22.12.25 ✓

Delhi Public School, Howrah

PERIODIC TEST – III (2025-2026)

Class-XII

Care must be taken not to write anything on the question paper. All the questions must be attempted in the correct sequence.

SUBJECT: PHYSICS (CODE- 042)

Time :- 3 Hours **F.M.-70**

General Instructions:

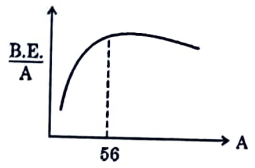
(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQ and four assertion reasoning based of 1 mark 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 two questions in Section B, one question in Section C 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. $m_e = 9.1$ x10-31 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

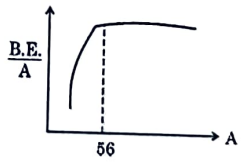
SECTION - A

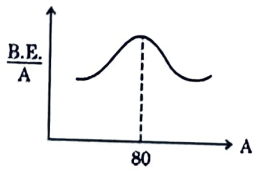
1. Two wires P and Q are made of the same material. The wire Q has twice the diameter and half the length as that of wire P. If the resistance of wire P is R, the resistance of the wire Q will be 1

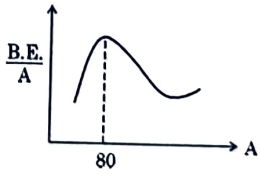
A. R B. R/2 C. R/8 D. 2R

2. Which of the following figures correctly represent the shape of the curve of binding energy per nucleon as a function of mass number? 1

A.


B.


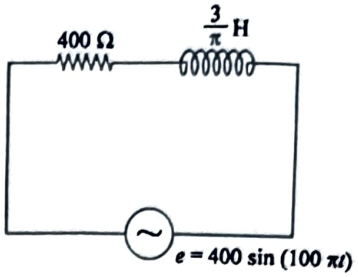
C.


D.


3. When a p-n junction diode is forward biased, 1

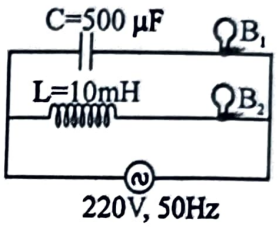
   A. The barrier height and the depletion layer width increase.
   B. The barrier height increases and the depletion layer width decrease.
   C. The barrier height and the depletion layer width decrease.
   D. The barrier height decreases and the depletion layer width increase.

4. A resistance of 400 Ω is connected in series with an inductor of $3/\pi$ H and this combination is connected across an A.C. source as shown in the figure. 1



   A. Peak value of current is 5/4 A.
   B. Potential difference across resistance is in same phase with the current.
   C. Potential difference across inductor is 53° leading with current.
   D. Potential difference across inductor is 37° leading with current.

5. In the circuit shown in the figure, if both the bulbs B_1 and B_2 are identical, then 1



   A. Their brightness will be the same.
   B. B_2 will be brighter than B_1.
   C. As frequency of supply voltage increases, brightness of B_1 will increase and that of B_2 will decrease.
   D. Only B_2 will glow because the capacitor has infinite impedance.

6. Two ends of a horizontal conducting rod of length l are joined to a voltmeter. The whole arrangement moves with a horizontal velocity v, the direction of motion being perpendicular to the rod. Vertical component of the earth's magnetic field is B. The voltmeter reads a voltage equal to, 1

   A. Blv if the rod moves in any direction.
   B. Blv only if the rod moves westward.
   C. Blv only if the rod moves eastward.
   D. Zero.

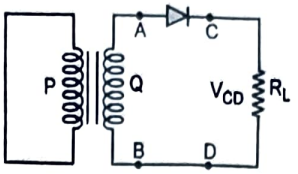
7. Two point charges placed at a distance r in air exert a force F on each other. The value of distance R at which they experience force 4F when placed in a medium of dielectric constant K = 16 is: 1

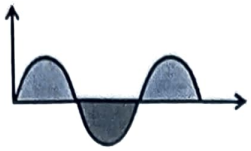
   A. r B. r/4 C. r/8 D. 2r

8. If a proton and an electron are placed in an uniform electric field, then which of the following statements is true? 1

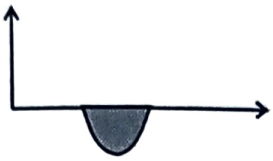
   A. The electric forces acting on them will be equal.
   B. The magnitudes of the forces will be equal.
   C. Their acceleration will be equal.
   D. The magnitudes of acceleration will be equal.

