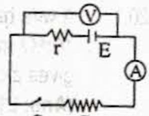
9. In the given figure, when switch s is open, the voltmeter v reads 3.08v. When the switch is closed, the voltmeter reading drops to 2.97v, and the ammeter A reads 1.65 A. Find the emf, the internal resistance of the battery and the resistor R. Assume that the two meters are ideal.



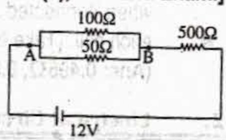
[Ans: 3.08V, 0.067Ω, 1.8Ω] **[Q.N. 9 (a), Set 'A' 2069]**

10. The resistance of a conductor is 10 ohm at 50°C and 15 ohm at 100°C. Calculate its resistance at 0°C. **[Q.N. 9(c), Set 'B' 2069]**
[Ans: 6.67 Ω]

11. An electric heating element to dissipate 480 watts on 240V mains is to be made from nichrome wire of 1mm diameter. Calculate the length of the wire required if the resistivity of nichorme is 1.1×10^{-6} ohm-meter. **[Q.N.9(a),2068 1st Exam.]**
[Ans: 85.68 m]

12. A resistor of 500 Ohms and one of 2000 Ohms are placed in series with a 60 volt supply. What will be the reading on a voltmeter of internal resistance 2000 Ohms when placed across (i) the 500 Ω resistor and (ii) the 2000 Ω resistor?
[Ans: 10 volts, 40 volts] **[Q.N.9(a),2068 2nd Exam.]**

13. What is the potential difference across 100Ωresistor in the circuit given below? **[Q.N. 9(a), 2067 1st Exam.]**



[Ans: 0.75V]

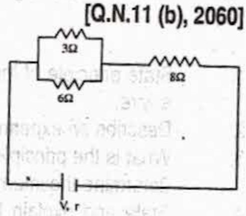
14. A galvanometer can bear maximum current of 25 mA and a resistance 5Ω. Find suitable resistance to convert it into
(a) a voltmeter of range 0–2V
(b) an ammeter of range 0–10 Amp.
[Ans: (a) 75Ω (b) 0.0125 Ω] **[Q.N. 11(b), 2065]**

15. Twelve cells each of e.m.f. 2V and of internal resistance 0.5 ohm are arranged in a battery of *n* rows and an external resistance 0.4 ohm is connected to the poles of the battery. Estimate the current flowing through the resistance in terms of *n*.
$\left[\text{Ans: } \frac{60\,n}{15 + n^2}\right]$ **[Q.N.11 (b), 2062]**

16. As shown in the figure, a battery of emf 24v and internal resistance r is connected to a circuit containing two parallel resistors of 3Ω and 6Ω in series with an 8Ω resistor. The current flowing in the 3Ω is 0.8A. Calculate the current in the 6Ω resistor and the internal resistance of the cell.
[Ans: 0.4 A, 10 Ω] **[Q.N.11 (b), 2061]**

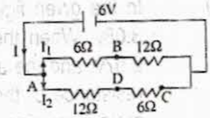
17. A battery of emf 1.5 v has a terminal p.d. of 1.25 v when a resistor of 25Ω is joined to it. Calculate the current flowing, the internal resistance and terminal p.d. when a resistance of 10Ω replaces 25Ω resistor.
[Ans: 0.05A, 5Ω, 1V] **[Q.N.11 (b), 2060]**

18. In the given circuit, calculate the potential difference between the points B and D.
[Ans: 1.998V] **[Q.N.11 (b), 2058]**



19. Two resistors of 1200Ω and 800Ω are connected in series with a battery of emf 24V and negligible internal resistance. A Voltmeter of resistance 600Ω is now connected across 1200Ω resistor. Find the p.d. recorded by the voltmeter.
(Ans: 8V) **[HSEB 2056]**

20. A wire having the diameter of 1.2mm and resistivity of 100 × $10^{-8}\Omega$ m at 0× C is connected across a cell of emf 1.5V and gives a current of 10mA. Calculate the length of the wire.
(Ans: 216m) **[HSEB 2055]**



21. The temperature of 0.2Kg of paraffin oil in a vacuum flask rises 1°C per minute with an immersion heater of 12.3 watts. In repeating with 0.4kg of oil the temperature rises by 1.2°C per minute for an input of 19.2 watts. Find the specific heat capacity of oil and thermal capacity of the flask. **[HSEB 2054]**
(Ans: 1110 $JKg^{-1}{}^\circ C^{-1}$, 516 J kg^{-1})

22. A heating coil is to be made from nichrome wire which will operate on 12V supply and will have power of 25W when immersed in water at 100°C, the wire available has an area of cross-section of $10mm^2$. What length of wire will be required at 0× C?
(Resistivity at 0°C = $1.08 \times 10^{-6}\Omega$m and temperature coefficient, $\alpha = 8 \times 10^{-5} K^{-1}$.)
(Ans: 53m) **[HSEB 2051]**

23. Two similar cells A and B are connected in series with a coil of resistance 9.8Ω. A voltmeter of very high resistance connected to the terminals of A reads 0.98V and when connected to the terminals of B it reads 1.0V. Find the internal resistance of each cell. (Take emf of each cell as 1.08V) **[HSEB 2051]**
(Ans: 0.495Ω, 0.396Ω)

2. Electrical Circuits

Short Questions

1. Why do we prefer a potentiometer to measure emf of a cell rather than a voltmeter? **[Q.N.1(a), 2072'C']**
2. Draw a circuit diagram of meter bridge to determine the resistance of a wire. Give the formula used. **[Q.N.1(b), 2072'D']**
3. The elements of a heater is very hot while the wires carrying current are not. Why? **[Q.N.1(b), 2072'E']**
4. If the length of the wire be doubled, what will be the effect on the position of zero deflection in a potentiometer? **[Q.N. 1(b), Set 'C' 2071]**
5. State and explain Kirchhoff's laws of electric circuits. **[Q.N. 1(b), Set 'D' 2071]**
6. We prefer a potentiometer to measure emf of a cell rather than a voltmeter. Why? **[Q.N. 1(b), 2070 'D']**
7. Why do we prefer a potentiometer to measure emf of a cell rather then a voltmeter? **[Q.N. 1(b), 2069 Set A]**
8. How would you convince that the principle of measurement of resistance of wire by meter bridge is based on Wheatstone bridge principle? Explain. **[Q.N. 1(d), Set 'B' 2069]**
9. State Kirchhoff's laws of electric circuits. **[Q.N.10 (c), 2062]**
10. Draw a circuit diagram to determine internal resistance of a cell using a potentiometer. **[HSEB 2051]**

Long Questions

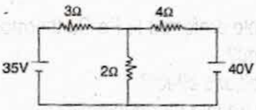
1. State principle of meter bridge. Describe how it is used to determine the resistance of a wire. **[Q.N.5(b), 2072'C']**
2. Describe an experiment to verify Joule's Laws of heating. **[Q.N.5(b), 2072'D']**
3. What is the principle of a potentiometer? Explain with necessary theory how you would determine the internal resistance of a cell using this principle. **[Q.N. 5 (a), Set 'D' 2071]**
4. State and explain Kirchhoff's laws of current and voltage. Apply them to obtain the condition of balance of Wheatstone's bridge. **[Q.N. 5 (a), 2070 'C']**

5. What is Wheatstone bridge? Use Kirchhoff's laws of current and voltage to obtain balance condition of it. [Q.N. 5 (a), 2070 'D']
6. What is potentiometer principle? Explain how a potentiometer can be used to compare the emf's of two cells. [Q.N. 5 (a), Supp. 2069]
7. Explain Kirchoff's laws. How are the conditions of balance in Whetstone bridge established through these laws? [Q.N. 5 (c), Set 'B' 2069]
8. What is internal resistance of a cell? How can you measure the internal resistance of a cell by using potentiometer? [Q.N.5(d), 1st Exam 2068]
9. What is a wheatstone bridge? Obtain the balanced condition for the bridge. Explain how resistance can be measured by a meter bridge. [Q.N.5(c), 2nd Exam 2068]
10. What is the principle of potentiometer? Describe a method to measure the internal resistance of a cell by using potentiometer. [Q.N. 5(d), 2067 1st Exam.]
11. What is potentiometer? How can you use it to measure internal resistance of a cell? [Q.N. 5(a), 2067 2nd Exam.]
12. What is the principle of potentiometer? Explain how would you use it to measure the internal resistance of a cell. [Q.N. 11(a), 2065]
13. Explain the principle of potentiometer. How is this used to measure the internal resistance of a cell? [Q.N.11 (a) (Or), 2062]
14. Discuss the principle of potentiometer and use it to compare the emf's of two cells. [Q.N.11 (a) (Or), 2061]
15. Discuss the principle of potentiometer and use it to determine the internal resistance of a cell. [Q.N.10 (a) (Or), 2060]
16. What is a wheatstone bridge bridge? Using Kirochhoff's law, derive the principle of wheatstone bridge? [Q.N.11(a) (or) 2059]
17. What is a potentiometer? Explain how do you compare emf of two cells using potetiontiometer. [Q.N.11(a), 2058]

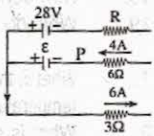
Numerical Problems

1. The total length of the wire of a potentiometer is 10m. A potential gradient of 0.0015V/cm is obtained when a steady current is passed through this wire. Calculate,
   i) the distance of null point on connecting standard cell of 1.018V.
   ii) the unknown p.d. if the null point is obtained at a distance of 940cm, and
   iii) the maximum p.d. which can be measured by this instrument. [Q.N.9(a), 2072'E']

   [Ans: (i) 6.78 m, (ii) 4V, (iii) 1.5V]
2. Using Kirchhoff's laws of current and voltage, find the current in 2Ω resister in the given circuit. [Q.N. 9 (a), Set 'C' 2071]



   [Ans : 10A]
3. In the adjacent circuit find:



   (1) the current in resistor R, *[Ans: 2A]*
   (2) resistance R, *[Ans: 5Ω]*
   (3 the unknown emf ε, *[Ans: 42V]*
   (4) if the circuit is broken at P, what is the current n resistor R?
   [Ans: 3.5A] [Q.N. 9(a), 2067 2nd Exam.]
4. The driver cell of a potentiometer has an e.m.f. of 2V 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. 5.0 m V is required across the whole wire. The wire is 100.0 cm long and a balanced length of 60 cm is obtained for a thermocouple of e.m.f. E. What is the value of E ?
   [Ans: 1197.2 Ω, 3 mV] [Q.N. 11(b), 2064]

