GURU HARKRISHAN PUBLIC SCHOOL
(Running under the aegis of GHPS Society)
HALF YEARLY/ TERM I EXAMINATION
SESSION (2024-2025)
SUBJECT - PHYSICS
CLASS - XII

Time allowed: 3 hours **Maximum Marks: 70**

General Instructions:

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

(B). This question paper has **five** sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.

(C). Section **A** contains **sixteen** questions (12MCQs & 4 Assertion Reason questions) of **1 mark** each, Section **B** contains **five** questions of **2 marks** each, Section **C** contains **seven** questions of **3 marks** each, Section **D** contains **two** case study-based questions of **4 marks** each and Section **E** contains **three** long questions of **five marks** each

(D). 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.

SECTION – A

1. The conditions of total internal reflection are

(a)Light must travel from rarer to denser medium and Angle of incidence should be less than critical angle

(b) Light must travel from rarer to denser medium and Angle of incidence should be greater than critical angle

(c) Light must travel from denser to rarer medium and Angle of incidence should be greater than critical angle

(d) Light must travel from denser to rarer medium and Angle of incidence should be less than critical angle

2. Two point charges A & B, having charges +Q and -Q respectively, are placed at certain distance apart and force acting between them is F. If 25% charge of A is transferred to B, then force between the charges becomes

(a) 9F/16 (b) F (c) 4F/3 (d) 16F/9

3. A student measures the terminal potential difference (V) of a cell (of emf $\mathcal{E}$ and internal resistance r) as a function of the current (I) flowing through it. The slope, and intercept, of the graph between V and I, then, respectively, equal

(a) $-r$ and $\mathcal{E}$ (b) r and $-\mathcal{E}$ (c) $-\mathcal{E}$ and r (d) $\mathcal{E}$ and $-r$

4. Which of the following statements is incorrect?

(a) Magnetic field lines form closed loops.

(b) Magnetic field lines start from north pole and end at south pole outside a magnet.

(c) The tangent at a point on a magnetic field line represents the direction of the magnetic field at that point.

(d) The magnetic field lines may tend to contract laterally & expand longitudinally.

5. The magnetic flux linked with a coil is given by $\phi = 5t^2 + 2t + 3$ Wb. The induced e.m.f in the coil at t=3s will be

(a) 54 V (b) 32 V (c) 40 V (d) 65 V

6. An object has a charge of 1 C and gains 5×10^{18} electrons. The net charge on the object becomes

(a) -0.8C (b) +0.8C (c) +0.2C (d) +1.8C

7. A magnetic needle is kept in a non-uniform magnetic field. It experiences

(a) a force and a torque (b) a force and but not a torque

(c) a torque but not a force (d) neither a force nor a torque

8. A ray of light travels a distance of 12m in a transparent sheet in 60 ns. The refractive index of the sheet is

(a)1.33 (b) 1.50 (c) 1.65 (d) 1.70

9. A plane em wave propagating along x direction can have the following pairs of E and B

(a) (Ex , By) only (b) (Bx , Ey) or (Ex , By)

(c) (Ez , By) only (d) (Ez , By) or (Ey , Bz)

10. An a.c generator consists of a coil of 100 turns each of area 0.5 m^2 and rotating at an angular speed of 60 rad/sec in a uniform magnetic field of 0.8 T. The resistance of the coil is 100 Ω. The peak value of current induced in the coil is

(a) 240 A (b) 120 A (c) 24 A (d) 12 A

11. The current flowing through an ac circuit is given by $I = 5 \sin(120\pi t)$ Amp. How long will the current take to reach the peak value starting from zero?

(a) $\frac{1}{60}$ sec (b)60 sec (c) $\frac{1}{120}$ sec (d) $\frac{1}{240}$ sec

12. The electric dipole moment of an electron & a proton 4 nm apart is

(a) 6.4×10^{-28} Cm (b) 6.4×10^{-10} Cm^{-1} (c) 12.8×10^{-28} Cm (d) 12.8×10^{-10} Cm^{-1}

For Questions 13 to 16, two statements labelled as Assertion (A) and Reason (R) are given. Select the correct answer to these questions from the options as given below:

(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.