9. In the half-wave rectifier circuit shown, which one of the following wave forms is true for V_{CD}, the output across C and D? 1



A. 

B. 

C. 

D. 

10. A diamagnetic substance is brought first, near the north pole and then near the south pole of a bar magnet. It is 1

A. repelled by north pole and attracted by south pole.
B. attracted by north pole and repelled by south pole.
C. attracted by north pole as well as by south pole.
D. repelled by north pole as well as by south pole.

11. A hollow sphere is uniformly charged. Inside the sphere, 1

A. The potential is zero but the electric field is non–zero.
B. The electric field is zero but the potential is non–zero.
C. Both the electric field and the potential are non–zero.
D. Both the electric field and the potential are zero.

12. In a permanent magnet at room temperature, 1

A. magnetic moment of each molecule is zero.
B. the individual molecules have non-zero magnetic moment which are all perfectly aligned.
C. domains are all perfectly aligned.
D. domains are all partially aligned.

For question numbers 13 to 16, two statements are given- one labeled as Assertion (A) and the other labeled as Reason (R). Select the correct answer to these questions from the codes A, B, C and D as given below.

A. Both A and R are true and R is the correct explanation of the 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 but R is true.

13. **Assertion (A):** In his study of photoelectric emission, Hallwachs connected a negatively charged zinc plate to an electroscope. He found that negatively charged particles were emitted from the zinc plate under the action of visible light. 1

Reason (R): An uncharged zinc plate becomes positively charged when it is irradiated by visible light.

14. **Assertion (A):** Out of infrared and radio waves, the radio waves show more diffraction effect. 1
Reason (R): Radio waves have higher frequency than infrared waves.

15. **Assertion (A):** Electromagnetic waves do not require a material medium for their propagation. 1
Reason (R): In an electromagnetic wave, the changing electric field produces a changing magnetic field, and the changing magnetic field produces a changing electric field.

16. **Assertion (A):** The de Broglie wavelength of a particle decreases when its momentum increases. 1
Reason (R): According to de Broglie relation, the wavelength associated with a moving particle is given by $\lambda = \frac{h}{p}$.

SECTION - B

17. A battery of emf E and internal resistance r is connected to a rheostat. When a current of 2A is drawn from the battery, the potential difference across the rheostat is 5V. The potential difference becomes 4V when a current of 4A is drawn from the battery. Calculate the values of E and r. 2

18. A p-type Silicon semiconductor is made by doping an average of one dopant atom per 5×10^7 silicon atoms. If the number density of silicon atoms in the specimen is 5×10^{28} atoms m^{-3}, find the number of holes created per cubic centimeter in the specimen due to doping. Also give one example of such dopants. 2

19. A spherical convex surface of radius of curvature R separates glass (refractive index = 1.5) from air. Light from a point source placed in air at a distance R/2 from the surface falls on it. Find the position and nature of the image formed. 2

20.(A) In a Young's double – slit experiment, two light waves, each of intensity I_0, interference at a point, having a path difference $\lambda/8$ on the screen. Find the intensity at this point. 2

OR

20.(B) In a diffraction experiment, the slit is illuminated by light of wavelength 600 nm. The first minimum of the pattern falls at $\theta = 30°$. Calculate the width of the slit. 2

21.(A) A particle of mass m and charge q is thrown at a speed u against a uniform electric field E. How much distance will it travel before coming to momentary rest? Find out the time required till that moment. (Neglect gravity) 1+1

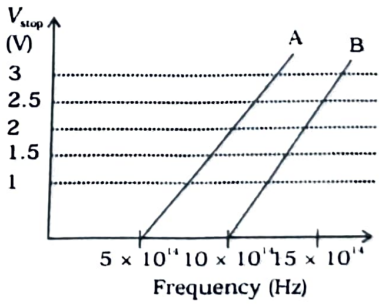
OR

21.(B) The bob of a simple pendulum has a mass of 40 g and a positive charge of 4.0×10^{-6} C. It makes 20 oscillations in 45 s. A vertical electric field pointing upward and of magnitude 2.5×10^4 N/C is switched on. How much time will it take now to complete 20 oscillations? 2

SECTION - C

22. Using Biot-Savart law, derive the expression for the magnetic field due to a circular current carrying loop at a point on its axis and hence at its centre. 3

23. A student performs an experiment on photoelectric effect, using two materials A and B. A plot of V_{stop} vs v(frequency) is shown in the figure. 1+1+1



a. Which material A or B has a higher work function?
b. Given the electric charge of an electron = 1.6×10^{-19} C, find the value of h (Planck's constant) obtained from the experiment for both A and B.
c. Comment on whether it is consistent with Einstein's theory.

