SAMPLE QUESTION PAPER

BLUE PRINT

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

S. No.	Chapter	VSA/ AR/ Case Based (1 mark)	SA-I (2 marks)	SA-II (3 marks)	LA (5 marks)	Total
1.	Electrostatics	3(6)	2(4)	–	–	**8(16)**
2.	Current Electricity	1(1)	1(2)	1(3)	–	
3.	Magnetic Effects of Current and Magnetism	3(3)	1(2)	–	–	**8(17)**
4.	Electromagnetic Induction and Alternating Current	–	2(4)	1(3)	1(5)	
5.	Electromagnetic Waves	3(3)	–	1(3)	–	**10(18)**
6.	Optics	2(2)	2(4)	2(6)	–	
7.	Dual Nature of Radiation and Matter	1(4)	–	–	1(5)	**4(12)**
8.	Atoms and Nuclei	1(1)	1(2)	–	–	
9.	Electronic Devices	2(2)	–	–	1(5)	**3(7)**
	Total	**16(22)**	**9(18)**	**5(15)**	**3(15)**	**33(70)**

Subject Code : **042**

PHYSICS

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

(i) All questions are compulsory. There are 33 questions in all.
(ii) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(iii) Section A contains ten very short answer questions and four assertion reasoning MCQs of 1 mark each. Section B has two case based questions of 4 marks each, Section C contains nine short answer questions of 2 marks each, Section D contains five short answer questions of 3 marks each and Section E contains three long answer questions of 5 marks each.
(iv) There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.

SECTION - A

All questions are compulsory. In case of internal choices, attempt any one of them.

1. If yellow light emitted by sodium lamp in Young's double slit experiment is replaced by monochromatic blue light of the same intensity, what happens with fringe width?

2. In an equilateral prism if incident angle is 45° then what is the angle of minimum deviation.

3. The electric field associated with an em wave in vacuum is given by [$E = \hat{i}\, 40 \cos (kz - 6 \times 10^8 t)$] where E, z and t are in volt/m, meter and seconds respectively. What is the value of wave vector k?

OR

If ε_0 and μ_0 are the electric permittivity and magnetic permeability in a free space, ε and μ are the corresponding quantities in medium, what is the index of refraction of the medium?

4. To find the resistance of a gold bangle, two diametrically opposite points of the bangle are connected to the two terminals of the left gap of a metre bridge. A resistance of 4 Ω is introduced in the right gap. What is the resistance of the bangle if the null point is at 20 cm from the left end?

5. An electric dipole is placed in an uniform electric field with the dipole axis making an angle θ with the direction of the electric field. What is the orientation of the dipole for stable equilibrium?

6. A point charge $+q$ is placed at the centre of a cube of side L. What is the electric flux emerging from the cube?

OR

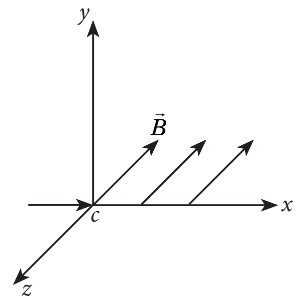
Two charges of magnitudes $-2Q$ and $+Q$ are located at points (a, 0) and ($4a$, 0) respectively. What is the electric flux due to these charges through a sphere of radius '$3a$' with its centre at the origin?

7. The wavelengths of some of the spectral lines obtained in hydrogen spectrum are 9546 Å, 6463 Å and 1216 Å. Which one of these wavelengths belong to Lyman Series ?

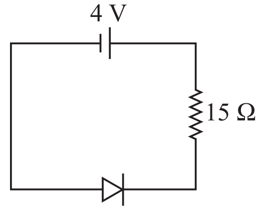
8. A particle of charge e and mass m moves with a velocity v in a magnetic field B applied perpendicular to the motion of the particle. What is the radius r of its path in the field?

OR

An electron moves along $+x$ direction. It enters into a region of uniform magnetic field $\vec{B}$ directed along $-z$ direction as shown in figure Draw the shape of trajectory followed by the electron after entering the field.

