INDIAN SCHOOL SOHAR **No. of Pages: 7**

TERM I EXAMINATION (2023-24)

PHYSICS (042)

CLASS : XII **MAX. MARKS: 70**

DATE : 24/09/2023 **TIME : 3 HOURS.**

General Instructions:

(i) *There are **33** questions in all. **All** questions are **compulsory**.*

(ii) *This question paper is divided into five Sections - **A**, **B**,**C**,**D** and **E**.*

(iii) *In **Section A** - Question no. **1** to **16** are MCQ type, carrying **1** mark each.*

(iv) *In **Section B** - Question no. **17** to **21** are Very Short Answer (VSA) type, carrying **2** marks each.*

(v) *In **Section C** - Question no. **22** to **28** are Short Answer (SA) type, carrying **3** marks each.*

(vi) *In **Section D** - Question no. **29** to **30***

(vii) *are case-based questions (CBQ), **4** marks each.*

(viii) *In **Section E** - Question no. **31** to **33** are Long Answer (LA) type, carrying **5** marks each.*

(ix) *There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.*

(x) *Use of calculators is not allowed.*

Use the following values of physical constants, if required:

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

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

Mass of electron $(m_e) = 9{\cdot}1 \times 10^{-31}$ kg

Mass of neutron $= 1{\cdot}675 \times 10^{-27}$ kg

Mass of proton $= 1{\cdot}673 \times 10^{-27}$ kg

Avogadro's number $= 6{\cdot}023 \times 10^{23}$ per gram mole

Boltzmann constant $= 1{\cdot}38 \times 10^{-23}$ JK^{-1}

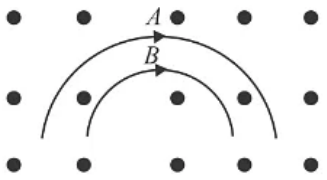
Section A

1. Charge on a body is an integral multiple of e . It is given by the law of
   (a) Conservation of charge (b) Conservation of mass
   (c) Conservation of energy (d) Quantisation of charge
2. Charge Q is kept in a sphere of 5 cm first then it is kept in a cube of side 5 cm. The outgoing flux will be
   (a) more in case of sphere (b) more in case of cube
   (c) same in both case (d) zero in both cases

3. A parallel plate capacitor is charged by a battery. Once it is charged the battery is removed. Now a dielectric material is inserted between the plates of the capacitor, which of the following does not change?
   (a) electric field between the plates (b) potential difference across the plates
   (c) charge on the plates (d) energy stored in the capacitor.
4. Three capacitors of capacitances 1μf, 2μF & 3μF are connected in series and a potential difference of 11V is applied across the combination them the potential difference across the plates of 1μF capacitor is
   (a) 2V (b) 4V (c) 1V (d) 6V

5. The temperature coefficient of resistance for a wire is 0.00125 per degree Celsius . At 27°K its resistance is 1 ohm. The temperature at which the resistance becomes 2 ohm is
   (a) 1127 K (b) 1100 K (c) 1400 K (d) 1154 K

6. A battery of e.m.f. 2 volt and internal resistance 0.1 Ω is being charged with a current of 5 ampere. The p.d. between the two terminals of the battery is
   (a) 1.5 V (b) 2.5 V (c) 1.2 V (d) 0.5 V
7. Two particles A and B of masses m_A and m_B respectively and having the same charge are moving in a plane. A uniform magnetic field exists perpendicular to this plane. The speeds of the particles are v_A and v_B respectively and the trajectories are as shown in the Fig Then

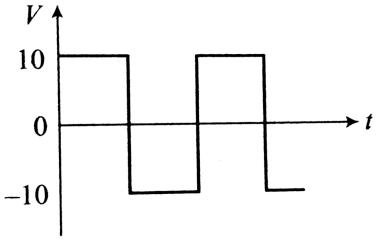


   (a) $m_A v_A < m_B v_B$ (b) $m_A v_A > m_B v_B$
   (c) $m_A < m_B$ and $v_A < v_B$ (d) $m_A = m_B$ and $v_A = v_B$

8. An electric current passes through a long straight copper wire. At a distance 5 cm from the straight wire, the magnetic field is B. The magnetic field at 20 cm from the straight wire would be
   (a) B/4 (b) B/6 (c) B/3 (d) B/2

9. The magnetic permeability of a superconductor is
   (a) zero (b) Infinity (c) +1 (d) -1

10. In a circuit with a coil of resistance 2 ohms, the magnetic flux changes from 2.0 Wb to 10.0 Wb in 0.2 second. The charge that flows in the coil during this time is
    (a) 5.0 C (b) 4.0 C
    (c) 1.0 C (d) 0.8 C
11. The r.m.s. voltage of the wave form shown is



    (a) 12 V (b) 7 V
    (c) 6.37 V (d) 10 V

12. In R-L-C series ac-circuit, impedance cannot be increased by
    (a) increasing frequency of source (b) decreasing frequency of source
    (c) increasing the resistance (d) increasing the voltage of the source

For Questions 13 to 16, two statements are given –one labelled Assertion and other labelled Reason. Select the correct answer to these questions from the options as given below.

a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

c) If Assertion is true but Reason is false.

d) If both Assertion and Reason are false.

