Solution

PHYSICS

Class 12 - Physics

Section A

1.
(d) high temp.
Explanation:
A pure semiconductor behaves slightly as a conductor at high temperatures.

2. **(a)** potential difference across the bigger resistor is greater.
Explanation:
potential difference across the bigger resistor is greater.

3.
(d) Diamond to air
Explanation:
Diamond to air

4.
(b) $\frac{5}{3}$
Explanation:
$\frac{M_1}{M_2}=\frac{T_2^2+T_1^2}{T_2^2-T_1^2}$
$=\frac{1+\left(\frac{T_1}{T_2}\right)^2}{1-\left(\frac{T_1}{T_2}\right)^2}=\frac{1+\frac{1}{4}}{1-\frac{1}{4}}=\frac{5}{3}$

5.
(d) is zero.
Explanation:
For an equipotential surface, $V_A = V_B$
So, work done = 0

6.
(d) infinity
Explanation:
An ideal voltmeter should have an infinite resistance.

7.
(c) $\tau \ln(10)$
Explanation:
$I=I_0\left(1-e^{\frac{-t}{\tau}}\right)$
and $I=0.9I_0$
$\frac{0.9I_0}{I_0}=1-e^{\frac{-t}{\tau}}$
$e^{\frac{-t}{\tau}}=\frac{1}{10}$
$\frac{t}{\tau}=\ln\frac{10}{1}$
$t=\tau\ln 10$

8.

(c) 1.28 Am^2

Explanation:

m = NIA

$= 2000 \times 1.6 \times 10^{-4} \times 4$

= 1.28 Am^2

9.

(c) they are not monochromatic

Explanation:

When two waves of same frequency, same wavelength and same velocity move in the same direction, their superposition results in the interference. The two beams are monochromatic.

10.

(c) (a) - (iv), (b) - (iii), (c) - (i), (d) - (ii)

Explanation:

As we know that,

Linear charge density, $\lambda = \frac{q}{L},$ where, L is length of rod

Volume charge density, $\rho = \frac{q}{V},$ where, V is volume

The electric field is quantified by electric field intensity.

The unit of torque is Newton meter.

11.

(b) 3 corresponds to forward bias of junction and 1 corresponds to reverse bias of junction

Explanation:

When p-n junction is forward biased, it opposes the potential barrier across junction. When p-n junction is reverse biased, it supports the potential barrier junction, resulting increase in potential barrier across the junction.

12.

(c) 2 cm and 12 cm

Explanation:

In normal adjustment, m = f_o/f_e = 6. Therefore f_o = 6 f_e

Now, $f_o + f_e = 14$

or $7f_e = 14$ or f_e = 2 cm

Hence, f_o = 12 cm

13. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

Both A and R are true and R is the correct explanation of A.

14.

(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

Explanation:

If a material contains polar molecules, they will generally be in random orientations when no electric field is applied. An applied electric field will polarize the material by orienting the dipole moment of polar molecules.

15. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

For reflected system of the film, the maxima or constructive interference is $2\mu t \cos r = \frac{(2n+1)\lambda}{2}$ while the maxima for transmitted system of film is given by equation $2\mu t \cos r = n\lambda$ where t is thickness of the film and r is angle of refraction. From these two equations we can see that condition for maxima in reflected system and transmitted system are just opposite.

16.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation:

The phase angle for the LCR circuit is given by tan ϕ = $\frac{X_L - X_C}{R} = \frac{\omega L - 1/\omega C}{R}$

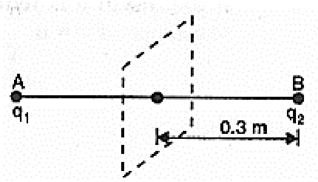
Where X_L, X_C are inductive reactance and capacitive reactance respectively when $X_L > X_C$ then tan ϕ is positive i.e. ϕ is positive (between 0 and $\frac{p}{2}$). Hence emf leads the current.

Section B

17. Given, $q_1 = 2\mu C = 2 \times 10^{-6} C$

$q_2 = -2\mu C = -2 \times 10^{-6} C$

a. Potential will be zero due to both charges at equipotential surface.



