26/08/2022

Slot-2

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Answers & Solutions

Time : 45 min. | *for* | M.M. : 200

CUET UG-2022

(Physics)

IMPORTANT INSTRUCTIONS:

1. The test is of 45 Minutes duration.
2. The test contains 50 Questions out of which 40 questions need to be attempted.
3. Marking Scheme of the test:
   a. Correct answer or the most appropriate answer: Five marks (+5)
   b. Any incorrect option marked will be given minus one mark (–1).
   c. Unanswered/Marked for Review will be given no mark (0).

Choose the correct answer :

Question ID: 1187801

Magnitude of electric field due to a point charge + Q experienced by a test charge q at a distance r from the point charge $+Q$ is equal to:

(A) Magnitude of dielectric force experienced by the point charge/Q

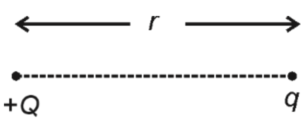
(B) Magnitude of electric force experienced by the test charge/q

(C) Magnitude of repulsive force between the point charge and the test charge

(D) Magnitude of electric force experienced by point charge Q multiplied by the magnitude of charge on the test charge

Answer (B)

Sol.



$$E = \frac{F}{q}$$

Hence option (B) is the correct.

Question ID: 1187802

Point A lies at a distance r on the axis of q short electric dipole. Electric field at this point is 160 $\frac{\text{V}}{\text{m}}$. Now consider another point P at a distance $2r$ on its axis. The value of electric field at this point will be

(A) 160 $\frac{\text{V}}{\text{m}}$ (B) 40 $\frac{\text{V}}{\text{m}}$

(C) 20 $\frac{\text{V}}{\text{m}}$ (D) 10 $\frac{\text{V}}{\text{m}}$

Answer (C)

Sol. Electric field due to a dipole on its axis.

$$E = \frac{2KP}{r^3};\ E \propto \frac{1}{r^3}$$

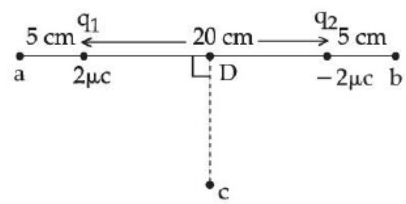
$$\frac{E_1}{E_2} = \left(\frac{r_2}{r_1}\right)^3$$

$$\frac{160}{E_2} = \left(\frac{2r}{r}\right)^3$$

$$E_2 = \frac{160}{8} = 20\ \frac{\text{V}}{\text{m}}$$

Question ID: 1187803

Two point charges q_1 = 2μC and q_2 = –2μC are placed 20 cm apart from each other. Point 'a' is 5 cm away from q, on the line joining q_1 and q_2 on the side opposite to q_2. Point 'b' is 5 cm away from q_2, on the line joining q_1 and q_2, opposite to q_1. Point 'c' is at a perpendicular distance of 10 cm from the centre point D of the line joining q_1 and q_2. Identify the correct statement depicting the situation.



(A) Point C and D are equipotential

(B) Potential at point a, $V_a < V_b$, potential at point b

(C) Potential at point a, $V_a < V_c$, potential at point c

(D) Potential at point D, $V_D > V_b$ potential at point b $V_D > V_b$

Answer (A*)

Sol. Point C and D are equidistant from q_1 and q_2. So net potential on C and D is zero. Hence option (A) is correct.

*Option (D) is not clear (There must be an error in option D).

Question ID: 1187804

A spherical metal body has +Q charge, uniformly distributed over its outer surface. The body has a cavity at its centre. Select proper procedure from those given below which will change the charge on the outer surface of this body from +Q to –Q.

(A) Charge –2Q is inserted in the cavity and is kept insulated from the inner surface of the cavity

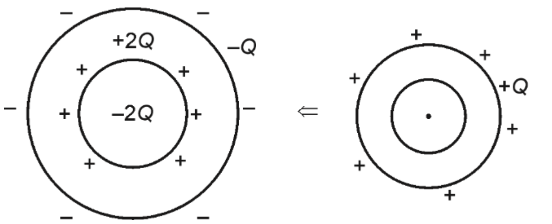
(B) Charge –2Q is brought closer to the body externally and kept at some small distance away from it

(C) Another metal sphere having total charge –2Q distributed on its surface is kept in contact with the given spherical body for some time and then the two are separated

(D) A metal body having charge –Q is inserted in the cavity and kept touching the inner surface of the cavity

Answer (A)

Sol.



Now to change net charge on outer surface of sphere as –Q. Place a charge –2Q at centre of sphere without making a contact with sphere.

Question ID: 1187805

A 300 μF capacitor is charged by 90 volt. Once it is charged battery is removed. Now another uncharged capacitor of capacitance 600 μF is connected across it (in parallel). The value of common potential is

(A) 30 volt (B) 60 volt

(C) 120 volt (D) 0 volt

Answer (A)

Sol. Common potential

$$V = \frac{C_1V_1 + C_2V_2}{C_1 + V_2}$$

$$= \frac{300 \times 90 + 600 \times 0}{300 + 600}$$

$$= \frac{300 \times 90}{900} = 30 \text{ V}$$

Question ID: 1187806

Given below are two statements:

Statement I: Electric potential at every point inside a uniformly charges conducting sphere is equal to that on its surface.

Statement II: Work done by an electrostatic field in moving a charge from one point to another depends on the length of the path taken to go from one point to the other.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(A) Both **Statement I** and **Statement II** are correct

(B) Both **Statement I** and **Statement II** are incorrect

(C) **Statement I** is correct but **Statement II** is incorrect

(D) **Statement I** is incorrect but **Statement II** is correct

Answer (C)

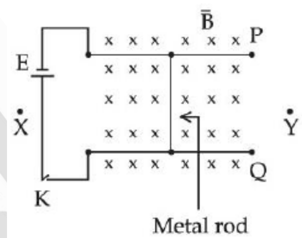
Sol. **Statement I:** Electric potential inside solid conducting sphere is constant and equal to the value on its surface.

Statement II: Electrostatic force is conservative in nature. It does not depend on the path followed.

Hence, **Statement I** is correct but **Statement II** is incorrect.

