CLASS – 12

WORKSHEET- CURRENT ELECTRICITY

A. MICROSCOPIC VIEW OF ELECTRIC CURRENT

(1 Mark Questions)

1. How does the random motion of fee electron in a conductor get affected when a electrons in a conductor get affected when a potential difference is applied across its ends?

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2. The ratio of current density and electric field is called
(a) resistivity (b) conductivity (c) drift velocity (d)Mobility

3. A copper wire of non-uniform area of cross-section is connected to a d.c battery. The physical quantity which remains constant along the wire is_____.

4. How is the drift velocity in a conductor affected with the rise in temperature?

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_____

5. Define the term 'electrical conductivity' of a metallic wire. Write its S.I. unit.

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6. Define the term drift velocity of change carries in a conductor and write its S.I. unit.

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7. When electrons drift in a metal from lower to higher potential, does it mean that all the free electrons of the metal are moving in the same direction?

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8. Plot a graph showing variation of current versus voltage for the material GaGAs.

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9. How does one explain increase in resistivity of a metal with increase of temperature?

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10. Plot a graph showing the variation of resistance of a conducting wire as a function of its radius. Keeping the length of the wire and its temperature as constant.

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11. Ni, chrome and cooper wires of same length and same radius are connected in series. Current I is passed through them. Which wire gets heated up more? Justify your answer.

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12. Answer the following questions: (1 mark each)

(a) A steady current flows in a metallic conductor of non-uniform cross- section. Which of these quantities is constant along the conductor: current, current density, electric field, drift speed?

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(b) Is Ohm's law universally applicable for all conducting elements?
If not, give examples of elements which do not obey Ohm's law.

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(c) A low voltage supply from which one needs high currents must have very low internal resistance. Why?

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(d) A high tension (HT) supply of, say, 6 kV must have a very large internal resistance. Why?

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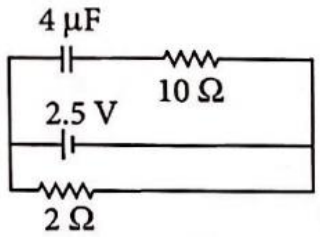
13. A capacitor of 4 μ F is connected as shown in the circuit. The internal resistance of the battery is 0.5Ω . The amount of charge on the capacitor plates will be



(a) 0 (b) 4 μ C (c) 16 μ C (d) 8 μ C

14. Is the motion of a charge across junction momentum conserving? Why or why not?

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15. Consider a current carrying wire (current I) in the shape of a circle. Note that as the current progresses along the wire, the direction of j (current density) changes in an exact manner, while the current I remain unaffected. The agent that is essentially responsible for is
(a) source of emf.
(b) electric field produced by charges accumulated on the surface of wire.
(c) the charges just behind a given segment of wire which push them just the right way by repulsion. (d) the charges ahead.

16. Which of the following characteristics of electrons determines the current in a conductor?
(a) Drift velocity alone. (b) Thermal velocity alone.
(c) Both drift velocity and thermal velocity. (d) Neither drift nor thermal velocity

(2 Marks Questions)

17. Define the term 'mobility' of charge carriers in a current carrying conductor. Obtain the relation for mobility in terms of relaxation time.

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18. Using the concept of drift velocity of charge carriers in a conductor, deduce the relationship between current density and resistivity of the conductor.

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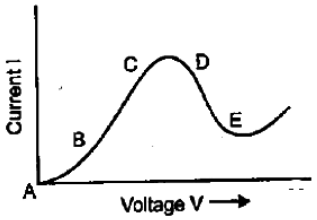
19. Estimate the average drift speed of conduction electrons in a copper wire of cross sectional area 1.0×10^{-7} m^2 carrying a current of 1.5A. Assume the density of conductor electrons to be 9×10^{28} m^{-3}.

20. A conductor of length 'l' is connected to a dc source of potential 'V'. if the length of the conductor is tripled by gradually stretching it keeping 'V' constant, how will (i) drift speed of electrons and (ii) resistance of the conductor be affected. Justify your answer.

21. Graph showing the variation of current versus voltage for a material GaAs is shown in the figure. Identify the region of



(i) Negative resistance (ii) Where ohm's law is obeyed.

(3 Marks Questions)

22. (a) Define the term 'conductivity' of a metallic wire. Write its SI unit.
(b) Using the concept of free electrons in a conductor, derive the expression for the conductivity of a wire in terms of number density and relaxtion time. Hence obtain the relation between current density and the applied electric field E.

