DAV PUBLIC SCHOOL C.R.R.C MEDICAL ROAD, GAYA

SUNDAY-TEST 2024-2025

रोल नं.

Roll No.

परीक्षार्थी प्रश्न-पत्र कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें ।

Candidates must write the Q.P. Code on the title page of the answer-book. *

भौतिक विज्ञान (सैद्धान्तिक)
PHYSICS (Theory)

निर्धारित समय : 3 घण्टे | *अधिकतम अंक : 70*

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

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*) $m_p = 1.7 \times 10^{-27}$ kg

(*iv*) $e = 1.6 \times 10^{-19}$ C

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

(*vi*) $h = 6.63 \times 10^{-34}$ J s

(*vii*) $\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

(*viii*) Avogadro's number = 6.023×10^{23} per gram mole

SECTION A

1. In a series LCR circuit, the capacitance is changed from C to C/4. For the resonant frequency to remain unchanged, the inductance should be changed from L to nL, where n is :

(a) $\frac{1}{2}$ (b) 2

(c) 4 (d) $\frac{1}{4}$

2. An electron with velocity $\vec{v} = (v_x \hat{i} + v_y \hat{j})$ moves through a magnetic field $\vec{B} = (B_x \hat{i} - B_y \hat{j})$. The force $\vec{F}$ on the electron is : (e is the magnitude of its charge)

(a) $-e(v_x B_y - v_y B_x)\hat{k}$ (b) $e(v_x B_y - v_y B_x)\hat{k}$

(c) $-e(v_x B_y + v_y B_x)\hat{k}$ (d) $e(v_x B_y + v_y B_x)\hat{k}$

3. A small bar, when placed near a magnet is repelled by it. This is because the bar is made of :

(a) Iron (b) Copper

(c) Aluminium (d) Nickel

4. When a negative charge (–Q) is brought near one face of a metal cube, the :

(a) cube becomes positively charged

(b) cube becomes negatively charged

(c) face near the charge becomes positively charged and the opposite face becomes negatively charged

(d) face near the charge becomes negatively charged and the opposite face becomes positively charged

5. A metal detector is based on :

(a) Self-induction (b) Mutual induction

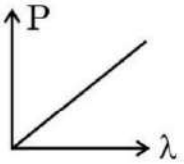
(c) Electrical resonance (d) Power transmission

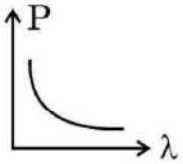
6. In Young's double-slit experiment, the intensity on the screen is I_0 at a point where path difference is λ. The intensity at the point where path difference is $\frac{\lambda}{4}$ is :

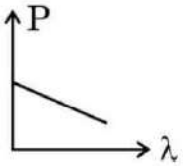
(a) $\frac{I_0}{4}$ (b) $\frac{I_0}{2}$

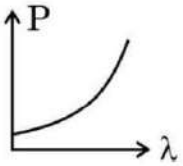
(c) I_0 (d) zero

7. Which of the following figures represents the variation of a particle's momentum with the de Broglie wavelength associated with it ?

(a) 

(b) 

(c) 

(d) 

8. The binding energy per nucleon of ${}_8O^{16}$ is 7·97 MeV and that of ${}_8O^{17}$ is 7·75 MeV. The energy (in MeV) required to remove a neutron from ${}_8O^{17}$ is :

(a) 0·42 MeV (b) 7·86 MeV

(c) 4·23 MeV (d) 3·64 MeV

9. The impact parameter for an alpha particle approaching a target nucleus is maximum when the scattering angle (θ) is :

(a) 0° (b) 90°

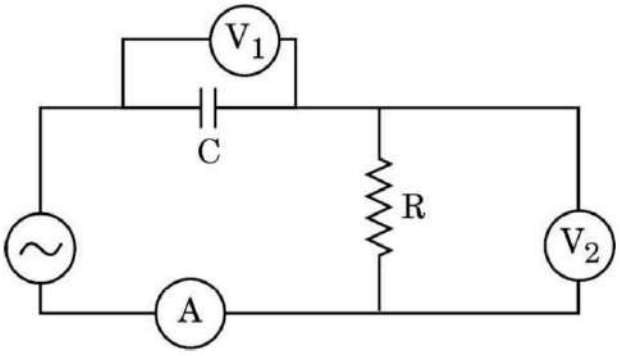
(c) 180° (d) 45°

10. Two nuclei have their mass numbers in the ratio of 1 : 27. What is the ratio of their nuclear densities ?

(a) 1 : 27 (b) 1 : 1

(c) 1 : 9 (d) 1 : 3

11. The given figure shows a capacitor C and a resistor R connected in series to an ac source. V_1 and V_2 are voltmeters and A is an ammeter.