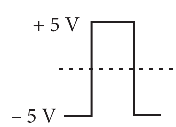


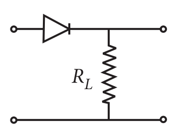
9. In the circuit shown if drift current for the diode is 20 μA, find the potential difference across the diode.



OR

If in a p–n junction, a square input signal of 10 V is applied, as shown,





then show the output across R_L.

10. A wire is wound in the form of a solenoid of length l and diameter d. When a strong current is passed through the solenoid, why both length and diameter remain constant?

For question numbers 11, 12, 13 and 14 two statements are given one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these question from the codes (a), (b), (c) and (d) as given below.

(a) Both A and R are true and R is correct explanation of A.

(b) Both A and R are true but R is not correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is also false.

11. **Assertion (A) :** Magnetism is relativistic.

Reason (R) : When we move along with the charge so that there is no motion relative to us, we find no magnetic field associated with the charge.

12. **Assertion (A) :** p-n junction diode can be used even at ultra high frequencies.

Reason (R) : Capacitive reactance of a p-n junction diode increases as frequency increases.

13. **Assertion (A) :** Penetrating power of X-rays decreases with increasing wavelength.

Reason (R) : The penetrating power of X-rays increases with the frequency of X-rays.

14. **Assertion (A) :** Microwaves have more energy than the radio waves.

Reason (R) : Energy of wave is directly proportional to the frequency.

SECTION - B

Questions 15 and 16 are Case Study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.

15. Electric field between the plates of parallel plate capacitor is directly proportional to capacitance C of the capacitor. The strength of electric field is reduced due to presence of dielectric when a dielectric is placed between its plates and if the total charge on the plates is kept constant then the potential difference is reduced across the capacitor plates. In this way dielectric increases the capacitance of capacitor.

(i) Find the capacitance of the given capacitor

(a) 88.54 pF (b) 76.54 pF (c) 88.54 nF (d) 76.54 nF

(ii) Find the amount of free charge on each plate.

(a) 4.42 pC (b) 4.42 nC (c) 6.79 mC (d) 6.79 pC

(iii) Find the surface density of free charge on the plates.

(a) 1.273×10^{-6} C m^{-2} (b) 2.629×10^{-6} C m^{-2} (c) 1.476×10^{-6} C m^{-2} (d) 2.869×10^{-6} C m^{-2}

(iv) Calculate the electric field between the plates, assuming the same amount of charge on each plate.

(a) 1.273×10^{5} V m^{-1} (b) 1.667×10^{5} V m^{-1} (c) 2.246×10^{5} V m^{-1} (d) 1.892×10^{5} V m^{-1}

(v) Find the electric field between the plates in the presence of dielectric medium.

(a) 1.273×10^{5} V m^{-1} (b) 2.968×10^{4} V m^{-1} (c) 7.892×10^{4} V m^{-1} (d) 8.335×10^{4} V m^{-1}

16. According to de-Broglie, a moving material particle exhibits dual nature (*i.e.*, a particle as well as a wave). He also predicted that a wave is associated with every moving material particle (which controls the particle) called matter wave and its wavelength is called de-Broglie wavelength given by $\lambda = h/mv$

where h is Planck's constant, m is the mass of the particle moving with velocity v. The existence of matter waves was first experimentally verified by Davisson and Gemer using slow moving electrons which where accelerated with moderate accelerating potential.

(i) De-Broglie wavelength of a body of mass m and kinetic energy E is given by (symbols have their usual meanings)

(a) $h/\sqrt{2mE}$ (b) $h/2mE$ (c) $2mE/h$ (d) hmE

(ii) An electron is accelerated under a potential difference of 64 V, the de-Broglie wavelength associated with electron is (Use charge of electron 1.6×10^{-19} C, mass of electron 9.1×10^{-31} kg ; $h = 6.623 \times 10^{-34}$ J s)

(a) 1.53 Å (b) 2.53 Å (c) 3.53 Å (d) 4.54 Å

(iii) An α-particle and proton have same velocities, the ratio of de-Broglie wavelength of α-particle and proton is

(a) 2 (b) 1 (c) 1/2 (d) 1/4

(iv) According to de-Brogile, matter should exhibit dual behaviour, that is both particle and wave like properties. However, a cricket ball of mass 100 g does not move like a wave when it is thrown by a bowler at a speed of 100 km/h. why it does not show wave nature?