23. (a)Find the relation between drift velocity and relation time of charge carriers in a conductor.
(b) A conductor of length L is connected to a d.c. source of e.m.f. V. If the length of the conductor is tripled by stretching it, keeping V constant. Explain how drift velocity would be affected.

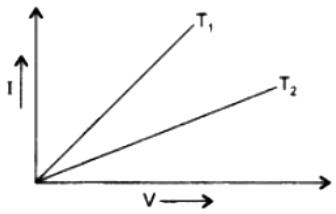
(5 Marks Questions)

24. Define the term 'drift velocity' of charge carriers in a conductor . Obtain the expression for the current density in term of relaxation time.

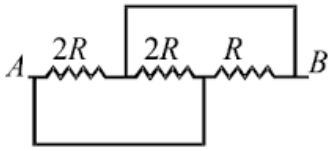
B. OHM'S LAW

(1 Mark Questions)

1. I-V graph for a metallic wire at two different temperatures, T_1 and T_2 is as shown in the figure. Which of the two Temperature is lower and why?

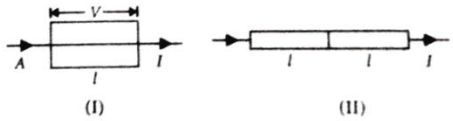


2. What is the equivalent resistance between points A and B of the circuit in Figure?



(2 Marks Questions)

3. A metal rod of square cross-sectional area A having length l has current I flowing through if when a potential difference of V volt is applied across its ends (figure 1). Now the rod is cut parallel to its length into two identical pieces and joined as shown in figure II. What potential difference must be maintained across the length of 2l so that the current in the rod is still?



4. At room temperature (27.0 °C) the resistance of a heating element is 100 Ω. What is the temperature of the element if the resistance is found to be 117 Ω, given that the temperature coefficient of the material of the resistor is $1.70\times10^{-4}{}^{\circ}C$ [Ans. 1027°C]

5. A negligibly small current is passed through a wire of length 15 m and uniform cross-section 6.0×10^{-7} m^2, and its resistance is measured to be 5.0 Ω. What is the resistivity of the material at the temperature of the experiment? [Ans. 2.0×10^{-7}Ωm]

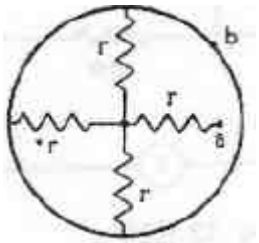
6. A silver wire has a resistance of 2.1 Ω at 27.5 °C, and a resistance of 2.7 Ω at 100 °C. Determine the temperature coefficient of resistivity of silver. [Ans. 0.00394°C^{-1}]

7. The earth's surface has a negative surface charge density of 10^{-9} C m^{-2}. The potential difference of 400 kV between the top of the atmosphere and the surface results (due to the low conductivity of the lower atmosphere) in a current of only 1800 A over the entire globe. If there were no mechanism of sustaining atmospheric electric field, how much time (roughly) would be required to neutralise the earth's surface? (This never happens in practice because there is a mechanism to replenish electric charges, namely the continual thunderstorms and lightning in different parts of the globe). (Radius of earth = 6.37×10^6 m.) [Ans. 283 s]

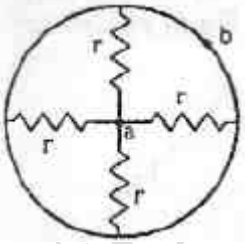
8. Two wires of equal length, one of aluminium and the other of copper have the same resistance. Which of the two wires is lighter? Hence explain why aluminium wires are preferred for overhead power cables. ($\rho_{Al} = 2.63 \times 10^{-8}$ Ω m, $\rho_{Cu} = 1.72 \times 10^{-8}$ Ω m, Relative density of Al = 2.7, of Cu = 8.9.) [Ans. 2.2]

9. A letter A consists of a uniform wire of resistance 1 ohm per cm. The sides of the letter are 20cm long and the cross piece in the middle is 10cm long while apex angle is 60° Find the resistance of the letter between the two ends of the legs.

