# Electricity & Magnetism

Electrical Circuits

1. a. State and explain Kirchhoff's 1st and 2nd laws?
   b. Using Kirchhoff's laws, find the current through 2 Ω resistor in the given circuit.
   (Ans: 10A)

2. Write the balance condition Wheatstone bridge along with circuit diagram. Can we measure the internal resistance of a car battery with help of Wheatstone bridge?
3. a. What is the working principle of meter bridge? What happens if the meter bridge wire is made with copper wire?
   b. 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.
4. Potentiometer is an ideal voltmeter that measures the emf of the cell very accurately,
   a. How is it superior to the voltmeter in the accurate measurement of emf?
   b. What is the working principle of potentiometer?
   c. How can we increase sensitivity of potentiometer?
   d. Why we prefer potentiometer of longer wire?
   e. If the length of the wire be doubled, what will be the effect on the position of zero deflection in a potentiometer?
   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?
   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 Ω. 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. Find the value of E?
5. A shunt is used to convert a galvanometer of resistance G into an ammeter.
   a) A shunt must have very low resistance. Why?
   b) A galvanometer of resistance 5 Ω can bear a maximum current of 25 mA. Find the suitable resistance to convert it into,
      i. An ammeter of range (0-10A)
      ii. Voltmeter of range (0-2V)
6. What difference are there between super conductor and conductor? Discuss with necessary plots.
7. What is joules law of heating?
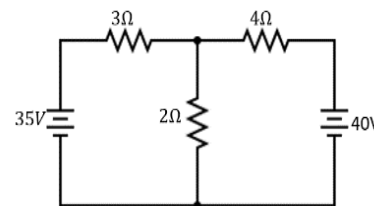
Thermoelectric Effect:

1. What is thermoelectric effect? On what factors the production of thermo emf depends.
2. What is the cause of Seebeck effect?
3. Peltier effect is converse of Seebeck effect. Explain?
4. Why lead is used as reference metal in thermoelectricity?
5. Thermocouple is made with two dissimilar metals. Why do we generally prefer Sb-Bi thermocouple?
6. Define neutral temperature and temperature of inversion. Write the factors on which neutral temperature and temperature of inversion depends?
7. What is the significance of thermoelectric series?
8. Differentiate between Seebeck and Peltier effect.
9. Does the thermoelectric effect obey the law of conservation of energy?
10. What are the uses of thermoelectric effect?
11. Explain briefly the construction and working of a Thermopile.
12. Due to the temperature, difference between the junctions of thermocouple, thermo emf is produced. How thermo emf varies with temperature of hot junction in the thermocouple. Discuss?
13. The thermo emf E and the temperature of hot junction θ satisfy the relation $E = a\theta + b\theta^2$, where $a = 14\mu V°C^{-1}$ and $b = -0.04\mu V°C^{-2}$. If the cold junction temperature is 0°C find the neutral temperature and the temperature at which the thermo emf changes sign.

Rotational Dynamics:

1. Define moment of inertia. On what factors does it depend? Define radius of gyration. On what factor does it depend?2

2. Explain why spokes are fitted in the cycle wheel? In a fly wheel, most of the mass is concentrated at the rim? Explain why?

3. A wheel starts from rest and accelerates with constant angular acceleration to an angular velocity of 15 rev/sec in 10 seconds. Calculate the angular acceleration and angle which the wheel has rotated at the end of 2 sec.

4. A constant torque of 500Nm turns a wheel which has a moment of inertia $20 Kg\ m^2$ about its center. Find the angular velocity gained in 2seconds and the kinetic energy gained.

5. Write the total kinetic Energy of a rolling object. A disc of radius 1m and mass 5Kg is rolling along a horizontal plane. Its moment of inertial about its center is 2.5 Kgm^2. If its velocity along the plane is 2m/s, find its angular velocity and the total energy. **[15J]**

6. Define the terms: torque and couple in rotational dynamics. It is easier to open the cap of a bottle by the help of two fingers, why? 2

7. Establish a relationship between moment of inertia and the torque. 2

8. Speed of a body spinning about an axis increase from rest to 100 rev/sec in 5 secs if a constant torque of 20Nm is applied. The external torque is then removed and the body comes to rest in 100 secs due to friction. Calculate the frictional torque. **[1N]** 3

9. Define angular momentum. Write its vector expression. 2

10. State and explain the principle of conservation of angular momentum with suitable example. 2

11. If the earth is suddenly struck by meteorites, the earth will slow down slightly. Explain. 2

12. If the earth shrinks to half of its radius, what will be the duration of a day be affected? 2

13. If the ice on the polar caps of the earth melt, how will be the duration of the affected? Explain.

14. Explain why angular velocity of the earth increases when it comes closer to the sun in its orbit. 2

15. What happens to the angular velocity of a ballet dancer as she stretches her hand from the folded position?

16. A ballet dancer spins about a vertical axis at $1\ rpm$ with her arms outstretched. With her arms folded, her moment of inertia about the axis decreases by 40%. Calculate the new rate of revolution. 2