Educomp smartclass™

Sample Paper (CBSE)

Series PHY/SP/1D **Code No. SP/1-D**

PHYSICS (Theory)

Time Allowed: 3 hours *Maximum Marks: 70*

General Instructions:

(i) *All questions are compulsory.*

(ii) *This question paper has five sections: Section A, Section B, Section C, Section D and Section E.*

(iii) *Section A contains five questions of one mark each, Section B contains five questions of two marks each, Section C contains twelve questions of three marks each, Section D contains one value based question of four marks and Section E contains three questions of five marks each.*

(iv) *There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions of five marks each weightage. You have to attempt only one of the choices in such questions.*

(v) *You may use the following values of physical constants wherever necessary:*

$c = 3 \times 10^8$ m/s

$h = 6.63 \times 10^{-34}$ Js

$e = 1.6 \times 10^{-19}$ C

$\mu_o = 4\pi \times 10^{-7}$ T mA^{-1}

$\frac{1}{4\pi\epsilon_o} = 9 \times 10^9$ N m^2 C^{-2}

$m_e = 9.1 \times 10^{-31}$ kg

Mass of Neutrons = 1.675×10^{-27} kg

Mass of proton = 1.673×10^{-27} kg

Avogadro's number = 6.023×10^{23} per gram mole

Boltzmann constant = 1.38×10^{-23} JK^{-1}

Section A

1. If the distance between two equal point charges is doubled and their individual charges are also doubled, what would happen to the force between them? 1

2. Magnetic field lines can be entirely confined within the core of a toroid, but not within a straight solenoid. Why? 1

3. Why are convex mirror used as side view mirrors in cars? 1

4. Write the expression for the de Broglie wavelength associated with a charged particle having charge 'q' and mass 'm', when it is accelerated by a potential V. 1

5. How does the energy gap of an intrinsic semiconductor vary, when doped with a trivalent impurity? 1

Section B

6. An electric flux of -5×10^3 Nm^2C^{-1} passes through a spherical Gaussian surface of radius 20 cm due to the charge placed at its centre.

a. Calculate the charge enclosed by the Gaussian surface.

b. If the radius of the Gaussian surface is doubled, how much flux would pass through the surface? 2

7. Two metallic wires of the same material have the same length but

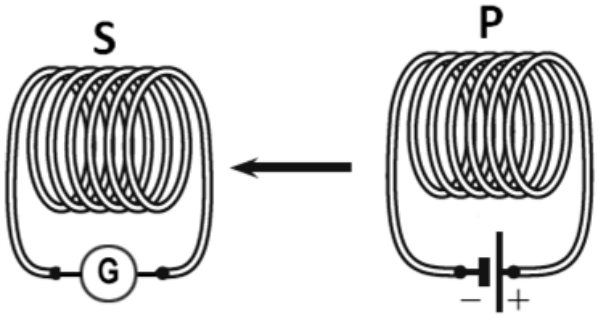
cross-sectional area is in the ratio 1: 2. They are connected

a. in series and

b. in parallel.

Compare the drift velocities of electrons in the two wires in both the cases. 2

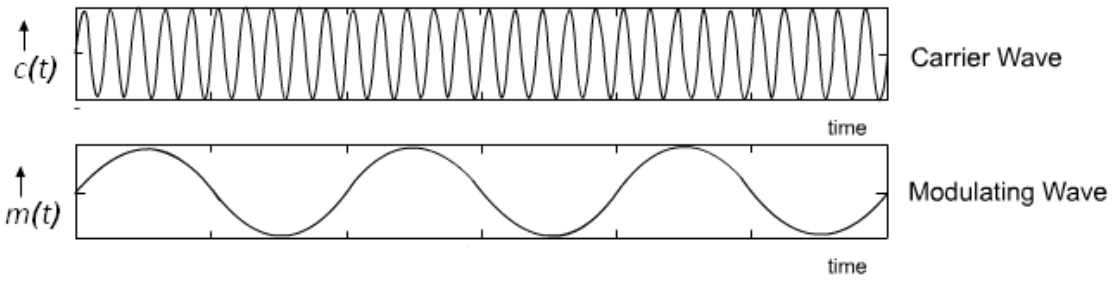
8. When primary coil P is moved towards secondary coil S, as shown in figure, the galvanometer shows momentary deflection. What can be done to have larger deflection in the galvanometer with same battery? State the related law.



