G. D. GOENKA PUBLIC SCHOOL, SEC-22, ROHINI

Periodic Test – I (2024-2025)

Class – XII

Subject – Physics

Set-B

Time : 50 minutes **Maximum Marks : 25**

Name : Yashwi Goel **Roll No. :** _____

No. of printed pages : (2)

General Instructions:

- Q.1 to Q.5 carry 1 mark each.
- Q.6 to Q.7 carry 2 marks each.
- Q.8 to Q.9 carry 3 marks each.
- Q.10 and Q11 carry 5 marks each.

Q.1 Two charged spheres separated by a distance d exert some force on each other. If they are immersed in a liquid of dielectric constant 2, then what is the force exerted by them, if all other conditions are same? (1)

(a) F/2 (b) 2 F (c) F (d) 4 F

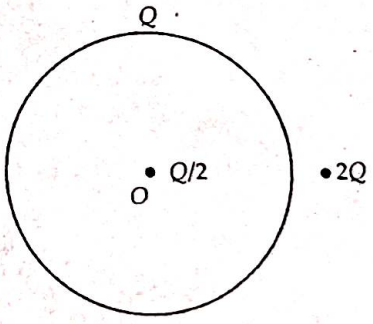
Q.2 A point charge of q coulomb is placed at the centre of a cube of side 2 cm. The flux through one of the cube faces is (1)

(a) $\frac{q}{6\varepsilon_0}$ (b) $\frac{q}{-6\varepsilon_0}$ (c) $\frac{6\varepsilon_0}{q}$ (d) $\frac{-6\varepsilon_0}{q}$

Q.3 If the radius of the Gaussian surface enclosing a charge is doubled, then the electric flux through the Gaussian surface would be (1)

(a) halved (b) doubled (c) zero (d) remain same

Q.4 As shown in given figure, a thin spherical shell carries a charge Q on its surface. A point charge Q/2 is placed at its centre O and another charge 2Q placed outside. If all the charges are positive, what will be the force on the charge at the centre? (1)



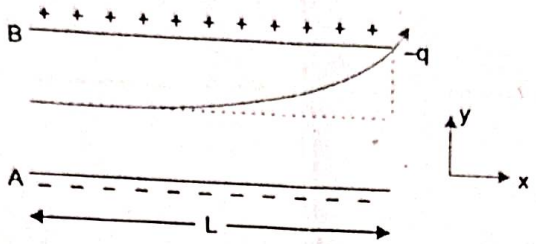
a) $\frac{-2Q}{\varepsilon_0}$ (b) $\frac{Q}{2\varepsilon_0}$ (c) $\frac{-Q}{\varepsilon_0}$ (d) ZERO

Q.5 Two charges of magnitudes –2Q and +Q are located at points (a, 0) and (4a, 0) respectively. What is the electric flux due to these charges through a sphere of radius 5a with its centre at the origin? (1)

a) $\frac{-2Q}{\varepsilon_0}$ (b) $\frac{Q}{\varepsilon_0}$ (c) $\frac{-Q}{\varepsilon_0}$ (d) ZERO

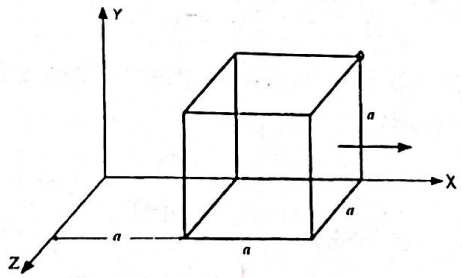
Q.6 State and prove Gauss's theorem for a point charge. (2)

Q7 A particle of mass m and charge (-q) enters the region between the two charged plates initially moving along X-axis with speed 'v' as shown in figure. The length of plate is L and an uniform electric field E is maintained between the plates. Show that the vertical deflection of the particle at the far edge of the plate is $\frac{qEL^2}{2mv^2}$. (2)



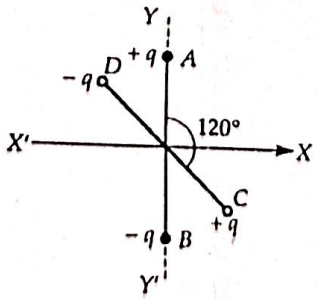
Q.8 Three charges, each equal to q are placed at the three corners of a square of Side 'a'. Find the electric field at the fourth corner. (3)

Q.9 The electric field components in the figure are Ex = α x1/2, Ey = Ez=0, in which α =800 N/Cm². Calculate (i) the flux Φ_E through the cube and (ii) the charge within the cube. Assume that a = 0.1 m. (3)



Q.10 (a) Derive an expression for the torque experienced by an electric dipole kept in a uniform electric field.

(b) Two small identical electrical dipoles AB and CD, each of dipole moment 'p' are kept at an angle of 120° as shown in the given figure. What is the resultant dipole moment of this combination? If this system is subjected to electric field $(\vec{E})$ directed along + X direction, what will be the magnitude and direction of the torque acting on this. (5)



Q.11 Using Gauss's law, deduce the expression for the electric field due to a uniformly charged spherical conducting shell of radius R at a point.

