# VISHNU BHAGWAN PUBLIC SCHOOL

Pre Board Exam (2023-24)

Class – 12

Subject – Physics

Time: 3:00 Hours **{SET-B}** M.M:70

**General Instructions**

(1) There are 33 questions in all. All questions are compulsory

(2) This question paper has 5 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) $\mu_0 = 4\pi \times 10^{-7}$ $Tm^{-1}$

(v) $h = 6.63 \times 10^{-34}$ Js

(vi) $e_0 = 8.854 \times 10^{-12}$ $C^2$ $N^{-1}$ $m^{-2}$

(vii)Avogadro's number = $6.023 \times 10^{23}$ per gram mole

## Section – A (16X1=16)

1. Which of the following circuits exhibits maximum power dissipation?
   a. Pure Inductive Circuit
   b. Pure Capacitive Circuit
   c. Pure Resistive Circuit
   d. None of the above

2. An electric dipole placed in an electric field of intensity 2 × 105 N/C at an angle of 30° experiences a torque equal to 4 Nm. The charge on the dipole of dipole length 2 cm is

   (A) 7 mC (B) 8 mC (C) 2 mC (D) 5 mC

3. Which of the following is conserved when light waves interfere?
   a. Intensity
   b. Amplitude
   c. Phase
   d. None of the above

4 Magnetic field at any point inside the straight solenoid is given as————-
   a. $B = \mu_0 + nI$
   b. $B = \mu_0 + n + I$
   c. $B = \mu_0 / nI$
   d. $B = \mu_0 nI$

5. Who discovered the first spectral series?
   a. Lyman
   b. Balmer
   c. Paschen
   d. Pfund

6. The relative magnetic permeability of a substance X is slightly less than unity and that of substance Y is slightly more than unity, then

   (A) X is paramagnetic and Y is ferromagnetic
   (B) X is diamagnetic and Y is ferromagnetic
   (C) X and Y both are paramagnetic
   (D) X is diamagnetic and Y is paramagnetic

7. An ammeter of resistance 0.81 ohm reads up to 1 A. The value of the required shunt to increase the range to 10 A

(A) 0.9 ohm (B) 0.09 ohm (C) 0.03 ohm (D) 0.3 ohm

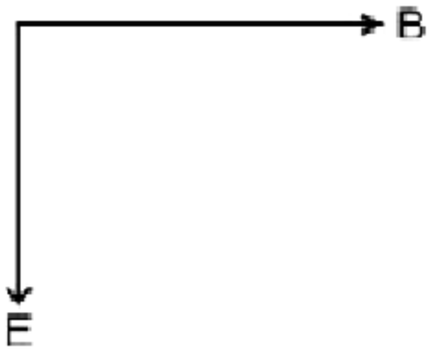
8. An electron with angular momentum L moving around the nucleus has a magnetic moment given by

(A) e L/ 2m (B) e L/3m (C) e L /4m (D) e L / m

9. What is the dielectric constant of a metal?

a. -1
b. 0
c. 1
d. Infinite

10. The diagram below shows the electric field (E ) and magnetic field ( B) components of an electromagnetic wave at a certain time and location.




**(E)**

The direction of the propagation of the electromagnetic wave is

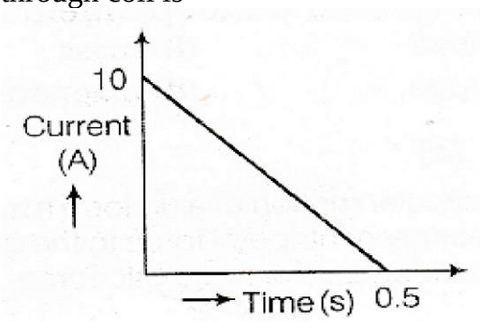
(A) perpendicular to E and B and out of plane of the paper

(B) perpendicular to E and B and into the plane of the paper

(C) parallel and in the same direction as E

(D) parallel and in the same direction as B

11. In a coil of resistance 100 ohm a current is induced by changing the magnetic flux through it. The variation of current with time is as shown in the figure. The magnitude of change in flux through coil is




(A) 200 Wb (B) 275 Wb (C) 225 Wb (D) 250 Wb

12. The energy of an electron in nth orbit of hydrogen atom is En = –13.6/n2 eV. The negative sign of energy indicates that

(A) electron is free to move. (B) electron is bound to the nucleus.

(C) kinetic energy of electron is equal to potential energy of electron.

(D) atom is radiating energy.

**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 both Assertion and Reason are false.

13. Assertion (A) : For the radiation of a frequency greater than the threshold frequency, photoelectric current is proportional to the intensity of the radiation.

Reason (R) : Greater the number of energy quanta available, greater is the number of electrons absorbing the energy quanta and greater is number of electrons coming out of the metal.

14. Assertion (A) : Putting p type semiconductor slab directly in physical contact with n type semiconductor slab cannot form the pn junction.

Reason (R) : The roughness at contact will be much more than inter atomic crystal spacing and continuous flow of charge carriers is not possible.