5. The driver cell of a potentiometer has an emf 2V and negligible internal resistance. The potentiometer wire has a resistance of 3Ω. Calculate the resistance needed in series with the wire if a p.d. of 5mV is required across the whole wire.
[Ans: 1197.2 Ω] **[Q.N. 11,(b) 2063]**
6. The e.m.f. of a battery A is balanced by a length 75.0 cm on a potentiometer wire. The e.m.f. of a standard cell 1.02 volt is balanced by a. length of 50.0 cm. What is the e.m.f. of A?
[Ans: 1.53V] **[Q.N.11 (b), 2059]**
7. The driving cell of a potentiometer has an e.m.f of 2V and negligible internal resistance. The potentiometer wire has a resistance of 3Ω. Calculate the resistance needed in series with the wire if a p.d. of 5m V is required across the whole wire.
[Ans: 1197 Ω] **[Q.N.11 (b), 2056]**

3. Thermoelectric Effect

Short Questions

1. Is see back effect reversible effect? Explain. **[Q.N.1(d), 2072'E']**
2. What is neutral temperature? On what factors does it depend? **[Q.N. 1(c), Set 'D' 2071]**
3. "Good thermal conductors are also good electrical conductor". If so, why don't the connecting wires that are used to connect heaters get hot by conduction of heat from the heating element ? **[Q.N.1(b), 2070 'Supp']**
4. Why does an electric bulb nearly always burn out just as we turn on the light, but almost never while the light is shining? **[Q.N. 1(b), 2070 'C']**
5. Define temperature of inversion. If the temperature of cold junction of a thermocouple is lowered, what will be the effect on it? **[Q.N. 1(c), 2070 'C']**
6. What is temperature of inversion? On what factors does it depend?
[Q.N. 1(c), 2069 Set A]
7. Peltier effect is the converse of seebeck effect. Explain. **[Q.N. 1(c), Set 'B' 2069]**
8. Define temperature of inversion. On what factors does it depend? **[Q.N.1(c), 1st Exam 2068]**
9. Does the thermo-electric effect obey the law of conservation of energy? Explain.
[Q.N.1(b), 2nd Exam 2068]
10. What are the factors on which thermo-emf depend? **[Q.N. 1(b), 2067]**
11. What do you mean by inversion temperature? On what factor does it depend? **[Q.N. 10(c), 2065]**
12. How is Seebeck effect different from Peltier effect? Explain. **[Q.N.10 (b), 2062]**
13. What are the factors on which the thermo emf produced in a thermocouple depends?
[Q.N.10 (a), 2061]
14. Why is Sb-Bi thermocouple preferred to Fe-Cu thermocouple? **[Q.N.10 (c), 2060]**
15. What is thermoelectric emf? **[Q.N.10 (a), 2059]**
16. What do you mean by Peltier's effect? **[Q.N.10 (b), 2058]**
17. What is neutral temperature in a thermocouple? **[HSEB 2055]**
18. How does the thermoelectric emf vary with the temperature? **[HSEB 2053]**
19. What do you mean by Peltier's effect? **[HSEB 2052]**

Long Questions

1. What is thermoelectric effect? How does the thermo emf of a thermocouple vary with increase in temperature of hot junction, keeping cold junction at 0°C? Explain. **[Q.N.5(a), 2072'D']**
2. What is seebeck effect ? How does the emf of thermocouple vary with temperature of the hot junction ? **[Q.N.5(b), Supp. 2071]**
3. What is thermocouple? Define neutral temperature and temperature of inversion of a thermocouple. Are they constant for a given thermocouple? **[Q.N. 5 (b),Set 'C' 2071]**
4. What is thermo electric effect ? Discuss the variation of thermo emf with the change in temperature of the hot junction. **[Q.N.5(a), 2070 'Supp']**
5. Define Seebeck effect. Discuss the variation of thermoelectric emf in a thermocouple with the increase of temperature of hot junction. **[Q.N. 5 (b), 2070 'D']**

6. What is Seebeck effect? How does the emf of a thermocouple vary with temperature of hot junction? Hence define inversion temperature. [Q.N. 5 (b), Supp. 2069]
7. What is thermoelectric effect? Discuss the variation of thermo-emf with the change in temperature of the hot junction. [Q.N. 5(a), 2067 1st Exam.]
8. What is Seebeck effect? How does the thermo emf of a thermocouple vary with temperature of the hot junction? [Q.N. 11,(a)(or) 2063]
9. What is Seebeck effect? How does the emf of a thermocouple vary with the temperature of the hot junction. [Q.N.11 (a), 2057]
10. Explain, what do you mean by seebeck effect? How does thermolectric emf vary with the temperature? [Q.N. 11(a or), 2057]

4. Chemical Effect of Current

Short Questions

1. The conductivity of an electrolyte is very low as compared to a metal at room temperature. Why? [Q.N.1(b), 2072'C']
2. Why is the conductivity of an electrolyte very low as compared to a metal at room temperature? [Q.N.1(c), 2072'E']
3. What is meant by Faraday constant ? [Q.N.1(f), Supp. 2071]
4. Why is the conductivity of an electrolyte low as compared to that of a metal? [Q.N. 1(e), Set 'C' 2071]
5. The conductivity of an electrolyte is low as compared to a metal. Why?[Q.N. 1(e), 2070 'C']
6. State and explain Faraday's law of electrolysis. [Q.N. 1(e), 2070 'D']
7. Give reason why the electrical conductivity of electrolite is less than that of metals. [Q.N. 1(c), Supp. 2069]
8. Distinguish between ionic and electronic conduction. [Q.N. 1(c), 2067 1st Exam.]
9. Why does voltameter measure current more accurately than an ammeter? [Q.N. 10(b), 2063]
10. What is meant by 'Faraday's Constant'? [Q.N.10 (c), 2056]
11. Distinguish between ionic and electronic conductions. [HSEB 2055]
12. How do you distinguish between the passage of electric current through metal and that through electrolyte? [HSEB 2053]

Long Questions

1. State and explain Faraday's laws of electrolysis. How can you verify the second law experimentally? [Q.N. 5 (b),Set 'D' 2071]
2. State the explain Faraday's laws of electrolysis. How will you verify Faraday's second law of electrolysis experimentally? [Q.N. 5 (c), 2069 Set A]
3. Verify Faraday law of electrolysis. [Q.N. 5 (a), Set 'B' 2069]
4. State Faraday's law of electrolysis. Explain how will you experimentally verify them? [Q.N. 11(a, or), 2065]
5. State Faraday's laws of electrolysis. Discuss the experiment to verify them. [Q.N.11(a), 2064]
6. State the Faraday's laws of electrolysis and verify the second law. [Q.N.11 (a), 2062]
7. State and explain Faraday's laws of electrolysis. Hence, define Faraday's constant. [Q.N. 11(a)(or), 2058]

Numerical Problems

1. Calculate the charge needed to deposit 2 g of Oxygen in the electrolysis of water. (Relative molecular mass of Oxygen is 32, Faraday constant F is 96,5000 c mol^{-1})
[Ans: 24125C] [Q.N.11 (b), 2057]
2. Assuming the Faraday constant is 9650 $Cmol^{-1}$ and that the relative atomic mass of copper is 63, calculate the mass of copper liberated by 0.5A in 10 minutes. (Electronic charge = -1.6×10^{-19}C). [HSEB 2056]
(Ans: 9.8×10^{-5} kg)

3. A copper refining cell consists of two parallel copper plate electrodes, 6cm apart and 1m square, immersed in a copper sulphate solution of resistivity $1.2 \times 10^{-2}\Omega$ m. Calculate the p.d. which must be established between the plates to provide a constant current to deposit 0.48kg of copper on the cathode in one hour (mass of the copper liberated per coulomb, $Z = 3.29 \times 10^{-7}$Kg C^{-1}). **[HSEB 2055]**
(Ans: 29.16×10^{-3} V)

Magnetic Field of Current

1. Magnetic Field

Short Questions

1. Can a charge particle move through a magnetic field without experiencing any force ? Explain. **[Q.N.1(f), 2072'C']**
2. Does a charged particle moving through a magnetic field always experience a force? Explain. **[Q.N.1(c), 2072'D']**
3. How will an electron move in a homogenous magnetic field if the velocity of the electron at the initial moment forms an angle 'θ' with the force lines of the field? **[Q.N.1(e), 2072'E']**
4. A vertical magnetic field is perpendicular to the vertical plane of a loop. When the loop is rotated about a horizontal axis in the plane, the current produced in the loop reverses directions twice per rotation. Explain why there are two reversals for one rotation. **[Q.N.1(c), Supp. 2071]**
5. A uniform magnetic field directed upward exists in some region of space. In what directions could an electron be moving if its trajectory is (i) a straight line ? (ii) a circle. **[Q.N.1(d), Supp. 2071]**
6. A current was sent through a helical coil spring. The spring contracted, as if it had been compressed. Why? **[Q.N. 1(c), Set 'C' 2071]**
7. A sheet of copper is placed between the poles of an electromagnet with the magnetic field perpendicular to the sheet. When it is pulled out, a considerable force is required, and the force required increases with speed. Explain. **[Q.N. 1(d), Set 'C' 2071]**
8. Can a charged particle move through a magnetic field without experiencing any force ? Explain the reason. **[Q.N.1(c), 2070 'Supp']**
9. Pairs of conductors carrying current into or out of the power supply components of electronic equipments are twisted together. Why ? **[Q.N.1(d), 2070 'Supp']**
10. An electron can be deflected by electric field as well as magnetic field. What is the characteristics difference in these deflections? **[Q.N. 1(d), Supp. 2069]**
11. An electron beam and a proton beam are moving parallel to each other in the beginning. Do they always maintain this status? Justify your answer. **[Q.N.1(e), 2nd Exam 2068]**
12. A solenoid tends to contract when a current passes through it, why? **[Q.N.1(d), 1st Exam 2067]**
13. A current carrying solenoid tends to contract why? **[Q.N. 1(e), 2067 2nd Exam]**
14. Explain how the direction of Lorentz force is determined. **[Q.N.2(e), 2065]**
15. Ampere's circuital law can be applied to certain case only. Justify. **[Q.N.2(a), 2062 Supp.]**
16. How is magnetic field made radial in a moving coil galvanometer? **[Q.N.2(e), 2061]**
17. A conductor, even though it is carrying a current, has zero net charge. Why, then, does a magnetic field exert a force on it? **[Q.N.2(c), 2060 Supp.]**
18. Why is the cylindrical core of soft iron used in moving coil galvanometer ? **[Q.N.1(e), 2060]**
19. Define an Ampere in terms of the force between current carrying conductors. **[Q.N.2(e), 2060]**

20. A proton moving in a straight line enters a strong magnetic field along the field direction. How will its path and velocity change? [Q.N. 2(e), 2057]
21. Explain in brief, the motion of an electron moving normal to a magnetic field. [Q.N.7(d), 2056]
22. Does a charged particle moving through a magnetic field experience a force? Express with conditions, maximum, and minimum force it experiences. [Q.N.7(a), 2055]
23. Under that condition does a charge affect a magnet? [Q.N.7(d), 2054]
24. State Ampere's theorem. [Q.N.7(h), 2054]