13. **Assertion:** If a convex lens is kept in water, its convergence power decreases.

Reason: The refractive index of convex lens relative to water is less than that relative to air.

14. **Assertion:** Work done in moving a charge in an equipotential surface is always zero.

Reason: Electric field is always perpendicular to the equipotential surface.

15. **Assertion:** Micro waves, X-Rays, UV Rays and Gamma Rays travel with same speed in free space.

Reason: In an em wave, the quantity $\sqrt{\mu_0 \epsilon_0}$ represents speed of light in free space.

16. **Assertion:** Two parallel current carrying conductors repel while two anti-parallel current carrying conductors attract each other.

Reason: The total force on a charged particle moving in simultaneous electric field and magnetic field is given by $\vec{F} = q(\vec{E} + \vec{B} \, X \, \vec{v})$

SECTION – B

17. Obtain an expression for electrostatic potential energy of a system of three charges q , 2q and −3q placed at the vertices of an equilateral triangle of side 'a'.

18. The primary of a transformer has 400 turns while the secondary has 2000 turns. If the power output from secondary of 1100V is 12.1KW, calculate the primary voltage. If the resistance of the primary is 0.2 Ω & that of the secondary is 2Ω & the efficiency of the transformer is 90%, calculate the current in the primary & the secondary coils.

19. Using Gauss Theorem derive an expression for the electric field intensity at a point near a thin infinite plane sheet of charge density σ Cm^{-2}.

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20. A slab of material of dielectric constant K has same area as the lates of a parallel plate capacitor but has thickness equal to (3/4)d where d is the separation of plates of capacitor. Calculate new value of capacitance.

21. Plot a graph showing the variation of magnetic field intensity 'B' produced by current carrying solenoid of length 'L' with distance 'r' from the centre of the solenoid along the axis of solenoid. Where is the magnetic field (i) maximum, (ii) minimum and (iii) half of the maximum value?

OR

Use Biot Savart's law to derive an expression for the magnetic field due to circular current carrying loop lying at the centre of the coil.

SECTION – C

22. **(a)** An infinite line charge produces a field of $19 \times 10^4\ NC^{-1}$ at a distance of 5 cm. Calculate the linear charge density.

(b) A spherical shell of metal has a radius of 0.25 m and carries a charge of $0.2\mu C$. Calculate electric field intensity at a point (i) on the shell (ii) 3m from the centre of the shell.

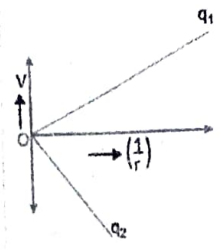
23. **(a)** Two identical bars, one of paramagnetic material and other of diamagnetic material are kept in a uniform external magnetic field parallel to it. Draw diagrammatically the modifications in the magnetic field pattern in each case.

(b) How does the (i) pole strength and (ii) magnetic moment of each part of a bar magnet change if it is cut into two equal pieces transverse to its length?

(c) Points A and B are situated perpendicular to the axis of a 2 cm long bar magnet at large distances x and $3x$ from its centre on opposite sides. Find the ratio of the magnetic fields at points A and B.

24. **(a)** Plot a graph comparing the variation of potential 'V' and electric field 'E' due to a point charge 'Q' as a function of distance 'R' from the point charge.

(b) The two graphs drawn below show the variations of potential 'V' with '1/r'(r being the distance of field point from the point charge) for two point charges q_1 and q_2. (i) What are the signs of the two charges? (ii) Which of the two charges has the larger magnitude and why?



25. **(a)** Name the electromagnetic waves used for (i) Detection of cracks in metallic products and (ii) Aircraft Navigation.

