KSEAB PYQ 2024

Physics

1. The electric dipole placed in uniform electric field is unstable, if the angle between electric field and dipole moment is

(A) 0° (B) 60°

(C) 90° (D) 180°

2. The capacitance of a capacitor is 6×10^{-6} farad. It is connected to 200 volt cell. The energy released on discharging it fully, will be

(A) 0.12 J (B) 0.24 J

(C) 0.6 J (D) 12 J

3. The current density is a

(A) scalar and its SI unit is Am^2

(B) vector and its SI unit is $\mathrm{A/m^3}$

(C) vector and its SI unit is $\mathrm{A/m^2}$

(D) scalar and its SI unit is $\mathrm{A/m}$

4. A current I flows along the length of an infinitely long, straight thinwalled pipe, then the magnetic field

(A) at all points inside the pipe is same but not zero

(B) at any point inside the pipe is zero

(C) is zero only on the axis of the pipe

(D) is different at different points inside the pipe

5. The universal property among all substances is

(A) Diamagnetism (B) Paramagnetism

(C) Ferromagnetism (D) Non-magnetism

6. A bar magnet is kept along the axis of a circular coil. If the magnet is rotated about its axis, then

(A) a current will be induced in the coil

(B) no current will be induced in the coil

(C) an emf and current both will be induced in the coil

(D) only an emf will be induced in the coil

7. Current in a coil changes from 1.6 A to 0.2 A in 2 second inducing an emf of 2.8 V . The value of self-inductance of the coil is

(A) 40 H (B) 28 H

(C) 4 H (D) 56 H

8. The resonance phenomenon is exhibited by a circuit only if following components are present

(A) L and R (B) R and C

(C) L and C (D) None of the above

9. According to the generalised Ampere-Maxwell law, $\oint$ B.dI is equal to

(A) $\mu_0 i_c + \mu_0\varepsilon_0\dfrac{d\phi_E}{dt}$

(B) $\mu_0 i_c$

(C) $\varepsilon_0\dfrac{d\phi_E}{dt}$

(D) $\mu_0\varepsilon_0\dfrac{d\phi_E}{dt}$

10. Modern telescopes called reflecting telescopes use a concave mirror rather than a lens for the objective because

I. no chromatic aberration in a mirror.

II. giving mechanical support to a mirror is easier.

(A) I is true, II is false

(B) I is false, II is true

(C) Both I and II are true

(D) Both I and II are false

11. According to Huygen's principle, the speed of the secondary wavelets is

(A) twice that of the wave

(B) zero

(C) same as the wave
(D) infinite

12. Macroscopic particles in our daily life do not show wave-like properties because
(A) they are not associated with waves
(B) their wavelength is extremely high
(C) their wavelength is zero
(D) their wavelength is negligibly small

13. At the distance of closest approach of an α -particle with gold nucleus,
(A) both kinetic energy and potential energy are equal
(B) entire kinetic energy is converted into potential energy
(C) entire potential energy is converted into kinetic energy
(D) both kinetic energy and potential energy are zero

14. The nuclear force is
(A) attractive for distance $r = 0.5\text{fm}$
(B) attractive for distance $r < 0.8\text{fm}$
(C) repulsive for distance $r > 0.8\text{fm}$
(D) repulsive for distance $r < 0.8\text{fm}$

15. p-type semiconductor is electrically
(A) positive
(B) negative
(C) neutral
(D) as temperature increases it becomes negative

16. The torque on a rectangular current loop in a uniform magnetic field increases by —— the area of the loop.

17. The mutual inductance of a solenoid can be decreased by —— the number of turns per unit length either in inner or outer solenoid.

18. Fringes of unequal intensities are obtained in —— pattern.

19. Alpha particle is a —— nucleus.

20. The value of energy band in insulators is —— than 3 eV .

21. State and explain Gauss's law in electrostatics.

22. Two point charges $5\times10^{-8}\text{C}$ and $-3\times10^{-8}\text{C}$ are located 10 cm apart. Find the point between the two charges where potential is zero.

