying current I at a distance **r** from it in a vector form. Hence derive the expression for the magnetic field due to a current carrying loop of radius R at a point P distant x from its centre along the axis of the loop.

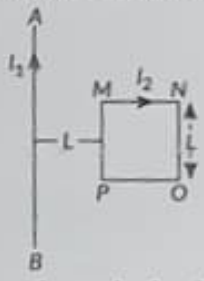
b) P and Q are two identical charged particles of mass 4×10^{-26} kg and charge 4.8×10^{-19} C, each moving with the same speed of 2.4×10^{5} m/s as shown in the figure. The two particles are equidistant from the vertical y-axis. At some instant, a magnetic field B is switched on so that the two particles undergo head-on collision. Find (a) the direction of the magnetic field and (b) the magnitude of the magnetic field applied in the region.



OR

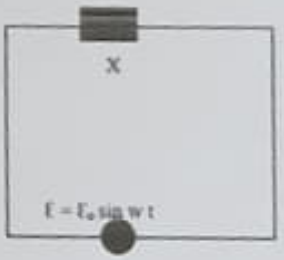
a) Two long straight parallel conductors carry steady current I_1 and I_2 separated by a distance d. If the currents are flowing in the same direction, show how the magnetic field set up in one produces an attractive force on the other. Obtain the expression for this force. Hence define one ampere.

b) A square shaped current carrying loop MNOP is placed near a straight long current carrying wire AB as shown in the figure. The wire and the loop lie in the same plane. If the loop experiences a net force F towards the wire, find the magnitude of the force on the side 'NO' of the loop.



33. If X, an unknown circuit element is connected to the X source as shown in the diagram, such that the current through X is given as $I = Io \sin(\omega t + \pi/2)$.

(i)Identify the device X?
(ii)Write expression for the reactance of X.
(iii) Draw phasor diagram for device X
(iv) Draw a graph showing variation of reactance of device X with frequency.
(v) What happen if the source is replaced by a dc source?



OR

(a) What is impedance?
(b) A series LCR circuit is connected to an ac source having voltage $V = V_0 \sin \omega t$. Derive expression for the impedance, instantaneous current and its phase relationship to the applied voltage. Find the expression for resonant frequency.