Which of the following statements is correct ?

(a) Current in the circuit lags in phase with voltage shown in V_2 .

(b) The voltage shown in V_1 is ahead in phase with voltage shown in V_2.

(c) The current in the circuit and the voltage shown in V_1 are always in phase.

(d) The voltage shown in V_1 lags behind in phase with the voltage shown in V_2 .

12. A plane wave is incident on a concave mirror of radius of curvature R. The reflected wave is a spherical wave of radius :

(a) $\frac{R}{4}$ (b) $\frac{R}{2}$

(c) R (d) 2R

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 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 (A): de Broglie wavelength depends on the nature of moving charge.

Reason (R): de Broglie wavelength associated with a moving charge particle is given by $\lambda = \frac{h}{mv}$.

14. Assertion (A): In forward biasing, width of the depletion layer decreases.

Reason (R): In forward bias, *p*-side and *n*-side of the *p*-n junction are connected to positive and negative terminals of the battery respectively.

15. Assertion (A): Electric potential in the field of a negative charge is lower at near points and higher at distant points.

Reason (R): Electric potential due to negative charge is negative.

16. Assertion (A): The objective of a telescope have a larger focal length.

Reason (R): To obtain large magnifying power and greater intensity of light, objective should be of larger focal length.

SECTION – B

17. Sometimes *p-n* junction is also known as junction diode. Give reason. Also explain why a potential barrier sets up across it.

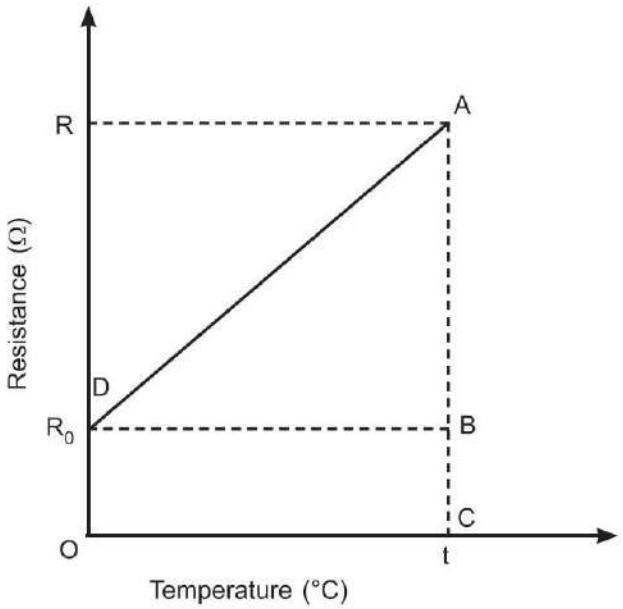
18. In relation to photoelectric effect, define the following terms.

(*a*) Stopping potential

(*b*) Threshold frequency

19. In Young's double slit experiment, the separation between the slits is 0.3 mm and the screen is 1.5 m away. When a white light is passed through the screen first violet fringe is formed at 2.0 mm away from the central white fringe and second red fringe is formed. If the difference in wavelengths of red and violet light is 300 nm, find the position of red fringe from central white fringe.

20. In the graph given below, the variation of resistance with temperature for a metallic conductor is shown.



(*a*) Find the temperature coefficient with the help of the given graph.

(*b*) Explain how the resistance of the conductor increases with the rise in temperature?

21. What do you understand by a wavefront? Draw the shape of a plane wavefront after refraction through (*a*) a prism (*b*) a convex lens.

Or

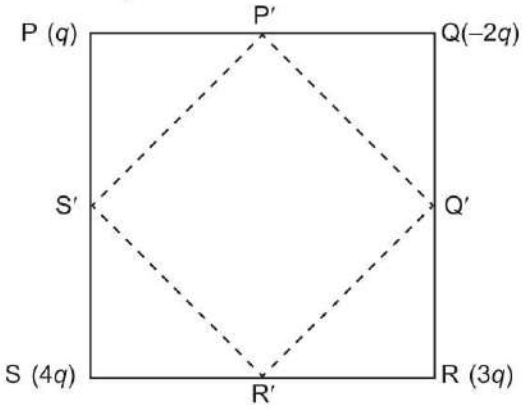
An object is placed at a distance of 60 cm from the optical centre of an equiconvex lens whose radius of curvature is 30 cm. Find the position of the image formed ($\mu = 1.5$).