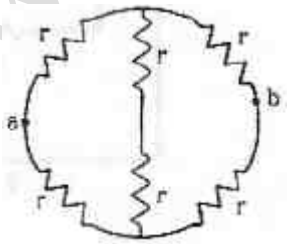
10. Find the equivalent resistance of the networks shown in the figure between the points A and B. [Ans. (a) 4/3r (b) r/4 (c) r]



(a)

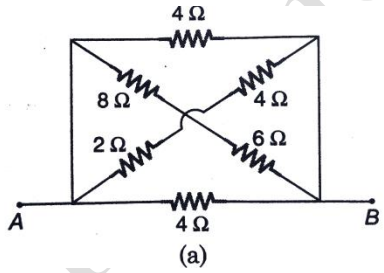


(b)

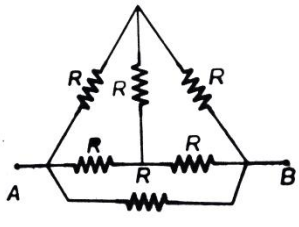


(c)

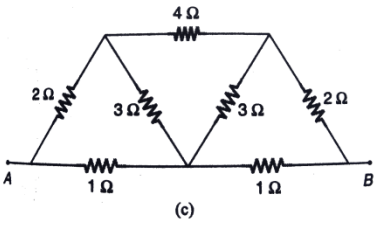
11. Calculate the equivalent resistance between points A and B in each case of the following networks of resistors:



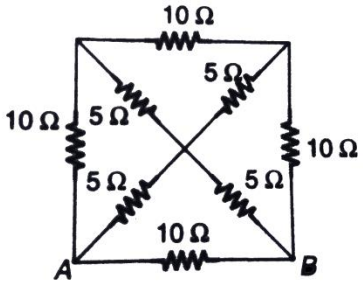
(a)



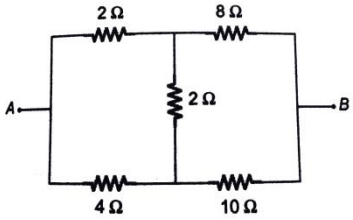
(b)



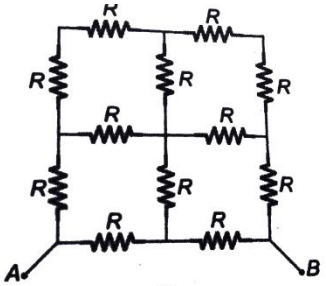
(c)



(d)



(e)



(f)

23. Name two factors on which the resistivity of a given material depends? A carbon resistor has a value of 62kΩ with a tolerance of 5%. Give the colour code for the resistor.

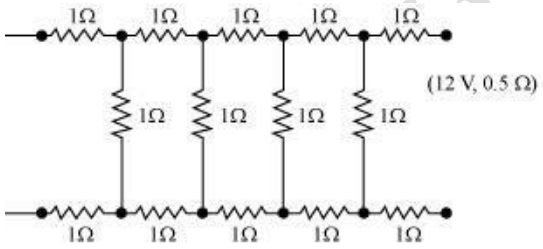
(3 Marks Questions)

13. What conclusion can you draw from the following observations on a resistor made of alloy manganin?

Current A	Voltage V	Current A	Voltage V
0.2	3.94	3.0	59.2
0.4	7.87	4.0	78.8
0.6	11.8	5.0	98.6

0.8	15.7	6.0	118.5
1.0	19.7	7.0	138.2
2.0	39.4	8.0	158.0

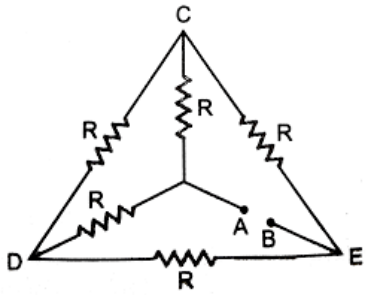
14. Determine the current drawn from a 12 V supply with internal resistance 0.5 Ω by the infinite network shown in Fig. Each resistor has 1 Ω resistance.



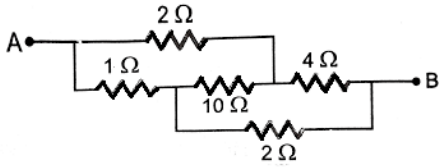
[Ans. 3.713 A]

15. Two metallic rods, each of length L, area of cross section A_1 and A_2 having resistivity p_1 and p_2 are connected in parallel across a d.c. battery. Obtain the expression for the effective resistivity of this combination.

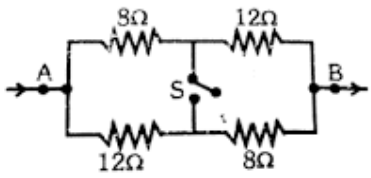
16. (i) Calculate the equivalent resistance of the given electrical network between points A and B.
(ii) Also calculate the current through CD and ACB, if a 10V dc source is connected between A and B and the value of R is assumed as 2Ω.



17. Calculate the equivalent resistance between points A and B of the network shown in figure.



18. Find the effective resistance of the network shown in Figure between points A and B when (i) the switch S is open (ii) switch S is closed.



