# B.K. BIRLA CENTRE FOR EDUCATION

SARALA BIRLA GROUP OF SCHOOLS
A CBSE DAY-CUM-BOYS' RESIDENTIAL SCHOOL

## TERM-1 EXAMINATION (2026-27)

## PHYSICS (042) SET-2

**Class: XII** **Time: 3hrs**
**Date: 31.08.26** **Max Marks: 70**
**Admission no:** **Roll no:**

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**General Instructions:**

(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section E contains three long answer questions of five marks each.
(5) 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.
(6) Use of calculators is not allowed.
(7) You may use the following values of physical constants where ever necessary:
i. $c = 3 \times 10^8$ m/s ii. $m_e = 9.1 \times 10^{-31}$ kg iii. $e = 1.6 \times 10^{-19}$ C iv. $\mu_0 = 4\pi \times 10^{-7}$ Tm$A^{-1}$
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 = $6.023 \times 10^{23}$ per gram mole

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### SECTION-A (16 Q X 1 M= 16 M)

1. The unit of electric field is:
   (a) C/m (b) V/m (c) J/C (d) Both a and b

2. Capacitance of a parallel plate capacitor increases with:
   (a) Increase in separation (b) Increase in plate area
   (c) Decrease in dielectric constant (d) None of these

3. The temperature (T) dependence of resistivity of materials A and material B is represented by fig (i) and fig (ii) respectively. Identify material A and material B.

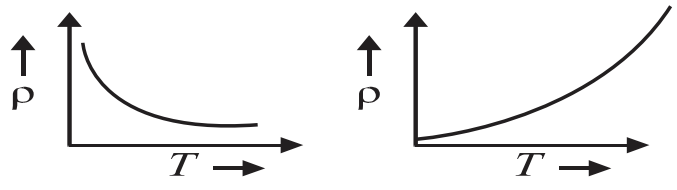


fig. (i) fig. (ii)

(a) material A is copper and material B is germanium
(b) material A is germanium and material B is copper
(c) material A is nichrome and material B is germanium
(d) material A is copper and material B is nichrome

4. A long straight wire of circular cross section of radius a carry a steady current I. The current is uniformly distributed across its cross section. The ratio of the magnitudes of magnetic field at a point distant a/2 above the surface of wire to that at a point distant a/2 below its surface is
(a) 4 :1 (b)1:1 (c) 4: 3 (d) 3 :4
5. The direction of magnetic force on a moving charge is given by:
(a) Lorentz force (b) Right-hand thumb rule (c) Fleming's left-hand rule (d) Ampere's law
6. The magnetic susceptibility of a diamagnetic material is:
(a) Small and positive (b) Large and positive (c) Negative and small (d) Infinite
7. If the number of turns in a solenoid is doubled, its self-inductance becomes:
(a) Double (b) Four times (c) Half (d) Unchanged
8. Which of the following circuits has maximum power dissipation?
(a) Pure inductive circuit (b) Pure capacitive circuit
(c) Pure resistive circuit (d) LC circuit
9. In an AC circuit containing only a capacitor, the current:
(a) Is zero (b) Lags the voltage
(c) Is in phase with voltage (d) Leads the voltage
10. What is the relative refractive index of water with respect to glass?
(a) Unity (b) More than unity
(c) Less than unity (d) Zero
11. Which of the following has the highest frequency?
(a) Radio waves (b) X-rays (c) Infrared (d) Microwaves
12. The wavelength of light coming from a sodium source is 589 nm. What will be its wavelength in the water?
(a) 625 nm (b) 443 nm (c) 789 nm (d) 125 nm

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

**(a) If both Assertion and Reason are true and Reason is 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 Reason is true but Assertion is false.**

13. **Assertion**: In a cavity within a conductor, the electric field is zero.
    **Reason:** Charges in a conductor reside only at its surface.
14. **Assertion (A):** The magnetic field inside a long straight current-carrying solenoid is uniform.
    **Reason (R):** The magnetic field lines inside the solenoid are parallel and equally spaced.
15. **Assertion (A):** A transformer can function with both alternating current (AC) and direct current (DC) supplies.
    **Reason (R):** Transformers work on the principle of electromagnetic induction.
16. **Assertion:** When the frequency of the AC source in an LCR circuit equals the resonant frequency, the reactance of the circuit is zero, and so there is no current through the inductor or the capacitor.
    **Reason:** The net current in the inductor and capacitor is zero.