Long Questions

1. Derive an expression for the force per unit length acting on each of the two straight parallel metallic conductors carrying current in the same direction and kept near each other. Why do such current carrying conductors attract each other? [Q.N.5(c), 2072'C']
2. State and explain Biot-Savart law. Use this law of find the magnetic field due to a long straight current carrying conductor. [Q.N.5(c), 2072'D']
3. Derive an expression for the force per unit length between two parallel current carrying conductors. [Q.N.5(b), 2072'E']
4. Derive an expression for the force per unit length between parallel conductors carrying current in the opposite direction. [Q.N.5(d), Supp. 2071]
5. State Biot-Savart law. Derive an expression for the magnetic field produced by a current carrying circular coil at any point on the axis of the coil. [Q.N. 5 (c), Set 'C' 2071]
6. State and explain Ampere's theorem and use it to calculate the magnetic field due to a long solenoid. [Q.N. 5 (c), Set 'D' 2071]
7. State Biot Savart law. Use this law to find the magnetic field intensity due to a current carrying straight conductor at a distance 'd' from it. [Q.N.5(b), 2070 'Supp']
8. What is Ampere's circuital law? Use this law to derive an expression for the magnetic field due to a long solenoid carrying current. [Q.N. 5 (c), 2070 'C']
9. Describe with the help of a diagram, the principle, construction and working of a moving coil galvanometer. [Q.N. 5 (d), 2070 'C']
10. Find an expression for the force per unit length between two long parallel conductors carrying currents and hence define one ampere. [Q.N. 5 (c), 2070 'D']
11. State Biot-Savart law. Derive an expression for the magnetic field produced by a current carrying circular coil at any point on the axis of the coil. [Q.N. 5 (b), 2069 Set A]
12. State and explain the Biot–Savart law to find magnetic field due to a long straight current carrying conductor. [Q.N. 5 (d), Set 'B' 2069]
13. State and explain Ampere's theorem and hence use it to find the magnetic field due to a long solenoid carrying current I. [Q.N.5(c), 1st Exam 2068]
14. Deduce an expression for the force between two parallel current carrying conductors. Define one ampere current. [Q.N.5(a), 2nd Exam 2068]
15. State and explain Biot-savart law and use it to find magnetic field due to a long straight current carrying conductor. [Q.N.5(b), 1st Exam 2067]
16. Find an expression for the magnetic field on the axis of a solenoid, carrying current, using Ampere's law. [Q.N. 5(b), 2067 2nd Exam.]
17. Derive an expression of force per unit length between two parallel conductors separated by a distance 'r' and carrying currents I_1 and I_2 in the same direction. [Q.N.7(a), 2066]
18. State and explain Biot-Savart law with a case of its application. [Q.N.7(a, Or), 2065]
19. State and explain Biot-Savart law. Use this law to find the magnetic field intensity at any point due to a long straight current carrying conductor. [Q.N.7(a), 2064]
20. Find an expression for torque on rectangular coil in a uniform magnetic field. [Q.N.7(a), 2063]
21. What is a Helmholtz coil? Derive an expression for the magnetic field due to this coil. [Q.N.7(a, Or), 2063]

22. State and explain Biot-Savart law and hence use it to find the magnetic field intensity at any point due to a long straight conductor. [Q.N.7(a), 2062]
23. Derive the formula for the magnetic field at a point due to a long straight current carrying conductor using Biot and Savart law. [Q.N.7(a), 2061]
24. Derive an expression for the torque experienced by a current carrying rectangular coil placed in a uniform magnetic field and hence define magnetic dipole moment of the coil. [Q.N.5(a), 2060 Supp.]
25. State and explain Ampere's theorem and hence use it to find the magnetic field intensity due to a long current carrying solenoid. [Q.N.7(a), 2060]
26. Derive the formula for the magnetic field at the centre of a circular coil carrying current. Explain why the magnetic field at the centre of the coil disappears when the circular coil is made infinitely large. [Q.N.7(a), 2059]
27. What is a Helmholtz Coil? Derive an expression for the magnetic field due to this coil. [Q.N.7(a, Or), 2058]
28. Derive an expression for the magnetic field at a point due to a long straight conductor carrying current. [Q.N.7(a), 2057]
29. Derive an expression for the magnitude of the magnetic flux density at the centre of a narrow circular coil. [Q.N. 8, 2056]
30. State Biot-Savart law and obtain the expression for the magnetic field at the centre of the circular coil. [Q.N.9(Or), 2055]
31. Find the expression for the magnetic intensity due to an infinitely long solenoid at a point on its axis inside the solenoid. [Q.N.8, 2054]

Numerical Problems

1. The coil of a moving coil galvanometer has 50 turns and its resistance is 10Ω. It is replaced by a coil having 100 turns and resistance 50Ω. Find the factor by which the current and voltage sensitivities change. [Q.N.9(b), 2072'D']

   $\left[Ans: \frac{1}{2}, \frac{2}{5}\right]$
2. A 60 cm long wire of mass 10g is suspended horizontally in a transverse magnetic field of flux density 0.4T through two springs at its two ends. Calculate the current required to pass through the wire so that there is zero tension in the springs. [Q.N.9(c), 2072'E']

   [Ans: 0.14 a]
3. The coil of a moving coil galvanometer has 50 turns and its resistance is 10Ω. It is replaced by a coil having 100 turns and 50Ω. Find the factor by which the current sensitivity and voltage sensitivity change. [Q.N.9(b), Supp. 2071]

   $\left[Ans: 2, \frac{2}{5}\right]$
4. A horizontal straight wire of mass 0.12 gm and length 10cm is placed perpendicular to a uniform horizontal magnetic field of flux density 0.6T. If the resistance per unit length of the wire is $3.8\Omega m^{-1}$, calculate the potential difference that has to be applied between the ends of the wire to make it just self supporting. [Q.N. 9 (b), Set 'C' 2071]

   [Ans : 7.6×10^{-4} v]
5. A copper wire has 10^{29} free electrons per cubic meter, a cross sectional area of 2 mm^2 and carries a current of 5A. Calculate the force acting on each electron if the wire is now placed in a magnetic field of flux density 0.15T which is perpendicular to the wire.

   [Ans : 3.75×10^{-24} N] [Q.N. 9 (a), Set 'D' 2071]
6. An electron of K.E. 10ev is moving in a circular orbit of radius 11 cm, in a plane at right angles to a uniform magnetic field. Determine the value of the flux density. (mass of an electron = 9.1×10^{-31}kg, e = 1.6×10^{-19}C)

   [Ans : 9.3×10^{-4}T] [Q.N.9(b), 2070 'Supp']

7. A metal aircraft with a wing span of 40 m flies with a speed 1000 km hr^{-1} in a direction due east at constant altitude in a region of the northern hemisphere where the horizontal component of the earth's magnetic field is 1.6×10^{-5}T and the angle of dip is 41°. Find the potential difference developed between the tips of the wing.
[Ans : 0.15 V] **[Q.N. 9 (b), 2070 'C']**

8. A slab of copper, 2mm thick and 1.50cm wide, is placed in a uniform magnetic field of flux density 0.40T, so that maximum flux pass through the slab. When a current of 75A flows through it, a potential difference of 0.81μV is developed between the edges of the slab. Find the concentration of the mobile electrons in copper.
[Ans : 1.15×10^{29} m^{-3}] **[Q.N. 9 (b), 2070 'D']**

9. A straight horizontal rod X, of mass 50g and length 0.5m, is placed in a uniform horizontal magnetic field of 0.2 T perpendicular to X. Calculate the current in X if the force acting on it just balances its weight. **[Q.N. 9 (b), Supp. 2069]**
[Ans : 5A]

10. A slice of indium antimonide is 2.5 mm thick and carries a current of 150 mA. A magnetic field of flux density 0.5T, correctly applied, produces a maximum Hall voltage of 8.75mV between the edges of the slice. Calculate the density of free charge carriers, assuming they each have a charge of -1.6×10^{-19} C.
[Ans: 2.14×10^{22}) **[Q.N. 9 (b), Set 'A' 2069]**

11. A long wire carrying a current of 10 A is placed perpendicular to magnetic field of flux density 5 Tesla. Calculate the force acting on 2m of the wire.
[Ans: 100 N] **[Q.N.9(b),2068 1st Exam.]**

12. A coil consisting of 100 circular loops with radius 0.60 cm carries a current of 5 A. At what distance from the center, along the axis, the magnetic field magnitude $\frac{1}{8}$as great as it is at the center ? **[Q.N.9(b),2068 2nd Exam.]**
[Ans: ± 1.04 m)

13. A slice of indium antimonide is 2.5 mm thick and carries a current of 150mA. A magnetic field to flux density 0.5T, correctly applied, produces a maximum Hall voltage of 8.75 mV between the edges of the slice. Calculate the number of free charge carriers per unit volume, assuming they each have a charge of -1.6×10^{-19}C.
[Ans: 2.14×10^{22}] **[Q.N. 9(b), 2067 1st Exam.]**

14. The coil of a moving coil galvanometer has 50 turns and its resistance is 10Ω. It is replaced by a coil having 100 turns and resistance 50Ω. Find the factor by which the current sensitivity and voltage sensitivity change.
$\left[\textit{Ans: } 2; \frac{2}{5}\right]$ **[Q.N. 9(b), 2067 2nd Exam.]**

15. A wire carrying current of 10 A and 2 m in length is placed in a field of flux density 0.34 Tesla. What is the force on the wire if it is placed at 60° to the field ?
[Ans: 5.88 N] **[Q.N.7(b), 2065]**

16. In the Bohr's model of hydrogen atom the electron circulates round the nucleus in a path of radius 5.1 × 10–11 metre at a frequency of 6.8 × 1015 Hz. What value of B is set up at the centre of the orbit it.
[Ans: 13.48 T] **[Q.N.5(b), 2063 Supp.]**

17. Calculate the magnetic flux density at a distance of 1 cm from a very long vertical straight wire carrying current of 5 A. At what distance from the wire is the field flux density 2×10^{-5} T. ($\mu_0\times10^{-7}$ HM^{-1}) **[Q.N.5(b), 2062 Supp.]**
[Ans : 2.5×10^{-2} m]

18. A horizontal straight wire 5cm long weighing 1.2gm^{-1} is placed perpendicular to a uniform horizontal magnetic field of flux density 0.6T. If the resistance of the wire is 3.8Ωm^{-1}, calculate the p.d. that has to be applied between the ends of the wire to make it just self supporting. *[Ans : 3.72×10^{-3}V]* **[Q.N. 7(b), 2061]**