23. When the force experienced by a moving charge in magnetic field becomes
(A) maximum
(B) minimum?

24. Define susceptibility and magnetisation for a magnetic material.

25. Write the principle of AC generator. Mention the expression for induced emf in it.

26. Give any two sources of energy loss in actual transformer.

27. Mention any two applications of UV (Ultraviolet) rays.

28. What is the power of a lens? Write its SI unit.

29. Distinguish between intrinsic and extrinsic semiconductors.

30. Mention any three properties of the electric field lines.

31. Deduce $E = -\frac{dV}{dx}$ where, the terms have usual meaning.

32. Give any three limitations of Ohm's law.

33. Explain, how a galvanometer is converted into an voltmeter?

34. Mention any three properties of paramagnetic materials.

35. Lenz's law is the consequence of law of conservation of energy. Explain.

36. Write Cartesian sign conventions adopted for measuring distances in reflection of light at spherical mirrors.

37. Write three postulates of Bohr's atom model.

38. Mass defect of $_7N^{14}$ is $0.11236u$. Calculate the binding energy and binding energy per nucleon in MeV .

39. **(**A) What are polar and non-polar molecules?
(B) Derive the expression for the capacitance of a parallel plate capacitor.

40. Arrive the expressions for equivalent emf and internal resistance of two cells connected in series.

41. Deduce the expression for the magnetic field on the axis of a circular. current loop.

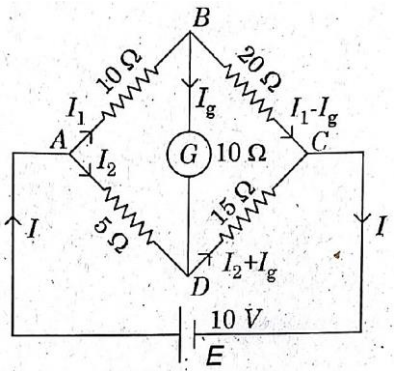
42. (A) What is the interference of light?
(B) Give the conditions for constructive and destructive interference of light in terms of path difference.
(C) Mention any two applications of Polaroids.

43. Write Einstein's photoelectric equation. Using this, explain the experimental observations of photo electric effect.

44. What is a rectifier? Explain the working of p-n junction diode as a full wave rectifier with circuit and input-output waveforms.

45. Two point charges $+15\mu C$ and $-10\mu C$ are separated by a distance of 20 cm in air. Calculate the electric field at the mid point of line joining two charges. If a point charge of 20 mC is placed at that mid-point, What is the magnitude of electric force experienced by it?

46.



In the given Wheatstone's network, calculate the value of electric current flowing through the galvanometer.

47. A sinusoidal voltage of 250 V and frequency 50 Hz, is applied to a series LCR circuit. In which, R=6Ω,L=25mH and $C = 796\mu\ F$. Calculate
(A) the impedance of the circuit and
(B) the power factor.

48. A small bulb (a point source) is placed at the bottom of a tank containing water to a depth of 80 cm . What is the radius of the circular surface of water through which light emerge out? Refractive index of water is 1.33 .