2

9. Two thin converging lenses of focal lengths 15 cm and 30 cm are held in contact with each other. Calculate power and focal length of the combination. 2

10. Figure shows a carrier wave *c (t)* that is to be amplitude modulated by a modulating wave *m (t)*.



Draw the general shape of the resulting amplitude modulated wave. Define its modulation index. 2

Section C

11. A proton and an alpha particle having the same kinetic energy are allowed to pass through a uniform magnetic field perpendicular to their direction of motion. Compare the radii of the paths of proton and alpha particle. 3

12. What are eddy currents? State the main undesirable effects of these current and give the method used to minimize this undesirable effect. 3

13. a. For a given a.c., $i = i_m sin\,\omega t$, show that the average power dissipated in a resistor R over a complete cycle is $\frac{1}{2} i_m^2 R$.

b. A light bulb is rated at 125 W for a 250 V a.c. supply. Calculate the resistance of the bulb. 3

14. Identify the type of electromagnetic waves, whose method of production is associated with-

a. klystron valve

b. vibration of atoms and molecules and

c. decay of atomic nuclei.

Also give the approximate range of wavelengths of each of these waves. 3

15. Draw a ray diagram to show the image formation by a concave

mirror, when the object is kept between its focus and the pole. Using this diagram, derive the magnification formula for the image formed. 3

16. What are optical fibers? Write down their applications. 3

17. Write Einstein's photoelectric equation and point out any two characteristic properties of photons on which this equation is based. Briefly explain the three observed features which can be explained by this equation. 3

18. Write the main postulates of Rutherford's atomic model and the cause of failure of this model. 3

19. In the hypothetical fission reaction:

$$X_{92}^{236} \rightarrow Y_{a}^{141} + Z_{36}^{b} + 3n_{0}^{1}$$

What are the values of the numbers a and b? Calculate the total energy released per nuclear fission in MeV units, when the masses in a.m.u. units are of neutrons = 1.009 a.m.u., of X-nucleus = 235.891 a.m.u, of Y-nucleus = 140.673 a.m.u. and of Z-nucleus = 91.791 a.m.u.. 3

20. Define current gains, α and β of a transistor. A transistor has a current gain of 30. If the collector resistance is 6 kΩ, input resistance is 1 kΩ, calculate its voltage gain. 3

21. The output of an OR gate is connected to both the inputs of NAND gate. Draw the logic circuit of this combination of gates and write its

truth table. 3

22. What is modulation and demodulation? What are the different types of modulation? Draw a simple demodulation circuit or detector circuit. 3

Section D

23. Sudhir was performing an experiment to carry out a project. He required an ammeter of range 7.5 A. It was not available in the laboratory and in the market. So, he decided to convert a galvanometer into an ammeter of given range.

a. What values do you think are there in Sudhir?

b. How could he do that? Explain by showing calculations. 4

Section E

24. a. Draw equi-potential surfaces due to a point charge Q>0. Are these surfaces equidistant from each other? If not, explain why?

b. Derive an expression for the potential energy of an electric dipole in uniform electric field. 5

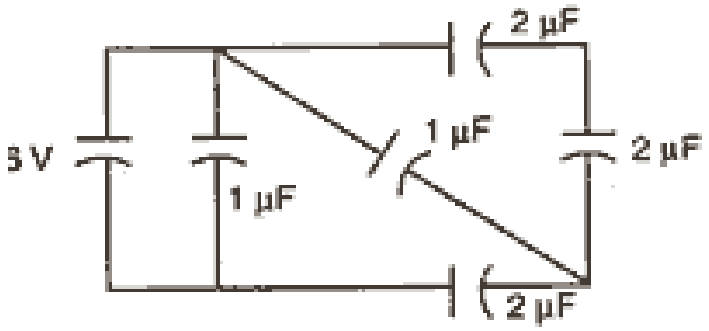
OR

a. Capacitors P, Q and R have each a capacitance C. A battery can charge the capacitor P to a potential difference V. If after charging P, the battery is disconnected from it and the charged capacitor P is connected in following separate instances to Q and R