(a) Outside and (b) Inside the shell

Plot a graph showing variation of electric field as a function of r > R and r < R. (r being the distance from the centre of the shell) (5)

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G. D. GOENKA PUBLIC SCHOOL, SECTOR-22, ROHINI

Term- I Examination (2024-2025)

Class – XII

Subject – PHYSICS

Set- A

Time: 3 hours

Maximum Marks: 70

Name: _____

Roll No.: _____

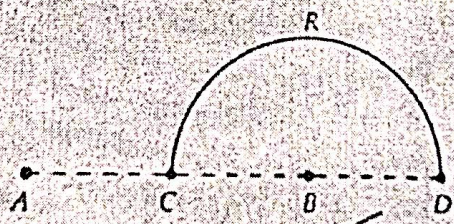
No. of printed pages: (8)

General Instructions: -

- The question paper contains 4 Sections.
- All Sections are compulsory.
- You may use the following values of physical constants wherever necessary
  - i. $c = 3 \times 10^{6}$ m/s
  - ii. $m_e = 9.1 \times 10^{-31}$ kg
  - iii. $e = 1.6 \times 10^{-19}$ C
  - iv. $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}
  - v. $h = 6.63 \times 10^{-34}$ Js
  - vi. $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N^{-1}m^{-2}$
  - vii. Avogadro's number = 6.023×10^{23} per gram mole

SECTION - A (ONE MARK QUESTIONS)

Q.1 Charges + q and – q are placed at points A and B respectively which are a distance 2 L apart, C is the midpoint between A and B. The work done in moving a charge + Q along the semicircle CRD is



(a) $\frac{qQ}{2\pi\varepsilon_0 L}$ (b) $\frac{qQ}{6\pi\varepsilon_0 L}$ (c) $-\frac{qQ}{6\pi\varepsilon_0 L}$ (d) $\frac{qQ}{4\pi\varepsilon_0 L}$

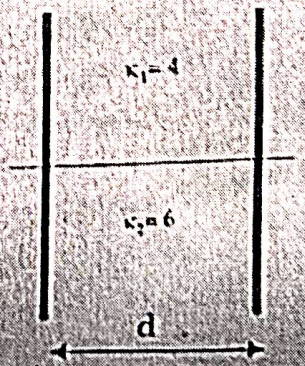
Q.2 A capacitor of capacitance 1μF is filled with two dielectrics of dielectric constants 4 and 6. What is the new capacitance?

(a) 10μF

(b) 5μF

(c) 4μF

(d) 7μF



Q3. The magnetic flux linked with the coil (in Weber) is given by the equation –

$$\Phi = 5t^2 + 3t + 16$$

The induced EMF in the coil at time, t = 4 will be-

(a) -27 V (b) - 43 V (c) -108 V (d) 210 V

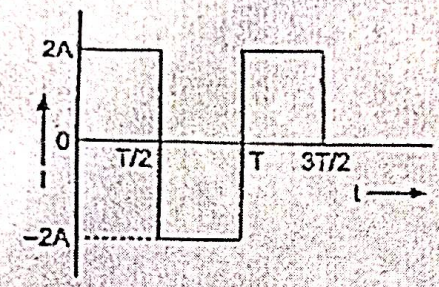
Q.4 A cylinder of radius r and length l is placed in a uniform electric field parallel to the axis of the cylinder. The total flux for the surface of the cylinder is given by-

(a) zero (b) πr^2 (c) $E \pi r^2$ (d) $2E\pi r^2$

Q.5 A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which R = 3 Ω, L = 25.48 mH, and C = 796 μF, then the power dissipated at the resonant condition will be-

(a) 39.70 KW (b) 26.70 kW (c) 13.35 kW (d) Zero

Q.6 What is the rms value of alternating current shown in figure?

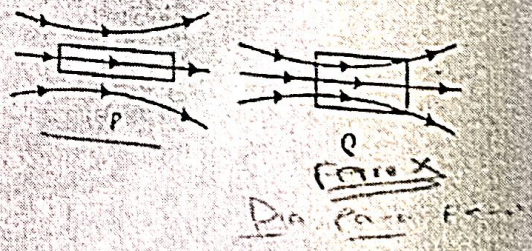


(a) 2 A (b) $2\sqrt{2}$ A (c) $2/\sqrt{2}$ A (d) $\sqrt{2}$ A

Q.7 A uniform electric field pointing in positive X-direction exists in a region. Let A be the origin, B be the point on the X-axis at x = +1 cm and C be the point on the Y-axis at y = +1 cm. Then the potential at point A, B and C satisfies:

(a) $V_A < V_B$ (b) $V_A > V_B$ (c) $V_A < V_C$ (d) $V_A > V_C$

Q.8 Two similar bars P and Q made from different materials are introduced in two identical uniform magnetic fields. The figure shows the distribution of magnetic line of force. Which of these statements is true?



(a) P is paramagnetic

(b) Q is paramagnetic

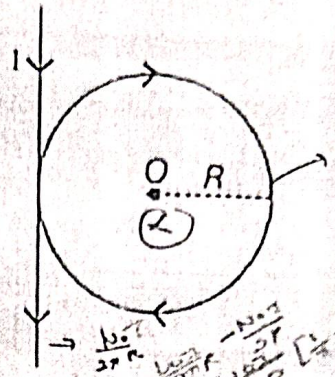
(c) Both P and Q are diamagnetic

(d) P is paramagnetic and Q is diamagnetic

Q.9 A 15Ω resistor, an 80 mH inductor and a capacitor of capacitance C are connected in series with a 50 Hz AC source. If the source voltage and current in the circuit are in phase, then the value of capacitance is

(a) 100 μF (b) 127 μF (c) 142μF (d) 160 μF

Q.10 A current I flows through a long straight conductor which is bent into a circular loop of radius R in the middle as shown in the figure.



The magnitude of the net magnetic field at point O will be

(a) zero (b) $\frac{\mu_0 I}{2R}(1+\pi)$ (c) $\frac{\mu_0 I}{4\pi R}$ (d) $\frac{\mu_0 I}{2R}\left(1-\frac{1}{\pi}\right)$

For Q11-14: In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct answer out of the following choices.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false and R is also false.