2. Magnetic Properties of Materials

Short Questions

1. What is retentively and coercivity of a ferromagnetic material? [Q.N.1(c), 2072'C']
2. Define angle of dip. What will be its value at a place where the horizontal and vertical components of earth's magnetic field are equal? [Q.N.1(d), 2072'D']
3. What is the role of hysterisis loop in choosing a material for making permanent magnets ? [Q.N.1(e), Supp. 2071]
4. Why should the permeability of a paramagnetic material be expected to decrease with increasing temperature? [Q.N. 1(d), Set 'D' 2071]
5. The magnetic susceptibility of a paramagnetic material is quite strongly temperature dependent, but that of diamagnetic material is nearly independent of temperature. Why? [Q.N. 1(c), 2070 'D']
6. Above curie temperature a ferromagnetic material becomes paramagnetic. Why? [Q.N.1(e), 1st Exam 2068]
7. A permanent magnet can be used to pick up a string of nails, tacks or paper clips, even though these are not magnets by themselves. How can this be? [Q.N.1(c), 2nd Exam 2068]
8. Why does a magnet lose its magnetism when heated to high temperature? [Q.N. 1(c), 2067 2nd Exam.]
9. A ferromagnetic substance becomes paramagnetic above curie point. Explain why? [Q.N. 8(a), 2065]
10. Why does a bar magnet not retain its magnetism when it is melted ? [Q.N. 8(a), 2064]
11. A ferromagnetic substance becomes paramagnetic above curie temperature. Explain why? [Q.N. 8,(a) 2063]
12. How does dip vary from place to place on earth's surface? [Q.N.8 (c), 2059]
13. Define angle of dip and angle of declination at a place. [Q.N.8 (c), 2058]
14. What is angle of dip? How does it vary from the equator to the poles? [Q.N.8 (c), 2057]

Long Questions

1. Prove that $\cot^2\delta = \cot^2\delta_1 + \cot^2\delta_2$, where symbols have usual meanings.[Q.N.5(d), 2070 'Supp']
2. Define magnetic susceptibility and relative permeability and establish a relation between them. [Q.N. 5 (b), 2070 'C']
3. What do you mean by true dip and apparent dip? Show that $\cot^2\delta = \cot^2\delta_1 + \text{cost}^2\delta_2$, Where symbols have usual meanings. [Q.N.5(c), 2072'E']
4. Distinguish between diamagnetic and paramagnetic substances. Also explain the retentivity of ferromagnetic substance. [Q.N. 5 (c), Supp. 2069]

Numerical Problems

1. The needle of a dip circle shows an apparent dip of 45° in a particular position and 53° when the circle is rotated through 90°. Find the true dip.
   [Ans: 37°] [Q.N.9 (b), 2062]
2. A jet plane is traveling due west at the speed of 1800 km/h. What is the voltage difference developed between the ends of the wings 25 m long, if the earth's magnetic field at the location is 5.0×10^{-4}T and the dip angle is 30° ?
   [Ans : 3.5 V] [Q.N. 7(b), 2058]

3. Electromagnetic Induction

Short Questions

1. If the number of turns of a solenoid it doubled, keeping the other factors constant, how does the self inductance of the solenoid change? [Q.N.1(d), 2072'C']
2. Why does acceleration of a magnet falling through a long solenoid decrease? [Q.N.1(e), 2072'D']
3. A long straight conductor passes through the centre of a metal ring, perpendicular to its plane. If the current in the conductor increases, does current get induced in the ring? Explain. [Q.N. 1(e), Set 'D' 2071]

4. Does Lenz law violate principle of conservation of energy ? Explain. [Q.N.1(e), 2070 'Supp']
5. A copper ring is suspended by a thread in a vertical plane. One end of magnet is brought horizontally towards the ring. How will the position of the ring be affected? [Q.N. 1(d), 2070 'C']
6. A copper ring is held horizontally and a bar magnet is dropped through the ring with its length along the axis of the ring. Will the acceleration of the falling magnet be equal to the acceleration due to gravity? Explain. [Q.N. 1(d), 2070 'D']
7. Does lenz's law violet the law of conservation of energy? Explain. [Q.N. 1(e), Supp. 2069]
8. Steel is used in making permanent magnets whereas soft iron is preferred for making the core of transformer. Why? [Q.N. 1(d), 2069 Set A]
9. State and explain lenz's law. [Q.N. 1(f), 2069 Set A]
10. Explain Faraday laws of electromagnetic induction. [Q.N. 1(e), Set 'B' 2069]
11. A student asserted that if a permanent magnet is dropped down a vertical copper pipe, it eventually reaches a terminal velocity even if there is no air resistance. Why should this be? [Q.N.1(d), 1st Exam 2068]
12. If a permanent magnet is dropped down a vertical copper pipe, it eventually reaches a terminal velocity even if there is no air resistance. Why should this be? [Q.N.1(d), 2nd Exam 2068]
13. Permanent magnets are made of steel while the core of transformer is made of soft iron. Why? [Q.N.1(e), 1st Exam 2067]
14. A sheet of copper is placed between the poles of an electromagnet with magnetic field perpendicular to the sheet. When it is pulled out, a considerable force is required and force increases with speed. Explain. [Q.N. 1(d), 2067 2nd Exam.]
15. A sheet of copper is placed between the poles of an electromagnet with the magnetic field perpendicular to the sheet. When it is pulled out, a considerable force is required, and the force required increases with speed, why? [Q.N.1(e), 2066]
16. State Faraday's laws of electromagnetic induction. [Q.N.1(e), 2065]
17. A transformer cannot be used in dc circuits, why? [Q.N.2(e), 2064]
18. A bar magnet falls through a metal ring. Will its acceleration be equal to g ? Justify your answer. [Q.N.1(b), 2063 Supp.]
19. Why can't a transformer be used to step up or down the d.c. voltage? [Q.N.1(e), 2063]
20. What is eddy current? Write down its uses. [Q.N.2(d), 2063]
21. What is Lenz's law? [Q.N.1(c), 2062 Supp.]
22. What are different power losses in a transformer? What measures do you take to minimize these losses? [Q.N.2(e), 2062]
23. Why can't a transformer be used to change the value of d.c. voltage? [Q.N.1(e), 2061]
24. Explain why a transformer cannot work with direct current. [Q.N.1(c), 2060 Supp.]
25. Two closely wound circular coils have the same number of turns, but one has twice the radius of the other. What is the ratio of self inductances of the two coils ?[Q.N.2(e), 2059]
26. Show that Lenz's law is an example of conservation of energy. [Q.N.1(e), 2058]
27. State Lenz's law. [Q.N. 7(e), 2056]
28. Mention two types of loss in a transformer. [Q.N.7(c), 2055]
29. What is Lenz's law? [Q.N.4(b), 2053]

Long Questions

1. What is Lenz's law? Deduce an expression for the emf induced in a straight conductor moving in a uniform magnetic field. [Q.N.5(d), 2072'C']
2. Define self inductance. An inductor having self inductance L is used in a ac power supply. calculate the energy stored in it. [Q.N. 5 (d), Set 'C' 2071]
3. Describe the principle and working of a.c. generator. [Q.N.5(c), 2070 'Supp']
4. State and explain Faraday's laws of electromagnetic induction. Deduce an expression for the induced emf in a coil rotating uniformly in a uniform magnetic field. [Q.N.5(b), 1st Exam 2068]
5. Describe the theory and working of an a.c. generator. [Q.N.5(b), 2nd Exam 2068]

6. State and explain Faraday's law of electromagnetic induction. Derive an expression for the emf induced in a coil rotating in a uniform magnetic field. **[Q.N.5(c), 1st Exam 2067]**
7. State Faraday's laws of electromagnetic induction. Derive an expression for induced emf in a coil rotating in a magnetic field. **[Q.N. 5(c), 2067 2nd Exam.]**
8. State and explain Faraday's law of electromagnetic induction. Derive an expression for the emf induced in a coil rotating in a uniform magnetic field. **[Q.N.7(a, Or), 2064]**
9. With the help of labelled diagram explain the construction and working of a.c. generator. **[Q.N.5(a, Or), 2063 Supp.]**
10. State and explain the laws of electromagnetic induction. Derive an expression for the emf induced in a conductor moving in a magnetic field. **[Q.N.5(a), 2062 Supp.]**
11. State Lenz's law and explain how this law leads to the conservation of energy principle. **[Q.N.7(a, Or), 2062]**
12. State and explain Lenz's law. **[Q.N.7 (a, Or), 2059]**
13. Deduce an expression for induced emf in a coil rotating in a magnetic field. **[Q.N.7(a, Or), 2057]**
14. State the laws of electromagnetic induction. Derive an expression for the emf induced in a conductor moving in a magnetic field. **[Q.N. 10, 2053]**
15. Obtain the expression for the emf induced in the conductor moving in a magnetic field. **[Q.N.5, 2052]**

Numerical Problems

1. A horizontal wire, of length 5cm and carrying a current of 2A, is placed inthe middle of a long solenoid at right angles to its axis. The solenoid has 1000 turns per meter and carries a steady current I. Calculate I if the force on the wire is equal to 10^{-4}N. ($\mu_0 = 4\pi \times 10^{-7}$Hm^{-1}). **[Q.N.9(b), 2072'C']**
   [Ans : 0.79A]
2. A long solenoid of 1000 turns and cross sectional area 2×10^{-3}m^2 carries a current of 2A and produces a flux density 52×10^{-3} T inside it. Calculate the self inductance of the coil.
   [Ans : 0.052 H] **[Q.N.9(c), 2072'D']**
3. The magnetic flux passing perpendicular to the place of coil is given by $\phi = 4t^2 + 5t + 2$, where ϕ is in Weber and t is in seconds. Calculate the magnitude of instantaneous emf induced in the coil when t = 3 sec. **[Q.N.9(b), 2072'E']**
   [Ans: 29V]
4. A plane circular coil has 200 turns and its radius is 0.10m. It is connected to a battery. After switching on the circuit a current of 2A is set up in the coil. Calculate the energy stored in the coil. ($\mu_0 = 4\pi \times 10^{-7}$ Hm^{-1}) **[Q.N.9(c), Supp. 2071]**
   [Ans : 7.89×10^{-3} J]
5. Find the emf induced in a straight conductor of length 25cm. on the armature of a dynamo and 12 cm from the axis, when the conductor is moving in a uniform radial magnetic field of 0.5T. The armature is rotating at 1000 revolutions per minute.
   [Ans : 1.57V] **[Q.N. 9(c), Set 'D' 2071]**
6. A rectangular coil of 100 turns has dimensions 15×10 cm. It is rotated at the rate of 300 revolutions per minute in a uniform magnetic field of flux density 0.6T. Calculate the maximum emf induced in it.
   [Ans : 4.50 V] **[Q.N. 9(c), 2070 'D']**
7. The armature of a small generator consists of a flat, square coil with 120 turns and sides with a length of 1.6cm. The coil rotates in a magnetic field of 0.75T. What is the average speed of the coil if the maximum emf produced is 24 mV?
   [Ans : 1.67×10^{-2} m/s] **[Q.N. 9(c), Supp. 2069]**
8. A long solenoid with 15 turns per cm has a small loop of area 2cm^2 placed inside, normal to the axis of the solenoid. If the current carried by the solenoid changes steadly from 2A to 4A in 0.1 second, what is the induced voltage in the loop, while the current is changing? **[Q.N. 9(c), Set 'A' 2069]**
   [Ans: 7.5×10^{-6} V]