1. To Q in parallel and
2. To R in series

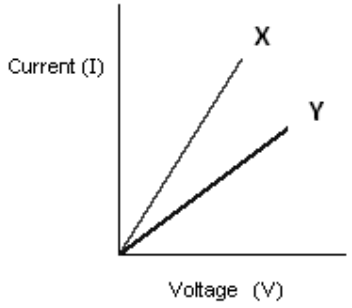
   Then what will be potential differences between the plates of P in the two instances?

b. Find the total energy stored in the capacitors in the network shown in the figure:



5

25. a. The voltage-current variation of two metallic wires X and Y at constant temperature is shown in figure. Assuming that the wires have the same length and same diameter, explain which wire will have a larger resistivity and why?



b. A large number of identical cells, n, each of e.m.f. E, internal resistance r connected in series are charged by a d.c. source of e.m.f. E, using a resistor R.

1. Draw the circuit arrangement.

2. Deduce the expression for the charging current across the combination of the cells. 5

OR

a. Explain with the help of a circuit diagram, how the value of an unknown resistance can be determined using a Wheatstone bridge. Give the formula used.

b. The length of a potentiometer wire is 1200 cm and it carries a current of 80 mA. For a cell of e.m.f. 4 V and internal resistance 20 Ω, the null point is found to be 1000 cm. If a voltmeter is connected across the cell, the balancing length decreases by 20 cm. Find:

1. The resistance of the potentiometer wire
2. Reading of the voltmeter and
3. The resistance of the voltmeter. 5

26. Draw a neat labeled diagram of astronomical telescope. Derive the expression for the magnification of an astronomical telescope. 5

OR

Describe Young's double slit experiment or the interference of light and obtain an expression for the fringe width. 5

ANSWERS

1. The force will remain the same.

2. The field lines are confined within the core of the toroid because the turns of the wires in a toroidal solenoid are wound over its core in circular form. Whereas, in a straight solenoid the field lines cannot form closed loops within the solenoid.

3. Because it gives a wide field of view of the traffic.

4. $\lambda = \frac{h}{\sqrt{2mqV}}$

5. The electrons from the valence band are easily transferred to the acceptor energy level created in the forbidden energy gap just above the valance band due to the addition of the trivalent impurity.

6. a. Charge on the sphere is given by:

$$q = \varepsilon_0 \varphi = -4.43 \times 10^{-8} C$$

b. If the radius of the Gaussian surface is doubled, the electric flux through the new surface will remain the same i.e. $-5 \times 10^3 Nm^2 C^{-1}$

7. Given: A' = 2A

a. For series combination:

$$\frac{v_d}{v_d'} = \frac{A'}{A} = 2$$

b. For parallel combination:

$$\frac{v_d}{v_d'} = 1$$

8. The primary coil P should be moved faster towards the secondary coil to have larger deflection in the galvanometer with same battery. The related law is Faraday's laws of electromagnetic induction which states that whenever magnetic flux linked with a circuit changes, induced e.m.f. is produced whose magnitude is directly proportional to the rate of change of magnetic flux linked.

9. Focal length of the combination is given by:

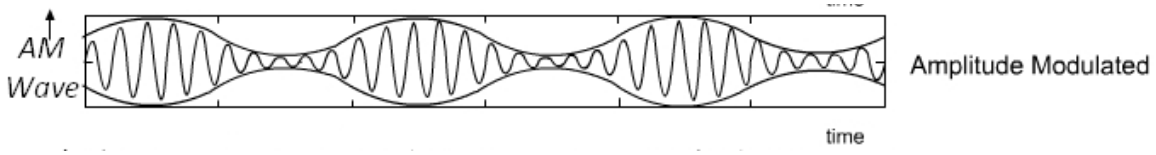
$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{10}$$

$$\therefore \quad f = 10cm$$

Power of combination is:

$$P = \frac{1}{f(in\ meter)} = 10D$$

10.



The degree to which the carrier wave is modulated is called as modulation index.

11. Charge on alpha particle Q = 2(charge on proton) = 2q

Mass of alpha particle M = 4(mass of proton) = 4m

For proton:

$$r = \frac{mv}{Bq}$$

For alpha particle:

$$R = \frac{2mV}{Bq}$$

$$\therefore \quad \frac{r}{R} = \frac{1}{2}$$

12. Eddy currents are the induced currents discovered by Foucalt. Whenever the magnetic flux associated with a conducting surface changes, an induced current starts flowing on the surface of the conductor. The flow pattern resembles swirling eddies in water, hence named eddy currents.