$\frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{x} + \frac{q_2}{(0.06 - x)}\right] = 0$

or $\frac{q_1}{x} = -\frac{q_2}{(0.06 - x)}$

or $\frac{2 \times 10^{-6}}{x} = \frac{(-2 \times 10^{-6})}{[(0.06) - x]}$

or x = 0.06 - x

$x = \frac{0.06}{2} = 0.03m$

i.e. the plane normal to AB and passing through its mid point has zero potential everywhere.

b. The direction of electric field is normal to the plane in the AB direction.

18. i. The torque acting on a bar magnet of magnetic moment $\vec{m}$ placed in magnetic field $\vec{B}$ at an angle θ with it is given by

$\vec{\tau} = \vec{m} \times \vec{B}$

Magnitude of torque, $\tau = mB \sin\theta$

If B = 1, θ = 90^o, sin θ = 1, then τ = m

Hence magnetic moment may be defined as the torque acting on a magnetic dipole placed perpendicular to a uniform magnetic field of unit strength.

ii. Potential energy, U = -mB cos θ

When θ = 0^o, U = -mB cos 0^o = -mB $\times$ 1 = -mB

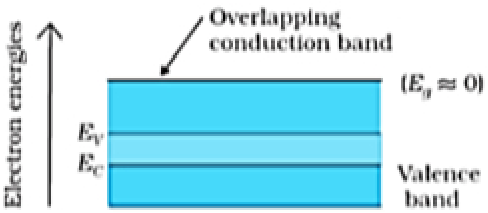
Thus the potential energy of the magnet is minimum when its magnetic moment $\vec{m}$ is aligned parallel to the field $\vec{B}$.

19. a. An enormously large number of energy levels closely spaced in a very small energy range constitute an energy band. The allowed energy bands are separated by regions in which energy levels cannot exist. These forbidden regions are called band gaps or energy gaps.

The highest energy band occupied by the valence electrons is called the valence band and the next empty allowed band is called the conduction band.

b. i. Metal

ii. Semiconductor

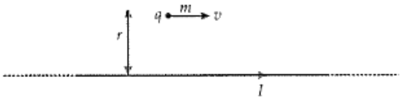


20. We know that the velocity of an electron moving around a proton in a hydrogen atom in an orbit of radius is 5.3 $\times$ 10^{-11} m is 2.2 $\times$ 10^6 m/s. Thus, the frequency of the electron moving around the proton is given by ;

$v = \frac{v}{2\pi r} = \frac{2.2\times10^6 \text{ms}^{-1}}{2\pi(5.3\times10^{-11}\text{m})}$

$\approx 6.6 \times 10^{15}$ Hz

According to the classical electromagnetic theory, we know that the frequency of the electromagnetic waves emitted by the revolving electrons is equal to the frequency of its revolution around the nucleus. Thus the initial frequency of the light emitted is given by 6.6 $\times$ 10^{15} Hz.

21. 

For the charged particle to move undeflected a particle of mass m and charge q moves with a velocity v.

Net force, $\vec{F} = \vec{F}_E + \vec{F}_m = \vec{0}$

$\vec{F}_E = -\vec{F}_m$ ...(i)

$\vec{F_E} \rightarrow$ electric force, $\vec{F}_m \rightarrow$ magnetic force

$|\vec{F_E}| = |\vec{F_m}|$ ....(ii)

qE = Bqv sin 90° = Bqv

E =vB ...(iii)

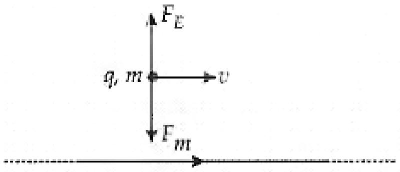
B = $\frac{\mu_0 I}{2\pi r}$ ...(iv)

Using (iv) and (iii)

E = $\frac{\mu_0}{2\pi}\frac{vI}{r}$

Magnetic force F_m is towards the wire.

$\therefore$ Electric force and electric field should be away from the line.



OR

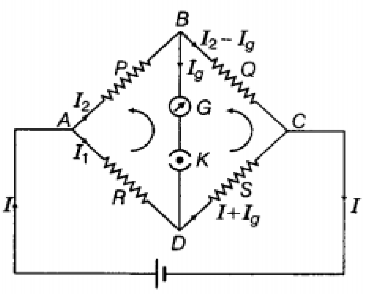
The velocity v of the particle is along the x-axis, while B, the magnetic field is along the y-axis, so v $\times$ B is along the z-axis (screw rule or right-hand thumb rule). So, depending upon the charge force is given by:

a. for electron it will be along –z axis.
b. for a positive charge (proton) the force is along +z axis.