(b) The amplitude of electric field of an electromagnetic wave is $E_0 = 120$ N/C and its frequency is 50 MHz. Calculate amplitude of magnetic field and wavelength of em wave.

(c) The voltage between the plates of a parallel plate capacitor of capacitance 1μF is changing at the rate of 5V/s. What is the displacement current in the capacitor?

26. **(a)** An emf of 0.5 V is developed in the secondary coil, when current in primary coil changes from 5A to 2A in 300 millisec. Calculate the mutual inductance of two coils.

(b) Derive an expression for self-inductance of a long solenoid carrying current.

27. **(a)** A compound microscope with an objective of 1cm focal length and an eyepiece of 2cm focal length has a tube length of 20 cm. Calculate the magnifying power of the microscope if the final image is formed at the near point of the eye.

(b) You are given following three lenses. Which two lenses will you use as an eyepiece and as an objective to construct an astronomical telescope? Give Reason.

Lenses	Power(D)	Aperture(cm)
L_1	3	8
L_2	6	1
L_3	10	1

OR

(a) A diverging lens of focal length 15 cm forms an image 10 cm from the lens. Calculate the distance of the object from the lens, given μ =1.5.

(b) An erect image 3 times the size of the object is obtained with a concave mirror of radius of curvature 36 cm. Find the values of object distance and image distance.

28. Use Kirchoff's laws to obtain the balance condition in terms of the resistances of four arms of Wheatstone Bridge.

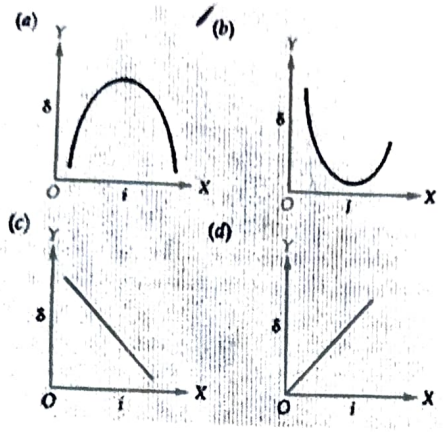
SECTION – D

Case Study Based Questions

29. Read the following paragraph and answer the questions that follow:

Prism formula is used for accurate determination of refractive index of a transparent medium, of which the prism is made. A ray of light suffers two refractions on passing through a prism and hence deviates through a certain angle from its original path called angle of deviation. This angle of deviation changes with angle of incidence. In the position of minimum deviation, the refracted ray in the prism is parallel to the base of prism.

I. The graphical representation of the variation of angle of deviation 'δ' with angle of incidence 'i' in a prism is



II. The relationship between angle of incidence 'i', angle of prism 'A' and angle of emergence 'e' and angle of deviation 'δ' for a prism is

(a) $i+e = A+\delta$ (b) $i-A = e+\delta$

(c) $i+\delta = e-A$ (d) $i-e = A-\delta$

III. The angle of deviation through a prism is minimum when

(A) Incident ray and emergent ray are symmetric to the prism
(B) The refracted ray inside the prism becomes parallel to its base
(C) Angle of incidence is equal to angle of emergence
(D) Angle of incidence is double the angle of incidence

Choose the correct answer from the options given below:

(a) Only statement (B) is true
(b) Statements (A) and (B) are true
(c) Statements (B) and (C) are true
(d) Statements (A) , (B) and (C) are true

IV. The angle of prism is 60° and angle of deviation is 30°. At minimum deviation position, the angle of incidence 'i' and the angle of emergence 'e' are

(a) $i = 45°$, $e = 50°$ (b) $i = 30°$, $e = 45°$

(c) $i = 45°$, $e = 45°$ (d) $i = 30°$, $e = 30°$

OR

Calculate the refractive index of the material of an equilateral prism for which the angle of minimum deviation is 60°.