(a) de- Broglie hypothesis is not applicable for macroscopic particles.
(b) de- Broglie hypothesis is not applicable for microscopic particles.
(c) The wavelength produced is too small to be detected.
(d) de- Broglie hypothesis is only applicable to particles moving with speed comparable to speed of light.

(v) Calculate the de-Broglie wavelength of the ball.
(a) 238.5×10^{-36} m (b) 238.5×10^{36} m (c) 678.9×10^{-52} m (d) 678.9×10^{24} m

SECTION - C

All questions are compulsory. In case of internal choices, attempt anyone.

17. In series *LCR* circuit obtain the conditions under which the impedance of the circuit is minimum.

18. *n* small drops of same size are charged to *V* volt each. They coalesce to form a bigger drop. Calculate the capacity and potential of the bigger drop.

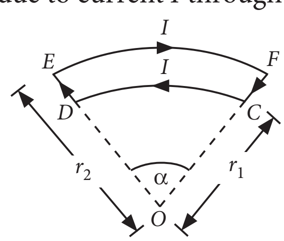
19. Two heating elements of resistance R_1 and R_2 when operated at a constant supply of voltage *V*, consume powers P_1 and P_2 respectively. Deduce the expression for the power of their combination when they are in turn, connected in (a) series and (b) parallel across the same voltage supply.

OR

Two wires of same radius having lengths l_1 and l_2 and resistivities ρ_1 and ρ_2 are connected in series. What is the equivalent resistivity of the wires?

20. A magician during a show makes a glass lens with $\mu = 1.47$ disappear in a trough of liquid. What is the refractive index of the liquid? Could the liquid be water?

21. Find magnetic induction at centre *O* due to current *I* through the circuit shown in figure.



OR

A particle of charge '*q*' and mass '*m*' is moving with velocity $\vec{v}$. It is subjected to a uniform magnetic field $\vec{B}$ directed perpendicular to its velocity. Show that it describes a circular path. Write the expression for its radius.

22. The radius of the innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. What are the radii of the $n = 2$ and $n = 3$ orbits?

OR

Consider two different hydrogen atoms. The electron in each atom is in an excited state. Is it possible for the electrons to have different energies but the same orbital angular momentum according to the Bohr model?

23. When monochromatic light is incident on a surface separating two media, the reflected and refracted light both have the same frequency. Explain why?

24. An ordinary moving coil ammeter used of d.c. cannot be used to measure an alternating current even if its frequency is low. Explain why ?

25. Why can one ignore quantisation of electric charge when dealing with macroscopic *i.e.,* large scale charges?

SECTION - D

All questions are compulsory. In case of internal choices, attempt anyone.

26. Three hollow concentric spheres *A*, *B* and *C*, having radii *a*, *b* and $c (a < b < c)$ have uniform surface charge densities $+\sigma$, $-\sigma$ and $+\sigma$ respectively. Compute the electric field at the surface of each sphere.

27. A source of ac voltage $V = V_0 \sin\omega t$ is connected to a series combination of a resistor '*R*' and a capacitor '*C*'. Draw the phasor diagram and use it to obtain the expression for (a) impedance of the circuit and (b) phase angle.

OR

A series *LCR* circuit is connected to an ac source. Using the phasor diagram, derive the expression for the impedance of the circuit. Plot a graph to show the variation of current with frequency of the source, explaining the nature of its variation.

28. Derive condition of balance for a Wheatstone bridge.

29. Describe Young's double slit experiment to produce interference pattern due to a monochromatic source of light. Deduce the expression for the fringe width.

30. **(a)** For what angle of incidence, the lateral shift produced by a parallel sided glass slab is maximum?

(b) Light of wavelength 6000 Å in air enters a medium of refractive index 1.5. What will be its frequency in the medium?