Hint & Solution

1. (B) 60^0 or (C) 90^0 or (D) 180^0

2. (A) 0.12 J

3. (C) Vector and its SI unit is A/m^2

4. GRACE MARK WILL BE AWARED IF STUDENT ATTENDED THE QUESTION

5. (A) diamagnetism

6. (B) no current will be induced in the coil

7. (C) 4 H

8. (C) L and C

9. (A) $\mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\varphi_E}{dt}$

10. (C) both I and II are true

11. (C) same as the wave

12. (D) their wavelength is negligibly small

13. (B) entire kinetic energy is converted into potential energy

14. (D) repulsive for distance $r < 0.8fm$

15. (C) neutral

16. Increasing

17. Decreasing

18. Diffraction

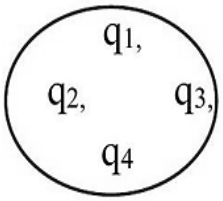
19. Helium

20. Greater

PART - B

21. Electric flux through a closed surface is $\frac{1}{\varepsilon_0}$ times total charge enclosed by the surface.

Let $q_1, q_2, q_3, q_4 \ldots\ldots$ be the charges enclosed by the surface.
or



The electric flux through closed surface is

$$\varphi_E = \frac{1}{\varepsilon_0}(q_1 + q_2 + q_3 + q_4 + \ldots\ldots..)$$

22. $$V = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{x} + \frac{q_2}{d-x}\right]$$

$$0 = 9\times10^9\left[\frac{5\times10^{-8}}{x} + \frac{-3\times10^{-8}}{d-x}\right]$$

$x = 6.25$ cm or $x = 0.06$ m

23.

(a) when charge is moving perpendicular to the magnetic field (i.e., $\theta = 90^0$).

(b) when charge is moving parallel or anti parallel to the magnetic field (i.e., $\theta = 0^0$ or 180^0).

OR

If a student answered in any one of the concept in terms of q or v or B or θ can be considered.

24.

The ratio of magnetisation (M) of a sample and magnetic intensity (H) is called magnetic susceptibility.

The magnetic moment of a sample per unit volume is called magnetisation.

25.

It works on the principle of electromagnetic induction.

$E = E_0 \sin\omega t$ or $E = NAB\omega \sin\omega t$

26.

1. flux leakage loss
2. loss due to resistance of the windings
3. eddy current loss
4. hysteresis loss

27.

1. LASIK (Laser-assisted in situ keratomileusis) eye surgery
2. UV lamps are used to kill germs in water purifiers

28.

Ability of a lens to converge or diverge incident beam of light.

Or

It is a measure of the convergence or divergence of the light falling on it.

Or

It is defined as the tangent of the angle by which it converges or diverges a beam of light parallel to the principal axis falling at unit distance from the optical centre.

SI Unit : dioptre

29.

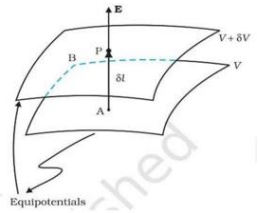
S.No	Intrinsic semiconductors	Extrinsic semiconductors
1.	These are chemically pure semiconductors	These are chemically impure semiconductors
2.	These are undoped semiconductors	These are dopped semiconductors
3.	Number of holes are equal to number of free electrons ($n_h = n_c$)	Number of holes are not equal to number of free electrons ($n_h \neq n_e$)
4.	conductivity depends on the temperature	conductivity depends on the temperature and doping concentration.

30.

Properties of electric field lines

1. They originate from positive charge and terminate at negative charge.
2. They do not form a closed loop.
3. They do not intersect each other.
4. They are crowded at strong electric field and are farther apart in weak electric field.
5. They are perpendicular to the charged surface.
6. They do not penetrate through conductors but can penetrate through insulators.

31.



Consider two closely spaced equipotential surfaces A and B with potential values V and $V + dV$ respectively.

Where, dV is the potential difference between two surfaces

E be the electric field. Imagine a unit positive charge q_0 is moved from surface B to surface A through distance 'dl' against electric field E. The workdone in this process is $W = q_0(dV)$

F. $dl\cos\theta = q_0(dV)$

$\therefore \theta = 180^\circ$ and $F = q_0E$ - $(q_0E)\cdot dl = q_0(dV)$

$$E = -\frac{dV}{dl}$$

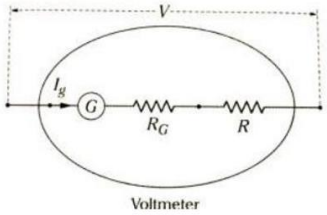
32. Limitation of Ohm's law:

(1) It is applicable only for conductors not applicable for semiconductors.