Question ID: 1187807

Two conducting rails P and Q are held parallel to each other in the plane of the paper. There is uniform magnetic field 'B' perpendicular to the length of the rails going into the paper. A metal rod is kept touching both the rails and is perpendicular to the rails. A dc source is connected, with switch K, to the ends of the rails on one side as shown in the figure. Select the correct statement describing the situation of the metal rod when the switch K is closed.



(A) The rod will remain stationary.

(B) The rod will oscillate along the length of the rails.

(C) The rod will move along the rails from in the direction from X to Y.

(D) The rod will move along the rails from in the direction from Y to X.

Answer (D)

Sol. By Fleming's left hand rule.

Rod will experience force in the direction from Y to X.

Hence (D) is the correct answer.

Question ID: 1187808

Magnetic flux through any closed surface around magnetic pole is always zero. The correct reason for this fact, is

(A) Magnets always exist in pairs

(B) Magnets are always dipoles

(C) Magnets can exist as monopoles

(D) No magnet exerts force on another magnet

Answer (B)

Sol. Magnets are always dipoles. So net magnetic flux through any closed surface around magnetic pole is zero.

Question ID: 1187809

Match List-I with List-II.

	List-I		List-II
(A)	Magnetic field	(I)	NA^{-2}
(B)	Magnetic flux	(II)	$NA^{-1}m^{-1}$
(C)	Magnetic permeability	(III)	Am^2
(D)	Magnetic moment	(IV)	NmA^{-1}

Choose the correct answer from the options given below :

(1) (A) - (II), (B) - (III), (C) - (I), (D) - (IV)

(2) (A) - (IV), (B) - (II), (C) - (III), (D) - (I)

(3) (A) - (II), (B) - (IV), (C) - (I), (D) - (III)

(4) (A) - (III), (B) - (I), (C) - (IV), (D) - (II)

(A) 1 (B) 2

(C) 3 (D) 4

Answer (C)

Sol. SI unit of $\vec{B}$ is N/mA.

$\phi = BA$ $A \rightarrow II$

$= Tm^2$ $B \rightarrow IV$

$= NA^{-1}m^{-1}m^2$ $C \rightarrow I$

$= NA^{-1}m$ $D \rightarrow III$

Question ID: 1187810

A charge particle is moving on a helical path in a uniform magnetic field. The correct statement describing the velocity of this charge particle, is :

(1) The particle has non-zero components, of velocity along the parallel as well as perpendicular directions of magnetic field

(2) The particle velocity is in a direction parallel to the direction of magnetic field

(3) The particle velocity is in a direction perpendicular to the direction of magnetic field

(4) The particle is initially at rest while switching the magnetic field on

(A) 1 (B) 2

(C) 3 (D) 4

Answer (A)

Sol. As charge particle is moving in helical path therefore it have non-zero components of velocity, along parallel as well as normal to magnetic field.

Question ID: 1187811

In the magnetic meridian at a certain place the horizontal component of earths magnetic field is 32 G and the angle of dip is 60°. The total magnetic field of the earth at this location, is :

(A) 0.52 G (B) 0.64 G

(C) 0.54 G (D) 0.32 G

Answer (B*)

Sol. H = 32 G

$\delta = 60°$

$H = R\cos\delta$

$$R = \frac{H}{\cos\delta}$$

$$= \frac{32 \times 2}{1} = 64 \text{ G}$$

If H would be 0.32 G then answer would be 0.64 G.

Question ID: 1187812

Below are mentioned some properties of ferromagnetic substances. Identify the correct ones.

(A) These have strong tendency to move from a region of weak magnetic field to strong magnetic field

(B) In these substances, atomic dipoles align themselves in a common direction over a macroscopic volume called domains

(C) Magnetisation of these materials is inversely, proportional to the absolute temperature $M \propto \frac{1}{T}$ (Curl's law)

(D) These materials show Meissners effect super conducting magnets which is used in magnetically leviated superfast trains

(E) The temperature of transition from ferromagnetic to paramagnetic to called Curies law

Choose the correct answer from the options given below :

(1) (A), (B), (E) only (2) (B), (C), (D) only

(3) (C), (D), (E) only (4) (B), (D), (E) only

(A) 1 (B) 2

(C) 3 (D) 4

Answer (A)

Sol. (A) Ferromagnetic substance have large χ_m so they have tendency to move from weak magnetic field to strong magnetic field.

(B) Atoms have permanent magnetic moment which are organised in Domains.

(E) Above absolute temperature ferromagnetic materials looses their ferromagnetism & transition to paramagnetic.

Question ID: 1187813

Which of the following EM waves can be produced by using Klystron or Magnetrons or Gunn diodes?

(A) Gamma rays
(B) X rays
(C) Microwaves
(D) UV rays

Answer (C)

Sol. Magnetron Klystron or Gunn diode, all produces microwave signals.

Question ID: 1187814

Electric and Magnetic fields oscillate sinusoidally in an Electromagnetic Waves. The oscillating electric field cannot be represented in this way, where the symbols have their usual meaning:

(A) $E = E_0 \sin(kz - \omega t)$

(B) $E = E_0 \sin\left[2\pi\left(\frac{z}{\lambda} - \frac{t}{T}\right)\right]$

(C) $E = E_0 \sin\left[\frac{2\pi}{\lambda}(z - \nu t)\right]$

(D) $E = E_0 \sin\left[\frac{2\pi}{T}(\nu z - t)\right]$

Answer (D)

Sol. (A) $E = E_0 \sin(kz - \omega t)$ General form.

(B) $E = E_0 \sin\left[\frac{2\pi z}{\lambda} - \frac{2\pi}{T}t\right]$

$= E_0 \sin[kz - \omega t] \quad \left[\because k = \frac{2\pi}{\lambda},\ \omega = \frac{2\pi}{T}\right]$

(C) $E = E_0 \sin\left[\frac{2\pi}{\lambda}z - \frac{2\pi\nu}{\lambda}t\right]$

$= E_0 \sin[kz - 2\pi\nu t] \quad \left[\text{frequency } \nu = \frac{v}{\lambda}\right]$

$= E_0 \sin[kz - \omega t]$

(D) Dimensionally incorrect

Question ID: 1187815

For what distance is ray optics a good approximation when the aperture is 2 mm wide and the wavelength is 400 nm?

