Applied Academy

H-76 Sec 22

CH 3 CURRENT ELECTRICITY

Class 12 - Physics

1. The potential at a point, due to a positive charge of 100 μC at a distance of 9 m, is **[1]**

   a) 10^5 V
   b) 10^7 V
   c) 10^4 V
   d) 10^6 V

2. A spherical drop of capacitance 1 μF is broken into eight drops of equal radius. Then, the capacitance of each small drop is **[1]**

   a) $\frac{1}{4}\mu$F
   b) $\frac{1}{2}\mu$F
   c) 8 μF
   d) $\frac{1}{8}\mu$F

3. An electrolytic capacitor is marked 8 μF, 220 V. It can be used in a circuit where the p.d. across the capacitor may be **[1]**

   a) 200 V
   b) 300 V
   c) 1000 V
   d) 500 V

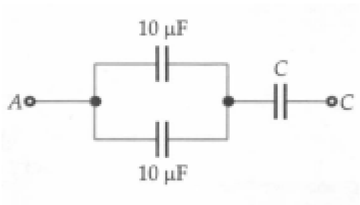
4. Two capacitors of capacitances 3 μF and 6 μF are charged to a potential of 12 V each. They are now connected to each other, with the positive plate of each joined to the negative plate of the other. The potential difference across each will be **[1]**

   a) 3 V
   b) 4 V
   c) 6 V
   d) zero

5. Four-point charges -Q, -q, 2q, and 2Q are placed, one at each corner of the square. The relation between Q and q for which the potential at the centre of the square is zero is: **[1]**

   a) $Q = -\frac{1}{q}$
   b) $Q = \frac{1}{q}$
   c) Q = -q
   d) Q = q

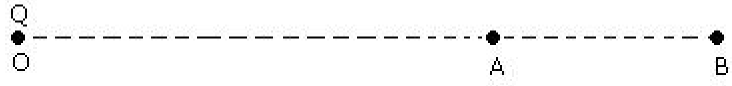
6. Assuming the earth to be a spherical conductor of radius 6400 km, calculate its capacitance. **[1]**
7. Why do ordinary capacitors have capacities of the order of microfarads? **[1]**
8. Calculate the capacitance of the capacitor in Fig. if the equivalent capacitance of the combination between A and B is 15 μF. **[1]**



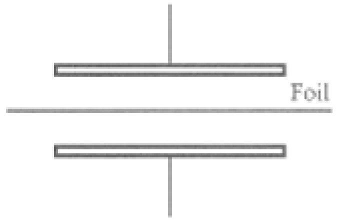
9. Three point charges 1 μC, -1 μC and 2 μC are kept at the vertices A, B and C respectively of an equilateral triangle of side 1 m. A_1, B_1 and C_1 are the midpoints of the sides AB, BC and CA respectively. Calculate the net **[1]**

amount of work done in displacing the charge from A to A_1, from B to B_1 and from C to C_1.

10. A point charge +Q is placed at point O as shown in the figure. Is the potential difference (V_A - V_B) positive, negative or zero? **[1]**



11. A sheet of aluminium foil of negligible thickness is placed between the plates of a capacitor, as shown in Fig. What effect has it on the capacitance if (i) the foil is electrically insulated, and (ii) the foil is connected to the upper plate with a conducting wire? **[2]**



12. A parallel-plate capacitor of capacity 0.5 μF is to be constructed using paper sheets of thickness 0.04 mm as dielectric. Find how many circular metal foils of diameter 0.1 m will have to be used. Take the dielectric constant of paper used as 4. **[2]**

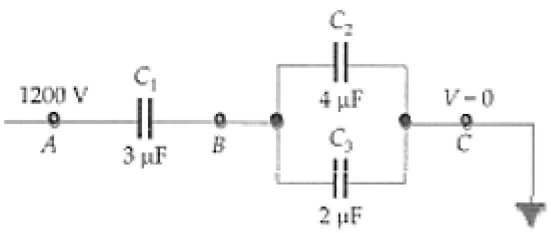
13. To what potential we must charge n insulated sphere of radius 14 cm so that the surface charge density is equal to 1μ Cm^{-2}? **[2]**

14. Two charges $5 \times 10^{-8} C$ and $-3 \times 10^{-8} C$ are located 16 cm apart. At what points on the line joining the two charges in the electric potential zero? Take the potential at infinity to be zero. **[3]**

15. A 10 μF capacitor is charged by a 30 V d.c. supply and then connected across an uncharged 50 μF capacitor. Calculate **[3]**
    1. the final potential difference across the combination,
    2. the initial and final energies. How will you account for the difference in energy?