(5 Marks Questions)

19. (i) Derive a expression for drift velocity of electron in a conductor. Hence deduce Ohm's law

(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?

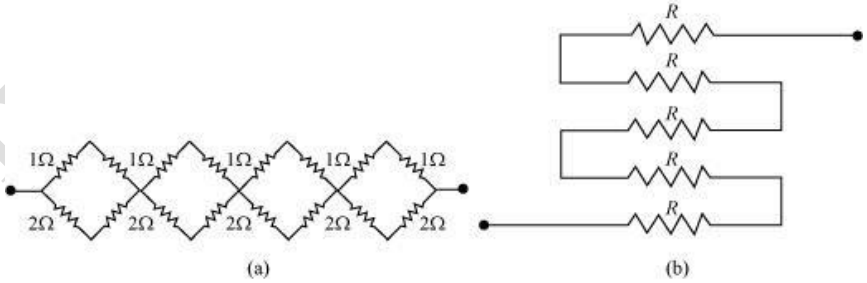
(a) drift speed (b) current density (c) electric current (d) electric field

Justify your answer.

20. **(a)** Given *n* resistors each of resistance *R*, how will you combine them to get the (i) maximum (ii) minimum effective resistance? What is the ratio of the maximum to minimum resistance?

(b) Given the resistances of 1 Ω, 2 Ω, 3 Ω, how will be combine them to get an equivalent resistance of (i) (11/3) Ω (ii) (11/5) Ω, (iii) 6 Ω, (iv) (6/11) Ω?

(c) Determine the equivalent resistance of networks shown in Fig. 3.31.



[Ans. (a) 1,(b) (i)11/ 3Ω, (ii)11/5 Ω, (iii) 6/11 Ω (c) (i) 16/3 Ω, (ii) 5R]

C. KIRCHHOFF'S LAW AND ELECTRIC CURRENT

(1 Mark Questions)

1. On what conservation principle is the Kirchhoff's first law based?

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_____

2. On what conservation principle is the Kirchhoff's second law based?

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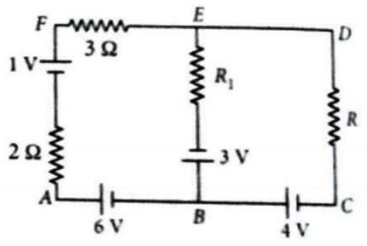
(2 Marks Questions)

3. Use Kirchhoff's rules to determine the potential between the points A and D when no current flows in the BE of the electric network shown in the figure.



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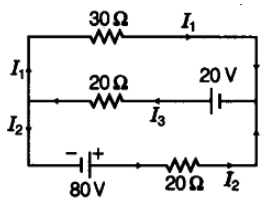
4. Use Kirchhoff's rules to determine the value of the current I_1 flowing in the circuit shown in the figure.



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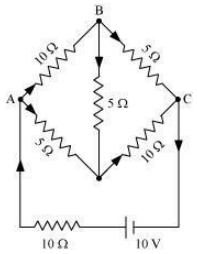
5. Determine the current in each branch of the network shown in figure: [Ans. 10/17 A]



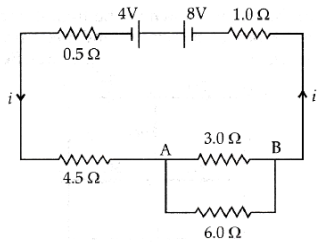
6. A point charge Q is kept at the intersection of (i) face diagonals (ii) diagonals of a cube of side a. What is the electric flux linked with the cube in (i) & (ii)?

(3 Marks Questions)

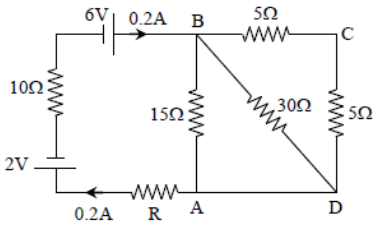
7. **(a)** Three resistors 1 Ω, 2 Ω, and 3 Ω are combined in series. What is the total resistance of the combination?
(b) If the combination is connected to a battery of emf 12 V and negligible internal resistance, obtain the potential drop across each resistor. [Ans. (a)6Ω, (b)2V, 4V, 6V]

8. (**a)** Three resistors 2 Ω, 4 Ω and 5 Ω are combined in parallel. What is the total resistance of the combination?
(b) If the combination is connected to a battery of emf 20 V and negligible internal resistance, determine the current through each resistor, and the total current drawn from the battery. [Ans. 20/19Ω, (b) 19A]

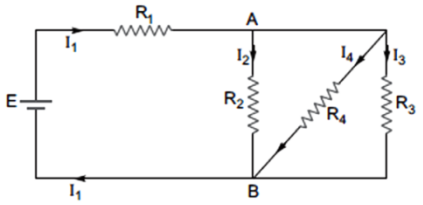
9. In the circuit shown in the figure, find the current through each resistor.