Q.11 **Assertion (A)** : On increasing the current sensitivity of a galvanometer by increasing the number of turns, may not necessarily increase its voltage sensitivity.

Reason (R) : The resistance of the coil of the galvanometer increases on increasing the number of turns

Q.12 **Assertion (A)** : Two parallel conducting wires carrying currents in same direction, come close to each other.

Reason (R) : Parallel currents attract, and anti-parallel currents repel.

Q.13 **Assertion (A)** : Magnetic lines of force form continuous closed loops whereas electric lines of force do not.

Reason (R) : Magnetic poles always occur in pairs as north pole and south pole.

Q.14 **Assertion (A)** : Capacitor serves as a barrier for DC and offers an easy path to AC.

Reason (R) : Capacitive reactance is inversely proportional to frequency.

For Q15 and 16, attempt any four out of five sub parts. Each part carries one mark

Q.15 **MAGNETIC DAMPING:**

When a conductor oscillates inside a magnetic field, eddy currents are produced in it. The flow of electrons in the conductor immediately creates an opposing magnetic field which results in damping of the magnet and produces heat inside the conductor similar to heat build-up inside of a power cord during use.

By Lenz's law the circulating currents create their own magnetic field that opposes the field of the magnet. Thus, the moving conductor experiences a drag force that opposes its motion. A damping force is generated when these eddy current and magnetic field interact with each other.

It is a damping technique where electromagnetically induced current slow down the motion of an object without any actual contact. As the distance between magnet and conductor decreases the damping force increases. The electromagnetic damping force is proportional to the induced eddy current) strength of the magnetic field and the speed of the object which implies that faster the object moves, greater will be the damping and slower the motion of object, lower will be damping which will result in the smooth stopping of the object.

(i) Foucault's current are also known as

(a) direct current (b) induced current

(c) eddy current (d) both eddy current and induced current

(ii) Eddy current have negative effect because they produce

(a) heating only (b) damping only

(c) heating and damping (d) harmful radiation

(iii) The electromagnetic damping force is proportional to

(a) the induced eddy current (b) the strength of magnetic field

(c) the speed of object (d) all of the above

(iv) In electromagnetic induction, line integral of induced field E around a closed path is _____ and induced electric field is _____.

(a) zero, non conservative (b) non zero, conservative

(c) zero, conservative (d) non zero, non conservative

(v) A circular coil of area 200 cm^2 and 25 turns rotates about its vertical diameter with a angular speed of 20 rad/s in a uniform horizontal magnetic field of magnitude 0.05 T. The maximum voltage induced in the coil is

(a) 0.5 V (b) 1.5 V

(c) 2.5 V (d) 2.0 V

Q.16 ELECTRON DRIFT:

An electric charge (electron, ions) will experience a force if an electric field is applied. If we consider solid conductors, then of course the atoms are tightly bound to each other so that the current is carried by the negative charged electrons. Consider the first case when no electric field is present, the electrons will be moving due to thermal motion during which they collide with the fixed ions. An electron colliding with an ion emerges with same speed as before the collision.

However, the direction of its velocity after the collision is completely random. At a given time, there is no preferential direction for the velocities of the electrons. Thus, on an average, the number of electrons travelling in any direction will be equal to the number of electrons travelling in the opposite direction. So, there will be no net electric current. If an electric field is applied, the electrons will be accelerated due to this field towards positive charge.

The electrons, as long as they are moving, will constitute an electric current. The free electrons in a conductor have random velocity and move in random directions. When current is applied across the conductor, the randomly moving electrons are subjected to electrical forces along the direction of electric field. Due to this electric field, free electrons still have their random moving nature, but they will move through the conductor with a certain force. The net velocity in a conductor due to the moving of electrons is referred to as the drift of electrons.

(i) When a potential difference V is supplied across a conductor at temperature T, the drift velocity of electrons is proportional to

(a) V (b) $\sqrt{V}$

(c) $\sqrt{T}$ (d) T

(ii) A steady current flows in a metallic conductor of non-uniform cross-section. Which of the following quantities is constant along the conductor?

(a) Current density (b) Drift speed

(c) Current (d) None of these

(iii) Relation between drift velocity (v_d) of electron and thermal velocity (v_T) of an electron at room temperature is

(a) $v_d = v_T = 0$ (b) $v_d > v_T$

(c) $v_d < v_T$ (d) $v_d = v_T$

(iv) Which of the following characteristics of electrons determines the current in a conductor?

(a) Thermal velocity alone

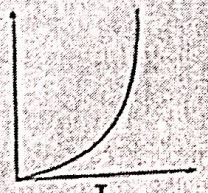
(b) Drift velocity alone

(c) Both drift velocity and thermal velocity

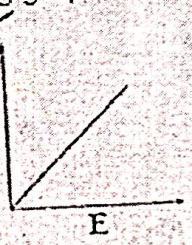
(d) Neither drift nor thermal velocity

(v) If E denotes electric field in a uniform conductor, I corresponding current through it, v_d drift velocity of electrons and P denotes thermal power produced in the conductor, then which of the following graphs is/are correct?