If a copper plate is allowed to oscillate in between the two pole-pieces of a magnet such that it moves in and out of the magnetic field, the motion of the plate is damped. The reason is the change in the flux passing through the plate and the production of induced current on the surface of the copper plate. These currents always oppose the cause producing it. Due to these currents the surface of the conductor is heated.

Since these currents flow on the surface of the conductor so they can be minimized by reducing the surface area of the conductor.

13. a. We know $P = i^2R$ and $i = i_m sin\, \omega t$. Thus average power is given by:

$\langle P \rangle = \frac{i_m^2}{2R}$ (rms current I related to peak current i_m as $I = \frac{i_m}{\sqrt{2}}$)

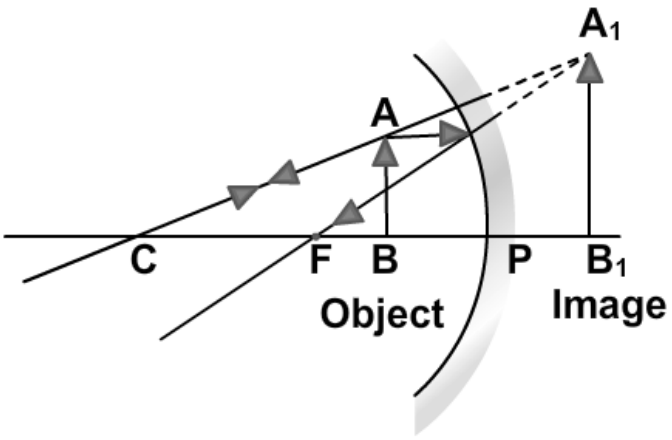
b. $R = \frac{V^2}{P} = 500\, \Omega$

14. a. Microwave: wavelength range = 10^{-3} m to 0.1m.

b. Infrared rays: wavelength range = 8×10^{-9} m to 8×10^{-3} m.

c. Gamma rays: wavelength range = 6×10^{-13} m to 10^{-11} m.

15.



The formula for magnification is:

$$m = \frac{I}{O} = -\frac{v}{u} = \frac{f - v}{f} = \frac{f}{f - u}$$

16. Optical fiber is a device which is used to transmit light from one place to the other along curved path in more effective manner.

Applications:

a. In the field of communication and computer for transmitting and receiving signals.

b. For making medical investigations such as endoscopy.

c. In the form of photometric sensors for measuring blood flow in heart.

d. In the form of refractometers to determine the refractive indices of liquids.

17. Einstein's photoelectric equation is:

$KE\ of\ emitted\ electrons =$

$Energy\ of\ photon - Work\ function\ of\ metallic\ surface$

$$\frac{1}{2}mv^2 = h(\nu - \nu_0)$$

Two characteristics of photons are:

a. Einstein's photoelectric equation is based on particle nature of light.

b. Total energy of photon is transferred completely to a single electron.

The three observed features which can be explained by this equation are:

1. If incident frequency ν < threshold frequency (ν_0), then kinetic energy will be negative which is not possible because kinetic energy cannot be negative. This shows that photoelectric emission is not possible if frequency (ν) of incident light is less than the threshold frequency (ν_0) of the metal.
2. One electron is emitted from the metal surface by one photon, so the number of photoelectrons emitted per second is directly proportional to the intensity of incident light. This depends upon number of photons present in the incident light.
3. The kinetic energy increases with the increase in the frequency (ν) of the incident light.

18. Postulates of Rutherford's atom model:

a. An atom is regarded as a sphere of diameter 10^{-10} m whose total positive charge and mass is concentrated in a small central core called nucleus.

b. The nucleus is surrounded by negatively charged electrons.

c. An atom is electrically neutral.

d. The electrons are revolving around the nucleus in circular orbits.

Cause of failure of Rutherford's atomic model:

a. Rutherford model cannot explain the stability of the atom. The accelerating electrons revolving around the nucleus continuously emit energy as a result of which the radius of revolving electron should go on decreasing and ultimately it should fall into the nucleus.
b. It could not explain the line spectrum of atoms like hydrogen.