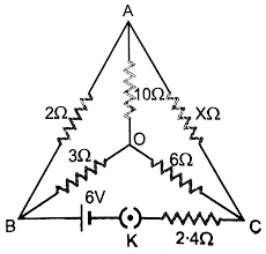
10. Calculate the value of the resistance R in the circuit shown in the figure so that the current un the circuit is 0.2 A. what would be the potential difference between points B and E.



11. In the circuit shown $R_1=4\Omega$, $R_2=R_3=15\ \Omega$, $R_4=30\ \Omega$ and E=10 V. Calculate the equivalent resistance of the circuit and the current is the current in each resistor.



12. Find the value of the unknown resistance X, in the following circuit, if no current flows through the section AO. Also calculate the current drawn by the circuit from the battery of emf 6V and negligible internal resistance.

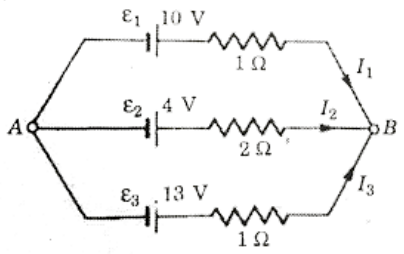


13. A battery of 10V and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 resistors each of resistors 1Ω. Determine the equivalent resistance of the network and the current along each edge of the cube.

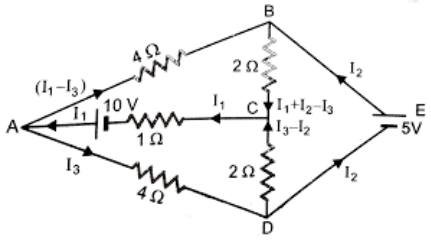
(5 Marks Questions)

14. (a)state Kirchhoff's rules for an elective network.
(b) Using Kirchhoff's rules, obtain the balance condition in terms of the resistance of four arms of Wheatstone bridge.

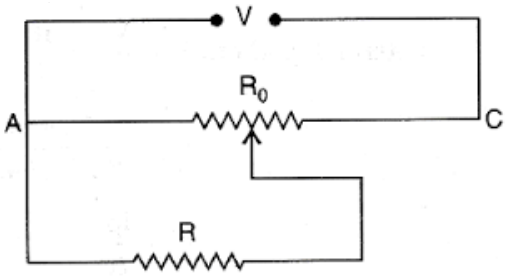
15. Find the current flowing through each cell in the circuit shown. Also calculate the potential difference across the terminals of each cell. [Ans. 0, -3A, 3A, 3V]



16. Determine the current in each branch of the network shown in figure.



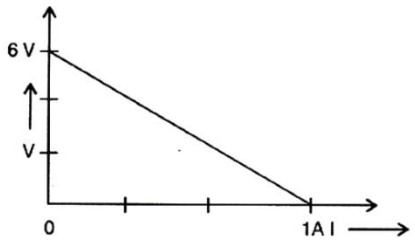
17. A resistance of RΩ draws current from a potentiometer. A potentiometer has a total resistance of R_0W (figure). A voltage V is supplied to the potentiometer. Derive an expression for the voltage fed into the circuit when the slide is in the middle of the potentiometer.



D. BATTERY

(1 Mark Questions)

1. The plot of the variation of potential difference across of tree identical cells in series versus current is shown in the figure. What is the emf internal resistance of each cell?



2. The emf of a cell is always greater that its terminal voltage. Why? Give reason?

3. Why is the terminal voltage of a cell less than its emf?

(2 Marks Questions)

4. (a) Distinguish between emf (ε) and terminal voltage (V) of a cell having internal resistor 'r' (b) Draw a plot showing the variation of terminal voltage (V) vs the current (I) drawn from the cell. Using this plot, how does one determine the internal resistance of the cell?

5. A cell of emf E and internal resistance r is connected to two external resistances R_1 and R_2 and a perfect ammeter. The current in the circuit is measured in four different situations:
(i) without any external resistance in the circuit.
(ii) withresistance R_1 only
(iii) with R_1 and R_2 in series combination
(iv) with R_1 and R_2 in parallel combination
The currents measured in the four cases are 0.42 A, 1.05A, 1.4 A and 4.2 A, but not necessarily in that order. Identify the current corresponding to the four cases mentioned above.