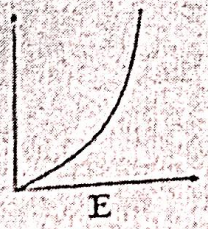
(a)



(b)



(c)

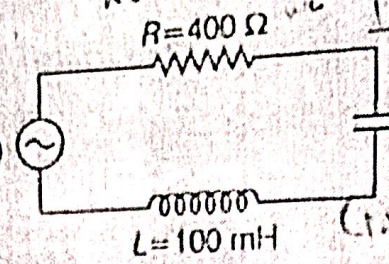


(d) All of the above

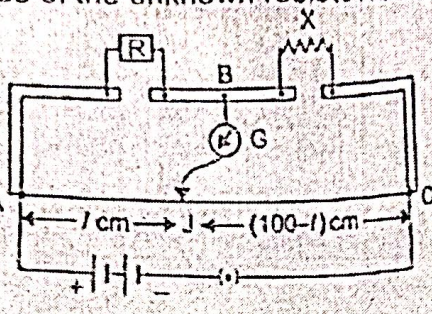
SECTION - B (2 MARK QUESTIONS)

Q.17 A wheel with 10 metallic spokes each 0.5 m long is rotated with a speed of 120 revolutions per minute in a plane normal to the horizontal component of Earth's magnetic field B at a place.
If B = 0.4G at that place, what is the induced EMF between the axle and the rim of the wheel?

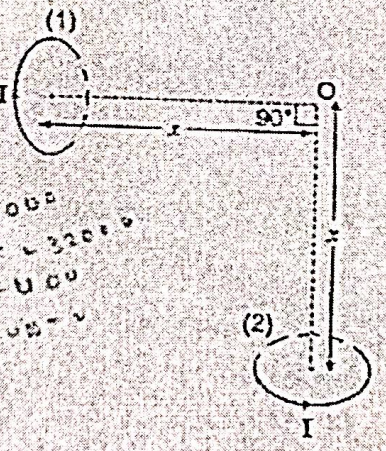
Q.18 Calculate the value of the additional capacitor which may be joined in parallel to the capacitor C that would make the power factor of the circuit unity.



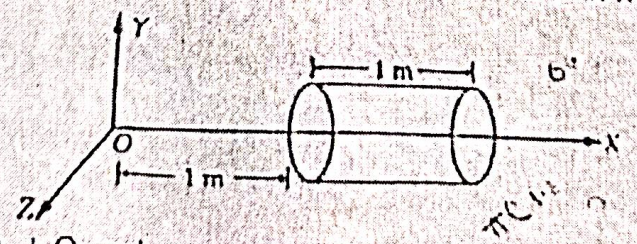
Q.19 A resistance R= 4 Ω is connected to one of the gaps in the metre bridge, which uses a wire of length 1m. An unknown resistance X > 4 ohm is connected in the other gap as shown in the figure. The balance point is noted at / cm from the positive end of the battery. On interchanging R and X, it is found that the balance point further shifts by 20cm. Calculate the value of the unknown resistance X.



Q.20 Two small identical circular loops, marked (1) and (2), carrying equal currents, are placed with the geometrical axes perpendicular to each other as shown in the figure. Find the magnitude and direction of the net magnetic field produced at the point O.



Q.21 A hollow cylindrical box of length 1 m and area of cross-section 25 cm² is placed in a three-dimensional coordinate system as shown in given figure. The electric field in the region is given by $\vec{E} = 50x\hat{i}$, , where E is in NC⁻¹ and x is in metres. Calculate the ϕ

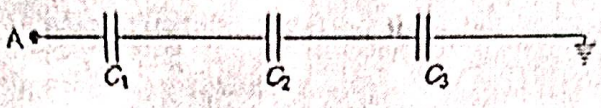


Q.22 Three charges -q, + Q and -q are placed at equal distances on a straight line. If the potential energy of the system of three charges is zero, find the ratio of Q/q.

Q.23 A closely wound solenoid 80 cm long has 5 layers of windings of 400 turns each. The diameter of the solenoid is 1.8 cm. If the current carried is 8.0 A, estimate the magnitude of B inside the solenoid near its centre.

A slab of material of dielectric constant K has the same area as that of the plates of a parallel plate capacitor but has the thickness d/2, where d is the separation between the plates. Find out the expression for its capacitance when the slab is inserted between the plates of the capacitor.

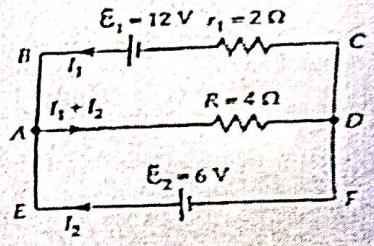
Q.25 Calculate the potential difference and the energy stored in the capacitor C_2 in the circuit shown in the figure. Given potential at A is 90 V, C_1 = 20 μF, C_2 = 30 μF, C_3 = 15 μF.



SECTION - C (3 MARK QUESTIONS)

Q.26 The susceptibility of a magnetic material is -2.6×10^{-5}, identify the type of magnetic material and state its two properties.

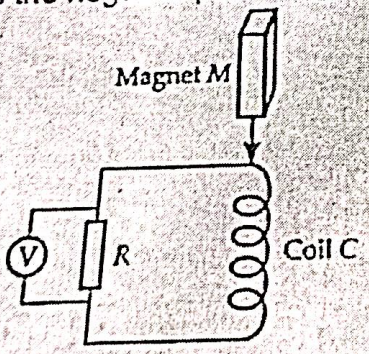
Q.27 In the electric network shown, use Kirchhoff's rule to calculate the power consumed by the resistance R=4 Ω



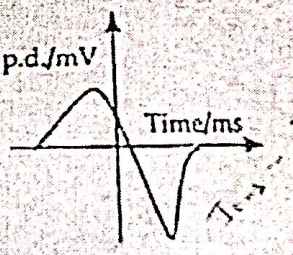
Q.28 A bar magnet M is dropped so that it falls vertically through the coil C. The graph obtained for voltage produced across the coil versus time is shown in the figure

(i) Explain the shape of the graph

(ii) Why is the negative peak longer than the positive peak?