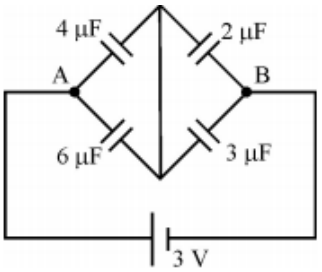
13. *Assertion* : an electron has a higher potential energy when it is at a location associated with a negative value of potential and has a lower potential energy when at a location associated with a positive potential.
    Reason: electrons move from a region of higher potential to a region of lower potential.
14. *Assertion*: When radius of a circular wire carrying current is doubled, its magnetic moment becomes four times
    Reason: magnetic moment is directly proportional to area of the loop
15. *Assertion*: when capacitive reactance is smaller than the inductive reactance in LCR current, e.m.f. leads the current .
    Reason: the phase angle is the angle between the alternating e.m.f. and alternating current of the circuit.
16. *Assertion*: in an electromagnetic wave, the magnitude of magnetic field vector B is much smaller than the magnitude of electric field vector **E** .
    Reason: This is because in an electromagnetic wave E/B = $c = 3 \times 10^8 m/s$.

Section B

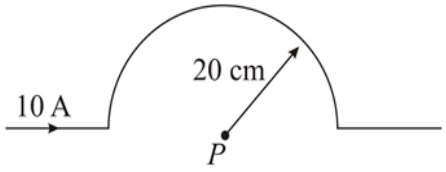
17. Obtain an expression for the capacitance of a parallel plate capacitor with air between the plates.

OR

Find the total charge stored in the network of capacitors connected between A and B as shown in figure.



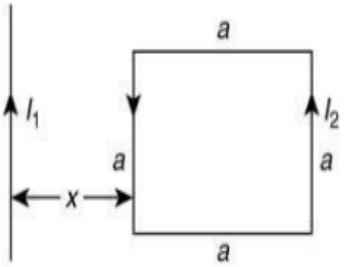
18. (a) One use of a capacitor is for the storage of electrical energy. Briefly explain how a capacitor stores energy.
    (b) Calculate the energy stored in a capacitor of capacitance 1200 μF when the potential difference across the capacitor is 50 V.
19. Use Kirchhoff's rules to obtain the balance condition in a Wheatstone bridge.
20. A current of 10 A is passing through a long wire which has a semicircular loop of radius 20 cm as shown in the figure. What is the magnetic field produced at the centre of the loop ?



21. The current through two inductors of self inductance 15 mH and 25 mH is increasing with time at the same rate. Draw graphs showing the variation of the:
    (i) emf induced with the rate of change of current
    (ii) energy stored in each inductor with the current flowing through it.

Section C

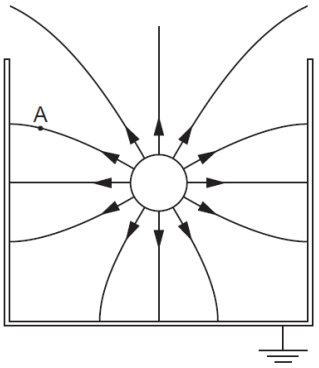
22. Two cells of emfs ϵ_1 & ϵ_2 and internal resistances r_1 & r_2 respectively are connected in parallel. Obtain expressions for the equivalent.
    (i) resistance and
    (ii) emf of the combination
23. Derive an expression for the electric field at any point on the equatorial line of an electric dipole.
24. Obtain a relation between the current flowing in a conductor and drift velocity of electrons in it. Hence obtain Ohm's law.
25. (a) Define mutual inductance and write its S.I. unit.
    (b) A square loop of side 'a' carrying a current I_2 is kept at distance x from an infinitely long straight wire carrying a current I_1 as shown in the figure. Obtain the expression for the resultant force acting on the loop.



OR

Two circular loops, one of small radius r and other of larger radius R, such that R >> r, are placed coaxially with centres coinciding. Obtain the mutual inductance of the arrangement.

26. An inductor of 200 mH, capacitor of 400 μ F and a resistance of 10 ohm are connected in series to an a.c. source of 50 V of variable frequency. Calculate (i) angular frequency at which maximum power dissipation occurs in the circuit and (ii) the corresponding value of effective current.
27. Draw a labelled diagram of an AC generator. Derive the expression for the instantaneous value of the emf induced in the coil.
28. Small charged metal sphere is situated in an earthed metal box. Fig illustrates the electric field between the sphere and the metal box.
    (a) By reference to Fig state and explain
    (i) whether the sphere is positively or negatively charged.
    (ii) why it appears as if charge on sphere is concentrated at the centre of the sphere.
    (b) show the direction of force on a stationary electron situated at point A
    (c) Radius r of the sphere is 2.4 cm. Magnitude of the charge q on the sphere is 0.76 nC. Calculate a value for magnitude of potential V at the surface of the sphere.



