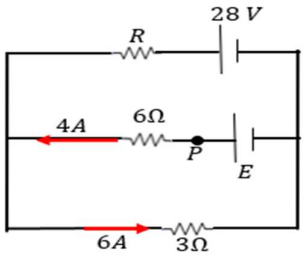
Electrical Circuits

1. a. State two Kirchhoff's laws. On which principle these laws are based on? [2]
   b. In the given circuit, find:



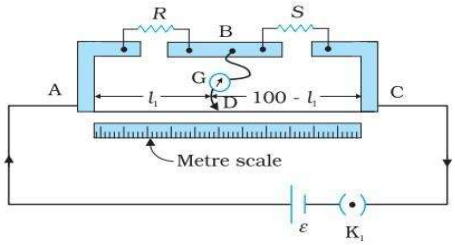
   i. The current in resistor R.
   ii. Resistance R
   iii. The unknown emf, E
   iv. If the circuit is broken at point P,what is the current in resistor R?

   $[\boldsymbol{Ans: 2A;\ 5\Omega;\ 42\ V;\ 3.5\ A}]$ [3]

2. Wheatstone bridge is a good engineering of circuit designing. It has several uses and sometimes it shows problems in measuring resistance.
   a. Write the balance condition Wheatstone bridge along with circuit diagram. [2]
   b. Describe a method for determining the unknown resistance. [3]
   c. Under what condition, Wheatstone bridge work perfectly (most sensitive)? [1]
   d. In a meter bridge when the resistance in the left gap is 3Ω and an unknown resistance in the right gap, the balance point is obtained at 40 cm from the zero end. Find the value of unknown resistance.
   On shunting the unknown resistance with 2Ω, find the shift of the balance point on the bridge wire. [2]

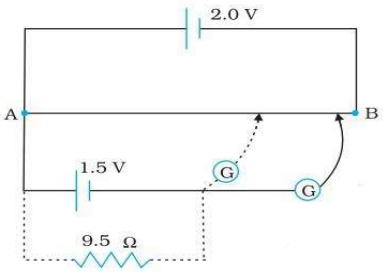
3. Meter Bridge is usually used to determine the resistance of a wire segment and the comparison of two resistors.
   a. On what principle does it work? [1]
   b. In a meter bridge when the resistance in the left gap is 3 ohm and an unknown resistance in the right gap, the balance point is obtained at 40 cm from the zero end. Find the value of unknown resistance. On shunting the unknown resistance with 2 ohms, find the shift of the balance point on the bridge wire. [3]
   c. What happens to the balanced length if the galvanometer and cell are interchanged at the balance point of the bridge? [1]

4. a. Why do we prefer a meter bridge of longer wire? [1]
   b. In the given meter bridge, the balance point is found to be at 39.5 cm from the end A, when the resistor S is of 12.5 Ω.
      i. Determine the resistance R. [1]
      ii. Determine the balance point of the bridge above if R and S are interchanged. [1]
   c. Describe the necessary theory to determine the unknown resistance by using a meter bridge with suitable diagram. [2]



5. Potentiometer is an ideal voltmeter that measures the emf of the cell very accurately.
   a. Why do we prefer a potentiometer of longer wire? [2]
   b. If the length of the wire be doubled, what will be the effect on the position of null deflection in a potentiometer? [2]
   c. Why do we prefer potentiometer to measure emf of a cell rather than a voltmeter? [2]
   d. What is the working principle of potentiometer? [1]
   e. How is it superior to the voltmeter in the accurate measurement of emf? [2]
   f. A potentiometer is 10 m long. It has a resistance of 20Ω. It is connected in series with a battery of 3V and a resistance of 10Ω. What is the potential gradient along the wire? [2]
   g. The driver cell of a potentiometer has an emf of 2 V and negligible internal resistance. The potentiometer wire has a resistance of 3 ohm. Calculate the resistance needed in series with the wire if a p.d. 5 mV is required across the whole wire. The wire is 100 cm long and a balanced length of 60 cm is obtained for a thermocouple of emf E. What is the value of E? [3]

6. Potentiometer has several applications. Out of them, comparing emfs of two cell, measuring internal resistance of a cell and measuring emf of a cell.
   a. Explain how you compare the emfs of two cells using potentiometer. [3]
   b. 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. [2]



7. Galvanometer is a very useful device, it can be used in various ways,
   a. How galvanometer can be converted into voltmeter? [2]
   b. How galvanometer can be converted into an ammeter? [2]
   c. The resistance of a galvanometer coil is 9.36 ohm, and the current required for full-scale deflection is 0.0224A. We want to convert this galvanometer to an ammeter reading 20 A full scale. The only shunt available has a resistance of 0.025 ohm. What resistance must be connected in series with the coil? [3]

8. A shunt is used to convert a galvanometer of resistance G into an ammeter.
   a. A shunt must have very low resistance. Why? [1]
   b. To increase the range of ammeter n times, what value of shunt is required? [2]
   c. If the galvanometer shows the deflection out of range in the experiment, what conclusion can be drawn? [1]
   d. While converting the galvanometer of resistance 10Ω into an ammeter in the range 1A, a very small resistance 0.1Ω in parallel and a resistor 89.9Ω in series are required with the galvanometer. What is full-scale reading in the galvanometer? [2]