24. a. Define mass defect and binding energy of a nucleus. Describe the process of nuclear fission on the basis of binding energy per nucleon. 1+2

b. A deuteron consists of a proton and a neutron and has a mass of 2.013553 u. Calculate the mass defect for it in the unit 'u' and its energy equivalence in MeV.

(Given, $m_p = 1.007277$ u, $m_n = 1.008665$ u, $1u = 931.5$ MeV/c^2)

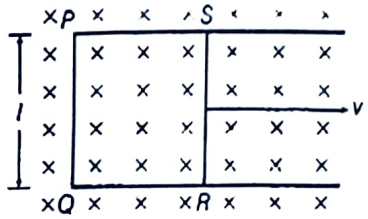
25. An A.C source of voltage $v = v_m \sin wt$ is connected to a series combination of LCR circuit. Draw the phasor diagram. Using it, obtain an expression for the impedance of the circuit and the phase difference between applied voltage and the current. 1+2

26. a. Draw circuit arrangement for studying V-I characteristics of a p-n junction diode. 1+1+1

b. Show the shape of the characteristics of a diode.

c. State two important points that you can get from these characteristics.

27.(A) Given figure shows a rectangular conducting loop PQRS in which arm RS of length l is movable. The loop is kept in a uniform magnetic field B directed downward perpendicular to the plane of the loop. The arm RS is moved with a uniform speed v. 1+1+1



Deduce an expression for

i. the emf induced across the arm RS.

ii. the external force required to move the arm.

iii. the power dissipated as heat.

OR

27.(B) Define self-inductance of a coil. Obtain the expression for the energy stored in an inductor L connected across a source of emf. 1+2

28. Two batteries of emfs 3 V & 6 V and internal resistances 0.2 Ω & 0.4 Ω are connected in parallel. This combination is connected to a 4 Ω resistor. Find: 1+1+1

a. the equivalent emf of the combination

b. the equivalent internal resistance of the combination

c. the current drawn from the combination

SECTION – D

29. **Read the following passage and answer the questions based on that.**

A magnetic field can be produced by moving charges or electric currents. The basic equation governing the magnetic field due to a current distribution is the Biot-Savart's law. Finding the magnetic field resulting from a current distribution involves the vector product and is inherently a calculus problem when the distance from the current to the field point is continuously changing. According to this law, the magnetic field at a point due to a current element of length $\vec{dl}$ carrying current I, at a distance r from the element is

$$dB = \frac{\mu_0}{4\pi} \frac{I(d\vec{l} \times \vec{r})}{r^3}$$

Biot-Savart's law has certain similarities as well as difference with Coulomb's law for electrostatic field. e.g. There is an angle dependence in Biot- Savart's law which is not present in electrostatic case.

i. The direction of magnetic field $\vec{dB}$ due to a current element $\vec{dl}$ at a point of distance $\vec{r}$ from it, when a current I passes through a long conductor is in the direction: 1

A. of position vector $\vec{r}$ of the point

B. of current element $\overrightarrow{dl}$

C. perpendicular to both $\overrightarrow{dl}$ and $\vec{r}$

D. perpendicular to $\overrightarrow{dl}$

ii. What is the magnetic field produced by current carrying straight wire segment of length L at a point on its perpendicular bisector located at a distance r (r>>L): 1

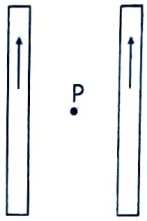
A. decreases as 1/r

B. decreases as $1/r^2$

C. decreases as $1/r^3$

D. approaches a finite limit as $r \to \infty$

iii. Two long straight wires are set parallel to each other. Each carries a current i in the same direction and the separation between them is 2r. The intensity of the magnetic field at a point P midway between them is: 1



A. $\frac{\mu_0 i}{r}$ B. Zero

C. $\frac{4\mu_0 i}{r}$ D. $\frac{\mu_0 i}{4r}$

iv. A long straight wire carries a current along the z-axis. For any two points in the x-y plane, which of the following is always false? 1

A. The magnetic fields are equal.

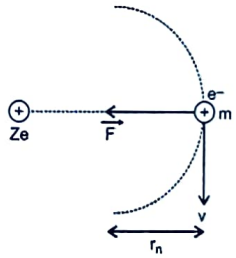
B. The directions of the magnetic fields are the same.