SECTION – C

22. (*a*) Draw a graph showing the variation of potential energy of a pair of nucleons as a function of their separation. Mark the regions in which nuclear force is (*i*) attractive (*ii*) repulsive.

(*b*) Write two features of nuclear force which make it different from coulomb force.

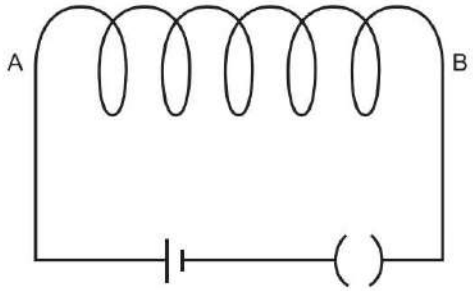
23. Four point charges q, $-2q$, $3q$, $4q$ are placed at the corners of a square $PQRS$ of side 'a'. If these charges are shifted to mid-points P', Q', R' and S' respectively, then find the amount of work done in shifting the charges to their new positions.



24. At room temperature an electron beam of 12.3 eV is used to bombard hydrogen gas. Upto which energy level the hydrogen atoms would be excited? Also calculate the orbital period of the electron in that excited state.

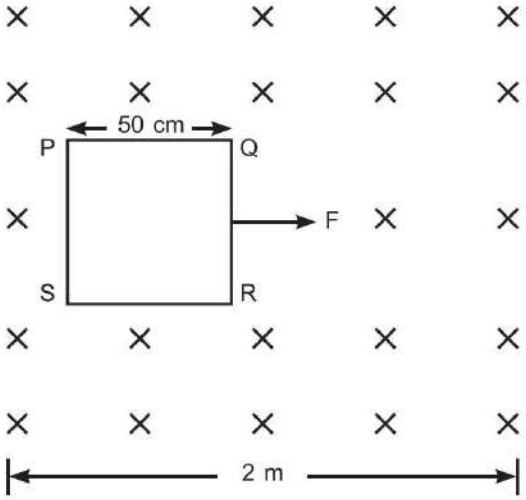
25. A circuit consists of a cell of emf ε, resistance R and key 'K'. It is observed that when circuit is opened then potential difference across the terminals is 'ε' but when circuit is closed then the potential difference across 'R' is V. Why does it happen? Define and derive an expression for that in terms of R, ε and V.

26. In the diagram shown below, when key is closed the current starts to flow due to which there is a magnetic field. Derive an expression for the magnetic field inside it. Also draw the magnetic field lines due to flow of current through it.



27. Which segment of electromagnetic waves has lowest frequency? How are these waves produced? Write two uses of these waves? Also write their frequency range.

28. A square loop PQRS of side 50 cm is placed in a magnetic field as shown. The loop is pulled with a force 'F' so that it starts to move with a constant velocity of 50 cm/s until it comes out of the field.



(*a*) For how long would the induced current in the loop persist? Also determine the direction of induced current.

(*b*) Draw the graphs showing the variation of magnetic flux and induced emf as a function of time.

Or

A metallic rod of length 'L' is rotated in a uniform magnetic field 'B' normal to it so that its angular speed is ω. Derive an expression for

(*a*) emf induced in the rod.

(*b*) current induced in the rod.

(*c*) heat dissipated in time 't' if the resistance of the rod is 'R'.

SECTION – D

Case Study Based Questions

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

At present most of the people use mobile. A mobile phone can work only if its battery is charged, which can be done by using mobile battery charger. In the mainline there is AC. When the charger is connected to mainline, AC input supplied to it is 220 V and this supply when passed through the charger, an output of 5 V DC is achieved.

(*i*) The device, due to which this output of 5 V DC is achieved, is

(*a*) solenoid. (*b*) rectifier. (*c*) galvanometer. (*d*) None of the above.