Section C

22. Applying Kirchhoff's loop law to close loop ABDA, we get

$I_1R - I_gG - I_2P = 0$ ...(i)



Here, G is the resistance of the galvanometer.

Applying Kirchhoff's loop law in the closed loop BDCB,we get

$I_gG + (I_1 + I_g)S - (I_2 - I_g)Q = 0$ .. (ii)

When the Wheatstone bridge is balanced, no current flows through the galvanometer,

i.e. $I_g = 0$

$\therefore$From Eq. (i), we get

$I_1R - I_2P = 0 \Rightarrow I_1R = I_2P$

$\Rightarrow \quad \frac{I_1}{I_2} = \frac{P}{R}$ .. (iii)

Similarly,from Eq. (ii), we get

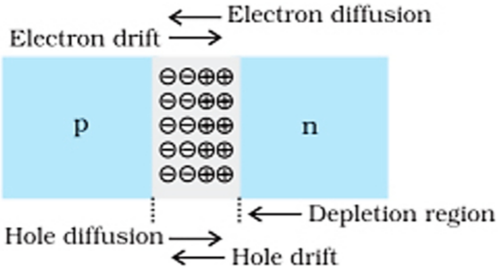
$I_1S - I_2Q = 0$

$\Rightarrow I_1S = I_2Q = 0$..... (iv)

From Eqs. (iii) and (iv), we get

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

This is the required balance condition in a Wheatstone bridge arrangement and also helps us to determine unknown resistance.

23. 

During the formation of p-n junction due to concentration gradient across p and n sides, holes diffuse from p side to n side and electrons diffuse from n side to p side This motion of charge carriers gives rise to diffusion current across the junction.

Diffusion of electrons develops a layer of positive charge on n side of the junction and diffusion of holes develops a layer of negative charge on p side of the junction.

Due to this space charge region on either side of the junction an electric field is developed. This electric field drifts charge carriers across the junction and sets up drift current in a direction opposite to diffusion current.

This process continues until the diffusion current is equal to drift current. Thus p-n junction is formed.

No, Any slab, howsoever flat, will have roughness much larger than the inter-atomic spacing ($\sim$2 to 3 $\mathring{A}$) and hence continuous contact at the atomic level will not be possible. The junction will behave as a discontinuity for the flowing charge carriers.

24. a. λ = 200 nm, stopping potential = -2.5 V

K.E. = $2.5 \times 1.6 \times 10^{-19}$ J = 4×10^{-19} J

E = hv = $h\frac{c}{\lambda}$

$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{200 \times 10^{-9}}$

= 9.945×10^{-19} J

Work function = E - eV

= $(9.945 \times 10^{-19} - 4 \times 10^{-19})$J

= 5.595×10^{-19} J

b. Wavelength of red light = 6328 $\mathring{A}$

E = hv = $h\frac{c}{\lambda}$

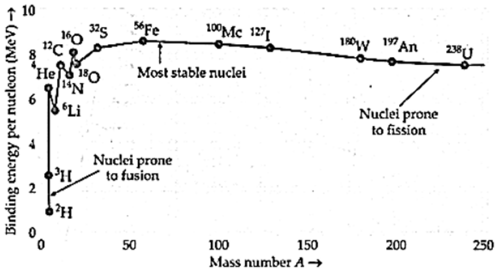
$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{6328 \times 10^{-10}}$

= 0.00314×10^{-16} J

= 3.14×10^{-19} J

Energy of red light < work function of metal surface

$\therefore$ No emission of photoelectrons takes place.

25. 

Binding energy per nucleon as a function of mass number A.

Two important conclusions from this graph are:

i. Nuclear forces non-central and short ranged force.

ii. Nuclear forces between proton-neutron and neutron-neutron are strong and attractive in nature.

Explanation of Nuclear Fission: When a heavy nucleus (A $\geq$ 235 say) breaks into two lighter nuclei (nuclear fission), the binding energy per nucleon increases i.e, nucleons get more tightly bound. This implies that energy would be released in nuclear fission.

Explanation of Nuclear Fusion: When two very light nuclei (A $\leq$ 10) join to form a heavy nucleus, the binding is energy per nucleon of fused heavier nucleus more than the binding energy per nucleon of lighter nuclei, so again energy would be released in nuclear fusion.