(A) 0.1 m
(B) 5×10^{10} m
(C) 5×10^3
(D) 10 m

Answer (D)

Sol. Aperture width a = 2 mm

Fresnel distance $z_f = \frac{a^2}{\lambda}$

$= \frac{(2\times10^{-3})^2}{400\times10^{-9}} = \frac{4\times10^{-6}}{400\times10^{-9}}$

= 10 m

Question ID: 1187816

A beam of light converges at a point *M*. Now a concave lens of focal length 32 cm is placed in the path of convergent beam 24 cm from *M*. Now the beam will converge at:

(A) 56 cm from lens
(B) 8 cm from lens
(C) +96 cm from lens
(D) –32 cm from lens

Answer (C)

Sol. Object is virtual

u = 24 cm

f = – 32 cm

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$-\frac{1}{32} = \frac{1}{v} - \frac{1}{24}$

$\frac{1}{v} = \frac{-1}{32} + \frac{1}{24} = \frac{8}{32\times24}$

v = 96 cm from lens.

Question ID: 1187817

An equiconvex lens of focal length 10 cm is made up of material with refractive index 1.5. The radius of curvature of the each surface is

(A) 10 cm
(B) 20 cm
(C) 40 cm
(D) 5 cm

Answer (A)

Sol. Lens maker's formula

$$\frac{1}{f}=(\mu-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$$

$$\frac{1}{f}=0.5\left[\frac{2}{R}\right]$$

R = 10 cm

Question ID: 1187818

A compound microscope has an objective lens of focal length f_o = 1.0 cm, an eyepiece of focal length 2.2 cm and has tube length 22 cm. The magnification produced compound microscope is

(A) –250 (B) –200

(C) –100 (D) –150

Answer (A)

Sol. $\text{M·P}=\frac{L}{f_o}\frac{D}{f_e}$

$$=-\frac{22\times 25}{1\times 2.2}$$

$$\boxed{\text{M·P}=-250}$$

Question ID: 1187819

The working of an optical fibre can be explained on the basis of

(A) Reflection of light

(B) Refraction of light

(C) Scattering of light

(D) Total Internal Reflection of Light

Answer (D)

Sol. Working of an optical fibre can be explained on the basis of total internal reflection.

Question ID: 1187820

A light source is kept in air ($n \approx 1$) at a distance of 200 cm from a convex spherical glass surface $\left(n=\frac{3}{2}\right)$ such that light falls on it. If the radius of curvature of the surface is 40 cm, the position of the image is at

(A) –100 cm (B) –200 cm

(C) +200 cm (D) +100 cm

Answer (C)

Sol. $\mu_2=\frac{3}{2},\ \mu=1$

R = 40 cm

u = – 200 cm

$$\frac{\mu_2}{v}-\frac{\mu_1}{u}=\frac{\mu_2-\mu_1}{R}$$

$$\frac{1.5}{v}+\frac{1}{200}=\frac{1.5-1}{40}$$

$$\frac{1.5}{v}=\frac{5}{400}-\frac{1}{200}$$

v = 200 cm

Question ID: 1187821

In Young's double Slit experiment 3rd maxima (Bright Band) is obtained at a distance d_1 from the central bright fringe when light of wavelength λ_1 is used and at a distance d_2 when light of wavelength λ_2 is used. What will be the ratio of d_1 and d_2?

(A) $\frac{\lambda_1^2}{\lambda_2^2}$ (B) $\frac{\lambda_2}{\lambda_1}$

(C) $\frac{\lambda_1}{\lambda_2}$ (D) $\sqrt{\frac{\lambda_2}{\lambda_1}}$

Answer (C)

Sol. Distance of nth maxima from the central bright fringe

$$x=\frac{n\lambda D}{d}$$

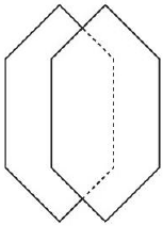
$$x_3=\frac{3\lambda D}{d}=d_1 \qquad \text{...(i)}$$

$$x_3'=\frac{3\lambda_2 D}{d}=d_2 \qquad \text{...(ii)}$$

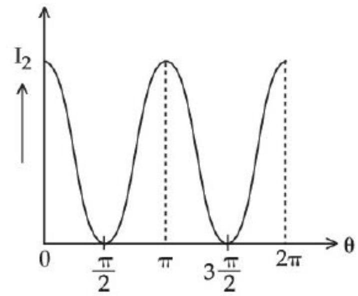
$$\frac{d_1}{d_2}=\frac{\lambda_1}{\lambda_2}$$

Question ID: 1187822

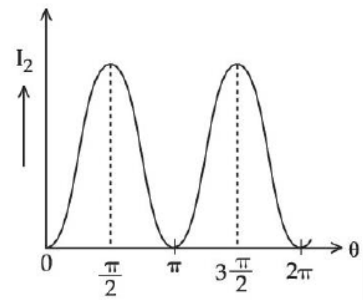
Consider the polaroids P_1 and P_2 kept with axis parallel to the other. Now the polaroid P_2 is rotated from 0 to 2π with respect to P_1. The variation of intensity of transmitted light through P_2 will be shown as



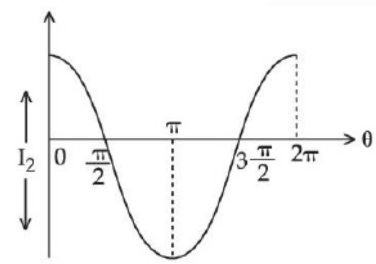
(A)



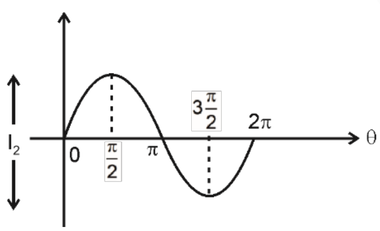
(B)



(C)



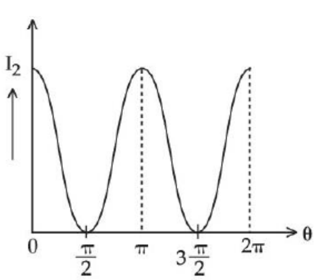
(D)



Answer (A)

Sol. Intensity of polarised light

$$I = \frac{I_0}{2}\cos^2\theta$$



Question ID: 1187823

The Brewster's angle for air to water transition is (Refractive index of water = $\frac{4}{3}$)

(A) $\sin^{-1}\left(\frac{4}{3}\right)$ (B) $\sin^{-1}\left(\frac{3}{4}\right)$

(C) $\tan^{-1}\left(\frac{4}{3}\right)$ (D) $\tan^{-1}\left(\frac{3}{5}\right)$

Answer (C)