9. An alpha particle makes a full rotation in circle of radius 1.0 meter in 2.0 sec. Calculate the value of magnetic field induction at the centre of the circle. ($\mu_0 = 4\pi \times 10^{-7}$ H m^{-1})
[Ans: 1×10^{-25} T] **[Q.N. 9 (a), Set 'B' 2069]**
10. Two plane coils having number of turns 1000 and 2000, and radii 5 cm and 10 cm respectively are placed co-axially in the same plane. Calculate their mutual inductance. ($\mu_0 = 4\pi \times 10^{-7}$ H/m)
[Ans: 0.79 H] **[Q.N. 9(c), 2067 2nd Exam.]**
11. A long solenoid of 1000 turns and cross-sectional area 2×10^{-3} m^2 carries a current of 2A and produces a flux density 52×10^{-3} T in the middle of the coil. Assuming this value of flux density at all sections of the solenoid, calculate its self-inductance.
(Ans: 0.052H) **[Q.N. 7(b), 2066]**
12. When a wheel with metal spoke 1.2m long is rotated in a magnetic field of flux density 5×10^{-5} T normal to the plane of the wheel, an emf of 10^{-2}V is induced between the rim and the axle. Find the rate of rotation of the wheel.
[Ans : 44 rev/s] **[Q.N.5(b), 2060 Supp.]**
13. A transformer has 500 turns in the primary coil and 100 turns in the secondary coil. What is the output voltage if the input voltage is 4000 volts ? If the transformer is assumed to have an efficiency of 100%, what primary current is required to draw 2000 watts from the secondary. **[Q.N. 7(b), 2060]**
[Ans : 0.005 A]
14. A circular metal disc of area $3.0 \times 10^{-3} m^2$ is rotated at 50 rev/s about an axis through its centre perpendicular to its plane. The disc is in a uniform magnetic field of flux density 5.0×10^{-3} T in the direction of the axle. What is the value of induced emf ?
[Ans : 75×10^{-5} V] **[Q.N. 11(Or), 2056]**
15. When a wheel with metal spokes 1.2m long is rotated in a magnetic field of flux density 5×10^{-5} T normal to the plane of wheel, an emf. of 10^{-2} V is induced between the rim and axle. Find the rate of rotation of the wheel.
[Ans : 44.2 rev/S] **[Q.N. 9, 2054]**
16. A step down transferer transforms a supply line voltage 220 volts into 100 volts. Primary coil has 500 turns. The efficiency and power transmitted by the transformer are 80% and 80kW. Find (a) the number of turns in the secondary coil (a) power supplied.
[Ans : 1100, 10^5 W] **[Q.N. 11(Or), 2052]**

4. Alternating Currents

Short Questions

1. A transformer gets heated up while in use. Why? **[Q.N.1(e), 2072'C']**
2. What is wattless current? **[Q.N.1(f), 2072'D']**
3. What are the advantages of A.C. over D.C.? **[Q.N.1(f), 2072'E']**
4. For a capacitor in an a.c. circuit, explain why there is a phase difference between current and voltage. **[Q.N.1(b), Supp. 2071]**
5. What is wattless current? **[Q.N. 1(f), Set 'C' 2071]**
6. Why is a choke coil preferable to a resistor is an ac circuit? **[Q.N. 1(f), Set 'D' 2071]**
7. Define rms values of alternating current. **[Q.N.1(f), 2070 'Supp']**
8. A 220V a.c. is more dangerous than 220V d.c. Why? **[Q.N. 1(f), 2070 'C']**
9. Fluorescent lights often use an inductor, to limit the current through the tubes. Why is it better to use an inductor rather then a resistor for this purpose? **[Q.N. 1(f), 2070 'D']**
10. Define power factor and wattless current. **[Q.N. 1(f), Supp. 2069]**
11. At high frequencies, a capacitor becomes a short-circuit and an inductor becomes an open circuit. Explain. **[Q.N. 1(e), 2069 Set A]**
12. Sketch the symbols of "a capacitor", "an inductor", "emf of a cell" and "a resistor". **[Q.N. 1(b), Set 'B' 2069]**

13. Choke coil is preferred to a resistor in an alternating current circuit. Why? [Q.N.1(f),Set 'B' 2069]
14. Why is a choke preferred to a rheostat in controlling alternating current? [Q.N.1(f), 1st Exam 2068]
15. Long-distance, electric power, transmission lines always operate at very high voltage, some time as much as 750 k.V. What are the advantages of such high voltages? [Q.N.1(a), 2nd Exam 2068]
16. Define r.m.s. value of alternating current. [Q.N.1(f), 2nd Exam 2068]
17. Define rms value of alternating current. [Q.N.1(f), 1st Exam 2067]
18. What do you mean by wattless current? [Q.N. 1(f), 2067 2nd Exam.]
19. Fluorescent lamps often use an inductor, called a ballast, to limit current through the tubes. Why is it better to use an inductor rather than a resistor for this purpose? [Q.N.2(e), 2066]
20. Define rms value of alternating current. [Q.N.1(e), 2064]
21. Does D.C. pass through a capacitor? [Q.N.2(f), 2063 Supp.]
22. Explain why choke coil is used in an a.c. [Q.N.2(c), 2062 Supp.]
23. Why is a choke coil better than a resistor in an electrical appliances? [Q.N.1(e), 2062]
24. Fluorescent tubes often use an inductor to limit the current through the tube. Why is it better to use inductor than a resistor for this purpose? [Q.N.1(e), 2059]
25. What is meant by wattless current? [Q.N.2(e), 2058]
26. Why is a choke coil preferable to resistor in an a.c.? [Q.N.1(e), 2057]
27. What do you mean by r.m.s. value of an A.C. current? [Q.N.7(h), 2056]
28. Why is choke coil preferable to resistor. [Q.N. 7(e), 2055]
29. What is meant by impedance of an ac circuit? [Q.N.7(g), 2054]
30. Why do we prefer a choke coil to rheostat in an a.c. circuit? [Q.N.7(e), 2053]

Long Questions

1. An alternating current passes through a circuit containing a resistor, a capacitor and an inductor in series. Derive an expression for the phase relation between the current and the voltage. [Q.N.5(d), 2072'D']
2. Derive the condition for resonant frequency of LCR alternating current circuit. [Q.N.5(d), 2072'E']
3. Define a.c. power. Drive an expression for it. Also define power factor. [Q.N.5(c),Supp. 2071]
4. Derive an expression for the impedance of an ac circuit with an inductor, L, a capacitor C and a resistor R in series. Draw the phase diagram if the voltage across the capacitor is greater than that across the inductor. [Q.N. 5 (d), Set 'D' 2071]
5. An ac passes through a circuit containing a resistor and an inductor in series. Derive an expression for the current and phase relation between the current and voltage. [Q.N. 5 (d), 2070 'D']
6. An a.c. passes through a circuit containing a resistance and a capacitance in series. Derive an expression for the phase relation between the current and the voltage. [Q.N. 5 (d), Supp. 2069]
7. Discuss the phase relationship between the voltage and current in the ac circuit containing an inductor and a resistor in series. What is power factor of the circuit? [Q.N. 5 (d), 2069 Set A]
8. Discuss the phase relationship between the current and voltage in the A.C. circuit containing capacitor and resistor in series and hence derive an expression for the impedance of the circuit. [Q.N. 5(d), 2067 2nd Exam.]

9. Derive an expression of current flowing through an a.c. circuit containing a resistor and capacitor in series combination. What is the power factor of this circuit? [Q.N.7(a, Or), 2066]
10. Derive the condition for resonant frequency of an L–C–R alternating current series circuit. [Q.N.7(a), 2065]
11. Derive the expression for the current is LCR series circuit and the phase relationship between current and voltage. [Q.N.5(a), 2063 Supp.]
12. Define impedance of an a.c. circuit. A resistor of resistance R and an inductance L are connected in series to an a.c. voltage of frequency f. Derive an expression for the phase difference between the voltage and the current. [Q.N.5(a, Or), 2062 Supp.]
13. Find an expression for impedance of an a.c. circuit containing a resistance and a capacitor in series. Also discuss the phase relation of current and emf in that circuit. [Q.N.7(a, Or), 2061]
14. Obtain an expression for the impedance of an a.c. circuit containing resistance, capacitance and inductance in series. Discuss how it varies with the frequency of the source. [Q.N.5(a, Or), 2060 Supp.]
15. Discuss the phase relationship between the voltage and current in the a.c. circuit containing capacitor and resistor in series and hence derive an expression for the impedance of the circuit. [Q.N.7(a, Or), 2060]
16. An a.c. passes through a circuit containing a resistor and an inductor in series. Derive an expression for the phase relation between the current and the voltage. [Q.N.7(a), 2058
17. An alternating e.m.f. is applied across a capacitor. Show that the current in it leads to the applied e.m.f. by 90°. [Q.N.9, 2056]
18. Find the impendence of LCR circuit in series. [Q.N.9, 2055]
19. Discuss the phase relationship between the voltage and current in the ac circuit containing inductance and resistance. What is power factor of the circuit? [Q.N.10(or), 2052]

Numerical Problems

1. A coil having inductance and resistance is connected to an oscillator giving a fixed sinusoidal output voltage of 5V rms. With the oscillator set at a frequency of 50Hz, the rms current in the coil is 1A and at a frequency of 100Hz, the rms current is 0.625A. Determine the inductance of the coil. [Q.N.9(c), 2072'C']
   [Ans : 1.14×10^{-2} H]
2. A circuit consists of a capacitor of 2μF and a resistor of 1000Ω. An alternating emf of 12V(rms) and frequency 50 Hz is applied. Find the current flowing, the voltage across capacitor and the phase angle between the applied emf and current.
   [Ans : 6.38×10^{-3}A, 10.16V, 57.85°] [Q.N. 9(c), Set 'C' 2071]
3. An iron cored coil of 2 H and 50 Ω resistance placed in series with a resistor of 450Ω and 200 v, 50Hz a.c. supply is connected across the arrangement, find
   a) the current flowing in the coil, b) its phase angle relative to the voltage supply, c) the voltage across the coil. [Q.N.9(c), 2070 'Supp']
   [Ans : 0.25A, 157.5V, 51.5°]
4. A 50V a.c. supply is connected to a resistor having resistance 50Ω, in series with a solenoid whose inductance is 0.25H. The potential difference between the ends of the resistor is 25V. Find the resistance of the wire of the solenoid. Take frequency of the ac source is 50Hz.
   [Ans : 11.89 Ω] [Q.N. 9(c), 2070 'C']
5. Alternating voltage in an ac circuit is represented by $V = 100\sqrt{2}\sin(100\pi t)$ volts. Find its root mean square value and the frequency.
   [Ans: 100 V, 50 Hz] [Q.N. 9 (b), Set 'B' 2069]