26. According to Bohr's second postulate only those orbits around the nucleus are allowed for electron to revolve for which the angular momentum of the electron is an integral multiple of $\frac{h}{2\pi}$ where h is Planck's constant

So the electron revolues as

Centripetal force = Coulombs force between proton electrons

$\frac{mv^2}{r} = \frac{ke^2}{r^2}$

$v^2 = \frac{ke^2}{mr}$

also for hydrogen atom

$r = \frac{\varepsilon_0 h^2 n^2}{e^2 \pi m}$

$v^2 = \frac{ke^2 \times e^2 \pi m}{m \times \varepsilon_0 h^2 n^2} = \frac{k\pi e4}{\varepsilon_0 h^2 n^2}$

$v^2 \propto \frac{1}{n^2}$

$v \propto \frac{1}{n}$

27. angular width of central maxima of a single slit diffraction is given as $2\theta = \frac{2\lambda}{a}$
    a. As λ increases (orange light has greater wave length) diffraction angle 2θ will also increase.
    b. Increasing or decreasing closeness of screen and slit does not affect angular width.
    c. If a (slit width) decreases, 2θ will increase as $2\theta \propto \frac{1}{a}$
28. i. Bulb lights up due to the induced current set up in coil B because of alternating current in coil A.
    ii. Bulb gets dimmer when coil B is moved upwards because the flux linked with coil B decreases and induced current also decreases.
    iii. When the copper sheet is inserted, eddy currents are set up in it which oppose the passage of magnetic flux. The induced emf in coil B decreases. This decreases the brightness of the bulb.

OR

The maximum back electromotive force (u) will be maximum when there is a maximum rate of change of magnetic flux which is directly proportional to the rate of change of current.

Maximum change or rate of current will be where (t - I) graph for the solenoid makes a maximum angle with time axis which is in part AB

So the maximum back e.m.f. will occur between 5 s to 10 s. As the back e.m.f. at t = 3 s it is e (given)

Rate of change of current at t = 3 s-slope of OA graph with time axis So the rate of change of current at 3s = $\frac{1}{5} A/s$

So back electromotive force at t = 3s $= L \times \frac{1}{5} = \frac{L}{5} = e$ (given)

$\because e = L \cdot \frac{dI}{dt}$ and L = constant for the solenoid.

Similarly back e.m.f. u between 5 to 10 sec.

$u_1 = L\left(\frac{-3}{5}\right) = -3\frac{L}{5} = -3e$

back e.m.f. between 10 to 30 sec

$u_2 = L\frac{[0-(-2)]}{(30-10)} = \frac{+2L}{20} = \frac{+1}{2}\frac{L}{5}$

$u_2 = +\frac{1}{2}e$

So back e.m.f. at 7 sec = -3 e

Back e.m.f. at 15 sec $= +\frac{1}{2}e$

At 40 sec graph is along the time axis, i.e. its slope with time axis is zero.

So, $\frac{dI}{dt} = 0$

Or back e.m.f. at 40 sec = 0

Section D

29. **Read the text carefully and answer the questions:**

Maxwell showed that the speed of an electromagnetic wave depends on the permeability and permittivity of the medium through which it travels. The speed of an electromagnetic wave in free space is given by c = $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$. The fact led Maxwell to predict that light is an electromagnetic wave. The emergence of the speed of light from purely electromagnetic considerations is the crowning achievement of Maxwell's electromagnetic theory. The speed of an electromagnetic wave in any medium of permeability μ and permittivity ε will be $\frac{c}{\sqrt{K\mu_r}}$ where K is the dielectric constant of the medium and μ_r is the relative permeability.

(i) **(b)** $ML^{-1}T^{-2}$

Explanation:

$\frac{1}{2}\varepsilon_0 E^2$ = energy density = $\frac{\text{Energy}}{\text{Volume}}$

$\therefore \left[\frac{1}{2}\varepsilon_0 E^2\right] = \frac{\mathrm{ML^2\ T^{-2}}}{\mathrm{L^3}}$ = $[ML^{-1}T^{-2}]$

(ii) **(c)** $[\varepsilon_0]$ = $M^{-1}L^{-3}T^4A^2$

Explanation:

As $\varepsilon_0 = \frac{q_1 q_2}{4\pi F R^2}$ (from Coulomb's law)

$\varepsilon_0 = \frac{\mathrm{C^2}}{\mathrm{Nm^2}} \frac{[\mathrm{AT}]^2}{\mathrm{MLT^{-2}\ L^2}}$ = $M^{-1}L^{-3}T^4A^2$

(iii) **(a)** wavelength is halved and the frequency remains unchanged.