**SECTION-B (5Q X 2 M= 10 M)**

17. Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude $17.7 \times 10^{-22}$ C/m$^2$. What is electric field intensity E:
    (a) in the outer region of the first plate, and
    (b) between the plates? 2
18. Derive the expression for energy stored in a capacitor. 2
19. Explain the term drift velocity of electrons in a conductor. Hence obtain the expression for the current through a conductor in terms of drift velocity. 2
20. Write any two properties of electromagnetic waves. 2
21. A narrow slit is illuminated by a parallel beam of monochromatic light of wavelength λ equal to 6000 Å and the angular width of the central maximum in the resulting diffraction pattern is measured. When the slit is next illuminated by light of wavelength λ', the angular width decreases by 30%. Calculate the value of the wavelength λ'. 2

    Or

    Define wave front. Explain different types of wave front with diagram.

**SECTION-C (7Q X 3 M= 21 M)**

22. State Gauss' law in electrostatics. Use this law to derive an expression for the electric field due to an infinitely long straight wire of linear charge density **λ** cm$^{-1}$. 3
23. Using Ampere's circuital law, obtain an expression for the magnetic field along the axis of a current carrying solenoid of length **l** and having **N** number of turns.

    Or

    Two long straight parallel conductors carrying currents $I_1$ and $I_2$ are separated by a distance d. If the currents are flowing in the same direction, show how the magnetic field produced by one exerts an attractive force on the other.

Obtain the expression for this force and hence define 1 ampere. 3

24. Find the stable and unstable potential energies for m = 0.32 J $T^{-1}$ and B = 0.15 T. 3

25. A metallic rod of 'L' length is rotated with angular frequency of 'ω' with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius L, about an axis passing through the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field B parallel to the axis is present everywhere. Deduce the expression for the emf between the centre and the metallic ring. 3

26. Write Maxwell's equations in integral form and explain their significance. 3

27. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes in a Young's double-slit experiment. Distance between two slits is 2mm and screen is placed at distance 1.2 m from the plane of slits. Find the distance of the third bright fringe on the screen from the central maximum for wavelength 650 nm. 3

28. What is the refractive index of the material of the prism in Fig. 1?

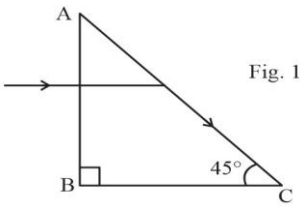


Fig. 1

(a) If the side AC of the above prism is now surrounded by a liquid of refractive index 2/√3 shown in Fig. 2, determine if the light ray continues to graze along the interface AC or undergoes total internal reflection or undergoes refraction into the liquid.

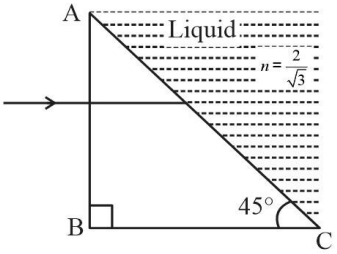


Fig. 2

(b) Draw the ray diagram to represent the path followed by the incident ray with the corresponding angle values. (Given, $sin^{-1}(\frac{\sqrt{2}}{\sqrt{3}}) = 54.6^{\circ}$) 3

**SECTION-D (Case Study Based Questions) (2 Q X 4 M= 8 M)**

29. Case Study: Read the following paragraph and answer the questions.

A number of optical devices and instruments have been designed and developed such as periscope, binoculars, microscopes and telescopes utilising the reflecting and refracting properties of mirrors, lenses and prisms. Most of them are in common use. Our knowledge about the formation of images by the mirrors and lenses is the basic requirement for understanding the working of these devices. Compound microscope and telescope are designed by using two coaxial convex lenses of different focal lengths, one of the lenses is objective lens and the other one is eye lens. Eye lens acts as simple microscope and there are two cases of image formation in both. Telescope is of two type refracting type and reflecting type in reflecting type objective lens is replaced by concave mirror.

(a) What is the role of objective lens in a compound microscope and telescope? 1

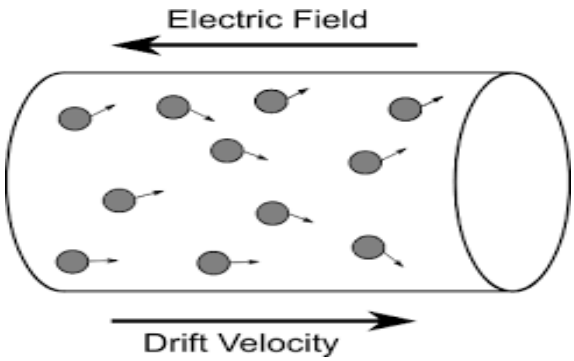
(b) What do you understand by tube length of telescope? 1

(c) Write two advantages of using reflecting telescope.