(a)



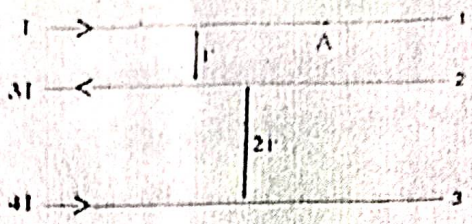
(b)

Q.29 An alternating voltage of 220 V is applied across a device X. A current of 0.22A flows in the circuit and it lags behind the applied voltage in phase by $\frac{\pi}{2}$ radian. When the same voltage is applied across another device Y. The current in the circuit remains the same and it is in phase with the applied voltage.

(i) Name the devices X and Y and

(ii) calculate the current flowing in the circuit when the same voltage applied across series combination of X and Y.

Q.30 The figure shows three infinitely long straight parallel current carrying conductors. Find the (i) magnitude and direction of the net magnetic field at point A lying on conductor 1, (ii) magnetic force on conductor 2.



SECTION - D (5 MARK QUESTIONS)

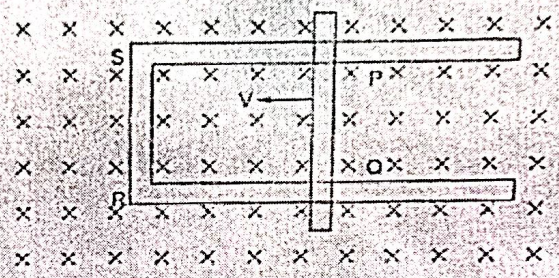
Q.31 (i) Describe the principle, construction and working of a moving coil galvanometer.

(ii) An ammeter of resistance 0.80 Ω can measure current up to 1 A. What must be the shunt resistance to enable the ammeter to measure current upto 5 A.

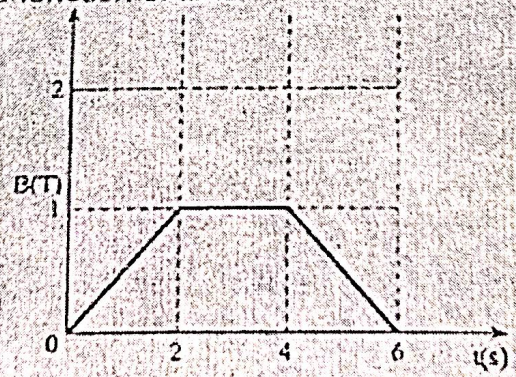
Q.32 (i) Figure shows a rectangular loop conducting PQRS in which the arm PQ is free to move. A uniform magnetic field acts in the direction perpendicular to the plane of the loop. Arm PQ is moved with a velocity v towards the arm RS. Assuming that the arms QR, RS and SP have negligible resistances and the moving arm PQ has the resistance r, obtain the expression for

(a) the current in the loop

(b) the force on arm PQ



(ii) The magnetic field through a circular loop of wire 12 cm in radius and 8.5 Ω resistance, changes with time as shown in the figure. The magnetic field is perpendicular to the plane of the loop. Calculate the induced current in the loop and plot it as a function of time.



Q.33 (i) Derive an expression for potential energy of an electric dipole p in an external uniform electric field E. When is the potential energy of the dipole (i) maximum, and (ii) minimum?

(ii) An electric dipole consists of point charges -1·0 pC and + 1·0 pC located at (0, 0) and (3 mm, 4 mm) respectively in x y plane. An electric field E =1000 V/m is switched on in the region. Find the torque acting on the dipole.

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Mass of neutron = 1.675×10^{-27} kg

Mass of proton = 1.673×10^{-27} kg

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

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

SECTION - A (1 MARK EACH) 18

Q.1 A thin plastic rod is bent into a circular ring of radius R. It is uniformly charged with charge density λ. The magnitude of the electric field at its centre is:

(A) $\frac{\lambda}{2\varepsilon_0 R}$ (B) Zero (C) $\frac{\lambda}{4\pi\varepsilon_0 R}$ (D) $\frac{\lambda}{4\varepsilon_0 R}$

Q.2 A 10 cm long wire lies along y-axis. It carries a current of 1.0 A in positive y-direction. A magnetic field $\vec{B} = (5mT)\hat{j} - (8mT)\hat{k}$ exist in the region. The force on the wire is:

(A) (0.8 mN) $\hat{i}$ (B) - (0.8 mN) $\hat{i}$ iBl

(C) (80 mN) $\hat{i}$ (D) - (80 mN) $\hat{i}$ $\frac{1}{10} \times (-8 \times 10^{-3})$

10cm (1A)

Q.3 The transition of electron that gives rise to the formation of the second spectral line of the Balmer series in the spectrum of hydrogen atom corresponds to :

(A) $n_f = 2$ and $n_i = 3$ (B) $n_f = 3$ and $n_i = 4$

(C) $n_f = 2$ and $n_i = 4$ (D) $n_f = 2$ and $n_i = \infty$

Q.4 Two beams, A and B whose photon energies are 3·3 eV and 11·3 eV respectively, illuminate a metallic surface (work function 2·3 eV) successively. The ratio of maximum speed of electrons emitted due to beam A to that due to beam B is:

(A) 3 (B) 9

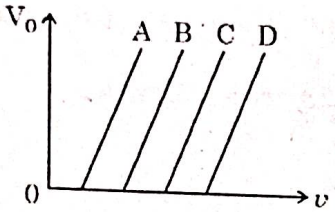
(C) $\frac{1}{3}$ (D) $\frac{1}{9}$

Q.5 The electromagnetic waves used to purify water are:

(A) Infrared rays (B) Ultraviolet rays

(C) X-rays (D) Gamma rays

Q.6 The variation of the stopping potential (V_0) with the frequency (υ) of the incident radiation for the metals A, B, C and D is shown in the figure. For the same frequency of incident radiation producing photoelectrons in all metals, the kinetic energy of photo-electrons will be maximum for metal:



(A) A (B) B

(C) C (D) D

Q.7 A young's double-slit experimental set up is kept in a medium of refractive index $\left(\frac{4}{3}\right)$. Which maximum in this case will coincide with the 6th maximum obtained if the medium is replaced by air?