Sol. By Brewster's law

$i_c = \tan^{-1}(\mu)$

$$i_c = \tan^{-1}\left(\frac{4}{3}\right)$$

Question ID: 1187824

A proton and a triton are accelerated from rest through a potential *V*. The ratio of their de Broglie wavelength is :

(A) 1 : 1 (B) 1 : 2

(C) $1:\sqrt{2}$ (D) $\sqrt{3}:1$

Answer (D)

Sol. de-Broglie wavelength of a charge moving in a electric field

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

Mass of triton = 3 (mass of proton)

$$\frac{\lambda_1}{\lambda_2} = \sqrt{3}:1$$

Question ID: 1187825

In the experimental study of photoelectric effect, a graph of stopping potential versus frequency of incident radiation for two metals *A* and *B* is plotted and identical slopes for both are obtained with different cut off frequencies ($\nu_{DB} > \nu_{OA}$). So

(A) Slope for all metals is same = *h*/*e*. Here work function of *A* > work function of *B*

(B) Slope for all metals is same = *h*/*e*. Here work function of *B* > work function of *A*

(C) Slope for all metals is same = *h*. Here work function of *A* > work function of *B*

(D) Slope for all metals is same = *h*. Here work function of *B* > work function of *A*

Answer (B)

Sol. By Einstein's photoelectric equation

$\phi = f_0 + eV$

$h\nu = h\nu_0 + eV$

$$V = \frac{h\nu}{e} - \frac{h\nu_0}{e}$$

On comparing with $y = mx + x$

$$m = \frac{h}{e} \text{ for all metal}$$

Cut-off frequency for B is more therefore work function of B will be more.

Question ID: 1187826

Photoelectric emission occurs only when the incident light has more than a certain minimum

(A) Intensity
(B) Angle of Incidence
(C) Speed
(D) Frequency

Answer (D)

Sol. Energy of the incident light should be greater than work function of the metal

$\phi > \phi_0$

$h\nu > h\nu_0$

$h > \nu_0$

Question ID: 1187827

A particular radioactive sample has a half life of 12 years. The fraction of it that remains undecayed after 48 years, will be :

(A) $\frac{1}{4}^{\text{th}}$ of its initial amount

(B) $\frac{1}{8}^{\text{th}}$ of its initial amount

(C) $\frac{1}{16}^{\text{th}}$ of its initial amount

(D) $\frac{1}{32}^{\text{th}}$ of its initial amount

Answer (C)

Sol. $N = \frac{N_0}{2^n}$

N is the number of remaining nuclei

N_0 is the number of initial nuclei

n is the number of half life

$$\text{half life} \left(\frac{T_1}{2}\right) = 12$$

$$n = \frac{48}{12} = 4$$

$$\frac{N}{N_0} = \frac{1}{2^4} = \frac{1}{16}$$

Question ID: 1187828

Choose the correct statements from the following based on the properties of atomic nucleus.

I. Radius of a nucleus of man no. A depends on its mass number as $R \propto A^3$

II. Radius of nucleus and mass number are related as $R \propto A^{\frac{1}{3}}$

III. Density of nuclei is always a constant

IV. Density of nuclei depends on its mass number A

V. Density of nuclei depends on its size, volume

Choose the **correct** answer from the options given below:

(A) I and III only
(B) II and III only
(C) II and IV only
(D) II and V only

Answer (B)

Sol. We known, volume of nucleus $V \propto A$

$$\therefore \frac{4}{3}\pi R^3 \propto A$$

$$\therefore R \propto A^{1/3}$$

Now, density of nucleus $\rho = \frac{M}{V} = \frac{A}{\frac{4}{3}\pi\left(R_0 A^{1/3}\right)^3}$

$$\rho = \frac{1}{\frac{4}{3}\pi R_0^3} \Rightarrow \text{constant}$$

Thus density of nucleus is constant

Question ID: 1187829

The constancy of the binding energy in the range 30 < A < 170 in binding energy curve, is a consequence of the given fact :

(A) Nuclear forces are charge independent

(B) Nuclear forces are short ranged

(C) Nuclear forces are the strongest forces

(D) Nuclear forces are the attractive in nature

Answer (B)

Sol. The number force is short range force. It is clear from the fact that if distance between nucleons is more than few fermi then the binding energy (for a little large size nucleus becomes almost constant)

Thus beyond certain range force has no much influence.

Question ID: 1187830

For a dynamically stable orbit in a hydrogen atom, according to Rutherford's atomic model the relation between the orbit radius (r) and the electron velocity (v) is :

(A) $r = \dfrac{e}{4z\varepsilon_0 mv^2}$

(B) $r = \dfrac{e^2}{4z\varepsilon_0 mv}$

(C) $r = \dfrac{e^2}{4z\varepsilon_0 mv^2}$

(D) $r = \dfrac{e}{4z\varepsilon_0 m^2 v}$

Answer (C)

Sol. According to Rutherford's model

Centripetal force on electron = Electrostatic force of attraction between electron and proton

$$\therefore \quad \frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$$

$$r = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{mv^2}$$

* No option is correct

In all option z should be replaced by π.

Question ID: 1187831

The spectral series to which the emission line belongs, when electron in the hydrogen atom jumps from 4th energy state to 2nd energy state, is :

(A) Paschen series

(B) Lyman series

(C) Balmer series

(D) Brackett series

Answer (C)

Sol. When the electron jumps to 2nd energy state from any higher energy state (for e.g., 4th energy state)

The spectral line corresponds to Balmer series.

Question ID: 1187832

Match **List - I** with **List – II**.