(*ii*) A load resistance is fed by a half-wave rectifier voltage. The load current will flow for the cycle

(*a*) 0° – 90° (*b*) 90° – 180° (*c*) 0° – 180° (*d*) 0° – 360°

(*iii*) Which device acts as a rectifier?

(*a*) Resistor (*b*) Capacitor (*c*) Inductor (*d*) Diode

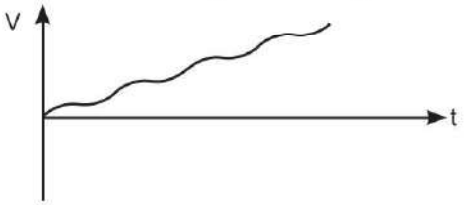
(*iv*) To form a centre-tap full-wave rectifier, we need at least

(*a*) 3 diodes. (*b*) 2 diodes. (*c*) 4 diodes. (*d*) 1 diode.

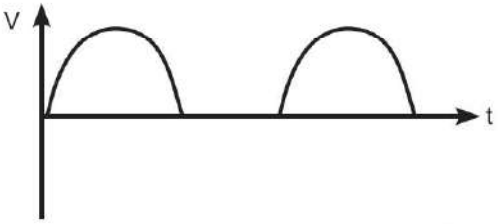
Or

(*iv*) Which of the following is the output of a full-wave rectifier?

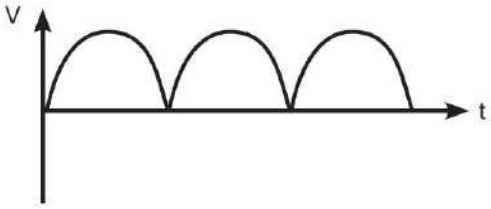
(*a*)



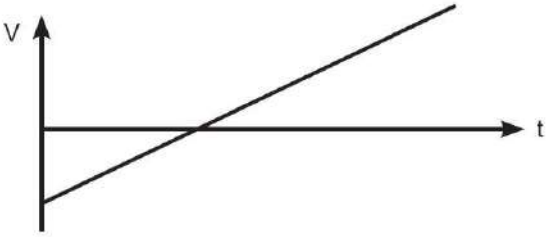
(*b*)



(*c*)



(*d*)



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

Diffraction of light is the phenomenon of bending of light around corners of an obstacle or aperture in the path of light. On account of this bending, light penetrates into the geometrical shadow of an obstacle. Diffraction is not limited to situations when light passes through a narrow opening such as a slit or pinhole. It also occurs when light passes an edge, such as the edge of the razor blade. Diffraction is a wave effect. That is it occurs with other types of waves as well.

(*i*) Diffraction of light gives us some information about

(*a*) transverse wave nature of light. (*b*) longitudinal wave nature of light.

(*c*) particle nature of light. (*d*) none of the above.

(*ii*) Choose the incorrect statement.

(*a*) In diffraction, the condition for first minimum is $a \sin \theta = \lambda$.

(*b*) For diffraction, size of obstacle should be of same order as that of the wavelength of light.

(*c*) Diffraction is interference between different parts of the same wavefront.

(*d*) In a single slit diffraction pattern, the width of central maximum increases when light of smaller wavelength is used.

(*iii*) We can hear a person behind a wall, but cannot see him because

(*a*) light is not a wave, but sound is.

(*b*) sound is not a wave but light is.

(*c*) wavelength of sound is large so it can easily get diffracted around the edges of the wall.

(*d*) light cannot be diffracted around the edge of the wall as its wavelength is large.

(*iv*) In a single slit diffraction experiment, green light is replaced by γ-rays, then

(*a*) the diffraction pattern will disappear.

(*b*) alternate bright and dark fringes of same intensity are obtained.

(*c*) alternate bright and dark fringes of decreasing intensity are obtained.

(*d*) central white fringe is obtained.

Or

(*iv*) Coloured spectrum is seen when we look through a muslin cloth because of

(*a*) diffraction. (*b*) interference.

(*c*) refraction. (*d*) both (*a*) and (*b*)

SECTION – E

31. (*a*) A spherical surface of radius of curvature R, separates two media of refractive indices μ_1 and μ_2 respectively ($\mu_2 > \mu_1$). If the surface is convex, draw a ray diagram for the refraction taking place through the surface and hence, derive the relation,

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

(*b*) If the above spherical surface is made of glass and is of refractive index 1.5 and radius of curvature 20 cm, then find the position of the object placed in front of it. Given that the image position is –180 cm. The surface is placed in air.