16. **[5]**
    i. Obtain an expression for the potential energy of an electric dipole placed in a uniform electric field.
    ii. Three capacitors of capacitance C_1, C_2 and C_3 are connected in series to a source of V volt. Show that the total energy stored in the combination of capacitors is equal to sum of the energy stored in individual capacitors.
    iii. A capacitor of capacitance C is connected across a battery. After charging, the battery is disconnected and the separation between the plates is doubled. How will (i) the capacitance of the capacitor, and (ii) the electric field between the plates be affected? Justify your answer.

17. In the circuit shown in Fig. If the point C is earthed and point A is given a potential of +1200 V, find the charge on each capacitor and the potential at point B. **[5]**



18. A parallel plate capacitor is charged by a battery. After some time the battery is disconnected and a dielectric slab with its thickness equal to the plate separation is inserted between the plates. What change, in any will take place in **[5]**

i. charge on the plates
ii. electric field intensity between the plates
iii. the capacitance of the capacitor,
iv. a potential difference between the plates and
v. the energy stored in the capacitor? Justify your answer in each case.

19. A capacitor of capacitance C_1 is charged to a potential V_1 while another capacitor of capacitance C_2 is charged to a potential difference V_2. The capacitors are now disconnected from their respective charging batteries and connected in parallel to each other. **[5]**

i. Find the total energy stored in the two capacitors before they are connected.
ii. Find the total energy stored in the parallel combination of two capacitors.
iii. Explain the reason for the difference of energy in parallel combination in comparison to the total energy before they are connected

20. i. Define the capacitance of a capacitor. Obtain the expression for the capacitance of a parallel plate capacitor in vacuum in terms of plate area A and separation d between the plates. **[5]**
ii. A slab of material of dielectric constant k has the same area as the plates of a parallel plate $\frac{3d}{4}$ capacitor but has a thickness -. Find the ratio of the capacitance with dielectric inside it to its capacitance without the dielectric.

21. For a fixed potential difference applied across a conductor, the drift speed of free electrons does **not** depend upon **[1]**

a) length of the conductor
b) temperature of the conductor
c) mass of the electrons
d) free electron density in the conductor

22. Direction of the conventional current **[1]**

a) is the direction in which negative charges move
b) is the direction in which positive charges move
c) is the direction in which no charges move
d) is the direction in which charges move

23. Which one of the following bonds produces a solid that reflects light in the visible region and whose electrical conductivity decreases with temperature and has high melting point? **[1]**

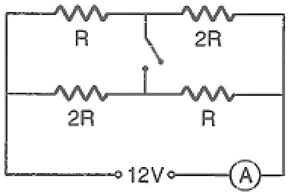
a) ionic bonding
b) covalent bonding
c) van der Waal's bonding
d) metallic bonding

24. Which of the following relation is called as current density? **[1]**

a) $\frac{I}{A}$
b) $\frac{I^3}{A^2}$
c) $\frac{I^2}{A}$
d) $\frac{A}{I}$

25. Two resistors R and 2R are connected in series. Two more resistors R and 2R are connected in series and the combination is connected in parallel to the first combination. A DC source of 12 volts and an ammeter are connected to this as shown in the figure. If there is a key between resistors of each combination as shown in the **[1]**

figure, what will be the ratio of ammeter reading before and after closing the key?



a) 1 : 2
b) 8 : 9
c) 2 : 1
d) 1 : 1

26. Current density of a conductor is **[1]**

a) Is always zero
b) the net charge flowing through the area
c) measure of the flow of electric charge in amperes per unit area of cross-section
d) the net charge flowing through the area per unit time