OR 2

(c)Draw the ray diagram of image formation by reflecting type telescope. 2

30. Draw the ray diagram of image formation by a refracting type telescope. Drift velocity is the average velocity of electrons in a conductor material due to an electric field. In a conducting material, it is also proportional to the magnitude of an external electric field.




(i) The drift velocity of electrons in a conductor is 0.8 mm/s. The potential difference across a conducting wire is doubled keeping other factors constant. What is the value of new drift velocity? 1

(a) 0.4mm/s (b) 0.64 mm/s (c) 1.6 mm/s (d) 0.2 mm/s

(ii) How would be the current density of a conductor get affected when the potential difference is tripled keeping other factors constant. 1

(a)Doubled (b) halved (c) no change (d) tripled

(iii) Two conducting wires of the same material, radii in the ratio 1:2 and lengths in the ratio 2:3 are connected in series to a battery of emf 5V. What is the ratio of the drift velocities of electrons in the two wires? 1

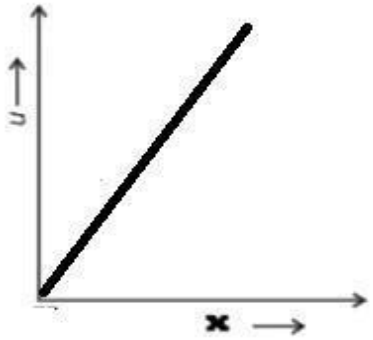
(a) 4:1 (b) 1:3 (c)2:3 (d) 4:3

(iv) A current of 3.2 A, flows through a conducting wire of number density $10^{28}$ $m^{-3}$ and cross sectional area $10^{-6}$ $m^2$. The drift velocity of electrons in the wire is 1

(a) 4 mm/s (b) 2 mm/s (c) 1mm/s (d) 0.5 mm/s

**Or**

(iv)The following is the graph between a drift velocity of electrons in a conductor and a physical quantity X. Identify the quantity.




(a) Current (b) Area of cross section (c) number density (d) length of conductor

**SECTION-E** **(3 Q X 5 M= 15 M)**

31. (a) Draw a schematic diagram of refraction at spherical surface and using it find the relation between object distance, image distance and refractive indices in terms of radius of curvature.

(b)Double-convex lenses are to be manufactured from a glass of refractive index 1.55, with both faces of the same radius of curvature. What is the radius of curvature required if the focal length is to be 20 cm? 5

Or

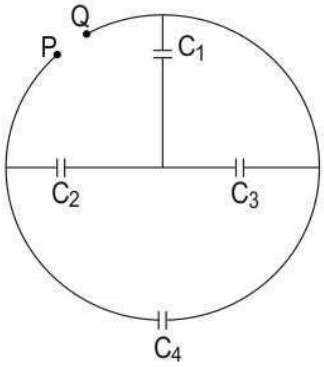
(a) A beam of light converges at a point P. Now a lens is placed in the path of the convergent beam 12 cm from P. At what point does the beam converge if the lens is a convex lens of focal length 20 cm.

(b) A small telescope has an objective lens of focal length 144 cm and an eyepiece of focal length 6.0 cm. What is the magnifying power of the telescope? What is the separation between the objective and the eyepiece?

32. Derive the expression for potential due to a uniformly charged spherical shell (i) outside the surface of the shell, (ii) at the surface of the shell, (iii) inside the shell. Draw the potential, distance graph. 5

Or

(a) Find the effective capacitance between points P and Q, if each capacitor has a capacitance of 6μF.




(b) Find the ratio of charges on capacitors $C_1$ and $C_4$, if the potential difference between points P and Q is 10 V.

33. (a) Draw graphs showing the variations of inductive reactance and capacitive reactance with frequency of applied ac source. 5

(b) Draw the phasor diagram for a series LRC circuit connected to an AC source.

(c) When an alternating voltage of 220V is applied across a device X, current of 0.25A flows which lags behind the applied voltage in phase by $\pi/2$ radian. If the same voltage is applied across another device Y, the same current flows but now it is in phase with the applied voltage.

(i) Name the devices X and Y.

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

Or

(a) A series LCR circuit is connected to an ac source. Using the phasor diagram, derive the expression for the impedance of the circuit.

(b) Plot a graph to show the variation of current with frequency of the ac source, explaining the nature of its variation for two different resistances $R_1$ and $R_2$ ($R_1 < R_2$) at resonance.

**----------ALL THE BEST----------**