List - I (Total energy eV)		**List – II** (States of electron in Hydrogen atom)
1.	–3.40	(I) At infinity
2.	–13.6	(II) I excited state
3.	0	(III) Ground state
4.	–0.85	(IV) III excited state

Choose the **correct** answer from the options given below :

(A) (1) - (II), (2) – (III), (3) – (I), (D) – (IV)

(B) (1) - (III), (2) – (I), (3) – (II), (D) – (IV)

(C) (1) - (IV), (2) – (I), (3) – (III), (D) – (II)

(D) (1) - (I), (2) – (II), (3) – (III), (D) – (IV)

Answer (A)

Sol. For H-atom (Energy)

$$\underset{(n=1)}{\text{Ground state}}\ E_{\text{I}} = \frac{-13.6}{12}\text{eV} = -13.6\text{ eV}$$

$$\underset{(n=2)}{\text{I}^{\text{st}}\text{ excited state}}\ E_{\text{II}} = \frac{-13.6}{2^2}\text{eV} = -3.4\text{ eV}$$

$$\underset{(n=4)}{\text{III}^{\text{rd}}\text{ excited state}}\ E_{\text{IV}} = \frac{-13.6}{4^2}\text{eV} = -8.5\text{ eV}$$

$$\underset{(n=\infty)}{\text{For ionisation}}\ E_{\infty} = \frac{-13.6}{\infty} = 0$$

Question ID: 1187833

In satellite communication the preferable range of frequency band for down link is:

(A) 88 – 108 MHz

(B) 540 – 1600 KHz

(C) 5.9 – 6.4 GHz

(D) 3.7 – 4.2 GHz

Answer (D)

Sol. In satellite communication preferable frequency bands are

(5.9 – 6.4) GHz for uplink

and (3.7 – 4.2) GHz for downlink

Question ID: 1187834

In the transmission and receiving of amplitude modulation of a signal, following steps are required. Arrange these in correct sequence.

(A) Modulated signal is fed to an antenna after providing necenay power through power amplifier before transmission

(B) The signal is passed though a rectifier, followed by a envelope detector to receive the message signal

(C) The modulating signal is superimposed on high frequency carrier wave

(D) After receiving antenna the received signal is fed to amplifier and then passed through. If stage where carrier frequency is lowered

Choose the correct answer from the options given below:

(A) (A), (B), (C), (D)

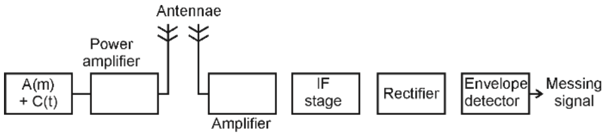
(B) (B), (C), (D), (A)

(C) (C), (B), (A), (D)

(D) (C), (A), (D), (B)

Answer (D)

Sol. Transmission and reception of amplitude modulated signal

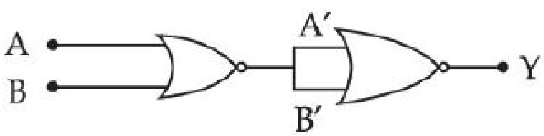


Modulated signal is superimposed on high frequency carrier wave

Thus the step are on : C → A → D → B

Question ID: 1187835

Identify the logic operation carried out by the given circuit.

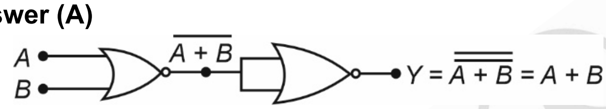


(A) OR (B) AND

(C) NOT (D) NAND

Answer (A)

Sol.



Hence the logic circuit realizes 'OR' gate

Question ID: 1187836

For transistor action, which of the following statements are correct:

(A) The base region must be very thin and lightly doped

(B) Base emitter and collector regions should have same size but different doping concentration

(C) The collector junction is reverse biased and emitter junction is forward biased

(D) Base, emitter and collector regions should have different sizes, but same doping concentration

(E) Both the emitter junction as well as the collector junction are forward biased

Choose the **correct** answer from the options given below:

(A) (A) and (C) only

(B) (A), (B) and (D) only

(C) (B), (C) and (D) only

(D) (B) and (C) only

Answer (A)

Sol. For proper action of transistor:

- The emitter section should be forward biased while the collector section should be reverse biased.
- Base is thin and lightly doped
- Emitter size is moderate (larger than base) but slightly smaller than collector (due to heat dissipation from collector region)

Question ID: 1187837

The electron and hole concentration in an extrinsic semiconductor in thermal equilibrium is given by:

(A) $n_e \cdot n_h = n_i^2$ (B) $\frac{n_e}{n_h} = n_i^2$

(C) $\frac{n_h}{n_e} = n_i^2$ (D) $n_e \cdot n_h = n_i$

Where n_e = electron density

n_h = hole density

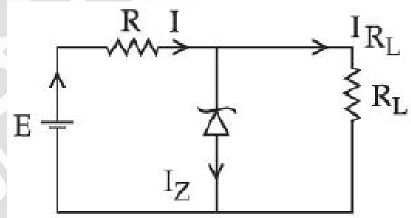
n_i = intrinsic charge density

Answer (A)

Sol. Electron–hole concentration in Thermal equilibrium is given by $n_e n_h = n_i^2$

Question ID: 1187838

A zener diode having $V_z = 12$ V and $I_{Z(\max)} = 40$ mA is used in a voltage regular circuit with unregulated power supply giving E = 19 V as shown in the circuit diagram shown below. The minimum value of the series resistor R required when the load resistance of 400 Ω is connected across the zener diode, so that the zener should not burn out, will be:

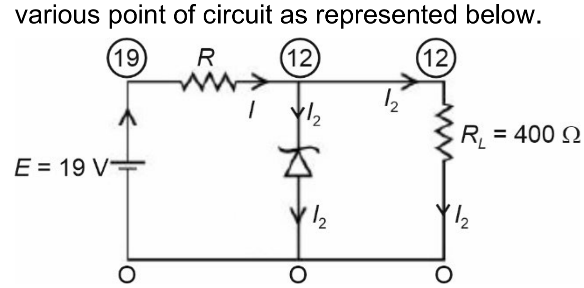


(A) 100 Ω (B) 233 Ω

(C) 271 Ω (D) 175 Ω

Answer (A)

Sol. According to information given, the potential at various point of circuit as represented below.



Here $I_1 = \frac{12}{400} = \frac{3}{100} = 30$ mA

I_2 = 40 mA (Given)

∴ I = 70 mA

Now, $R = \frac{19-12}{70 \text{ mA}} = \frac{7}{70 \times 10^{-3}}$

R = 100 Ω

Question ID: 1187839

Match List-I with List-II.