27. Thermo emf set up in thermocouple varies as $E = aT - \frac{1}{2}bT^2$, where a, b are constant and T is temperature in Kelvin. If a $= 16.3\mu V/^{\circ}C$ and $b = 0.042\mu V/(^{\circ}C)^2$, then inversion temperature is: **[1]**

a) 776°C
b) 388°C
c) 490°C
d) 279°C

28. A 5^{o}C rise in temperature is observed in a conductor by passing a current. If the current is doubled, the rise in temperature of the conductor will be nearly **[1]**

a) 25^{o}C
b) 40^{o}C
c) 10^{o} C
d) 20^{o}C

29. In producing chlorine by electrolysis 100 kW power at 125 V is being consumed. How much chlorine per minute is liberated? (E.C.E. of chlorine is 0.367 $\times$ 10^{-6} kg) **[1]**

a) 17.61 $\times$ 10^{-3} kg
b) 9.67 $\times$ 10^{-3} kg
c) 3.67 $\times$ 10^{-3} kg
d) 1.76 $\times$ 10^{-3} kg

30. Resistivity of a given conductor depends upon **[1]**

a) area of cross-section
b) length of conductor
c) temperature
d) shape of the conductor

31. Find the minimum number of cells required to produce an electric current of 1.5 A through a resistance of 30 Ω. Given that the emf of each cell is 1.5 V and internal resistance 10 Ω. **[1]**

32. The maximum power rating of a 20 Ω resistor is 2 kilowatt. Can it be connected to a 220 V d.c. supply? **[1]**

33. Two wires, one of copper and the other of manganin, have same resistance and equal thickness. Which wire is longer? Justify your answer. **[1]**

34. What is the amount of current flowing through the galvanometer of a balanced Wheatstone bridge? **[1]**

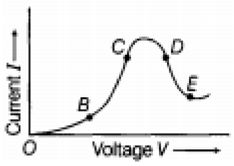
35. You are given a primary and a secondary cell of the same emf. From which cell will you be able to draw larger current and why? **[1]**

36. Why resistance becomes more in series combination? **[1]**

37. Graph showing the variation of current versus voltage for a material GaAs is shown in the figure. Identify the region **[1]**

i. of negative resistance.

ii. where Ohm's law is obeyed



38. Define the conductivity of a conductor. Write its SI unit. **[1]**

39. The emf of the driving cell used in the main circuit of the potentiometer should be more than the potential difference to be measured. Why? **[1]**

40. What is the difference between resistance and resistor? **[1]**

41. Find the time of relaxation between collision and free path of electrons in copper at room temperature. Given resistivity of copper = 1.7×10^{-8} Ωm, number density of electrons in copper = 8.5×10^{28}m^{-3}, charge on electron = 1.6×10^{-19} C, mass of electron = 9.1×10^{-31} kg and drift velocity of free electrons = 1.6×10^{-4} ms^{-1}. **[2]**

42. What is meant by drift velocity of free electrons? Derive Ohm's law on the basis of |the theory of electron drift. **[2]**

43. Two identical cells, whether joined together in series or in parallel give the same current, when connected to an external resistance of 1 Ω. Find the internal resistance of each cell. **[2]**

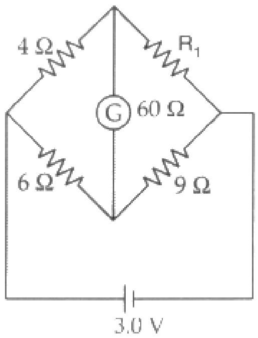
44. An electron beam has an aperture of 1.0 mm^2. A total of 6×10^{16} electrons flow through any perpendicular cross-section per second. Calculate **[2]**

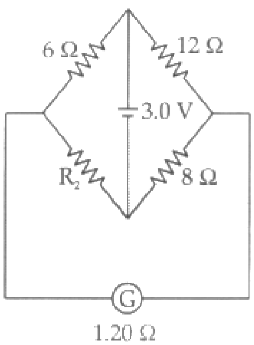
i. the current and

ii. the current density in the electron beam.