(2) It is applicable if temperature other physical conditions remains constant

(3) It is not applicable at very high and very low temperature.
(4) It is not applicable for electrolytes.
(5) It is not applicable for superconductors.

33. Conversion of Galvanometer into Voltmeter.
Galvanometer can be converted into voltmeter by connecting a high resistance in series with the galvanometer.



Let R be the resistance connected in series with a galvanometer of resistance R_G to convert it into voltmeter of range $(0-V)$ volt.
Let Ig be the current required for full-scale deflection. The value of R should be such that when I_g current flows, it measures the potential difference of $(0-V)$ volt

$$V = \begin{bmatrix} \text{Potential difference across} \\ \text{galvanometer} \end{bmatrix}$$

+[Potential difference across resistor]

$$V = I_g R_G + I_g R$$

$$\therefore V = I_g (R_G + R)$$

$$R_G + R = \frac{V}{I_g}$$

$$R = \frac{V}{I_g} - R_G$$

34.

Paramagnetic materials magnetise weakly in an external magnetic field in the direction of magnetising field.
Paramagnetic materials are weakly attracted by a powerful magnet.
When a bar of paramagnetic material is placed in an external magnetic field, the field lines tend to concentrate in the specimen and hence the field inside increases.
Relative permeability of paramagnetic magnetic materials is slightly greater than 1 . ($\mu_r > 1$)
They have a low positive value of susceptibility.
Susceptibility of a paramagnetic substance varies inversely as its absolute temperature i.e., $\chi \propto \frac{1}{T}$.
This is called Curie's law.

35.

When north pole of a bar magnet is moved towards a coil, the direction of induced current in the coil is in such a way that near face of the coil acquires north pole. Therefore work has to be done against the force of repulsion to move the magnet towards the coil.

Similarly, when north pole of the magnet is moved away from the coil, the direction of induced current in the coil is in such a way that, its near face acquires south polarity. Again work must be done against the force of attraction to move the magnet away from the coil. Thus work must be done to move the magnet. This work is stored as energy. Therefore energy is conserved.

36.

All the distances are measured from the pole of the spherical mirror along the principal axis.
The distances measured in the same direction as the incident light, are taken as positive. The distances measured opposite to the direction of incident light are taken as negative.
The height measured upwards and perpendicular to the principal axis of the mirror is taken as positive, the height measured downwards is taken as negative.

37.

Bohr's first postulate :
An electron in an atom could revolve in certain stable orbits without the emission of radiant energy.
Bohr's second postulate :

The electron revolving around the nucleus only in those orbits for which the angular momentum is some integral multiple of $\frac{h}{2\pi}$.

Where, h is the Planck's constant. $L = \frac{nh}{2\pi}$

Bohr's third postulate :

An electron might make a transition from one of its specified non-radiating orbits to another of lower energy. When it does so, a photon is emitted having energy equal to the energy difference between the initial and final states.

The frequency of the emitted photon is then given by, $h\nu = E_i - E_f$ where, E_i and E_f are the energies of the initial and final states.

38.

$E_b = \Delta m \times 931 MeV$

$= 0.11236 \times 931 MeV \quad E_b = 104.60716 MeV$

Binding energy per nucleon $(E_{bs}) = \frac{E_b}{A}$

$E_{bs} = \frac{104.60716}{14}$

$E_{bs} = 7.47194 MeV$

39.

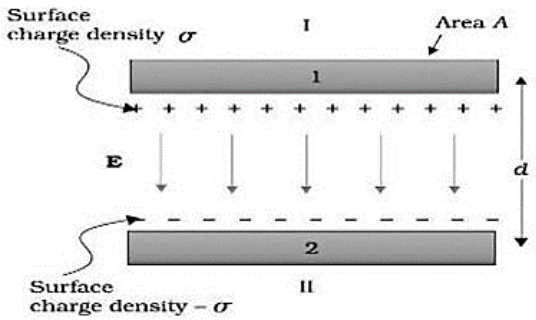
Polar molecules :

The molecules in which centre of positive and centre of negative charges are not coincided, are called polar molecules.