	List-I		List-II
(A)	Zener diode	(I)	Heavily doped operates in forward bias
(B)	Photo diode	(II)	No external bias required
(C)	Solar cell	(III)	Heavily doped operates in reverse bias as a voltage regulator
(D)	Light emitting diode	(IV)	Fabricated with a transparent window to allow light to fall on it

Choose the correct answer from the options given below:

(A) (A) - (II), (B) - (III), (C) - (IV), (D) - (I)

(B) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

(C) (A) - (IV), (B) - (I), (C) - (II), (D) - (III)

(D) (A) - (III), (B) - (IV), (C) - (II), (D) - (I)

Answer (D)

Sol.
- A Zener diode acts as a voltage regulator (A - III).
- A photo-diode is fabricated with a transparent window to allow light to fall on it (B - IV).
- A solar cell does not require any biasing (C - II).
- An LED is heavily doped and operates in forward bias (D - I).

Question ID: 1187840

A coil of 200 turns, area 0.20 m^2 is rotated in a uniform magnetic field of 0.4 G perpendicular to the axis of the coil at the rate of 7 rps. The maximum emf induced in the coil is

(A) 3.52×10^{-2} V (B) 4.28×10^{-2} V

(C) 6.24×10^{-2} V (D) 7.04×10^{-2} V

Answer (D)

Sol. We know, $\phi = \vec{B} \cdot \vec{A}$

$\Rightarrow$ $\phi = BA\cos\theta$ and $\theta = \omega t$

$\Rightarrow$ $\phi = NBA\cos(\omega t)$, $\varepsilon = \dfrac{-d\phi}{dt}$

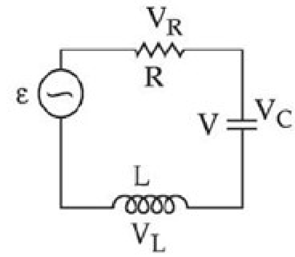
$\Rightarrow$ $\varepsilon = NBA\omega\sin(\omega t) \Rightarrow \varepsilon_{max} = NBA\omega$

$$\Rightarrow \varepsilon_{max} = 0.4 \times 10^{-4} \times \frac{20}{100} \times 7 \times 2\pi \times 200$$

$$\Rightarrow \varepsilon_{max} = 0.8 \times \frac{14\pi}{5} \times 10^{-2} = 7.04 \times 10^{-2} \text{ V}$$

Question ID: 1187841

A series LCR circuit connected to an AC source with voltage of the source $v = v_m \sin\omega t$.



If 'q' is the charge on the capacitor and 'i' is the current, from Kirchoff's loop rule :

$$L\frac{di}{dt} + iR + \frac{q}{c} = V$$

The current in the circuit is given by $i = I_m\sin(\omega t + \phi)$ where ϕ is the phase difference between the voltage across the source and current in the circuit. We know $V_{Rm} = L_m R$; $V_{Lm} = L_m X_L$; $V_{Cm} = L_m X_C$; and

$$X_L = \omega L; \; X_C = \frac{1}{\omega C}$$

Total impedance in the circuit regulates current. At resonance frequency of the LCR circuit current in the circuit is maximum.

A series LCR circuit has resonant frequency of ω_0. If inductance in the circuit is replaced by another one having the same value of inductance but higher value of internal resistance.

Select the statement that explains the change in functioning of the circuit correctly.

(A) Resonant frequency of the circuit will decrease

(B) Amplitude of current at the resonant frequency will increase

(C) Quality factor of the circuit will decrease

(D) Bandwidth of the circuit will decrease

Answer (C)

Sol. When inductance in the circuit is replaced by another one having the same value of inductance but higher of internal resistance then,

$$\omega_0 = \frac{1}{\sqrt{LC}}$$, no effect on resonant frequency

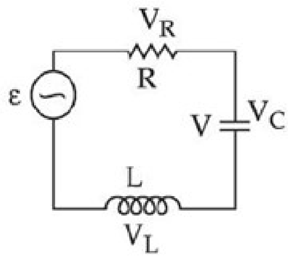
$i_{rms} = \dfrac{i_0}{\sqrt{2}} \Rightarrow i_0 = \sqrt{2} \times \dfrac{V_{rms}}{R}$ or resistance of the circuit increases hence amplitude of current at resonant frequency decreases.

Quality factor $= \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$ or $R\uparrow$, quality factor$\downarrow$

Band width, $\Delta\omega = \dfrac{R}{2L}$, or $R\uparrow$, $\Delta\omega\uparrow$

Question ID: 1187842

A series LCR circuit connected to an AC source with voltage of the source $v = v_m \sin\omega t$.



If 'q' is the charge on the capacitor and 'i' is the current, from Kirchoff's loop rule :

$$L\frac{di}{dt} + iR + \frac{q}{c} = V$$

The current in the circuit is given by $i = I_m \sin(\omega t + \phi)$ where ϕ is the phase difference between the voltage across the source and current in the circuit. We know $V_{Rm} = L_m R$; $V_{Lm} = L_m X_L$; $V_{Cm} = L_m X_C$; and

$X_L = \omega L$; $X_C = \frac{1}{\omega C}$

Total impedance in the circuit regulates current. At resonance frequency of the LCR circuit current in the circuit is maximum.

Given below are two statements

Statement I : In an LCR series circuit, power dissipated is minimum at resonance.

Statement II : In an LCR circuit, power is dissipated only in the inductor and capacitor.

In the light of the above statements, choose the **most appropriate** answer from the options given below

(A) Both Statement I and Statement II are true

(B) Both Statement I and Statement II are false

(C) Statement I is correct but Statement II is false

(D) Statement I is incorrect but Statement II is true

Answer (B)

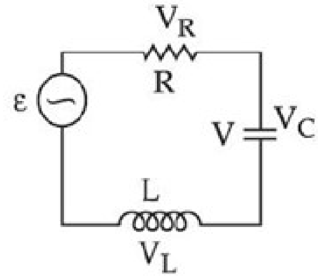
Sol. In LCR series circuit, $P_{avg} = V_{rms} \times I_{rms} \times \cos\phi$ at resonance, $\phi = 0°$, $\Rightarrow \cos\phi = 1 \Rightarrow$ hence power dissipated is maximum at resonance.

In LCR circuit, power is dissipated only across the resistor.

Hence both the statements are false.

Question ID: 1187843

A series LCR circuit connected to an AC source with voltage of the source $v = v_m \sin\omega t$.