Explanation:

The frequency of the electromagnetic wave remains same when it passes from one medium to another.

Refractive index of the medium, n = $\sqrt{\frac{\varepsilon}{\varepsilon_0}} = \sqrt{\frac{4}{1}}$ = 2

Wavelength of the electromagnetic wave in the medium,

$\lambda_{\text{med}} = \frac{\lambda}{n} = \frac{\lambda}{2}$

OR

(c) the speed of light c = 3×10^8 m s^{-1} in free space

Explanation:

The velocity of electromagnetic waves in free space (vacuum) is equal to velocity of light in vacuum (i.e., 3×10^8 m s^{-1}).

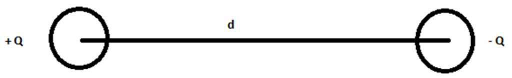
(iv) **(a)** β-rays

Explanation:

β-rays consists of electrons which are not electromagnetic in nature.

30. **Read the text carefully and answer the questions:**

Electric dipole consist of a pair of equal and opposite point charges separated by a small distance and its strength is measured by the dipole moment. The field around the dipole in which the electric effect of the dipole can be experienced is called the dipole field.



(i) **(c)** a vector quantity

Explanation:

a vector quantity

(ii) **(a)** cylindrically symmetric

Explanation:

cylindricaly symmetric

(iii) **(b)** C-m

Explanation:

C-m

(iv) **(c)** 10^{-10} C-m

Explanation:

10^{-10} C-m

OR

(d) Torque but no net force

Explanation:

Torque but no net force

Section E

31. In normal adjustment, image is formed at least distance of distinct vision,

d = 25 cm

Angular magnification of eyepiece $= \left(1 + \frac{D}{f_e}\right)$

$= \left(1 + \frac{25}{5}\right) = 6$

Since the total magnification is 30, magnification of objective lens,

$m = \frac{30}{6} = 5$

Now, $m = -\frac{v_0}{u_0} = 5$ or $v_0 = -5u_0$

As $\frac{1}{v_0} - \frac{1}{u_0} = \frac{1}{f_0}$

$\therefore \frac{1}{-5u_0} - \frac{1}{u_0} = \frac{1}{1.25}$

$-\frac{6}{5u_0} = \frac{1}{1.25}$

$u_0 = -\frac{6 \times 1.25}{5} = -1.5cm$

i.e. object should be held at 1.5 cm in front of objective lens.

As $v_0 = -5u_0$

$\therefore v_0 = -5(-1.5) = 7.5cm$

Now, $\frac{1}{v_e} - \frac{1}{u_e} = \frac{1}{f_e}$

$\frac{1}{u_e} = \frac{1}{v_e} - \frac{1}{f_e} = \frac{1}{-25} - \frac{1}{5} = -\frac{6}{25}$

$u_e = -\frac{25}{6} = -4.17cm$

Separation between the objective lens and eyepiece $= |u_e| + |v_0|$

= 4.17 + 7.5 = 11.67 cm

OR

i. There are two sets of apparatus of Young's double-slit experiment. In Set A: Stable interference pattern, the positions of maxima and minima do not change with time.

   In Set B: Positions of maxima and minima will change rapidly with time and an average uniform intensity distribution will be observed on the screen.

ii. Expression for the intensity of stable interference pattern in set-A

   If the displacement produced by slit S_1 is given by

   $y_1 = a\cos \omega t$

   then, the displacement produced by S_2 would be

   $y_2 = a\cos(\omega t + \phi)$

   and the resultant displacement will be given by

   $y = y_1 + y_2$

   $= a[\cos \omega t + \cos(\omega t + \phi)]$

   $= 2a\cos\left(\frac{\phi}{2}\right)\cos\left(\omega t + \frac{\phi}{2}\right)$

   The amplitude of the resultant displacement is $2a\cos\left(\frac{\phi}{2}\right)$ and therefore the intensity at that point will be