(A) 4th (B) 6th

(C) 8th (D) 10th

Q.8 Which of the following statements is **not** true for a p-n junction diode under reverse bias

(A) The current is almost independent of the applied voltage.

(B) Holes flow from p-side to n-side.

(C) Electric field in the depletion region increases.

(D) n-side of the junction is connected to +ve terminal and p-side to –ve terminal of the battery.

Q.9 A parallel plate capacitor is charged by a battery. The battery is then disconnected and the plates of the charged capacitor are then moved farther apart. In the process:

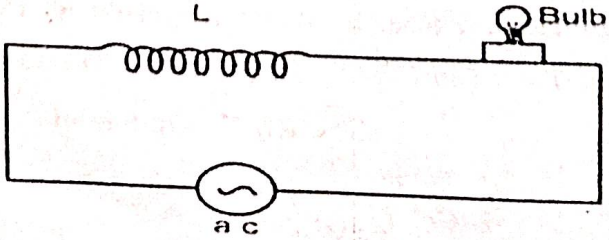
(A) the charge on the capacitor increases.

(B) the potential difference across the plates decreases.

(C) the capacitance of the capacitor increases.

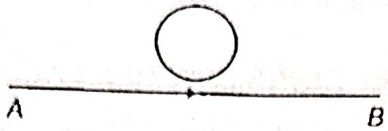
(D) the electrostatic energy stored in the capacitor increases.

Q.10 An iron cored coil is connected in series with an electric bulb with an AC source as shownin figure. When iron piece is introduced into the coil, the brightness of the bulb will



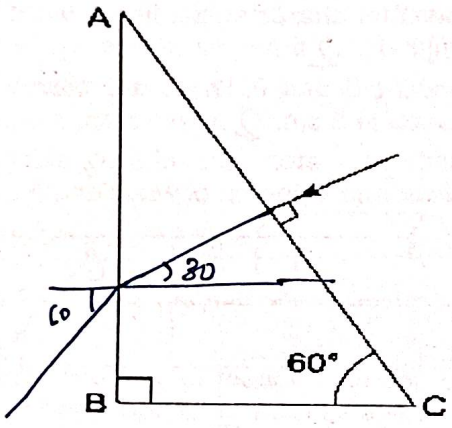
(A) increase (B) decrease
(C) remains unaffected (D) fluctuate

Q.11 A Current carrying wire is placed below a coil in its plane, with current flowing as shown. If the current increases.



(A) No current will be induced in the coil.
(B) An anti clock wise current will be induced in the coil.
(C) A clockwise current will be induced in the coil.
(D) The current induced in the coil will be first anti clockwise and then clockwise.

Q.12 If the refractive index of glass is $\sqrt{3}$, find out of the value of the angle of emergence from the prism.



$\frac{\sin i}{\sin e} = \frac{1}{\sqrt{3}}$

$\frac{\sqrt{3}}{2} = \sin e$

(A) 60° (B) 0°
(C) 30° (D) 90°

Q.13 A nuclear reaction is given below. The masses in amu of reactant and product nuclei are given in brackets:

$$\underset{(1.002)}{A} + \underset{(1.004)}{B} \longrightarrow \underset{(1.001)}{C} + \underset{(1.003)}{D} + Q \text{ Mev}$$

The value of energy Q is

(A) 1.234 MeV (B) 0.91 MeV
(C) 0.465 MeV (D) 1.862 MeV

Questions from 14 to 16 are Assertion(A) and Reasoning (R) type Questions. Select the most appropriate answer from below:

(A) Both A and R are true, and R is the correct explanation of A.
(B) Both A and R are true, and R is NOT the correct explanation of A.
(C) A is true but R is false.
(D) A is false and R is also false.

Q.14 **Assertion (A)** : In photoelectric effect, the kinetic energy of the emitted photoelectrons increases with increase in the intensity of the incident light.
D.
Reason (R) : Photoelectric current depends on the wavelength of the incident light.

Q.15 **Assertion (A)** : The mutual inductance between two coils is maximum when the coils are wound on each other.
A.
Reason (R) : The flux linkage between two coils is maximum when they are wound on each other.

Q.16 **Assertion (A)** : Although surfaces of a goggle lens are curved, it does not have any power.

Reason (R) : In case of goggles, both the curved surfaces are curved on the same side and have equal radii of curvature.

SECTION-B (2 MARKS EACH)

Q.17 (A) The magnetic susceptibility of a magnetic material is -4.2×10^{-6}. Name the type of magnetic material it represents.