Non - polar molecules :

The molecules in which centre of positive and centre of negative charges are coincided, are called non - polar molecules.

Expression for capacitance of parallel capacitor:



Consider a parallel plate capacitor having two identical metallic plates 1 and 2 of area ' A ' separated by small distance ' d

Let $+Q$ and $-Q$ charges are given to the plate 1 and 2 respectively. A Uniform electric field ' E ' is set up between the plate except at the edges.

The density (σ) of the charges on either plate is given by $\sigma = \frac{Q}{A}$.

According to Gauss' theorem, intensity at a point between the two plates is

$E = \frac{\sigma}{\epsilon_0}$

$\therefore E = \frac{Q}{A} \times \frac{1}{\epsilon_0} \quad \ldots.(1)$

If V be the potential difference between the two plates then

$E = \frac{V}{d}. \quad \ldots\ldots(3)$

From equation (2) and (3)

$\frac{V}{d} = \frac{Q}{A}\frac{1}{\epsilon_0} \quad \ldots..(4)$

According to definition of capacitance of parallel plate capacitor.

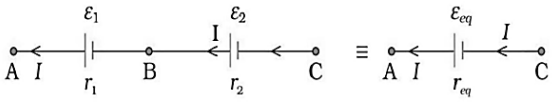
$C = \frac{Q}{V}$

$C = Qx\frac{A\epsilon_0}{Qd}$

$C = \frac{A\epsilon_0}{d}$

41.

Expression for equivalent emf and equivalent internal resistance of two cells connected in series:



Consider two cells of emf E_1 and E_2 of internal resistance r_1 and r_2 respectively are connected in series as shown in figure.

Let V_1 and V_2 be the potential across cells of emf E_1 and E_2 respectively. I be the current flowing through the combination.

From definition, $V = V_1 + V_2$

$V = (E_1 - I_1) + E_2 - Ir_2$

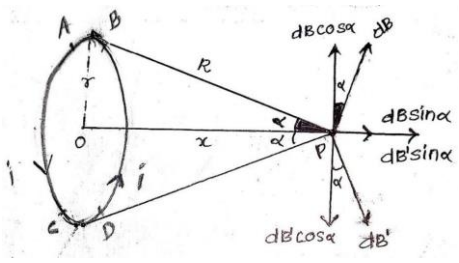
$V = (E_1 + E_2) + I(r_1 + r_2)$ .....(1)

Suppose two cells are replaced by a single cell of emf E_{eq} and internal resistance r_{eq} such that it produces same effect as produced by two cells combinedly. $V = E_{eq} - Ir_{eq}$ ……(2)

From equation (1) and (2)

$$\left.\begin{aligned} E_{eq} &= E_1 + E_2 \\ r_{eq} &= r_1 + r_2 \end{aligned}\right\}$$

41.



Consider a circular coil of ' n ' turn and radius ' r ' carrying a current I as shown in figure.

The plane of the coil is perpendicular to the plane of paper so that its axis lies on the plane of the paper. Let ' P ' be a point on the axis of the coil at a distance ' x ' from the centre ' O ' of the coil.

Consider two diametrically opposite current element AB and CD of length ' dl '.

Let R be the distance between current element and the point ' P '.

From fig. $R^2 = r^2 + x^2$ (1)

According to Biot- Savart's law, the magnetic field at point ' P ' due to current element ' AB ' is given by

$$dB = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{R^2}$$

$\because \theta = 90^\circ$, we have $\sin 90^\circ = 1$,

and $R^2 = r^2 + x^2$

$$\therefore dB = \frac{\mu_0}{4\pi}\frac{Idl}{\left(r^2 + x^2\right)} \quad \ldots.(3)$$

The field resolved into two rectangular components as horizontal component of dB. i.e. Along Px is $dB\sin\alpha$.