6. A 100 V, 50 Hz AC source is connected to an LCR circuit containing L=8.1mH, C=12.5 μ F and R=10 Ω all connected in series. Find the potential difference across the resistor. **[Q.N.9(c),2068 1st Exam.]**
[Ans: 3.96V]

7. A circuit consists of an inductor of 200 μH and resistance of 10 Ω in series with a variable capacitor and a 0.10 V (r.m.s.), 1.0 MHz supply. Calculate (i) the capacitance to give resonance (ii) the quality factor of the circuit at resonance.
[Ans: 1.26×10^{-10} F, 1256.89] **[Q.N.9(c),2068 2nd Exam.]**

8. An iron cored coil on inductance 2H and of resistance 50Ω is connected in series with a resistor of 950Ω, and a 220 V, 50 Hz ac supply. Find the current flowing in the circuit and the voltage across the coil. **[Q.N. 9(c), 2067 1st Exam.]**
[Ans: 0.1862A ;117.4V]

9. A 50V, 50 Hz, ac supply is connected to a resistor of resistance 40Ω in series with a solenoid having inductance 200 mH with same resistance. The potential difference across the ends of the 40Ω resistor is found to be 20 V. Find the resistance of the wire of the solenoid. **[Q.N. 7(b), 2064]**
[Ans : 38 Ω]

10. An inductor, a resistor and a capacitor are connected in series across an a.c. circuit. A voltmeter reads 60 V when connected across the inductor, 16 V across the resistor and 30 V across the capacitor : **[Q.N. 7(b), 2063]**
    i. What will the voltmeter read when placed across the series circuit ?
    ii. What is the power factor of the circuit ?
[Ans : 34 V, 0.47]

11. In a series LCR circuit, R = 25Ω,L = 30mH and C = 10μF and these elements are connected to 240 ac (rms) 50 Hz source. Calculate the current in the circuit and voltmeter reading across a capacitor. **[Q.N. 7(b), 2062]**
[Ans : 0.774 A and 246.37 V]

12. The maximum capacitance of a variable capacitor is 33 pF. What should be the self-inductance to be connected to this capacitor for the natural frequency of the LC circuit to be 810 KHz. Corresponding to A.M. broadcast band of Radio Nepal? **[Q.N. 7(b), 2059]**
[Ans : 1.17×10^{-3} H]

13. A circuit consists of a capacitor of 10 μF and a resistor of 1000Ω. An alternating emf of 12 V (r.m.s) and frequency 50 Hz is applied. Calculate the current flowingand voltage across the capacitor. **[Q.N. 7(b), 2057]**
[Ans : 0.015 A, 4.77 V]

14. A constant A.C. supply is connected to a series circuit consisting of a resistance of 300Ω in series with a capacitance 6.67 μF, the frequency of the supply being $3000/2\pi$ Hz. It is desired to reduce the current in the circuit to half its value. Show how this could be done by placing an additional resistance.
[Ans : 306.1 Ω] **[Q.N. 11, 2054]**

15. An iron cored coil of inductance 3H and 50 ohm resistance is placed in series with a resistor of 550 ohm, and a 100V, 50Hz ac supply is connected across the arrangements. Find the current following in the coil and the voltage across the coil.
[Ans : 0.09 A, 85 V] **[Q.N. 11, 2053]**

Unit 3 – Modern Physics

1. Electrons and Photons

Short Questions

1. Beams of electrons and protons having the same initial K.E. enter normally into an electric field, which beam will be more curved? Justify. [Q.N.2(a), 2072'E']
2. Explain why electric discharge through a gas takes place at low pressure. [Q.N.2(a), Supp. 2071]
3. The value of e/m is constant for cathode rays, but not for positive rays. Explain. [Q.N. 2(a), Set 'C' 2071]
4. A gas at lower pressure conducts electricity but the same gas at higher pressure does not. Explain. [Q.N. 2(a), Set 'D' 2071]
5. What happens to the kinetic energy of photoelectrons when the intensity of incident light is doubled ? Justify your answer. [Q.N.2(b), 2070 'Supp']
6. A charged particle is fired into a cubical region of space where there is a uniform magnetic field. Outside this region, there is no magnetic field. Is it possible that the particle will remain inside the cubical region? Explain. [Q.N. 2(a), 2070 'C']
7. A charged particle moves through a region of space with constant velocity. If the external magnetic field is zero in this region, can we conclude that the external electric filed in the region is also zero? Explain. [Q.N. 2(a), 2070 'D']
8. What are cathode rays? Write their two properties. [Q.N. 2(a), Supp. 2069]
9. The value of e/m is constant for cathode rays but not for positive rays. Why? [Q.N. 2(a), 2069 Set A]
10. What is the threshold frequency for photoelectric emission? Does it depend on the intensity of light? [Q.N. 2(e), 2069 Set A]
11. Write down expressions of acceleration of a moving charge Q in parallel and perpendicular magnetic fields. [Q.N. 2(f), Set 'B' 2069]
12. Gases are insulators at ordinary pressures and start conducting at low pressures. Why? [Q.N.2(a), 1st Exam 2068]
13. What property of the cathode rays indicates that they consist of electrons? [Q.N.2(a), 2nd Exam 2068]
14. Why does electric discharge take place at low pressure and high potential difference? [Q.N.2(a), 1st Exam 2067]
15. What is the importance of Millikan's oil drop experiment? [Q.N. 2(a), 2067 2nd Exam.]
16. Compare the specific charge of an electron with that of a proton. [Q.N.2(f), 2065]
17. Which metals are suitable for photoelectric effect ? Why ? [Q.N.2(b), Supp. 2063]
18. What are work function and threshold frequency in photoelectric effect? [Q.N.1(b), Supp. 2062]
19. Why discharge does not take place at very low pressure ? [Q.N.1(e), Supp. 2062]
20. What are cathode rays? [Q.N.2(d), Supp. 2062]
21. Cathode rays cannot be regarded as electromagnetic waves. Why? [Q.N.1(g), 2060]
22. What is meant by stopping potential? [Q.N.12(c), 2056]
23. Discuss the physical principles invovoled in Milikan's experiment for the determination of the charge of an electron. [Q.N. 13, 2055]
24. Explain why photoelectric effect cannot be observed with all wavelengths of light. [Q.N.12(d), 2054]
25. What is threshold frequency? [Q.N. 12(e), 2053]

Long Questions

1. Describe with necessary theory Thomson's method to determine specific charge of an electron. [Q.N.6(a), 2072'C']

2. Define photoelectric effect. Discuss Einstein's photoelectric equation. What is meant by stopping potential? [Q.N.6(a), 2072'D']
3. Explain Millikan's experiment for the verification of Einstein's photoelectric equation. [Q.N.6(d), 2072'E']
4. Verify quantization of charge using Millikan's oil drop experiment. [Q.N.6(a), Supp. 2071]
5. Discuss the motion of an electron in a uniform magnetic field and show that if a free electron moves at right angle to a magnetic field, the path is a circle and the time period of revolution is independent of the speech of the electron. [Q.N. 6 (a), Set 'C' 2071]
6. Describe with necessary theory of Millikan's oil drop experiment to determine the value of the charge associated with an electron. [Q.N. 6 (a), Set 'D' 2071]
7. Describe an experiment to determine the specific charge of an electron. [Q.N.6(a), 2070 'Supp']
8. What do you mean by stopping potential? Describe Millikan's experiment to determine Planck's constant. [Q.N. 6 (a), Supp. 2069]
9. Describe with necessary theory, Millikan's oil drop experiment to determine the value of the charge associated with an electron. [Q.N. 6 (a), 2069 Set A]
10. Describe Millikan's oil drop experiment with necessary theory. Estimate the specific charge of an electron from it. [Q.N. 6 (a), Set 'B' 2069]
11. Describe with necessary theory of Millikan's oil drop experiment to determine the value of the charge associated with an electron. [Q.N.6(a), 1st Exam 2068]
12. Describe the phenomenon of electrical discharge through gases. [Q.N.6(a), 2nd Exam 2068]
13. What is photoelectric effect? Discuss Einstein's Photoelectric equation. Does the work function of a metal depend on intensity of light? [Q.N.6(a), 1st Exam 2067]
14. Describe Millikan's experiment to verify Einstein's photoelectric equation. [Q.N. 6(a), 2067 2nd Exam.]
15. Describe an experimental method to determine the specific charge of an electron. [Q.N.9(Or), 2065]
16. What is specific charge of an electron? Describe and give necessary theory of J.J. Thomson's method to determine the specific charge of an electron. [Q.N.9, 2064]
17. Prove that the path of an electron is parabola in electric field. [Q.N.6(a), Supp. 2063]
18. Describe the theory of Millikan's oil drop experiment to determine the number of charge on oil drop. [Q.N.8(a, Or), 2063]
19. Show that electron motion in magnetic field is circular. Prove that frequency and time period are independent with the velocity of electron. [Q.N.9(Or), 2063]
20. Describe with neat diagram the discharge phenomenon through gas. [Q.N.6(a), Supp. 2060]
21. State the laws of photoelectric emission and describe Millikan's experiment for determining the value of planck's constant. [Q.N.7(a), Supp. 2060]
22. Write down Einstein's photoelectric equation and describe an experiment to verify it. [Q.N.8(a), 2060]
23. What are cathode rays? State their six properties. [Q.N.8(a), 2057]
24. Explain the phenomena of discharge of electricity through gases at low pressure. [Q.N.13, 2056]
25. Describe an experiment to determine the specific charge of electron. [Q.N.15, 2054]
26. Describe with necessary, theory, Millikan's oil drop experiment to determine the value of the charge associated with an electron. [Q.N. 15, 2052]