If 'q' is the charge on the capacitor and 'i' is the current, from Kirchoff's loop rule :

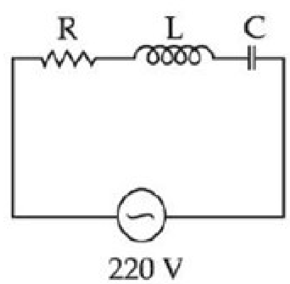
$$L\frac{di}{dt} + iR + \frac{q}{c} = V$$

The current in the circuit is given by $i = I_m \sin(\omega t + \phi)$ where ϕ is the phase difference between the voltage across the source and current in the circuit. We know $V_{Rm} = L_m R$; $V_{Lm} = L_m X_L$; $V_{Cm} = L_m X_C$; and

$X_L = \omega L$; $X_C = \frac{1}{\omega C}$

Total impedance in the circuit regulates current. At resonance frequency of the LCR circuit current in the circuit is maximum.

In a series LCR circuit $L = 4$ H, $C = 100$ μF and $R = 25$ Ω. The circuit is connected to a variable frequency 220 V source.



The source angular frequency (ω) which drives the circuit in resonance is

(A) 0.05 rad s^{-1} (B) 2 rad s^{-1}

(C) 314 rad s^{-1} (D) 50 rad s^{-1}

Answer (D)

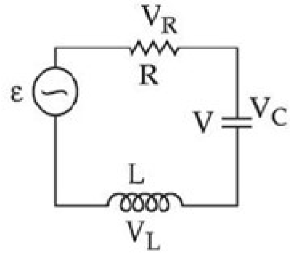
Sol. Resonant angular frequency, $\omega_0 = \frac{1}{\sqrt{LC}}$

$$\Rightarrow \omega_0 = \frac{1}{\sqrt{4 \times 100 \times 10^{-6}}} = \frac{1}{\sqrt{4 \times 10^{-4}}} = \frac{1}{2 \times 10^{-2}}$$

$\Rightarrow \omega_0 = 50$ rad s^{-1}

Question ID: 1187844

A series LCR circuit connected to an AC source with voltage of the source $v = v_m \sin\omega t$.



If '*q*' is the charge on the capacitor and '*i*' is the current, from Kirchoff's loop rule :

$$L\frac{di}{dt} + iR + \frac{q}{c} = V$$

The current in the circuit is given by $i = I_m\sin(\omega t + \phi)$ where ϕ is the phase difference between the voltage across the source and current in the circuit. We know $V_{Rm} = L_mR$; $V_{Lm} = L_mX_L$; $V_{Cm} = L_mX_C$; and $X_L = \omega L$; $X_C = \frac{1}{\omega C}$

Total impedance in the circuit regulates current. At resonance frequency of the LCR circuit current in the circuit is maximum.

In a series LCR circuit if frequency of the ac source is increased from resonance value f_0 to $2f_0$. Choose the statement depicting correct situation in the circuit.

(A) Impedance of the circuit would increase

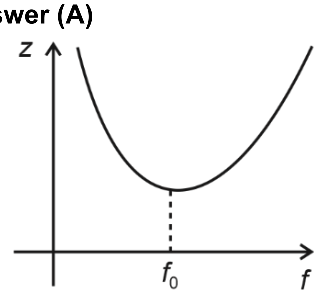
(B) Potential difference across the resistance would increase

(C) rms value of the current in the circuit will increase

(D) Potential difference across the series combination of L & C will become zero

Answer (A)

Sol.



$\Rightarrow$ When frequency of the ac source is increased from f_0 to $2f_0$ then impedance of the circuit increases.

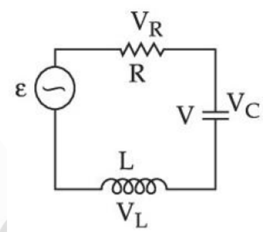
$i_0 = \sqrt{2} \times i_{rms} \Rightarrow i_0 = \sqrt{2} \times \frac{V_{rms}}{z}$, or impedance value increases, amplitude of current decreases hence potential difference across resistance would decrease.

$i_{rms} = \frac{V_{rms}}{z}$, or $z\uparrow$ $i_{rms}\downarrow$

Potential difference across the series combination of L & C will be non-zero as it is not condition of resosnance.

Question ID: 1187845

A series LCR circuit connected to an AC source with voltage of the source $v = v_m \sin\omega t$.



If '*q*' is the charge on the capacitor and '*i*' is the current, from Kirchoff's loop rule :

$$L\frac{di}{dt} + iR + \frac{q}{c} = V$$

The current in the circuit is given by $i = I_m \sin(\omega t + \phi)$ where ϕ is the phase difference between the voltage across the source and current in the circuit. We know $V_{Rm} = L_mR$;

$$V_{Lm} = L_mX_L; V_{Cm} = L_mX_C; \text{and } X_L = \omega L;\ X_C = \frac{1}{\omega C}$$

Total impedance in the circuit regulates current. At resonance frequency of the LCR circuit current in the circuit is maximum.

A pure inductor of 0.25 mH, a pure capacitor of 250 μF and a resistor of 350 Ω are connected in series. An ac source of amplitude 210 V is connected across this series combination of L, C and R. The impedance and current amplitude in the circuit at resonance will be :

(A) Z_{min} = 703 Ω and I_{max} = 0.30 A

(B) Z_{min} = 350 Ω and I_{max} = 0.60 A

(C) Z_{min} = 850 Ω and I_{max} = 0.25 A

(D) Z_{min} = 430 Ω and I_{max} = 0.5 A

Answer (B)

Sol. Impedance of the circuit, $Z = R$ [at resonance]

$\Rightarrow \; Z = R = 350\ \Omega$

At resonance impedance is minimum, $\Rightarrow Z_{min} = 350\ \Omega$

$$I_{max} = \frac{V_{max}}{R} \Rightarrow I_{max} = \frac{210}{350} = 0.60 \text{ A}$$

Question ID: 1187846

Potentiometer has multiple uses. It is based on the principle that when constant current flows through a wire of uniform area of cross-section then potential drop along its length is directly proportional to corresponding length.

i.e. $V \propto l$

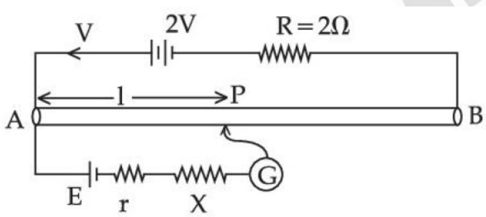
$V = Kl$

Various uses of potentiometer on :

– To measure potential differences between any two points in an electrical network
– To compare emf of a cell
– To measure emf of a cell
– To measure internal resistance of a cell etc:

Answer the following question related to potentiometer.