The vertical component of dB i.e., along PY is $dB\cos\alpha$.

The magnetic field at ' P ' due current element CD is dB '.

Let dB' is resolved into two rectangular components as horizontal and vertical.

The horizontal component of dB i.e., along $PX' = dB'\sin\alpha$. The vertical component of dB' i.e. along $PY' = dB'\cos\alpha$. The vertical components of dB' to current element AB and CD are equal in magnitude but opposite in direction hence cancel each other. The horizontal components of dB due to current element AB and CD add up.

$\therefore$ The resultant field at P is $B' = 2dB\sin\alpha$ for complete coil.

$B = \Sigma B'$

$$B = \Sigma 2\ dB\sin\alpha = \Sigma 2\left[\frac{\mu_0 Idl}{4\pi\left(r^2 + x^2\right)}\sin\alpha\right]$$

From fig, $\sin\alpha = \frac{r}{R} = \frac{r}{\left(r^2 + x^2\right)^{1/2}}$

$$B = \Sigma 2\left[\frac{\mu_0}{4\pi}\frac{Idl}{\left(r^2 + x^2\right)}\frac{r}{\left(r^2 + x^2\right)^{1/2}}\right]$$

$$= \left[\frac{\mu_0}{4\pi} I\Sigma 2dl\frac{r}{\left(r^2 + x^2\right)^{1/2}}\right]$$

Since, $\sum 2dl = 2\pi r$ $B = \frac{\mu_0}{4\pi} I.2\pi r\frac{r}{\left(r^2 + x^2\right)^{3/2}}$

42.

(a) The modification in the distribution of light energy due to the superposition of two or more waves of light is called interference of light.

(b) (i) For constructive interference, the path difference must be equal to the integral multiple of λ. where λ is the wave length of light.

Or

(i) $\Delta x = n\lambda =$ where $n = 0,1,2,3$

(ii) For destructive interference, the path difference must be equal to the odd integral multiple of $\frac{\lambda}{2}$.

Or

(ii) $\Delta x = (2n+1)\frac{\lambda}{2}$ where $n = 0,1,2,3\ldots\ldots$

(c) Uses of polaroids

Polaroids are used as sunglasses.

Automobile head lights are covered with polaroids to minimise glare.

Polaroids are used in cameras, microscope objectives to eliminate glare of reflected light.

Polaroids are used as sun films in window panes of aero planes.

Polaroids are used to view 3-D pictures and movies.

Polaroids are used to improve colour contrast in old oil paintings.

Polaroids are used in laboratory to study plane polarized light. +

43.

[Energy of incident photon] $=$ [work function] +[KE of photoelectron $]$

or

$KE = h\nu - W$

or

$KE = h\nu - h\nu_0$

or

$KE = h(\nu - \nu_0)$

where $\nu_0 \rightarrow$ threshold frequency

Einstein's explanation for photo-emission :

Einstein's explanation for experimental observations of photo-emission:

1. It is a simple elastic collision between two micro particles which takes place in very short time. Hence the process is instantaneous.

2. According equation, KE of photo electron is

$KE = h[\nu - \nu_0]$

If $\nu < \nu_0$, KE is negative, that is if frequency of incident light is less than threshold frequency, KE of photoelectrons is negative. It is not possible. Hence photoemission is not possible.

3. When intensity of incident light increases, number of photons falling on photo emissive surface increases. As a result, number photo electron and hence photoelectric current increases.

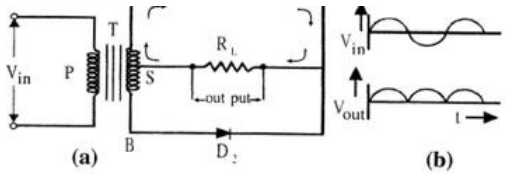
4. From Einstein's equation, $KE = h\nu - w$

In above equation, for a given metal surface work function ' w ' remains constant hence as frequency ν increases KE of photoelectrons increases.