   $I = 4I_0\cos^2\left(\frac{\phi}{2}\right)$

   $\phi = 0$

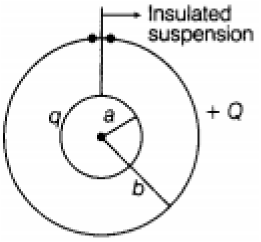
   $\therefore I = 4I_0$

   In set B, the intensity will be given by the average intensity is given by :-

   $I = 4I_0\cos^2\left(\frac{\phi}{2}\right)$

   $I = 2I_0$

32. Let small sphere has charge q and radius 'a' is placed inside a outer shell of charge +Q and radius b.



Electric potential on the small sphere due to its own charge q

{tex}V _ { 1 } = \frac {q}{4π \epsilon_0 a}{/tex} ...(i)

where, q = charge on the smaller sphere

a = radius of smaller sphere

Similarly, electric potential on the outer sphere due to its own charge

{tex}V _ { 2 } = \frac {Q}{4π \epsilon_0 b}{/tex} ...(ii)

where, Q = charge on the outer shell

b = radius of the outer shell.

Also, same potential V_2 exists at every point inside outer shell due to its own charge, +Q.

Now, net electric potential at inner sphere of radius a.

$V_i = V_1 + V_2$

$\therefore V_i = \frac{1}{4\pi\varepsilon_0}\frac{q}{a} + \frac{1}{4\pi\varepsilon_0}\frac{Q}{b}$ ....(iii)

Net electric potential at outer sphere due to charge on the both spheres

$V_o = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q}{b} + \frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{b}$ ...(iv)

$\therefore\ V_i - V_o = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right)$ ...(v) [We get this using Eqs. (iii) and (iv)]

$\because\ a < b, \therefore \frac{1}{a} > \frac{1}{b}$

$\therefore V_i - V_o > 0$

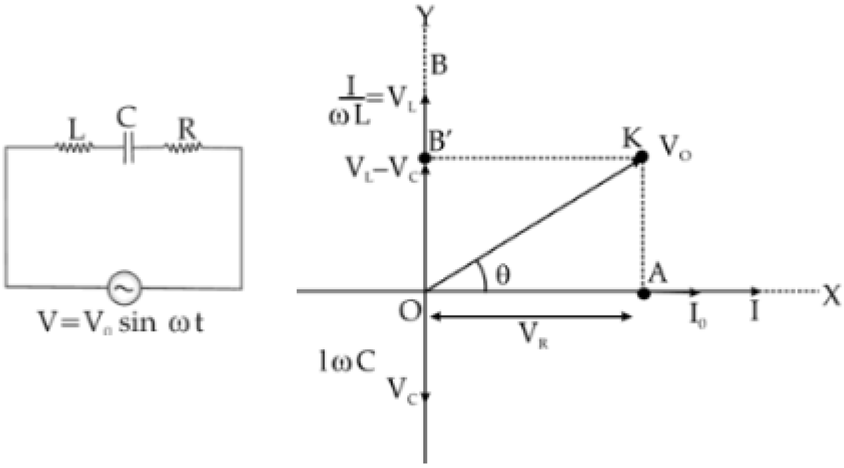
Thus, inner sphere has net potential higher than potential of outer sphere for any value of q and Q.

Therefore, when they are connected by a wire, positive charge will always flow from higher to lower potential i.e. from inner sphere to outer sphere (irrespective of the magnitude of charge).