Numerical Problems

1. The work function for the surface of aluminium is 4.2 eV. How much potential difference will be required to stop the emission of maximum energy electrons emitted by light of wavelength 2000A? (Plank's constant, $h = 6.6\times10^{-34}$JS)
[Ans : 1.98 v] **[Q.N.10(a), 2072'C']**
2. In a Millikan's oil drop experiment, a drop is observed to fall with a terminal speed 1.4 mm/s in the absence of electric filed. When a vertical electric field of 4.9×10^{5}v/m is applied, the droplet is observed to continue to move downward at a lower terminal speed 1.21 mm/s. Calculate the charge on the drop. (Density of oil = 750 kg/m^3, viscosity of air = 1.81×10^{-5}kg/ms, density of air = 1.29kg/m^3) **[Q.N.10(a), 2072'D']**
[Ans : 5.15×10^{-19}C]
3. A beam of electrons, moving with velocity of 10^7m/s, enters midway between two horizontal parallel plates in the direction parallel to the plates which are 5cm long and 2cm apart and have a p.d. of V volts between them. Calculate V if the beam is deflected so that if just grazes the edge of the plate.
(Assume e/m = 1.76×10^{11}c/kg) **[Q.N.10(b), 2072'E']**
[Ans: 90.9V]
4. Light of wavelength 5×10^{-7} m falls on a sensitive metal plate with photo electric work function 1.90eV. Find kinetic energy of the photoelectrons emitted and stopping potential. (given $h = 6.62 \times 10^{-34}$JS). **[Q.N. 10 (a), Set 'C' 2071]**
[Ans : 0.65ev, 0.65v]
5. Ultraviolet light of wavelength 3.6×10^{-7} m is made to fall on a smooth surface of potassium. Determine maximum energy of emitted photo electrons and stopping potential.
[Ans : 1.44 ev, 1.44v] **[Q.N. 10 (a), Set 'D' 2071]**
6. An electron is accelerated through a potential difference of 2000V and then it enters a uniform magnetic field of 0.02 Tesla is a direction perpendicular to it. Find the radius of the path of the electron in the magnetic field. Mass of an electron is 9.1×10^{-31} kg, charge of an electron is 1.6×10^{-19}C.
[Ans : 7.55×10^{-4}m] **[Q.N. 10 (c), Set 'D' 2071]**
7. Electrons with maximum kinetic energy of 3ev are ejected from a mental surface by ultra-violet radiation of wavelength 1.5×10^{-7} m. Determine work function, threshold wavelength and the stopping potential for the metal (Planck's constant $h = 6.62\times10^{-34}$ Js)
[Ans : 8.44×10^{-19}J, 2.35×10^{-7} m, 3V] **[Q.N.10(a), 2070 'Supp']**
8. An electron beam after being accelerated from rest through a potential difference of 5 KV in vacuum is allowed to impinge normally on a fixed surface. If the incident current is 50μA, Determine the force exerted on the surface assuming that it brings the electrons to rest. Take mass of electron is 9.1×10^{-31} Kg.
[Ans : 1.2×10^{-8} N] **[Q.N. 10 (a), 2070 'C']**
9. The photoelectric threshold wavelength of a tungsten surface is 272 nm. Calculate the maximum velocity of the electrons ejected from this tungsten surface by ultraviolet radiation of frequency 1.45×10^{15} Hz.
($h = 6.62\times10^{-34}$ Js, $c = 3\times10^{8}$m/s, $m_e = 9.1 \times 10^{-31}$ kg)
[Ans : 7.1×10^5 m/s] **[Q.N. 10 (b), 2070 'C']**
10. A beam of electrons, moving with a velocity of 10^7m/s, enters midway between two horizontal parallel plates in a direction parallel to the plates. Each plate is 5cm long. These plates are kept 2cm apart and a potential difference of 90V is applied between them. Calculate the velocity of the electron-beam with which it just grazes the edge of the positive plate. (e/m = 1.8×10^{11} c/kg.)
[Ans : 10.06×10^6 m/s] **[Q.N. 10 (a), 2070 'D']**

11. When ultraviolet light with a wavelength of 400nm falls on a certain metal surface, the maximum kinetic energy of the emitted electrons is 1.10eV. What is the maximum kinetic energy of the photoelectrons when light of wavelength 300nm falls on the same surface?
[Ans : 2.13 eV] **[Q.N. 10 (b), 2070 'D']**

12. In the ionosphere, electrons executes 1.4×10^6 revolutions in a second. Find the strength of the magnetic flux density B in this region. (mass of an electron = 9.1×10^{-31} kg, electronic charge = 1.6×10^{-19}c) **[Q.N. 10 (a), Supp. 2069]**
[Ans : 5×10^{-5} T]

13. An electron is accelerated through a potential difference of 2KV and then it enters a uniform magnetic field of 0.02T, in a direction perpendicular to it. Find the radius of the path of the electron in the magnetic field.
(mass of electron = 9.1×10^{-31} kg) **[Q.N. 10 (a), Set 'A' 2069]**
[Ans: 7.5×10^{-3} m)

14. Specific charge of particle is 4.4×10^7C kg^{-1}. It is moving in a circular orbit with a velocity 3.52×10^5 ms^{-1} in a magnetic flux density 0.4T. Find the radius of its orbit.
[Ans: 0.02 m) **[Q.N. 10 (c), Set 'B' 2069]**

15. Two plane metal plates 4 cm long are held horizontally 3 cm apart in a vacuum, one being vertically above the other. The copper plates is at a potential of 300V and the lower is earthed. Electrons having velocity of 10^7m/s are injected, horizontally midway between the plates and parallel to the 4cm edge. Calculate the vertical deflection of the electron beam as it emerges from the plates.(e/m for electron =1.8×10^{11} Ckg^{-1}.)
[Ans: 1.44×10^{-2}m] **[Q.N.10(a),2068 1st Exam.]**

16. What will be the change in the stopping potential for photoelectrons emitted from a source if the wavelength of incident light is reduced from 400 nm to 360 nm ?
[Ans: 0.34 volt] **[Q.N.10(c),2068 1st Exam.]**

17. An electron having 450 eV of energy moves at right angles to a uniform magnetic filed of flux density 1.50×10^{-3} T. Find the radius of its circular orbit. [Given specific charge of the electron = $1.76\times10^{+11}$ Ckg^{-1}]
[Ans: – 0.048 m) **[Q.N.10(a),2068 2nd Exam.]**

18. Light of frequency 5×10^{14} Hz liberates electrons with energy 2.31×10^{-19} J from a certain metallic surface. What is the wavelength of ultraviolet light which liberates electrons of energy 8.93×10^{-9} J from the same surface ?
[Planck constant = 6.62×10^{-34} JS] **[Q.N.10(b),2068 2nd Exam.]**
[Ans: 2.0×10^{-7} m)

19. In a Millikan-type apparatus the horizontal plates are 1.5 cm apart. With the electric field switched off an oil drop is observed to fall with the steady velocity 25×10^{-2} cms^{-1} when the field is switched on the upper plate being positive, the drop just remains stationary when the potential difference between the plates is 1500V. Calculate the radius of the drop and the number of electronic charges.
(Given – density of oil = 900 kg m^{-3} and viscosity of air = 1.8×10^{-5} NSm^2, Neglect air density)
[Ans: 1.5×10^{-6}m;8] **[Q.N. 10(a), 2067 1st Exam.]**

20. A beam of electrons is under potential difference of 1.36×10^4 V applied across two parallel plates 4 cm apart and a magnetic field 2×10^{-3} T at right angles to each other. If two fields produce no deflection in the electronic beam, calculate (i) the velocity of electrons (ii) the radius of the orbit in which the beam will move, if the electric field is made zero. [Given; mass of electron = 9.1×10^{-31} Kg.].
[Ans: (i) 1.7×10^8m/s (ii) 0.48 m] **[Q.N. 10(a), 2067 2nd Exam.]**

21. In Millikan-type apparatus, the horizontal plates are 1.5 cm apart. With the electric field switched off an oil drop is observed to fall with the steady velocity 2.5×10^{-2} cm/s. When the electric field is switched on the upper plate being positive, the drop just remains stationary when the p.d. between plates is 1500V. (a) Calculate the radius of the drop (b) How many electronic charges does it carry? **[Q.N. 8(b)Or, 2066]**

$$\left(\textbf{Ans: } 1.125\times10^{-2}\sqrt{\frac{\eta}{\rho}} \qquad 3.735\times10^{9}\sqrt{\frac{\eta^3}{\rho}}\right)$$

22. When a light of frequency 5.4×10^{14} Hz is incident on a metal surface, the maximum energy of the electrons emitted is 1.2×10^{-19} J. If the same surface is illuminated with light of frequency 6.6×10^{14} Hz, the maximum energy of the electrons is 2×10^{-19} J. Find the value of Planck's constant. **[Q.N. 8(b), 2064]**

[Ans : 6.67 × 10^{-34} Js]

23. Radiation of 3000Åfalls on a photo sensitive material of work function 3 eV and photoelectrons are ejected. Find the maximum kinetic energy of photoelectrons.

(Ans: 1.8 × 10^{-19} J) **[Q.N.6(b), Or, 2063 Supp.]**

24. When the light of frequency 5.4×10^{14} Hz is shone on to a metal surface the maximum energy of the electron emitted is 1.2×10^{-19} J. If the same surface is illuminated with light of frequency 6.6×10^{14} Hz the maximum energy of the electron emitted is 2×10^{-19} J. Use this data to calculate the value of Planck's constant. **[Q.N. 8(b), 2063]**

[Ans : 6.67 × 10^{-34} Js]

25. A beam of proton is accelerated from rest through a potential difference of 2000V and then enters a uniform magnetic field which is perpendicular to the direction of the proton beam. If the flux density is 0.2T, calculate the radius of the path which the beam describes.

(proton mass = 1.7×10^{-27} kg, Electronic charge = -1.6×10^{-19} C)

[Ans : 0.03 m] **[Q.N. 8(b), 2061]**

26. Two plane metal plates 4 cm. long are held horizontally 3cm. apart in a vacuum, one being vertically above the other. The upper plate is at a potential of 300 V and the lower is earthed. Electrons having a velocity of 10^7 m/s are injected horizontally midway between the plates and in a direction parallel to the 4 cm. edge. Calculate the vertical deflection of the electron beam as it emerges from the plates. (e/m for electron = 1.8×10^{11} C kg^{-1})

[Ans : 1.44 × 10^{-2} m] **[Q.N. 8(b)Or, 2060]**

27. A UV light of 400 nm strikes a cesium surface of work function 1.9 eV. Find the velocity of electron emitted from the cesium surface

($m_e = 1.9\times10^{-31}$ kg. c = 3×10^8 mls h = 6.62×10^{-34} JS) **[Q.N. 8(b), 2059]**

[Ans : 6.4 × 10^5 m/s]

28. Calculate the p.d. in volt necessary to be maintained between two horizontal conducting plates, one 5 mm above the other, so that a small oil drop of mass 1.31×10^{-14} kg with two electrons attached to it remains in equilllibricenn

(g = 9.8ms^{-2}, charge of electron = -1.6×10^{-19} C) **[Q.N. 8(b)Or, 2058]**

[Ans : 2000 V]

29. The photoelectric work function of potassium is 2eV and the surface is illuminated with radiation of wavelength 350 nm. What potential difference have to be applied between a potassium surface and the collecting electrode in order just to prevent collection of electrons? What would be the kinetic energy of the electrons? **[Q.N. 8(b), 2057]**