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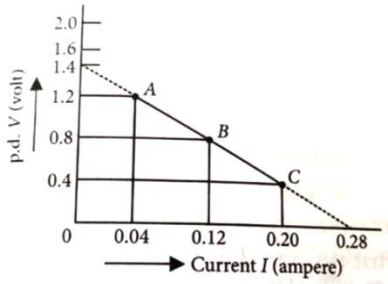
6. A straight line plot showing the terminal potential difference (V) of a cell as a function of current (I) drawn from it is shown in the figure. Using this plot, determine (i) the emf and (ii) internal resistance of the cell.



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7. The storage battery of a car has an emf of 12 V. If the internal resistance of the battery is 0.4Ω, what is the maximum current that can be drawn from the battery? [Ans. 30A]

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(3 Marks Questions)

8. A battery of emf 10 V and internal resistance 3 Ω is connected to a resistor. If the current in the circuit is 0.5 A, what is the resistance of the resistor? What is the terminal voltage of the battery when the circuit is closed? [Ans. 8.5V]

9 A storage battery of emf 8.0 V and internal resistance 0.5 Ω is being charged by a 120 V dc supply using a series resistor of 15.5 Ω. What is the terminal voltage of the battery during charging? What is the purpose of having a series resistor in the charging circuit? [Ans. 11.5V]

10. (a)Two cells of emf E_1 and E_2 have their internal resistance r_1 and r_2 respectively. Deduce an expression for the equivalent emf and internal resistance of their parallel combination when connected across and external resistance of their R, assume that the two cells are supporting each other.
(b) In case the two cells are identical , each of emf E= 5V and internal resistance r=2 Ω , calculate voltage across the external resistance R=10 Ω .

(5 Marks Questions)

11. **(a)** Six lead-acid type of secondary cells each of emf 2.0 V and internal resistance 0.015 Ω are joined in series to provide a supply to a resistance of 8.5 Ω. What are the current drawn from the supply and its terminal voltage?

(b) A secondary cell after long use has an emf of 1.9 V and a large internal resistance of 380 Ω. What maximum current can be drawn from the cell? Could the cell drive the starting motor of a car? [Ans. 1.4A, 0.05]

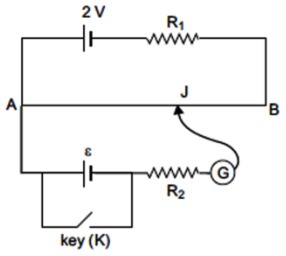
E. METRE BRIDGE AND POTENTIOMETER

(1 Mark Question)

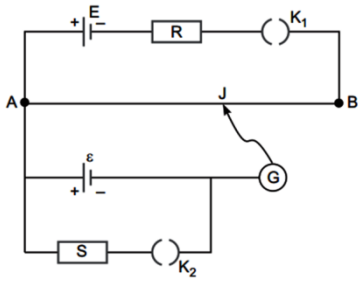
1. Define potential gradient. Give its SI unit.

(2 Marks Questions)

2. (i) state the principle of working of a potentiometer.
(ii) In the following potentiometer circuit A.B is a uniform wire of length 1 m and resistance 10 Ω. Calculate the potential gradient along the wire and balance length AO (= *l*)



3. Two student 'X' and 'Y' preform an experiment on potentiometer separately using the circuit given; keeping other parameters unchanged, how will the position of the null point be affected if.



(i)'X' increase the value of resistance R in the set-up by keeping the key K_1 closed and the key K_2 open ?
(ii)'Y' decrease the value of resistance S in the set-ip, white the key K_2 remains open and the key K_1closed?

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4. Why should we get the null point in the middle of the metre bridge wire?

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5. An electric dipole of dipole moment p, is held perpendicular to an electric field. If the dipole is released does it have (a) only rotational motion 24 Physics Class - XII) (b) only translatory motion (c) both translatory and rotatory motion explain?

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6. The net charge of a system is zero. Will the electric field intensity due to this system also be zero.

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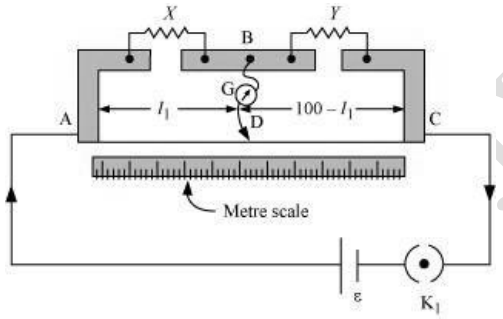
(3 Marks Questions)

7. **(a)** In a metre bridge [Fig. below], the balance point is found to be at 39.5 cm from the end *A*, when the resistor *Y* is of 12.5 Ω. Determine the resistance of *X*. Why are the connections between resistors in a Wheatstone or meter bridge made of thick copper strips?
(b) Determine the balance point of the bridge above if *X* and *Y* are interchanged.
(c) What happens if the galvanometer and cell are interchanged at the balance point of the bridge? Would the galvanometer show any current?