45. The resistivity of the material of a conductor of uniform cross-section varies along its length as $\rho = \rho_0$ (1 + αx). Deduce the expression for the resistance of the conductor, if its length is L and area of cross-section is A. **[2]**

46. The galvanometer, in each of the two given circuits, does not show any deflection. Find the ratio of the resistors R_1 and R_2 used in these two circuits. **[2]**





47. i. At what temperature would the resistance of a copper conductor be double its resistance at 0°C? **[2]**

ii. Does this temperature hold for all copper conductors regardless of shape and size?

Given α for Cu = 3.9×10^{-3} °C^{-1}

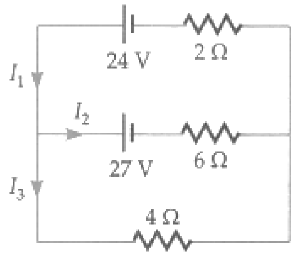
48. The size of a carbon block is 1.0 cm $\times$ 1.0 cm $\times$ 50 cm. Find its resistance **[2]**

i. between the opposite square faces

ii. between the opposite rectangular faces of the block. The resistivity of carbon is $3.5 \times 10^{-5}\Omega$ cm.

49. A coil of enamelled copper wire of resistance 50 Ω is embedded in a block of ice and a potential difference of 210 V applied across it. Calculate the rate at which ice melts. The latent heat of ice is 80 cal per gram. **[2]**

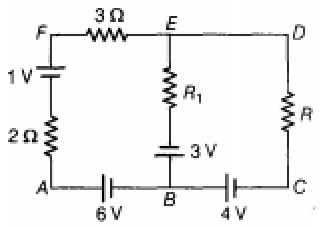
50. Using Kirchhoff's laws, determine the currents l_1, I_2 and I_3 for the network shown in Figure. **[2]**



51. A cell of emf ε and internal resistance r is connected across a variable resistance R. Plot graphs showing the variation of **[3]**
    i. ε and R,
    ii. terminal p.d. V with R. Predict from the second graph under which V becomes equal to ε.

52. i. Differentiate between the random velocity and the drift velocity of electrons in an electrical conductor. Give their order of magnitudes. **[3]**
    ii. A conductor of uniform cross-sectional area is connected across a dc source of variable voltage. Draw a graph showing variation of drift velocity of electrons (v_d) as a function of current density (J) in it.

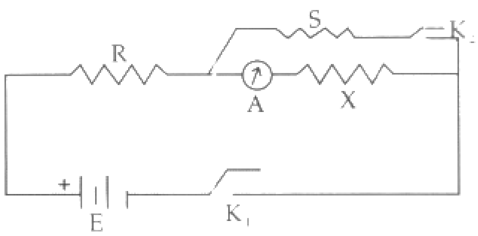
53. Use Kirchhoff's rules to determine the potential difference between the points A and D. When no current flows in the arm BE of the electric network shown in the figure below: **[3]**



54. A current of 30 amperes is flowing through a wire of cross-sectional area 2 mm^2. Calculate the drift velocity of electrons. Assuming the temperature of the wire to be 27°C, also calculate the rms velocity at this temperature. Which velocity is larger? Given that Boltzman's constant = $1.38 \times 10^{-23} JK^{-1}$, density of copper 8.9 g cm^{-3}, the atomic mass of copper = 63. **[3]**

55. A cell of emf E and internal resistance r is connected across a variable load resistor R. Draw the plots of the terminal voltage V versus (i) resistance R and (ii) current I. **[3]**
    It is found that when R = 4 Ω, the current is 1A and when R is increased to 9Ω, the current reduces to 0.5 A. Find the values of the emf E and internal resistance r.

56. The reading of the (ideal) ammeter, in the circuit shown here, is equal too. **[3]**



    i. I when key K_1 is closed but key K_2 is open.
    ii. $\frac{I}{2}$ when both keys K_1 and K_2 are closed.
    Find the expression of the resistance of X in terms of the resistances of R and S.

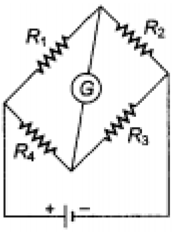
57. a. Obtain the expression for the current flowing through a conductor having number density of the electrons n, area of cross-section A in terms of the drift velocity v_d. **[3]**
    b. How does the resistivity of a semiconductor change with rise of temperature? Explain.