15. Assertion (A) Work done in moving a charge around a closed path in an electric field is always zero.
Reason (R) Electrostatic force is a conservative force.

16. Assertion (A) In Young's double slit experiment, all fringes are of equal width.
Reason (R) The fringe width depends upon wavelength of light (λ) used, the distance of screen from plane of slits (D) and slits separation (d).

## Section – B (5X2=10

17. (a) Name the device which utilizes unilateral action of a pn diode to convert ac into dc.
(b) Draw the circuit diagram of full wave rectifier.

18. The wavelength l of a photon and the de Broglie wavelength of an electron of mass m have the same value. Show that the energy of the photon is 2lmc/h times the kinetic energy of the electron, where c and h have their usual meanings.

19. Show that the radius of n th orbit in hydrogen atom varies as $n^2$, where n is the principal quantum no. of the orbit.

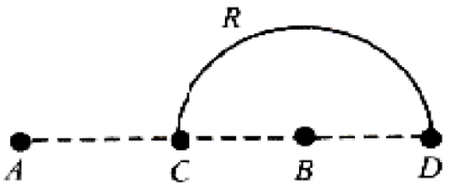
20. A heating element using nichrome connected to a 230 V supply draws an initial current of 3.2 A which settles after a few seconds to a steady value of 2.8 A. What is the steady temperature of the heating element if the room temperature is 27.0 °C and the temperature coefficient of resistance of nichrome is $1.70 \times 10^{-4}$ °$C^{-1}$?

21. Show that the least possible distance between an object and its real image in a convex lens is 4f, where f is the focal length of the lens.

## Section – C (7X3=21)

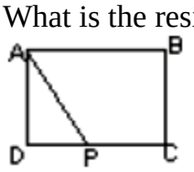
22. A given coin has a mass of 3.0g. Calculate the nuclear energy that would be required to separate all the neutrons and protons from each other. For simplicity assume that the coin is entirely made of 29 63Cu atoms (of mass 62.92960 u). Given mp = 1.007825u and mn = 1.008665u.

23. Charges (+q) and (–q) are placed at the points A and B respectively which are a distance 2L apart. C is the midpoint between A and B. What is the work done in moving a charge +Q along the semicircle CRD.

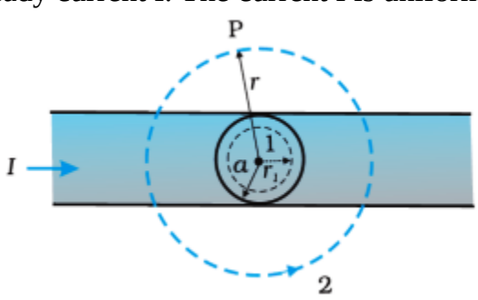



24. The total energy of an electron in the first excited state of the hydrogen atom is about –3.4 eV.
(a) What is the kinetic energy of the electron in this state?
(b) What is the potential energy of the electron in this state?
(c) Which of the answers above would change if the choice of the zero of potential energy is changed?

25. A wire of uniform cross-section and resistance 4 ohm is bent in the shape of square ABCD. Point A is connected to a point P on DC by a wire AP of resistance 1 ohm. When a potential difference is applied between A and C, the points B and P are seen to be at the same potential. What is the resistance of the part DP?




26. The given figure shows a long straight wire of a circular cross-section (radius a) carrying steady current I. The current I is uniformly distributed across this cross-section. Calculate the magnetic field in the region r < a and r > a.



27. State Lenz's law. Explain by giving examples that Lenz's law is a consequence of the conservation of energy.

28. (a) Define mutual inductance and write its SI unit. (b) 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

OR

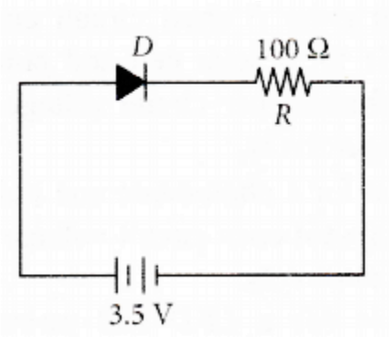
Two long straight parallel current carrying conductors are kept 'a' distant apart in air. The direction of current in both the conductors is same. Find the magnitude of force per unit length and direction of the force between them. Hence define one ampere.

## Section – D (2X4=8)

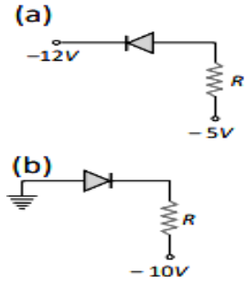
Directions (Q.Nos. 29-30) These questions are case study based questions. Read the following paragraph and answer the questions.