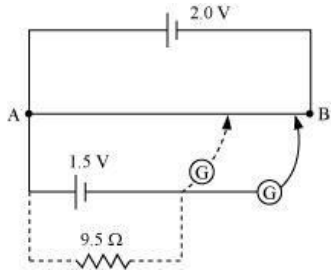


[Ans. 8.16 Ω, 60.5 Ω]

8. In a potentiometer arrangement, a cell of emf 1.25 V gives a balance point at 35.0 cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 63.0 cm, what is the emf of the second cell? [Ans. 2.25V]

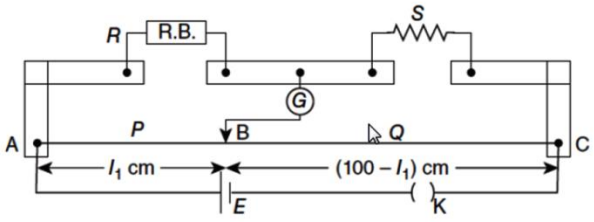
9. Figure shows a 2.0 V potentiometer used for the determination of internal resistance of a 1.5 V cell. The balance point of the cell in open circuit is 76.3 cm. When a resistor of 9.5

Ω is used in the external circuit of the cell, the balance point shifts to 64.8 cm length of the potentiometer wire. Determine the internal resistance of the cell. [Ans. 1.7 Ω]

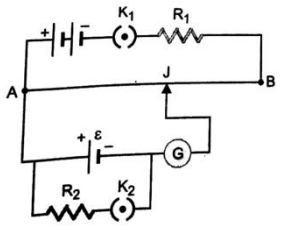


10. Draw the circuit diagram of a meter bridge to explain how it is based on Wheatstone bridge.

11. What is end error in a meter bridge? How is it overcome? The resistance in the two arms of the meter bridge are R=5 Ω and S respectively.



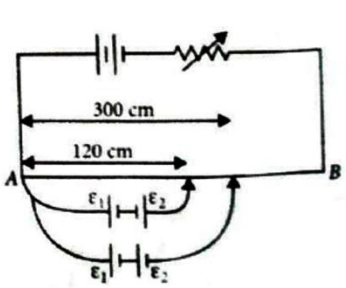
12. (a) For the circuit shown in the figure, how would the balancing length be affected, if.



(i)R_1 is decreased, (ii)R_2 is increase
The order factors remaining the same in the circuit? Justify your answer in each case.
(b) why is a potentiometer preferred over a voltmeter? Give reason?

13. (a)state the underlying principle of a photometer why is it necessary to (i)use a long wire.(ii)have uniform area of cross-section of the wire and (iii)use a driving cell of emf is taken be greater than the emf of the length of the wire increases uniformly from one end to the other, draw a graph showing how potential gradient would vary as the length of the wire increase from one end.

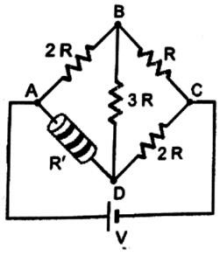
14. In the figure a long uniform potentiometer wire AB is having a constant potential for the two primary cells of elf ε_1 and ε_2 connected in the manner shown are obtained at a distance of 120 cm and 300cm from the end A. find (i) $\varepsilon_1/\ \varepsilon_0$ and (ii)position of null point for the cell ε_1. .How is the sensitively of a potentiometer increased?



15. What are the advantages of the null-point method in a Wheatstone bridge? What additional measurements would be required to calculate $R_{unknown}$ by any other method?

(5 Marks Questions)

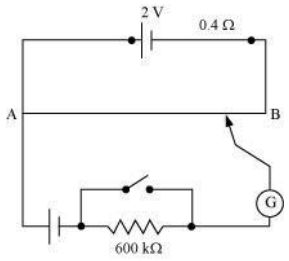
16. Use Kirchhoff's rules to obtain the balance condition in a Wheatstone bridge. Calculate the value of R in the balance condition of the Wheatstone bridge. If the carbon resistor connected across the arm CD has the color sequence red, red and orange, as is shown in the figure.



If now the resistance of the arms BC and CD are interchanged, to obtain the balance condition, another carbon resistor is connected in place of R. what would now be the sequence of color bands of the carbon resistor.