58. What is Wheatstone bridge? Deduce the condition for which Wheatstone bridge is balanced. **[3]**

59. i. You are required to select a carbon resistor of resistance $47\text{k}\Omega \pm 10\%$ from a large collection. What should be the sequence of colour bands used to code it? **[3]**

ii. Write the characteristics of manganin which make it suitable for making standard resistance.

60. For the circuit diagram of a Wheatstone bridge shown in the figure, use Kirchhoff's laws to obtain its balance condition. **[3]**

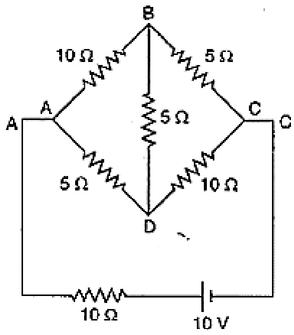


61. i. Define the term of drift velocity. **[5]**

ii. On the basis of electron drift, derive an expression for resistivity of a conductor in terms of number density of free electrons and relaxation time. On what factors does resistivity of a conductor depend?

iii. Why alloys like Constantan and Manganin are used for making standard resistors?

62. Determine the current in each branch of the network shown in figure. **[5]**



63. a. Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area 1.0×10^{-7} m^2 carrying a current of 1.5 A. Assume that each copper atom contributes roughly one conduction electron. The density of copper is 9.0×10^3 kg/m^3, and its atomic mass is 63.5 u. **[5]**

b. Compare the drift speed obtained above with,

i. thermal speeds of copper atoms at ordinary temperatures,

ii. speed of propagation of electric field along the conductor which causes the drift motion.

64. i. Derive an expression for drift velocity of electrons in a conductor. Hence, deduce Ohm's law. **[5]**

ii. A wire whose cross-sectional area is increasing linearly from its one end to the other, is connected across a battery of V volts. Which of the following quantities remain constant in the wire?

a. Drift speed

b. Current density

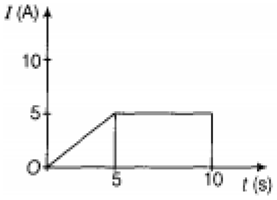
c. Electric current

d. Electric field

Justify your answer.

65. i. Deduce the relation between current I flowing through a conductor and drift velocity v_d of the electrons. **[5]**

ii. Figure shows a plot of current I flowing through the cross-section of a wire versus the time t. Use the plot to find the charge flowing in 10 through the wire.

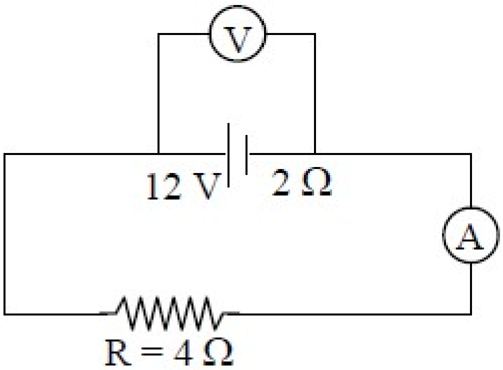


66. i. A cell emf of (E) and internal resistance (r) is connected across a variable load resistance (R). Draw plots showing the variation of terminal voltage V with (I) R and (II) the current (I) in the load. **[5]**

ii. Three cells, each of emf E but internal resistances 2r, 3r and 6r are connected in parallel across a resistor R. Obtain expressions for (i) current flowing in the circuit, and (ii) the terminal potential difference across the equivalent cell.