[Ans : 1.5 V, 2.4 × 10^{-19} J]

30. When light of frequency 5.4×10^{14} Hz is shone on to a metal surface the minimum energy of the electrons emitted is 1.2×10^{-19} J. If the same surface is illuminated with ligtht of frequency 6.6×10^{14} Hz the maximum energy of the electrons emitted is 2.0×10^{-19}J. Use this data to calculate a value for the Planck's constant. [Q.N. 15, 2056]
[Ans : 6.67×10^{-34} JS]

31. Find the electric field required to keep a water drop of radius 10^{-5} cm just suspended in vacuum when charged with one electron. (electronic charge = -1.6×10^{-19}C) [density of water = 1000 kg/m^3] [Q.N. 16(Or), 2056]
[Ans : 257 V]

32. The maximum kinetic energy of the electrons emitted from a metallic surface is 1.6×10^{-19} J when the frequency of the radiation is 7.5×10^{14} Hz. Calculate the minimum frequency of the radiationfor which electrons will be emitted. Assume that $h = 6.6 \times 10^{-34}$ Js. [Q.N. 15(Or), 2055]
[Ans : 5×10^{14} Hz]

33. A beam of proton is accelerated from test through a p.d. of 2000 V and then enters a uniform magnetic field which is perpendicular to the direction of the proton beam. If the flux density is 0.4 T, calculate the radius of the path which the beam describes.
(proton mass = 1.7×10^{-27} kg, electronic charge = -1.6×10^{-19}C).
[Ans : 162.9×10^{-4} m] [Q.N. 14, 2054]

34. Light of frequency 5×10^{14} Hz, liberated electrons with energy 2.31×10^{-19} J from a certain metallic surface. What is the wave length of ultraviolet light which liberates electrons of energy 8.93×10^{-19} J from the same surface.
(Given, $C = 3.0 \times 10^8$ ms^{-1}, $h = 6.62 \times 10^{-34}$ JS) [Q.N. 14, 2053]
[Ans : 2×10^{-7} m]

35. An oil drop of mass 3.25×10^{-15} kg falls vertically with uniform velocity, through the air between vertical parallel plates which are 2cm apart. When a p.d. of 1000V is applied to the plates the drop moves to the positively charged plate, being inclined at 45° to the vertical. Calculate the charge on the drop.
[Ans : 6.37×10^{-19} C] [Q.N. 16, 2053]

2. Solids and Semiconductor Devices

Short Questions

1. What are logic gates? Give a truth table for a two input NOR gate. [Q.N.2(b), 2072'C']
2. The output of two-input AND gete is fed to a NOT gate. Draw the logic circuit of the combination of gates. Write down its truth table. [Q.N.2(a), 2072'D']
3. What is mean by a charge carrier hold in a semi conductor? Can it be created in a conductor? [Q.N.2(b), 2072'E']
4. When examining a circuit diagram, how is it possible to tell whether a transistor is PNP or NPN ? [Q.N.2(b), Supp. 2071]
5. What is truth table? Write down the truth table for a two-input NAND gate. [Q.N. 2(d), Set 'C' 2071]
6. Draw a circuit diagram for a p-n junction diode in forward bias. Sketch the voltages - current graph for the same. [Q.N. 2(b), Set 'C' 2071]
7. What is nanotechnology? Explain. [Q.N. 2(d), Set 'D' 2071]
8. An n-type semiconductor has a large number of free electrons at room temperature, yet it is said to be electrical neutral. Why ? [Q.N.2(d), 2070 'Supp']
9. What is logic gate? Give logic symbol and truth table for an OR gate. [Q.N. 2(c), 2070 'C']
10. What is a logic gate? Give logic symbol and truth table for a two-input AND gate. [Q.N. 2(c), 2070 'D']
11. The conduction in a metal is mainly due to electrons. Justify. [Q.N. 2(b), Supp. 2069]
12. A p-type semiconductor has a large number of holes but still it is electrically neutral. Explain. [Q.N. 2(b), 2069 Set A]

13. What is a logic gate? Draw the truth table for an AND gate. [Q.N. 2(d), Set 'B' 2069]
14. How does the suitable impurity increase the conductivity of a semiconductor? [Q.N.2(c), 1st Exam 2068]
15. Would there be any advantage to adding n-type or p-type impurities to copper? Why or why not? [Q.N.2(b), 2nd Exam 2068]
16. A student asserts that Si and Ge became good conductors at very high temperature and good insulators at very low temperature. Do you agree? Explain your reasoning. [Q.N. 2(b), 2067 2nd Exam.]
17. An n-type semiconductor has a large number of electrons. It is electrically neutral? Explain. [Q.N.2(b), 1st Exam 2067]
18. What are logic gates? Give truth table for a two-input AND gate. [Q.N.2(c), 1st Exam 2067]
19. How is p-type semiconductor formed? Explain. [Q.N.1(f), 2065]
20. What is meant by barrier potential ? [Q.N.1(c), Supp. 2063]
21. Draw the logic symbol and truth table for OR gate. [Q.N.2(e), Supp. 2063]
22. Give the circuit symbol and truth table of NAND gate. [Q.N.1(f), 2063]
23. Differentiate between a conductor and a semiconductor. [Q.N.1(e), Supp. 2062]
24. What do you mean by biasing a transistor? [Q.N.1(f), 2062]
25. When P and N-type materials are interfaced, these exists a depletion layer at the interface. Explain. [Q.N.2(g), 2062]
26. Draw the logic symbol for a NAND gate and write down its truth table. [Q.N.2(d), Supp. 2060]
27. What factors determine whether a material is a semiconductor or an insulator? [Q.N.1(f), 2059]
28. A p-n diode conducts electricity when forward biased and does not conduct when reverse biased. Explain. [Q.N.1(f), 2058]
29. The base region of a transistor is made very thin as compared with emitter and collector regions, why? [Q.N.2(f), 2057]
30. How the conductivity of a semiconductor changes with the presence of impurities? [Q.N. 12(b), 2056]
31. How is it possible to rectify an AC? [Q.N.12(a), 2055]
32. When examining a circuit diagram, how is it possible to tell whether a transistor is a n-p-n or p-n-p? [Q.N.12(d), 2055]
33. Why may the addition of small quantities of suitable impurities to an intrinsic semiconductor result in a considerable decrease in its resistivity? [Q.N.12(e), 2054]
34. What do you mean by hole in the semi-conductor? [Q.N.12(f), 2052]

Long Questions

1. What is an extrinsic semiconductor? Explain the formation of potential barrier and depletion region in a p–n junction. [Q.N.6(b), 2072'C']
2. Explain the use of a p-n junction diode as a rectifier. Draw the circuit diagram of a full wave rectifier using diodes and explain its working. [Q.N.6(b), 2072'D']
3. What is rectification? How can you construct a full wave rectifier using two semiconductor diodes? Explain their working. [Q.N.6(a), 2072'E']
4. What is a semiconductor diode ? Explain the working of a full wave rectifier. [Q.N.6(b), Supp. 2071]
5. What is p-n junction? Describe forward biased and reverse biased condition of p-n junction. [Q.N. 6 (d), Set 'C' 2071]
6. Distinguish between intrinsic and extrinsic semiconductors. Explain the formation of potential barrier and depletion region in a p-n junction. [Q.N. 6 (d), Set 'D' 2071]
7. What is a rectifier ? Describe two semiconductor diodes as a full wave rectifier. [Q.N.6(d), 2070 'Supp']

8. What is Zener breakdown? Describe how a Zener diode can be used as a voltage regulator? [Q.N. 6 (a), 2070 'C']
9. What is a p-n junction diode? Explain the characteristics of it in the forward and reversed biased condition. [Q.N. 6 (a), 2070 'D']
10. How is a PN junction formed? Explain the working of a PN junction diode when it is forward biased. [Q.N. 6 (b), Supp. 2069]
11. Explain with neat diagram, the working mechanism of a full wave rectifier using junction diodes. How the out-put changes when a filter circuit is used? [Q.N. 6 (b), 2069 Set A]
12. What is Zener diode? Explain how it regulates the constant voltage in the electronic circuit. [Q.N. 6 (b), Set 'B' 2069]
13. What is a transistor? Discuss the input and output characteristics of a transistor in CE configuration. [Q.N.6(b), 1st Exam 2068]
14. What are Logic gates? Describe, with truth tables, three basis gates: OR, AND and NOT. [Q.N.6(b), 2nd Exam 2068]
15. What is rectifier? Describe how two diodes can work as full-wave rectifier. [Q.N.6(b), 1st Exam 2067]
16. What is rectifier? How do two diodes work as full wave rectifier? [Q.N. 6(b), 2067 2nd Exam.]
17. What is rectifier? Describe the working of full wave rectifier using two semiconductor diodes. [Q.N.8(a), 2066]
18. What do you understand by Zener diode? How can this be used as voltage regulator? [Q.N.9, 2065]
19. What do you mean by avalanche effect and zener effect? Describe with necessary circuit diagram the use of zener diode as a voltage regulator. [Q.N.8(a), 2064]
20. What is a junction diode? Discuss it's applications as a full wave bridge rectifier. [Q.N.7, Supp. 2063]
21. What is p-n-p transistor? Describe briefly a circuit of p-n-p transistor amplifier in its common emitted configuration. [Q.N.7(Or), Supp. 2062]
22. What is a junction diode? Explain its working as a half wave rectifier. [Q.N.9, 2061]
23. How are P-type and N-type semiconductors formed. Discuss the forward biasing of a P-N junction diode. [Q.N.6(a), 2060 Supp.]
24. How is an NPN transistor formed? Discuss the input and output characteristics of the transistor in CE configuration. [Q.N.9(Or), 2060]
25. What are N-type and P-type semiconductors? Describe with a neat diagram the working mechanism of a full wave rectifier for a junction diode. [Q.N.9, 2059]
26. Explain the characteristics of a diode and discuss its application as a full wave rectifier. [Q.N. 13(Or), 2055]
27. What is a junction diode? Explain full wave rectification produced by a filter circuit. [Q.N. 15(Or), 2054]
28. What is a junction diode? Discuss its applications as full wave rectifier. [Q.N.15(Or), 2053]

3. Quantization of Energy

Short Questions

1. If we go on increasing the wavelength of light incident on a metal surface, what changes take place in the number of electrons and energy of the electrons? [Q.N.2(a), 2072'C']
2. Even if a hydrogen atom contains an electron, its spectrum consists of a large number of lines. Explain how? [Q.N.2(c), 2072'C']
3. What is optical pumping in the production of laser? [Q.N.2(b), 2072'D']
4. Production of X-ray is the inverse phenomenon of photoelectric effect. Justify it.[Q.N.2(d), 2072'E']
5. "The total energy of an electron of an atom in an orbit is negative". What does this negative energy indicate? [Q.N.2(f), 2072'E']