17. (a) State the working principle of a potentiometer. Draw a circuit diagram to compare emf of two primary cells. Drive the formula used.
(b) Which material is used for potentiomer wire and why?
(c) How can the sensitivity of a potentiometer be increased ?

18. Figure shows a potentiometer with a cell of 2.0 V and internal resistance 0.40 Ω maintaining a potential drop across the resistor wire AB. A standard cell which maintains a constant emf of 1.02 V (for very moderate currents up to a few mA) gives a balance point at 67.3 cm length of the wire. To ensure very low currents drawn from the standard cell, a very high resistance of 600 kΩ is put in series with it, which is shorted close to the balance point. The standard cell is then replaced by a cell of unknown emf ε and the balance point found similarly, turns out to be at 82.3 cm length of the wire.



(a) What is the value ε ?
(b) What purpose does the high resistance of 600 kΩ have?
(c) Is the balance point affected by this high resistance?
(d) Is the balance point affected by the internal resistance of the driver cell?
(e) Would the method work in the above situation if the driver cell of the potentiometer had an emf of 1.0 V instead of 2.0 V?
(f) Would the circuit work well for determining an extremely small emf, say of the order of a few mV (such as the typical emf of a thermo-couple)? If not, how will you modify the circuit?

F. HEATING EFFECT OF CURRENT

(1 Mark Questions)

1. An electric current of 4.0A flows through a 12Ω resistor. What is the rate at which the heat energy is produced in the resistor? [Ans. 192W]

2. A beating element is marked 210V, 630W. What is the current drawn by the element when connected to a 210V dc mains? What is eh resistance of the element? [Ans. 70Ω]

(2 Marks Questions)

3. 100W, 220V bulb is connected to 110V source. Calculate the power consumed by the bulb. [Ans. 25W]

4. A 100W and a 200 W domestic bulbs joined in series are connected to the mains. Which bulb will glow more brightly? Justify.

(3 Marks Questions)

5. Two bulbs are marked 220V, 100W and 200V, 50W respectively. They are connected in series to 220V mains. Find the ratio of heats generated in them. [Ans. 1:2]

6. Two bulbs rated 25W, 220V and 100W, 220V respectively connected in series to a 440V supply. (i) Show with necessary calculations which bulb will fuse (ii) What will happen if the two bulbs are connected in parallel to the same supply?
[Ans. (i) 25W bulb will fuse (ii) Both the bulbs will fuse]

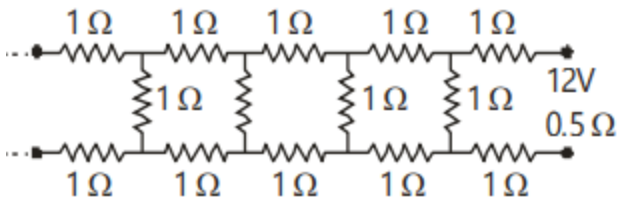
(5 Marks Questions)

7. Two heating elements of resistances R_1 and R_2 when operated at a constant supply of voltage V, consume powers P_1 and P_2 respectively. Deduce the expressions for the power of their combination when they are in turn, connected in (i) series and (ii) parallel across the same voltage supply.

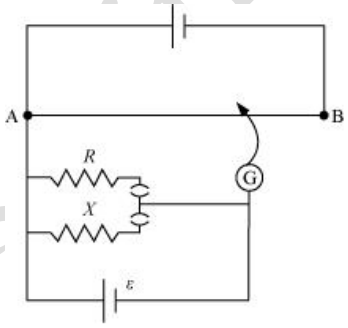
G. CHALLENGING PROBLEMS

1. Answer the following questions:
(a) A steady current flows in a metallic conductor of non-uniform cross- section. Which of these quantities is constant along the conductor: current, current density, electric field, drift speed?
(b) Is Ohm's law universally applicable for all conducting elements?
If not, give examples of elements which do not obey Ohm's law.
(c) A low voltage supply from which one needs high currents must have very low internal resistance. Why?
(d) A high tension (HT) supply of, say, 6 kV must have a very large internal resistance. Why?

2. Determine the current drawn from a 12V supply with internal resistance 0.5Ω by the following infinite network. Each resistor has 1Ω resistance.



3. Figure shows a potentiometer circuit for a comparison of two resistances. The balance point with a standard resistor R = 100Ω is found to be 58.3cm, while that with the unknown resistance X is 68.5cm. Determine the value of X. What might you do if you failed a balance point with the given cell E?



SPACE FOR ROUGH WORK

SPACE FOR NOTES