44.

Circuit diagram

Wave Forms



Circuit diagram one mark

Input and output waveform one mark

Working:

AC voltage which is to be rectified is applied to primary P of the transformer, it induces a voltage in the secandary S of the transformer.

During positive half cycles of the input, A is positive \& B is negative, diode D_1, is forward biased and D_2 is reverse biased, hence current flows through load resistance R_L due to D_1 and gives output.

During negative half cycles of the input, A is negative, B is positive, diode D_1 is reverse biased and diode D_2 is forward biased so current flows through load R_L due to D_2 and gives output.

Thus, in either case current flows through one or the other diode giving rise to current over the complete cycle.therefore this rectifier is called full wave rectifier.

45.

$$E = E_1 + E_2$$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{x^2} + \frac{1}{4\pi\varepsilon_0}\frac{q_2}{x^2}$$

$$E = 9\times10^9 \frac{15\times10^{-6}}{\left(10\times10^{-2}\right)^2} + 9\times10^9 \frac{10\times10^{-6}}{\left(10\times10^{-2}\right)^2}$$

$$E = 2.25\times10^7\ NC^{-1}$$

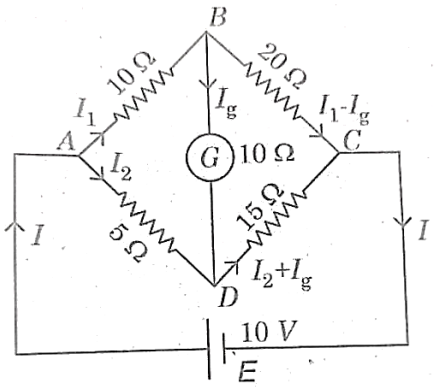
$$F = q_0 E$$

$$F = 20\times10^{-3}\times2.25\times10^7$$

$$F = 45\times10^4\ N$$

$$F = 4.5\times10^5\ N$$

46.



Apply KVL for loop ABDA

$$-10I_1 - 10I_g + 5I_2 = 0 \text{ or } 10I_1 + 10I_g - 5I_2 = 0$$

….(1)

Apply KVL for loop BCDB

$$-20I_1 + 45I_g + 15I_2 = 0 \Rightarrow \quad \text{…..(2)}$$

Solve equation (1) and equation (2)

$$10I_1 + 10I_g - 5I_2 = 0 \text{ x3}$$

$$\frac{-20I_1 + 45I_g + 15I_2 = 0}{10I_1 + 75I_g = 0} \quad \text{……(3)}$$

Apply KVL for loop ABCA

$$-30I_1 + 20I_g + 10 = 0 \quad \text{.....(4)}$$

$$-30I + 20I_g = -10$$

Solve equation (3) and equation (4)

$$10I_1 + 75Ig = 0 \text{ x by3}$$

$$\frac{-30I_1 + 20I_g = -10}{245I_g = -10}$$

$$I_g = -\frac{10}{245}A = -\frac{2}{49}\ A$$

Steps can be reduced by any alternative method

47.

$$X_L = 2\pi fL = 7.85\Omega$$

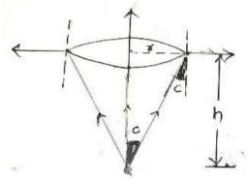
$$X_C = \frac{1}{2\pi fC} = 4\Omega$$

$$Z = \sqrt{R^2 + \left(X_L - X_C\right)^2}$$

$$Z = 7.13\Omega$$

$$\text{Power factor} = \cos\varphi = \frac{R}{Z} = 0.8415$$

48.



$$\sin C = \frac{1}{n} \quad C = 48.75^\circ$$

from trigonometry, $\tan C = \frac{r}{h}$

$$r = h\times\tan C = 80\times10^{-2}\times\tan\left(48.75^\circ\right) \quad r = 0.91\ m$$