19. $92 = a + 36 \Rightarrow a = 56$

$236 = 141 + b + 3 \times 1 \Rightarrow b = 92$

Total energy released is given by:

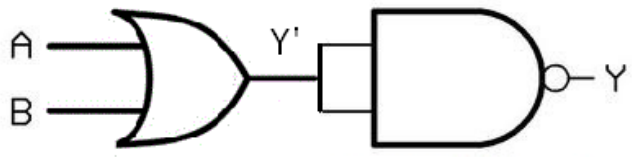
$Q = [m_X - (m_Y + m_Z + 3m_n)] \times 931 = 372.4\ MeV$

20. Current gain of a common base amplifier (α): The ratio of change in collector current to the change in emitter current at constant collector voltage is called current gain of a common base amplifier.

Current gain of a common emitter amplifier (β): The ratio of change in collector current to the change in base current at constant emitter current is called current gain of a common base amplifier.

$$Voltage\ gain = Current\ gain \times resistance\ gain = 180$$

21.



Truth Table:

A	B	Y'	Y
0	0	0	1
1	0	1	0
0	1	1	0
1	1	1	0

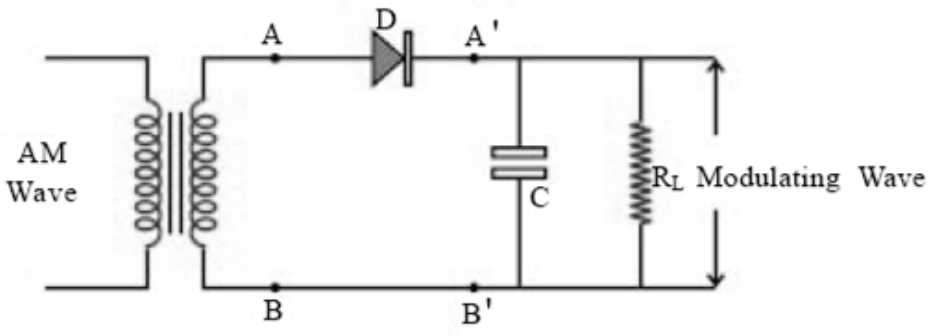
22. A modulation is the process of superposing low frequency audio signals on waves with high frequency.

In receiver AM, electrical signal is amplified by an amplifier, which is then mixed with another signal of higher frequency so that carrier wave changes to a lower frequency. This frequency is called intermediate frequency (IF). The main function of receiver is to separate the information signals from the carrier wave. This process is called demodulation. This is a reverse process of modulation.

Types of Modulation: Any one of the parameters can vary, keeping the other two constants. The three types of modulation based on three parameters are:

a. Amplitude modulation
b. Frequency modulation
c. Phase modulation

A simple demodulation circuit or detector circuit is shown in the figure below:

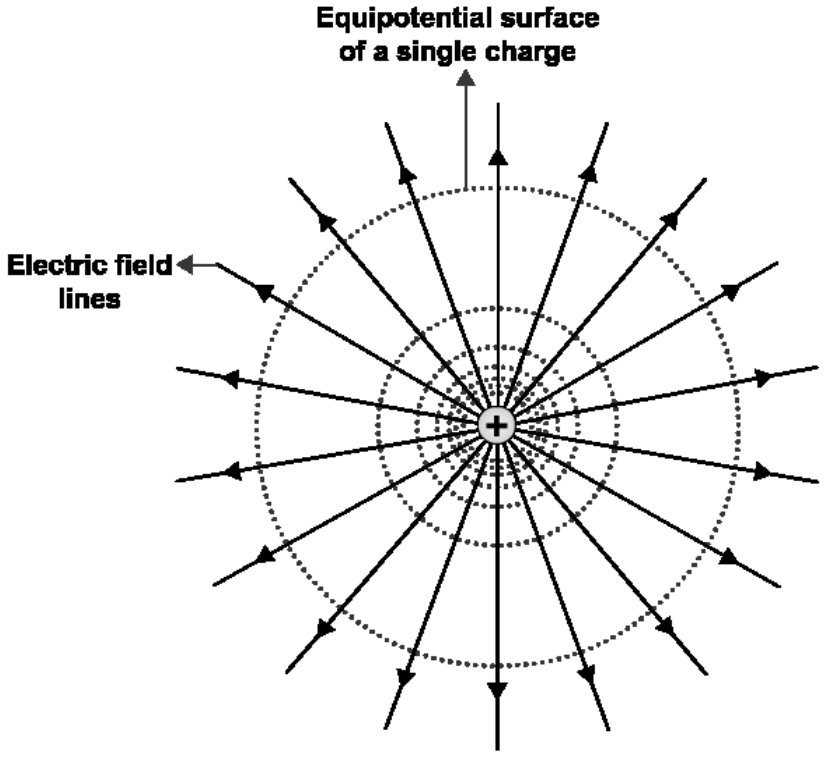


23. a. Quality to solve the problem by using scientific knowledge.

b. To convert a galvanometer into an ammeter of given range, he joined a resistance of appropriate value in parallel with the galvanometer. Value of resistance is given by:

$$S = \frac{I_g G}{I - I_g}$$

24. a.



No, equipotential surfaces are not equidistant from each other. We know that:

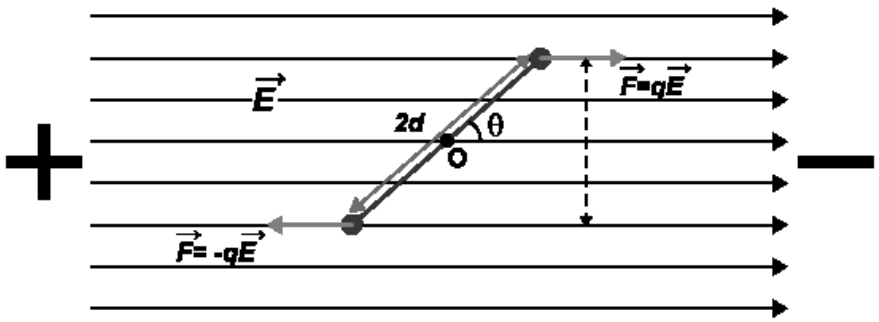
$$E = -\frac{dV}{dr} \; or \; dr = -\frac{dV}{E}$$

For the same change in the value of dV, dV = constant. Thus we have

$$dr \propto \frac{1}{E}$$

That is the equipotential surfaces are closer together where the electric field is stronger and farther apart where the field is weaker.

b.



Potential energy of an electric dipole placed in an electric field is given by:

$$U = -pE\cos\theta \;\; or \; U = -\vec{p}.\vec{E}$$

OR

a. Charge acquired by the capacitor when the capacitor P is charged to a potential difference V is, $q = CV$.

1. When capacitor P is connected to Q in parallel then total capacitance becomes 2C and total charge is q + 0 = q = CV. Therefore potential difference across each capacitor becomes

$$V' = \frac{C}{2} \cdot \frac{V}{2}$$

When capacitor P is connected to R in series then the circuit will not get complete and the potential difference across the capacitor P will remain unchanged.

b. Using the series and parallel combination of capacitors, the equivalent capacitance of the combination is 2 μF.

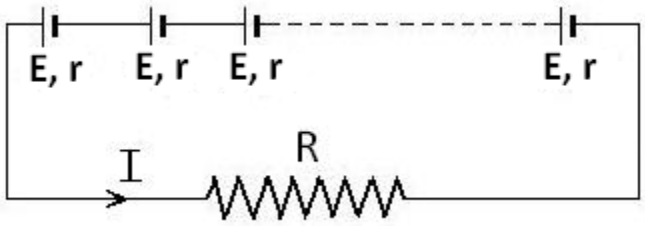
Thus using the formula

$$U = \frac{1}{2} CV^2$$

The energy stored in the network of capacitors is 9 x 10^{-6} J

25. a. The wire Y has greater resistivity as the current through Y will be smaller than that of X.

b. 1. The circuit diagram is:



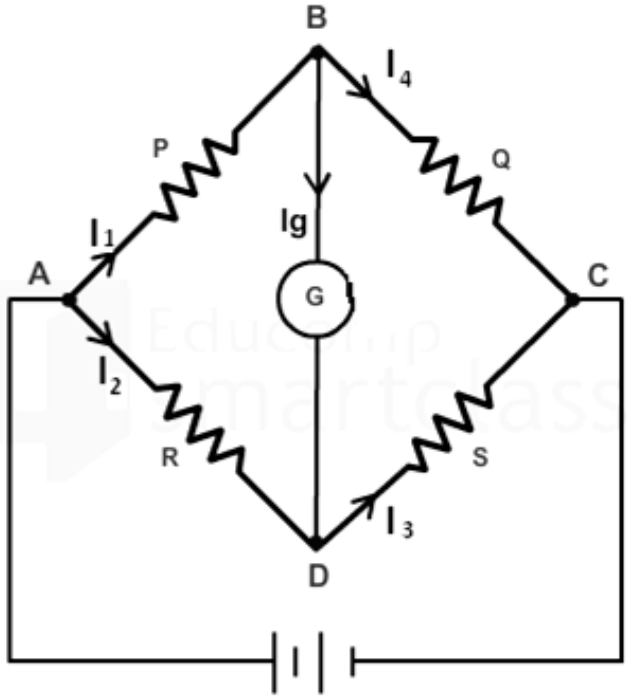
2. The current flowing through the circuit is given by:

$$I = \frac{Total\ emf}{Toatl\ resistance} = \frac{nE}{R + nr}$$

OR

a. A Wheatstone bridge is an electric circuit which is used to measure an unknown electrical resistance by balancing the resistances in the

two branches of a bridge circuit, one branch of which includes the unknown resistance.



When no current flows through the galvanometer, the bridge is said to be balanced. On attaining the balance condition, with given values of three resistances, one can find the value of the fourth unknown resistance. The balancing condition for Wheatstone bridge is:

$$\frac{P}{Q} = \frac{R}{S}$$

b. 1. Resistance of 1000 cm wire = R' = 50 Ω

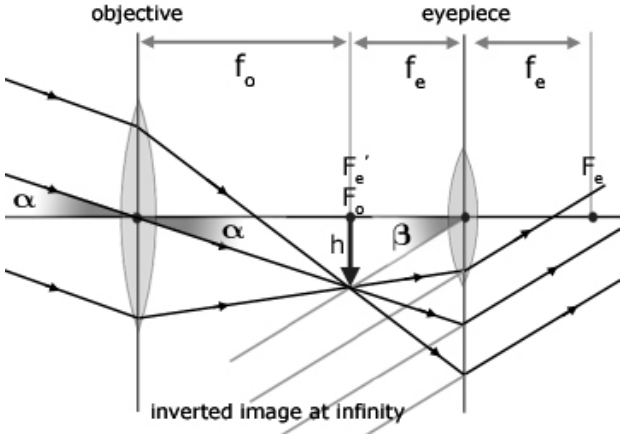
Resistance of the whole length of potentiometer wire = (R'/1000) × 1200 = 60 Ω.

Let R be the resistance of the potentiometer wire and I be the current flowing through it. As

$\frac{RI}{1200} \times 1000 = 4\ R = 60\ \Omega$

2. Reading of voltmeter = (4/1000) × 980 = 3.92 V
3. Resistance of voltmeter = $r\left(\frac{l_2}{l_1-l_2}\right) = 980\ \Omega$

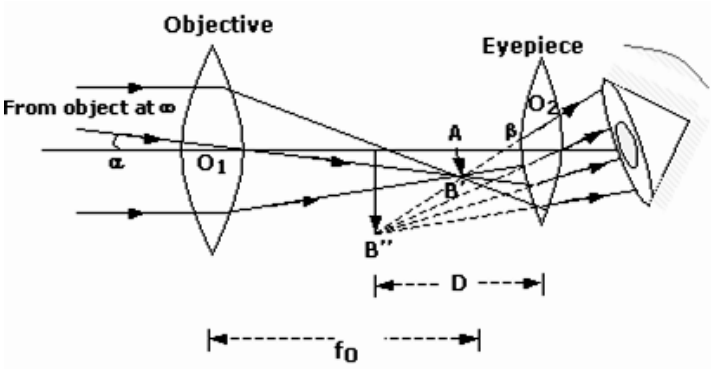
26. When the final image is formed at infinity:



The magnifying power is:

$$M = -\frac{f_o}{f_e}$$

When the final image is formed at least distance of distinct vision:



The magnifying power is:

$$M = -\frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$$

OR

Young's double slit experiment