In the following set up of potentiometer, the value of potential gradient is :



AP is balancing length for the primary cell of emf *E*, Resistors of *AB* length of the wire P_{AB} = 8 Ω, and length *AB* (L) = 10 m.

(A) 1 volt/m
(B) 2 volt/m
(C) 1.6 volt/m
(D) 0.16 volt/m

Answer (D)

Sol. Current in the circuit,

$$i = \frac{v}{R + r} \Rightarrow i = \frac{2}{2 + R_{AB}} \Rightarrow i = \frac{2}{2+8} = \frac{1}{5} A$$

$$\text{Potential gradient } = \frac{i \times R_{AB}}{l} = \frac{1}{5} \times \frac{8}{10} = 0.16 \text{ volt/m}$$

Question ID: 1187847

Case study-2 based

Potentiometer has multiple uses. It is based on the principle that when constant current flows through a wire of uniform area of cross-section then potential drop along its length is directly proportional to corresponding length.

i.e. $V \propto l$

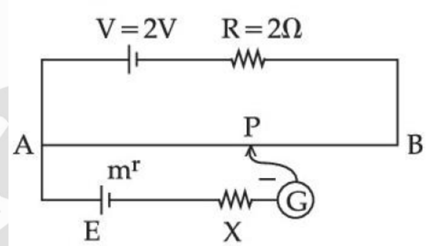
$V = Kl$

Various uses of potentiometer on :

– To measure potential differences between any two points in an electrical network
– To compare emf of a cell
– To measure emf of a cell
– To measure internal resistance of a cell etc:

Answer the following question related to potentiometer.

The length of potentiometer wire *AB* is 10 m and its resistance is 8 Ω. If balancing length on the potentiometer is 225 cm, the value of emf of the primary cell is :



(A) 0.36 volt
(B) 0.16 volt
(C) 36 volt
(D) 2 volt

Answer (A)

Sol. Potential gradient per unit length $= \dfrac{i \times R_{AB}}{l}$

$$\Rightarrow \; v = \frac{2}{2+8} \times \frac{8}{10} = \frac{1}{5} \times \frac{8}{10}$$

Now, emf of primary cell = Potential gradient × Balancing length

$$= \frac{1}{5} \times \frac{8}{10} \times \frac{225}{100} = 0.36 \text{ volt}$$

Question ID: 1187848

Case study-2 based

Potentiometer has multiple uses. It is based on the principle that when constant current flows through a wire of uniform area of cross-section then potential drop along its length is directly proportional to corresponding length.

i.e. $V \propto l$

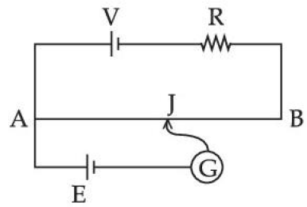
$V = Kl$

Various uses of potentiometer on :

- To measure potential differences between any two points in an electrical network
- To compare emf of a cell
- To measure emf of a cell
- To measure internal resistance of a cell etc:

Answer the following question related to potentiometer.

In the given potentiometer on increasing value of *R*:



(A) Balancing length will decreases

(B) Balancing length will increases

(C) Balancing length will remain unchanged

(D) Balancing length can be obtained again if polarity of cell *E* is reversed

Answer (B)

Sol. On increasing the value of *R*, the current decreases. Hence to obtain the same balancing length larger resistance of potentiometer wire would be needed.

Hence balancing length will increase.

Question ID: 1187849

Case study-2 based

Potentiometer has multiple uses. It is based on the principle that when constant current flows through a wire of uniform area of cross-section then potential drop along its length is directly proportional to corresponding length.

i.e. $V \propto l$

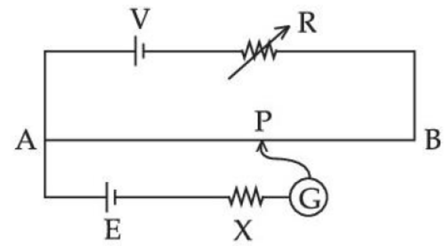
$V = Kl$

Various uses of potentiometer on :

- To measure potential differences between any two points in an electrical network
- To compare emf of a cell
- To measure emf of a cell
- To measure internal resistance of a cell etc:

Answer the following question related to potentiometer,

In the given potentiometer the null point for the primary cell is obtained at *P*. The effect on the balancing length when resistance *X* is increased, will be :



(A) Balancing length increases

(2) Balancing length remains unchanged

(3) Balancing length decreases

(4) Balancing length first increases and then decreases

Answer (B)

Sol. The balancing length will remain unchanged as on increasing '*X*' there is no change in emf of the battery.

Question ID: 1187850

Case study-2 based

Potentiometer has multiple uses. It is based on the principle that when constant current flows through a wire of uniform area of cross-section then potential drop along its length is directly proportional to corresponding length.

i.e. $V \propto l$

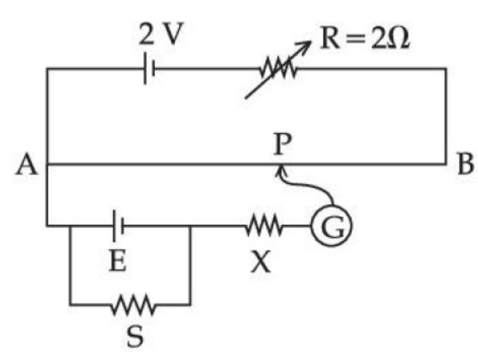
$V = Kl$

Various uses of potentiometer on :

- To measure potential differences between any two points in an electrical network
- To compare emf of a cell
- To measure emf of a cell
- To measure internal resistance of a cell etc:

Answer the following question related to potentiometer.

What happens to the balancing length when resistance *S* is increased?



(A) Balancing length decreases

(B) Balancing length increases

(C) Balancing length remains unchanged

(D) Balancing length first decreases then increases

Answer (B)

Sol. Terminal potential difference across battery,

$= E - ir$

$$\Rightarrow \ E - \frac{E}{S + r} \cdot r$$

Now as the value of S is increased, terminal potential difference increases hence balancing length increases.

❑ ❑ ❑