Section D

29. Read the following paragraph and answer the questions that follow.
    Microwave in aircraft navigation

The radar transmits a focused pulse of microwave energy at an object. Energy is emitted in various frequencies and wavelengths from large wavelength radio waves to shorter wavelength gamma rays. Part of this beam of energy bounces back and is measured by the radar, providing information about the object. Radar can measure precipitation size, quantity, speed and direction of movement, within about 100 mile radius of its location.

i. How are microwaves produced?
   a) klystron and magnetron valve
   b) sudden deceleration of electrons in X- ray tube
   c) accelerated motion of charge in conducting wire
   d) hot bodies and molecules

ii. Microwaves are considered suitable for radar systems used in aircraft navigation
   a) due to long wavelength hence low energy dispersion
   b) due to short wavelength hence low energy dispersion
   c) due to high energy dispersion
   d) due to their piercing power through clouds.

iii. What is the other use of microwave?
   a) in treatment of cancer
   b) to observe changing blood flow
   c) used to kill microbes
   d) quickly heating foods

iv. Where do microwaves fall in the electromagnetic spectrum?
   a) between u.v region and infrared
   b) between gamma and u.v
   c) between infrared and radio wave
   d) between gamma and infrared

OR

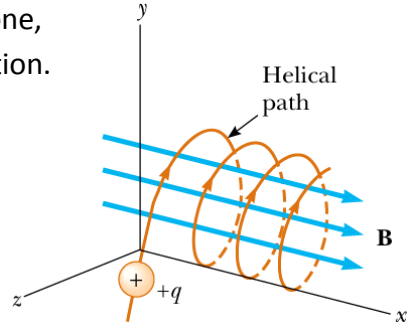
A radar sends a signal to an aircraft at a distance of 30 km away and receives it back after 0.2 ms (millisecond) . What is the speed of the signal?

a) 30,000 m/s
b) 30,000 km/s
c) 30,000 cm/s
d) 30 m/μs

30. Read the following paragraph and answer the questions that follow.

Helical motion

If velocity has a component along B, this component remains unchanged as the motion along the magnetic field will not be affected by the magnetic field. The motion in a plane perpendicular to the magnetic field is a circular one, thereby producing a helical motion.



i. The radius of the charged particle, (when v is perpendicular to B) placed in a uniform magnetic field is given by

a) R = mv/qB
b) R = qB/mv
c) R = Bqm/v
d) R = vq/mB

ii. An electron, proton, He+ and Li++ are projected with the same velocity perpendicular to a uniform magnetic field. Which one will experience maximum magnetic force?

a) Electron
b) Proton
c) He+
d) Li++

iii. The work done by the magnetic field on the charge particle moving perpendicular to a uniform magnetic field is (S is the displacement of the particle)

a) Zero
b) q (v x B). S
c) qvB
d) qBS/v

OR

At what tangent of an angle must the magnetic field be from the velocity so that the pitch of the resulting helical motion is equal to the radius of the helix?

a) π
b) 2π
c) π/4
d) π/3

iv. The distance moved by a charged particle along the magnetic field in one rotation, when v has a component parallel to B is

(a) $\frac{2\pi v\cos\theta}{qBm}$
(b) $\frac{2\pi mv\cos\theta}{qB}$
(c) $\frac{qBm}{2\pi v\cos\theta}$
(d) $\frac{Bq}{2\pi m}$

Section E

31. (a) State Gauss's law in electrostatics.
(b) Use Gauss' law to derive the expression for the electric field E due to a straight uniformly charged infinite line of charge density λ C/m.
(c) Draw a graph to show the variation of E with perpendicular distance r from line of charge.

OR

(a) Establish the relation between electric field and electric potential at a point.
(b) Derive the expression for the electric potential due to an electric dipole at a point on its axial line.
(c) Depict the equi-potential surfaces due to an electric dipole.

32. (a) Write the principle and with the help of a neat labelled diagram explain the working of a moving coil galvanometer ? Give two reasons to explain why a galvanometer cannot as such be used to measure the value of the current in a given circuit.
(b) Why is the magnetic field made radial in a moving coil galvanometer ? How is it achieved ?

OR

(a) State Biot–Savart law. Derive an expression for the magnetic field on the axis of a current carrying circular loop.

(b) Write any two points of difference between a diamagnetic and a paramagnetic substance.

33. A device X is connected across an ac source of voltage $V = V_0 sin\omega t$. The current through X is given as $I = I_0 \sin\left(\omega t + \frac{\pi}{2}\right)$

(a) Identify the device X and write the expression for its reactance.

(b) Draw graphs showing variation of voltage and current with time over one cycle of ac, for X.

(c) How does the reactance of the device X vary with the frequency of the ac ? Show this variation graphically.

(d) Draw the phasor diagram for the device X.

OR

(a) An a.c. source of voltage $V = V_0 sin\omega t$ is connected to a series combination of L, C and R. Use the phasor diagram to obtain expressions for impedance of the circuit and phase angle between voltage and current. Find the condition when current will be in phase with the voltage. What is the circuit in this condition called?

(b) In a series LR circuit $X_L = R$ and the power factor of the circuit is P_1. When a capacitor with capacitance C such that $X_L = X_C$ is put in series, the power factor becomes P_2. Calculate $\frac{P_1}{P_2}$

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