D.P.S R.K PURAM

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Roll no. -> 18

HALF YEARLY EXAMINATION 2016

PHYSICS (Set-1)

Time : 3 Hrs. MM : 70

Instructions:

(i) Questions 1 to 5 carry 1 mark each.
(ii) Questions 6 to 10 carry 2 marks each.
(iii) Questions 11 to 22 carry 3 marks each.
(iv) Question 23 is a value based question carry 4 marks.
(v) Questions 24 to 26 carry 5 marks each.
(vi) All questions are compulsory. However there is internal choice, one in 2 marks question, one in 3 marks question and three in 5 marks questions.

SECTION - A

1. When does an electric dipole placed in a non-uniform field experience a zero torque but non-zero force?
2. Two wires A and B made up of same metal, have the same area of cross-section and have their lengths in the ratio 2: 1. What will be the ratio of currents flowing through them respectively when the same potential difference is applied across the length of each of them?
3. A battery of emf 2 V and internal resistance 0.1 Ω is being charged by a current of 5A. What is the potential difference between the terminals of the battery?
4. In a certain arrangement, a proton does not get deflected while moving through a magneti field region. Under what condition is it possible?
5. Plot variation in reactance of LC circuit with the frequency of a.c.

SECTION - B

6. Find the relaxation time for free electrons in copper, if the density of free electrons is 8.4 x 10^{28} m^{-3}. Given that resistivity of copper at room temperature is 1.7 X 10^{-8} Ωm mass of electron is 9.1 x 10^{-31} kg and charge on electron = 1.6 x 10^{-19} C.
7. State the principle of a cyclotron. The frequency of revolution of a charged particle in a cyclotron does not depend on the speed of the particle. Why is this property necessary for the operation of a cyclotron ?
8. Two cells of emfs 1.5 V and 2.0 V having internal resistances 0.2 Ω and 0.3 Ω respectively are connected in parallel. Calculate the emf and internal resistance of the equivalent cell.
9. An infinite thin plane sheet of charge density 10^{-8} Cm^{-2} is held in air. How far apart are two equipotential surfaces, whose potential difference is 5V?
10. A short bar magnet of magnetic moment 0.9 J/T is placed inside uniform magnetic field with its axis at 30° to the magnetic field. It experiences a torque of 0.063 J. (i) Calculate

the magnitude of the magnetic field. (ii) In which orientation will the bar magnet be in stable equilibrium in the magnetic field?

OR

Show diagrammatically the behaviour of magnetic field lines in the presence of (i) paramagnetic and (ii) diamagnetic substances. How does one explain this distinguishing feature?

SECTION - C

11. The four arms of a Wheatstone bridge have the resistances as shown in the figure, calculate current through the galvanometer.

12. (i) State Faraday's laws of electromagnetic induction.
(ii) State Lenz's rule.

A A rod of length l is moved horizontally with a uniform velocity 'v' in a direction perpendicular to its length through a region in which a uniform magnetic field is acting vertically downward. Derive the expression for the emf induced across the ends of the rod.

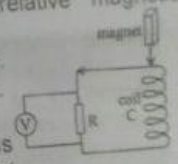
OR

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.

14. Two point charges $q_A = 3\mu C$ and $q_B = -3\ \mu C$ are located 20 cm apart in vacuum. i) Find the electric field at the midpoint O of the line AB joining the two charges. ii) If a negative test charge of magnitude 1.5×10^{-9} C is placed at the centre, find the force experienced and its direction by the test charge.

15. Define magnetic susceptibility. Deduce the relation between relative magnetic permeability and magnetic susceptibility.

16. A bar magnet *M* is dropped so that it falls vertically through the coil C.
(i) Draw the graph obtained for voltage induced across the coil vs. time.
(ii) Explain the shape of the graph.



17. A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5.0 ms^{-1}, at right angles to the horizontal component of the earth's magnetic field. 0.30×10^{-4} Wb m^{-2}.
(a) What is the instantaneous value of the emf induced in the wire? (b) What is the direction of the emf? (c) Which end of the wire is at the higher electrical potential?

18. You are given three circuit elements X, Y and Z. When the element X is connected across an a.c. source of a given voltage, the current and the voltage are in the same phase. When the element Y is connected in series with X across the source, voltage is ahead of the current in phase by $\pi/4$. But the current is ahead of the voltage in phase by $\pi/4$ when Z is connected in series with X across the source. Identify the circuit elements X, Y and Z.

When all the three elements are connected in series across the same source, obtain impedance of the circuit.
Draw a plot of the current versus the frequency of applied source and mention the significance of this plot.