OR

a. Since the work done depends on the final arrangement of the charges, and not on how they are put together, we calculate work needed for one way of putting the charges at A, B, C and D. Suppose, first the charge +q is brought to A, and then the charges –q, +q, and -q are brought to B, C, and D, respectively. The total work needed can be calculated in steps:
   i. Work needed to bring charge +q to A when no charge is present elsewhere: this is zero.
   ii. Work needed to bring –q to B when +q is at A. This is given by (charge at B) $\times$ (electrostatic potential at B due to charge +q at A)
   $= -q \times \left(\frac{q}{4\pi\varepsilon_0 d}\right) = -\frac{q^2}{4\pi\varepsilon_0 d}$
   iii. Work needed to bring charge +q to C when +q is at A and -q is at B. This is given by (charge at C) $\times$ (potential at C due to charges at A and B
   $= +q\left(\frac{+q}{4\pi\varepsilon_0 d\sqrt{2}} + \frac{-q}{4\pi\varepsilon_0 d}\right)$
   $= \frac{-q^2}{4\pi\varepsilon_0 d}\left(1 - \frac{1}{\sqrt{2}}\right)$
   iv. Work needed to bring -q to D when +q at A, -q at B, and +q at C. This is given by (charge at D) $\times$ (potential at D due to charges at A, B, and C)
   $= -q\left(\frac{+q}{4\pi\varepsilon_0 d} + \frac{-q}{4\pi\varepsilon_0 d\sqrt{2}} + \frac{q}{4\pi\varepsilon_0 d}\right)$
   $= \frac{-q^2}{4\pi\varepsilon_0 d}\left(2 - \frac{1}{\sqrt{2}}\right)$
   Add the work done in steps (i), (ii), (iii), and (iv). The total work required is
   $= \frac{-q^2}{4\pi\varepsilon_0 d}\left\{(0) + (1) + \left(1 - \frac{1}{\sqrt{2}}\right) + \left(2 - \frac{1}{\sqrt{2}}\right)\right\}$
   $= \frac{-q^2}{4\pi\varepsilon_0 d}(4 - \sqrt{2})$
   The work done depends only on the arrangement of the charges, and not how they are assembled. By definition, this is the total electrostatic energy of the charges.

b. The extra work necessary to bring a charge q_0 to point E when the four charges are at A, B, C, and D is $q_0 \times$ (electrostatic potential at E due to the charges at A, B, C, and D). The electrostatic potential at E is clearly zero since potential due to A and C is cancelled by that due to B and D. Hence, no work is required to bring any charge to point E. Also, it can be said that the work done over a closed surface is zero. (charges are opposite in corners so work done during one cycle cancel out by another cycle) hence work done is zero.

33. 

(a) (b)

Voltage of the source is given as V = V_0 sin ωt

Let current of the source be I = I_0 sin ωt

The maximum voltage across R is $\overrightarrow{V_R} = \overrightarrow{V_o} R$, represented along OX.

The maximum voltage across L is $\overrightarrow{V_L} = \overrightarrow{I_0} X_L$, represented along OY and is 90^o ahead of I_0.

The maximum voltage across C is $\overrightarrow{V_C} = \overrightarrow{I_0} X_C$, represented along OC and is lagging behind I_0 by 90^o.

The voltage across L and C has phase difference of 180^o.

Hence, reactive voltage is $\overrightarrow{V_L} - \overrightarrow{V_C}$ represented by OB'.

The vector sum of $\overrightarrow{V_R}, \overrightarrow{V_L}$ and $\overrightarrow{V_C}$, is resultant of OA and OB', represented along OK.

OK = V_0 = $\sqrt{OA^2 + OB'^2}$

$\Rightarrow V_0 = \sqrt{V_R^2 + (V_L - V_c)^2} = \sqrt{(I_0 R)^2 + (I_0 X_L - V_C)^2}$

$\Rightarrow \quad V_0 = I_0 \sqrt{R^2 + (X_L - X_C)^2}$

The impedance can be calculated as follows:

$Z = \frac{V_0}{I_0} = \sqrt{R^2 + (X_L - X_C)^2}$

When $X_L = X_C$, the voltage and current are in the same phase. In such a situation, the circuit is known as non-inductive circuit.

OR

i. Calculation of Capacitance

As power factor is unity,

$\therefore X_L = X_C$ also L=200mH and R= 10 Ω

$\Rightarrow \omega = \frac{1}{\sqrt{LC}}$

100 = $\frac{1}{\sqrt{200 \times 10^{-3} \times C}}$

$10^4 \times 2 \times 10^2 \times 10^{-3} \times C = 1$

hence ca[pacitance is given by ,C = $\frac{1}{2 \times 10^3}$ F

= 0.5×10^{-3} F

= 0.5mF

ii. Q-factor of circuit and its importance Calculation of average power dissipated

Quality factor, $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

$= \frac{1}{10}\sqrt{\frac{200 \times 10^{-3}}{0.5 \times 10^{-3}}}$

$= \frac{1}{10} \times 20 = 2$

Significance: It measures the sharpness of resnance.

Average Power dissipated,

$P = V_{rms} I_{rms} \cos \phi$

$= 50 \times \frac{50}{10} \times 1$ W

= 250 watts