Or

(*a*) Draw a ray diagram for the image formation by a refracting type telescope.

(*b*) Write three main limitations of refracting type telescope and how can these be minimised?

(*c*) Define magnifying power of refracting type telescope for relaxed eye and write one factor to increase its magnifying power.

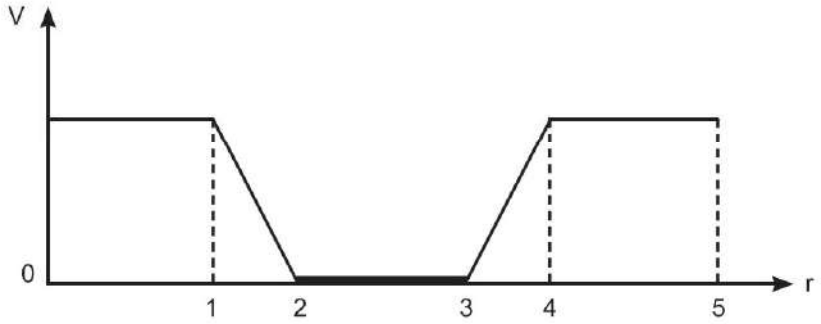
32. (*a*) A parallel plate capacitor is first connected to the battery and charged completely. It is then connected across another identical uncharged capacitor. Find the loss or gain in energy in the combination.

(*b*) Three capacitors of capacitance 1 μF, 2 μF and 3 μF are first connected in series and then in parallel combination. Find the ratio of their equivalent capacitances.

Or

(*a*) Derive a relation between electric field and electric potential gradient.

(*b*) The electric potential as a function of distance *r* is given below. Plot a graph for electric field intensity.



(*c*) If the electric potential is varying with distance as

$$V = (x^2 - 7x + 3)\ \text{V}$$

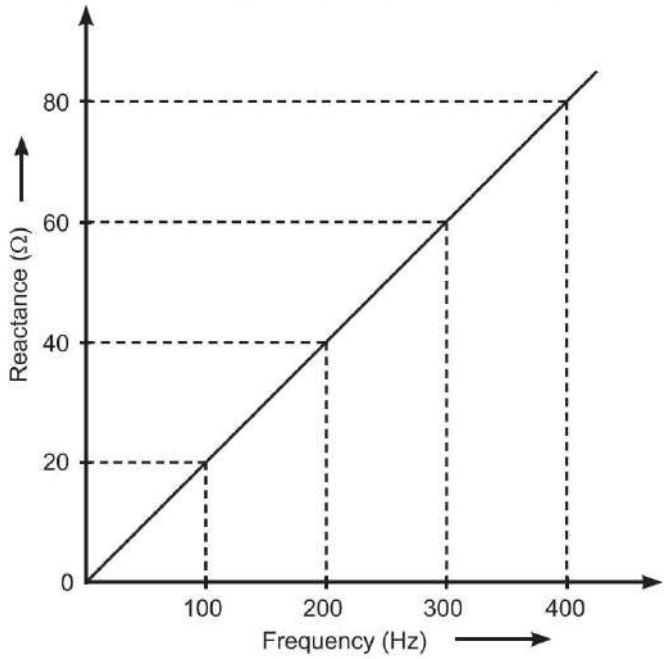
then find the electric field at $x = 2$ m.

33. (*a*) An a.c. source of angular frequency ω is fed across a resistor *R* and a capacitor *C* in series. The current flowing in the circuit found to be *I*. Now the frequency of the source is changed to $\frac{\omega}{3}$. Maintaining the same voltage, the current in the circuit is found to be halved. Calculate the ratio of the reactance to the resistance at the original frequency.

(*b*) A capacitor is connected in series to an ammeter across a d.c. source. Why does the ammeter show a momentary deflection during the charging of the capacitor? What would be the deflection when it is fully charged?

Or

The graph given below shows the variation of inductive reactance with frequency in an ac circuit.



(*a*) Calculate the inductance of the inductor using the data of the given graph.

(*b*) If a capacitor of 0.4π μF is connected in series to the inductor, then at what frequency will the resonance take place?

(*c*) If a resistor of 80 Ω is connected in series to the inductor, what would be the impedance of the circuit at 300 Hz?

(*d*) Draw the phasor diagrams for (*b*) and (*c*).