19. A bulb is rated as 100 W, 50 V d.c. The bulb is required to be operated on 200V , 50 Hz a.c. Suggest a possible method and calculate the value of required component.
20. Write principle of a.c generator. Explain construction and working of it.
21. (i) Write relation between critical angle and refractive index of the medium.
(ii) A tank is filled with water to a height of 12.5 cm. The apparent depth of a needle lying at the bottom of the tank is measured by a microscope to be 9.4 cm. What is the refractive index of water? If water is replaced by a liquid of refractive index 1.63 up to the same height, by what distance and in which direction would the microscope have to be moved to focus on the needle again?
22. Derive mirror formula using concave mirror.

SECTION - D

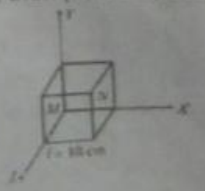
23. During the monsoons, especially in hilly areas there is a lot of thunder and lightning. During a trip to one of the hill stations, Archit was caught in one such thunder storm while driving on to the hill station. His parents at once told every occupant to leave the car and to take shelter under the tree. Archit advised them against doing so. He explained to his parents the risk involved in doing it and the advantage they have while sitting in doing so. Soon the thunder storm subsided and they continued their journey to the hill station.
i) What according to you are the values displayed by Archit ?
ii) Why did Archit advise his parents to stay inside the car?
iii) How many electrons should be removed from a coin of mass 1.6 g , so that it may just float in an electric field of intensity 10^9 NC^{-1} , directed upward? (1 +1+2)

SECTION - E

24. i) Derive an expression for the energy stored in a capacitor with air as the medium between its plates. How does the stored energy change if air is replaced by a medium of dielectric constant K?
ii) Two similarly equally charged identical metal spheres A and B repel each other with a force of 2×10^{-5} N. A third identical uncharged sphere C is touched to A, then placed at the mid-point between A and B. Calculate the net electrostatic force on C.

OR

i) Electric field in the given figure is directed along + X direction and given by $E_x = 5Ax + 2B$, where E is in NC^{-1} and x is in metre, A and B are constants with dimensions. Taking A = $10NC^{-1}$ m^{-1} and B = $5NC^{-1}$, calculate the electric flux through the cube.
ii) Use Gauss's law to obtain an expression for the electric field due to an infinitely long straight uniformly charged wire. (3+ 2)



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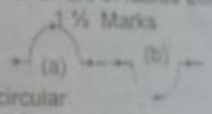
25. a) State Ampere's circuital law. Use it to derive the formula for the magnetic field due to an infinitely long straight current carrying wire. 2 ½ Marks

b) A straight wire carrying a current of 12 A is bent into a semicircular arc of radius 2cm as shown in figure (a). 1 ½ Marks



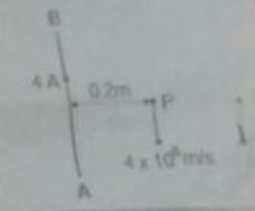
i) What is the direction and magnitude of B at the centre of the arc?

ii) Would there be any change if the wire were bent into a semicircular arc of same radius but in the opposite way as shown in figure (b) ?

A long straight wire in the horizontal plane carries a current of 50 A in the north to south direction. Give the magnitude and direction of B at-a point 2.5 m east of the wire 1 Mark

OR

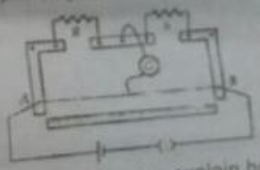
i) State the Biot-Savart. Use this law to obtain a formula for magnetic field at the centre of a circular loop of radius R carrying a steady current. Indicate the direction of the magnetic field. 1+2 Marks



ii) A long straight wire AB carries a current of 4 A. A proton P travels at 4×10^6 m/s, parallel to the wire, 0.2 m from it and in a direction opposite to the current as shown. Calculate the force and its direction experienced by the proton. Also specify the direction of the force. 2 Marks

26. State principle of potentiometer. With the help of a circuit diagram, explain how potentiometer be used to measure the internal resistance of a primary cell.

ii) In a metre bridge, the null point is found at a distance of 60 cm from A. If now a resistance of 5 Ω is connected in series with S, the null point occurs at 50cm. Determine the values of R and S.



OR

a) What is the principle of a metre bridge? With the help of a circuit diagram, explain how it can be used to find an unknown resistance.

b) A potentiometer wire of length 100 cm has a resistance of 10 Ω . It is connected in series with a resistance and a battery of emf 2 V and of negligible internal resistance as shown. A source of emf 10m V is balanced against a length of 40 cm of the potentiometer wire. What is the value of the external resistance?