C. The magnitudes of the magnetic fields are equal.

D. The field at one point is opposite to that at the other point.

30. **Read the following passage and answer the questions based on that.**

Hydrogen is the simplest atom of nature. There is one proton in its nucleus and an electron moves around the nucleus in a circular orbit. According to Niels Bohr, this electron moves in a stationary orbit. When this electron is in the stationary orbit, it emits no electromagnetic radiation. The angular momentum of the electron is quantized, i.e., mvr = (nh/2π), where m = mass of the electron, v = velocity of the electron in the orbit, r = radius of the orbit and n = 1, 2, 3, ... When transition takes place from k-th orbit to j-th orbit, energetic photon is emitted. If the wavelength of the emitted photon is λ, we find that



$$\frac{1}{\lambda} = R\left[\frac{1}{j^2} - \frac{1}{k^2}\right]$$

where R is Rydberg's constant.

On a different planet, the hydrogen atom's structure was somewhat different from ours.

The angular momentum of the electron was $P = 2n(\frac{h}{2\pi})$,

i.e., an even multiple of $\frac{h}{2\pi}$.

i. What is the minimum permissible radius of the orbit on the other planet? 1

ii. In our world, the velocity of electron is V_o, when the hydrogen atom is in the ground state. Find the velocity of electron in this state on the other planet. 1

iii. In our world, the ionization potential energy of a hydrogen atom is 13.6 eV. What will be the ionization potential energy on the other planet? 1

iv. What is the total energy (E_n) of the electron in the stationary states in the n^{th} orbit of the hydrogen atom on our planet? 1

SECTION - E

31.(A) i. What are coherent sources? Why are they necessary for observing a sustained interference pattern? Lights from two independent sources are not coherent. Explain. 3+2

ii. Two slits 0.1 mm apart are arranged at a distance of 1.20 m from a screen. Light of wavelength 600 nm from a distant source is incident on the slits.

a. How far apart will adjacent bright interference fringes be on the screen?

b. Find the angular width (in degree) of the first bright fringe.

OR

31.(B) i. Define a wavefront. An incident plane wave falls on a convex lens and gets refracted through it. Draw a diagram to show the incident and refracted wavefronts. 2+3

ii. A beam of light coming from a distant source is refracted by a spherical glass ball (refractive index 1.5) of radius 15 cm. Draw the ray diagram and obtain the position of the final image formed.

32.(A) i. Derive the expression for the energy stored in parallel plate capacitor. 2+1+2

ii. Obtain the expression for the energy density of the electric field.

iii. A fully charged parallel plate capacitor is connected across an uncharged identical capacitor. Show that the energy stored in the combination is less than the energy stored initially in the single charged capacitor.

OR

32.(B) a. If two similar large plates, each of area A, having surface charge densities $+\sigma$ and $-\sigma$ are separated by a distance d in air, then find the expression for - 3+2

i. the field at points between the two plates and on the outer side of the plates. Specify the direction of the field in each case.

ii. the potential difference between the plates.

iii. the capacitance of the capacitor so formed.

b. Two metallic spheres of radii R and 2R are charged so that both have the same surface charge density. If they are connected to each other with a conducting wire, in which direction will the charge flow and why?

33.(A) a. Draw a ray diagram for formation of a real and diminished image of an object kept in front of a concave mirror. Hence derive the mirror equation. 3+2

b. A concave mirror of focal length 10 cm produces a real image which is 3 times the size of the object. Find the distance of the object from the mirror.

OR

33.(B) a. A coin is placed inside a denser medium. Why does it appear to be raised? Obtain an expression for the height through which the object appears to be raised in terms of refractive index of the medium and real depth. 3+2

b. A compound microscope consists of an objective lens of focal length 2 cm and an eyepiece of focal length 6.25 cm separated by a distance of 15 cm. How far from the objective should an object be placed to obtain the final image at the least distance of distinct vision (25 cm)? Calculate the magnifying power of the microscope.