29. Read the following paragraph and answer the questions that follow. A semiconductor diode is basically a pn junction with metallic contacts provided at the ends for the application of an external voltage. It is a two terminal device. When an external voltage is applied across a semiconductor diode such that p-side is connected to the positive terminal of the battery and n-side to the negative terminal, it is said to be forward biased. When an external voltage is applied across the diode such that n-side is positive and p-side is negative, it is said to be reverse biased. An ideal diode is one whose resistance in forward biasing is zero and the resistance is infinite in reverse biasing. When the diode is forward biased, it is found that beyond forward voltage called knee voltage, the conductivity is very high. When the biasing voltage is more than the knee voltage the potential barrier is overcome and the current increases rapidly with increase in forward voltage. When the diode is reverse biased, the reverse bias voltage produces a very small current about a few microamperes which almost remains constant with bias. This small current is reverse saturation current

(i) In the given figure, a diode D is connected to an external resistance R = 100 ohm and an emf of 3.5 V. If the barrier potential developed across the diode is 0.5 V, the current in the circuit will be:




(A) 40 mA (B) 20 mA (C) 35 mA (D) 30 mA




(ii) In which of the following figures, the pn diode is reverse biased?

(iii) Based on the V-I characteristics of the diode, we can classify diode as

(A) bilateral device (B) ohmic device

(C) non-ohmic device (D) passive element

30. Read the following paragraph and answer the questions that follow. Types of Lenses and their combination A convex or converging lens is thicker at the centre than at the edges. It converges a beam of light on refraction through it. It has a real focus. Convex lens is of three types: Double convex lens, Plano convex lens and Concavoconvex lens. Concave lens is thinner at the centre than at the edges. It diverges a beam of light on refraction through it. It has a virtual focus. Concave lenses are of three types: Double concave lens, Plano concave lens and Convexo-concave lens. When two thin lenses of focal lengths f1 and f2 are placed in contact with each other along their common principal axis, then the two lens system is regarded as a single lens of focal length f and

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$1/f = 1/f_1 + 1/f_2$

If several thin lenses of focal length f1, f2, .... fn are placed in contact, then the effective focal length of the combination is given by

$1/f = 1/f_1 + 1/f_2 + 1/f_3 + \ldots\ldots + 1/f_n$
and in terms of power, we can write $P = P_1 + P_2 + .... + P_n$
The value of focal length and power of a lens must be used with proper sign consideration.
(i) Two thin lenses are kept coaxially in contact with each other and the focal length of the combination is 80 cm. If the focal length of one lens is 20 cm, the focal length of the other would be
(A) –26.7 cm (B) 60 cm (C) 80 cm (D) 30 cm
(ii) A spherical air bubble is embedded in a piece of glass. For a ray of light passing through the bubble, it behaves like a
(A) converging lens (B) diverging lens (C) mirror (D) thin plane sheet of glass
(iii) Lens generally used in magnifying glass is
(A) single concave lens (B) single convex lens
(C) combination of convex lens of lower power and concave lens of lower focal length
(D) Planoconcave lens
(iv) The magnification of an image by a convex lens is positive only when the object is placed
(A) at its focus F (B) between F and 2F (C) at 2F (D) between F and optical centre

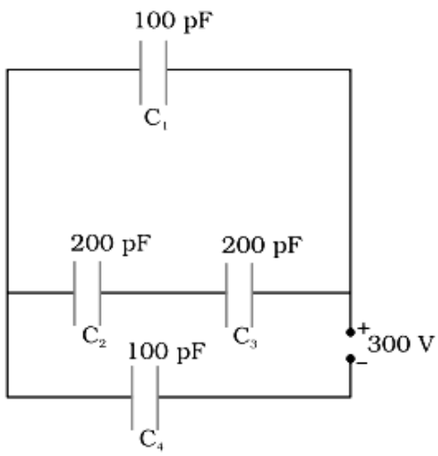
## Section-E (3X5=15)

31. (i) Draw a ray diagram for the formation of image of a point object by a thin double convex lens having radii of curvature R1 and R2. Hence derive lens maker's formula.
(ii) A converging lens has a focal length of 10 cm in air. It is made of a material of refractive index 1.6. If it is immersed in a liquid of refractive index 1.3, find its new focal length.

OR

(i) Define a wavefront. How is it different from a ray?
(ii) Using Huygens's construction of secondary wavelets draw a diagram showing the passage of a plane wavefront from a denser to a rarer medium. Using it verify Snell's law
(iii) In a double slit experiment using light of wavelength 600nm and the angular width of the fringe formed on a distant screen is 0.1°. Find the spacing between the two slits
(iv) Write two differences between interference pattern and diffraction pattern

32. (i) Derive an expression for the capacitance of a parallel plate capacitor with air present between the two plates.




(ii) Obtain the equivalent capacitance of the network shown in figure. For a 300V supply, determine the charge on each capacitor.

OR

In Young's double slit experiment , describe briefly how bright and dark fringes are obtained on the screen kept in front of a double slit. Hence obtain the expression for fringe width.
If the ratio of the intensities at minima to the maxima in Young's double slit experiment is 9:25. Then find the ratio of the widths of the two slits.

33. (a) Draw graphs showing the variations of inductive reactance and capacitive reactance with frequency of applied ac source.
(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, a current of 0.25A flows which lags behind the applied voltage in phase by p/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 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 R1 and R2 (R1 < R2) at resonance.