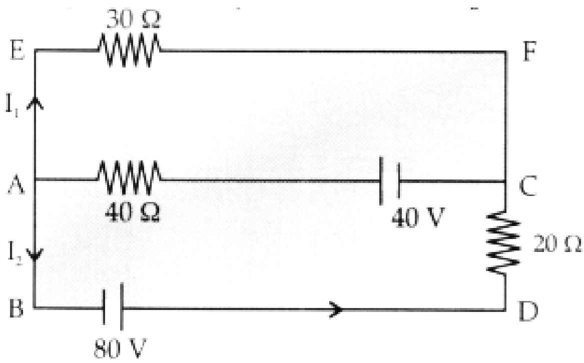
67. i. The potential difference applied across a given resistor is altered, so that the heat produced per second increases by a factor of 9. By what factor does the applied potential difference change? **[5]**

ii. In the figure shown, an ammeter A and a resistor of 4Ω are connected to the terminals of the source. The emf of the source is 12 V having an internal resistance of 2Ω. Calculate the voltmeter and ammeter readings.



68. i. Use Kirchhoff's rules, calculate the current in the arm AC of the given circuit. **[5]**

ii. On what principle does the metre bridgework? Why are the metal strips used in the bridge?



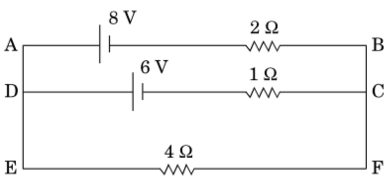
69. a. State the working principle of a meter bridge used to measure an unknown resistance. **[5]**

b. Give reason:

i. Why the connections between the resistors in a metre bridge are made of thick copper strips,

ii. Why is it generally preferred to obtain the balance length near the mid-point of the bridge wire.

c. Calculate the potential difference across the 4Ω resistor in the given electrical circuit using Kirchoff's rules.



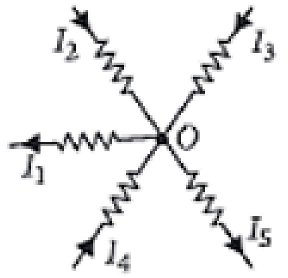
70. A cell of emf ε and internal resistance r is connected to two external resistances R_1 and R_2 ($R_2 > R_1$) and a perfect ammeter. The current in the circuit is measured in four different situations: **[5]**

i. Without any external resistance in the circuit
ii. With resistance R_1 only
iii. With resistance R_2 only
iv. With both R_1 and R_2 used in series combination, and
v. With R_1 and R_2, used in parallel combination.

The currents measured in the four cases are 0.42 A, 0.6 A, 1.05 A, 1.4 A, and 4.2 A but not necessarily in that order. Identify the currents corresponding to the four cases mentioned above.

71. **Read the text carefully and answer the questions:** **[5]**

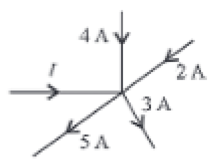
In 1942, a German physicist Kirchhoff extended Ohm's law to complicated circuits and gave two laws, which enable us to determine current in any part of such a circuit. According to Kirchhoff's first rule, the algebraic sum of the currents meeting at a junction in a closed electric circuit is zero. The current flowing in a conductor towards the junction is taken as positive and the current flowing away from the junction is taken as negative. According to Kirchhoff's second rule, in a closed loop, the algebraic sum of the emf's and algebraic sum of the products of current and resistance in the various arms of the loop is zero. While traversing loop, if negative pole of the cell is encountered first, then its emf is negative, otherwise positive.



(a) Kirchhoff's 1st law follows

a) law of conservation of momentum
b) law of conservation of energy
c) law of conservation of charge
d) Newton's third law of motion

(b) The value of current I in the given circuit is



a) 4.5 A
b) 2.5 A
c) 2.0 A
d) 3.7 A

(c) Kirchhoff's IInd law is based on

a) law of conservation of energy
b) law of conservation of charge
c) law of conservation of momentum of electron
d) law of conservation of charge and energy

(d) Point out the right statements about the validity of Kirchhoff's Junction rule.

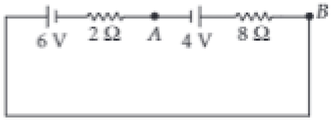
a) All of these
b) The current flowing towards the

junction are taken as positive.

c) The currents flowing away from the junction are taken as negative.

d) bending or reorienting the wire does not change the validity of Kirchhoff's Junction rule.

(e) Potential difference between A and B in the circuit shown here is



a) 6V

b) 2.8V

c) 4V

d) 5.6V