(a) $\sqrt{2}$ (b) $3/\sqrt{2}$ (c) $\sqrt{3}$ (d) $\sqrt{3}/2$

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

Moving coil galvanometer is a device used to detect current in a circuit. It is based on the principle that a current carrying coil placed in a magnetic field experiences a torque which tends to rotate the coil and produces angular deflection. It consists of a coil of wire of area A & N turns carrying current I to be measured. It is suspended in a radial magnetic field so that its plane always remains parallel to the direction of magnetic field by a suspension fibre of torsional constant k. In equilibrium position, Restoring torque is equal to Deflecting torque. A galvanometer can be converted into ammeter as well as voltmeter.

I. If in a moving coil galvanometer, a current I in its coil produces a deflection θ, then the current I is directly proportional to

(a) θ (b) θ^2 (c) $\sqrt{\theta}$ (d) tan θ

II. A moving coil galvanometer has a coil of effective area A and number of turns N. The magnetic field B is radial. If a current I is passed through a coil, the torque acting on the coil is (a) NA^2B^2I (b) NABI (c) N^2ABI (d) $NABI^2$

III. To convert a galvanometer into ammeter and voltmeter respectively, we connect

(a)shunt resistance in series and high resistance in parallel
(b)high resistance in series and shunt resistance in parallel
(c)shunt resistance in parallel and high resistance in series
(d)high resistance in parallel and shunt resistance in series

IV. In an ammeter,10% of main current is passing through the galvanometer. If the resistance of the galvanometer is G, then the shunt resistance, in ohm is

(a) 9G (b) G/90 (c) 90G (d) G/9

OR

The current sensitivity of a MCG increases by 20%. If its resistance also increases by 25%, then by what factor does its voltage sensitivity change?

(a) increases by 5% (b) decreases by 1%
(c)increases by 10% (d) decreases by 4%

SECTION – E

31.(a) Show graphically the variation of resistivity of (i) a conductor and (ii) a typical semiconductor as a function of temperature.

(b) Two conductors made of the same material have equal lengths but different cross-sectional areas A_1 and A_2 ($A_1 > A_2$). They are connected in parallel across a cell. Show that the drift velocities of electrons in two conductors are equal.

(c) Derive Ohm's Law using the concept of drift velocity.

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OR

(a)Nichrome and copper wires of same length and same radius are connected in series. Current I is passed through them. Which wire gets heated up more? Justify your answer.

(b) Under what condition will the current in a wire be the same when connected in series and in parallel of n identical cells each having internal resistance r and external resistance R?

(c) Two cells of different emfs and internal resistances are connected in series. Find the expression for the equivalent emf and equivalent internal resistance of the combination.

32. (a) Establish the relationship between the root mean square value of alternating current and the peak value of alternating current.

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

OR

(a) Show that in series LCR circuit, the average power transferred to a.c circuit is given by $P_{av} = E_v I_v \cos\phi$ where symbols have their usual meanings.

(b) A resistor of 50 ohms, an inductor of $(20/\pi)$ H and a capacitor of $(5/\pi)$ μF are connected in series to a voltage source 230 V, 50 Hz supply. Find the impedance of the circuit.

33. (a) For a thin convex lens, derive an expression for lens maker formula, where symbols have their usual meanings.

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

(b)A thin equiconvex lens of radius of curvature R made of material of refractive index μ_1 is kept coaxially in contact with an equi-concave lens of the same radius of curvature and refractive index μ_2 such that $\mu_2 > \mu_1$. Find the ratio of their powers.

OR

(a) Derive the relation between distance of object, distance of image and radius of curvature of a convex spherical surface, when refraction takes place from a rarer medium of refractive index μ_1 to a denser medium of refractive index μ_2 & the image produced is real.

(b) A concave spherical surface of refractive index 3/2 is immersed in water of refractive index 4/3. If a point object lies in water at a distance of 10 cm from the pole of refracting surface, calculate the position of the image. Given the radius of curvature of spherical surface is 18 cm.