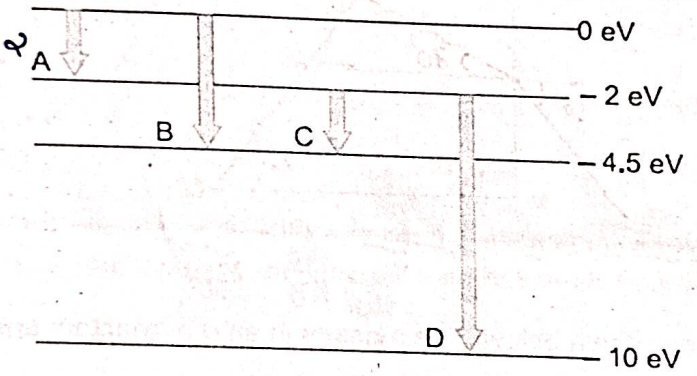
(B) State any two properties of the above type of materials.

Q.18 The Voltage between the plates of a parallel plate capacitor of capacitance 1μF is charging at the rate of 5 V/s. What is the displacement current in the capacitor?

Q.19 The earth revolves around the sun in an orbit of radius 1.5×10^{11} m with orbital speed 30 km/s. Find the quantum number that characterizes its revolution using Bohr's model in this case (mass of earth = 6.0×10^{24} kg).

Q.20 Two positive point charges of 0.2 μC and 0.01 μC are placed 10 cm apart. Calculate the work done in reducing the distance to 5 cm.

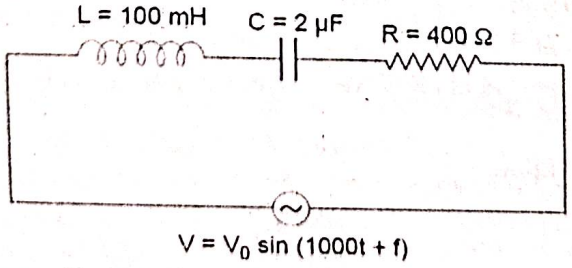
Q.21 The energy levels of a hypothetical atom are shown alongside. Which of the shown transitions will result in the emission of a photon of wavelength 275 nm?



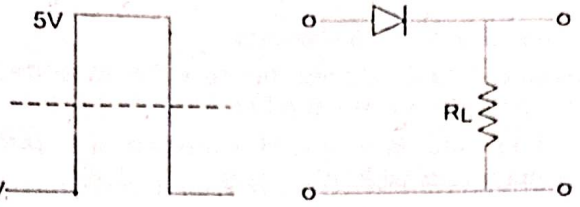
SECTION-C (3 MARKS EACH)

Q.22 (A) Find the value of the phase difference between the current and the voltage in the series LCR circuit shown below. Which one leads in phase: current or voltage?

(B) Without making any other change, find the value of the additional capacitor, C_1, to be connected in parallel with the capacitor C, in order to make the power factor of the circuit unity



Q.23 (A) Draw the output signal in a *p-n* junction diode when a square input signal of 10 V as shown in the figure is applied across it.



(B) The intensity of the two interfering waves in Young's double slit experiment is I_0 each. Find the intensity at a point on the screen where path difference between the interfering waves is (i) $\frac{\lambda}{2}$, and (ii) $\frac{\lambda}{3}$.

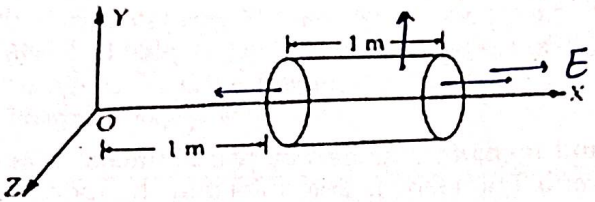
Q.24 Explain the following, giving reasons:

(A) A doped semiconductor is electrically neutral.

(B) In a p-n junction under equilibrium, there is no net current.

(C) In a diode, the reverse current is practically not dependent on the applied voltage.

Q.25 A hollow cylindrical box of length 1 m and area of cross-section 25 cm^2 is placed in a three dimensional coordinate system as shown in given figure. The electric field in the region is given by $\vec{E} = 50x\hat{i}$, , where E is in NC^{-1} and x is in metres. Calculate the flux through the cylinder and charge within the cylinder



Q.26 A telescope has an objective lens of focal length 150 cm and an eyepiece of focal length 5 cm. Calculate its magnifying power in normal adjustment and the distance of the image formed by the objective.

Q.27 Draw the graph showing the variation of binding energy per nucleon with the mass number for a large number of nuclei 2< A < 240. What are the main inferences from the graph? Explain with the help of this plot the release of energy in the processes of nuclear fission and fusion.

Q.28 (A) State Lenz's Law. In a closed circuit, the induced current opposes the change in magnetic flux that produced it as per the law of conservation of energy. Justify.

(B) A metal rod of length 2 m is rotated with a frequency 60 rev/s about an axis passing through its centre and perpendicular to its length. A uniform magnetic field of 2T perpendicular to its plane of rotation is switched-on in the region. Calculate the e.m.f. induced between the centre and the end of the rod.

SECTION-D (4 MARKS EACH)

(Case Study Based Questions)

Q.29 Dielectrics play an important role in design of capacitors. The molecules of a dielectric may be polar or non-polar. When a dielectric slab is placed in an external electric field, opposite charges appear on the two surfaces of the slab perpendicular to electric field. Due to this an electric field is established inside the dielectric.

The capacitance of a capacitor is determined by the dielectric constant of the material that fills the space between the plates. Consequently, the energy storage capacity of a capacitor is also affected. Like resistors, capacitors can also be arranged in series and/or parallel.

(A) Which of the following statements about dielectrics is correct?

(i) A polar dielectric has a net dipole moment in absence of an external electric field which gets modified due to the induced dipoles.

(ii) The net dipole moments of induced dipoles is along the direction of the applied electric field.

(iii) Dielectrics contain free charges.

(iv) The electric field produced due to induced surface charges inside a dielectric is along the external electric field.

(B) When a dielectric slab is inserted between the plates of an isolated charged capacitor, the energy stored in it:

(i) increases and the electric field inside it also increases.

(ii) decreases and the electric field also decreases.

(iii) decreases and the electric field increases.

(iv) increases and the electric field decreases.

(C) An air-filled capacitor with plate area A and plate separation d has capacitance C_0. A slab of dielectric constant K, area A and thickness d/5 is inserted between the plates. The capacitance of the capacitor will become:

(i) $\left[\frac{4K}{5K+1}\right] C_0$ (ii) $\left[\frac{K+5}{4}\right] C_0$

(iii) $\left[\frac{5K}{4K+1}\right] C_0$ (iv) $\left[\frac{K+4}{5K}\right] C_0$

(D) Two capacitors of capacitances $2C_0$ and $6C_0$ are first connected in series and then in parallel across the same battery. The ratio of energies stored in series combination to that in parallel is:

(i) $\frac{1}{4}$ (ii) $\frac{1}{6}$

(iii) $\frac{2}{15}$ (iv) $\frac{3}{16}$

Q.30 A lens is a transparent medium bounded by two surfaces, with one or both surfaces being spherical. The focal length of a lens is determined by the radii of curvature of its two surfaces and the refractive index of its medium with respect to that of the surrounding medium. The power of a lens is reciprocal of its focal length. If a number of lenses are kept in contact, the power of the combination is the algebraic sum of the powers of the individual lenses.

(A) : A double-convex lens, with each face having same radius of curvature R, is made of glass of refractive index n. Its power is:

(i) $\frac{2(n-1)}{R}$ (ii) $\frac{(2n-1)}{R}$

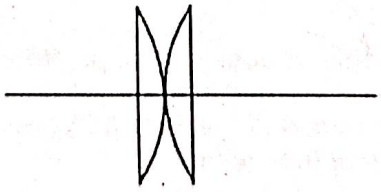
(iii) $\frac{(n-1)}{2R}$ (iv) $\frac{(2n-1)}{2R}$

(B) A double-convex lens of power P, with each face having same radius of curvature, is cut into two equal parts perpendicular to its principal axis. The power of one part of the lens will be:

(i) 2 P (ii) P

(iii) 4 P (iv) P/2

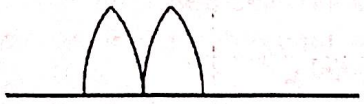
(C) The above two parts are kept in contact with each other as shown in the figure. The power of the combination will be:



(i) P/2 (ii) P

(iii) 2 P (iv) P/4

(D) A double-convex lens of power P, with each face having same radius of curvature, is cut along its principal axis. The two parts are arranged as shown in the figure. The power of the combination will be:



(i) Zero

(iii) 2P

(ii) P

(iv) P/2

SECTION-E (5 MARKS EACH) 15

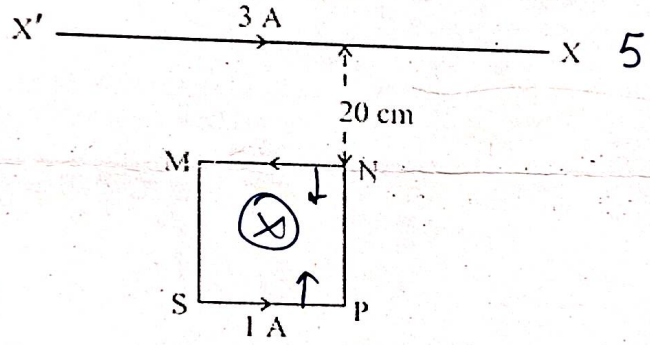
Q.31 (A) State Huygens' principle. A plane wave is incident at an angle i on a reflecting surface. Construct the corresponding reflected wavefront. Using this diagram, prove that the angle of reflection is equal to the angle of incidence.

(B) What are the coherent sources of light? Can two independent sodium lamps act like coherent sources? Explain. 4

(C) A beam of light consisting of a known wavelength 520 nm and an unknown wavelength λ, using in Young's double slit experiment produces two interference patterns such that the fourth bright fringe of unknown wavelength coincides with the fifth bright fringe of known wavelength. Find the value of λ.

Q.32 (A) With the help of a labelled diagram, explain the working of an ac generator. Obtain the expression for the emf induced at an instant 't'.

(B) A long, straight horizontal wire X'X is held stationary and carries a current of 3.0 A. A square loop MNPS of side 10 cm, carrying a current of 1.0 A is kept near the wire X'X as shown in the figure. Find the magnitude and direction of the net magnetic force acting on the loop due to the wire.



Q.33 (A) (i) You are given three circuit elements X, Y and Z. They are connected one by one across a given ac source. It is found that V and I are in phase for element X, V leads I by $\left(\frac{\pi}{2}\right)$ for element Y while I leads V by $\left(\frac{\pi}{2}\right)$ for element Z. Identify elements X, Y and Z. 4.5

(ii) Establish the expression for impedance of circuit when elements X, Y and Z are connected in series to an ac source. Show the variation of current in the circuit with the frequency of the applied ac source.

(iii) In a series LCR circuit, obtain the conditions under which (i) impedance is minimum and (ii) wattles current flows in the circuit.

OR

(B) (i) Describe the construction and working of a transformer and hence obtain the relation for $\left(\frac{v_s}{v_p}\right)$ in terms of number of turns of primary and secondary.

(ii) Discuss four main causes of energy loss in a real transformer.

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