OR

(a) A light ray travels from medium 1 of refractive index μ_1 to medium 2 of refractive index μ_2, where $\mu_2 < \mu_1$. Write an expression for critical angle of incidence.

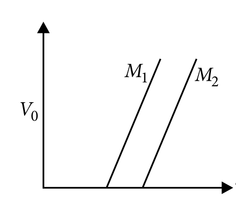
(b) A convex lens made of material of refractive index μ_2 is held in a reference medium of refractive index μ_1. Trace the path of a parallel beam of light passing through the lens when

(i) $\mu_1 = \mu_2$, (ii) $\mu_1 < \mu_2$ and (iii) $\mu_1 > \mu_2$.

SECTION - E

All questions are compulsory. In case of internal choices, attempt any one.

31. **(a)** Figure shows a plot of stopping potential (V_0) with frequency (υ) of incident radiation for two photosensitive material M_1 and M_2. Explain. why the slope of both the lines is same?



(b) What is the ratio of the de – Broglie wavelengths of an electron of energy 10 eV to that of person of mass 66 kg travelling at a speed of 100 km/h?

OR

(a) Write Einstein's photoelectric equation and mention which important features in photoelectric effect can be explained with the help of this equation.

(b) The maximum kinetic energy of the photoelectrons gets doubled when the wavelength of light incident on the surface changes from λ_1 to λ_2. Derive the expressions for the threshold wavelength λ_0 and work function for the metal surface.

32. In a *p-n* junction diode, the current I can be expressed as

$$I = I_0 \left[\exp\left(\frac{eV}{k_B T} \right) - 1 \right]$$

where I_0 is called the reverse saturation current, V is voltage across the diode and is positive for forward bias and negative for reverse bias and I is current through the diode, k_B is Boltzmann constant (8.6×10^{-5} eV K^{-1}) and T is the absolute temperature. If for a given diode $I_0 = 5 \times 10^{-12}$ A and $T = 300$ K, then

(a) What will be the forward current at a forward voltage of 0.6 V?

(b) What will be the increase in the current if the voltage across the diode is increased to 0.7 V?

(c) What is the dynamic resistance?

(d) What will be the change in current if reverse bias voltage changes from 1 V to 2 V?

OR

(a) Draw *V-I* characteristics of a *p-n* junction diode. Explain, why the current under reverse bias is almost independent of the applied voltage up to the critical voltage.

(b) A battery of emf 2 V is applied across the block of a semiconductor. The length of the block is 0.1 m and the area of cross-section is 1×10^{-4} m^2. If the block is of intrinsic silicon at 300 K, find the electron and hole currents.

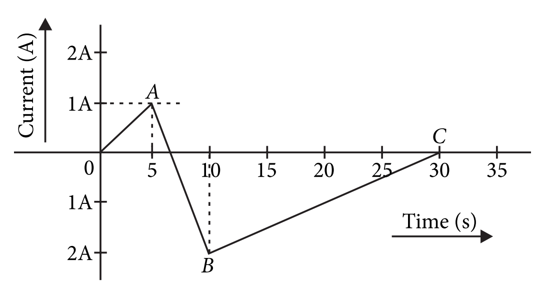
(c) What will be the magnitude of the total current?

(d) What will be the magnitude of the total current if germanium is used instead of silicon?

Given

	For Si at 300 K	For Ge at 300 K
μ_e	0.135 $m^2 V^{-1} s^{-1}$	0.39 $m^2 V^{-1} s^{-1}$
μ_h	0.048 $m^2 V^{-1} s^{-1}$	0.19 $m^2 V^{-1} s^{-1}$
n_i	1.5×10^{16} m^{-3}	2.4×10^{19} m^{-3}

33. (a) A (current vs time) graph of the current passing through a solenoid is shown in figure. For which time is the back electromotive force (u) is maximum. If the back emf at $t = 3$ s is e, find the back emf at $t = 7$ s, 15 s and 40 s. OA, AB and BC are straight line segments.



(b) There are two coils A and B separated by some distance. If a current of 2 A flows through A, a magnetic flux of 10^{-2} Wb passes through B (no current through B). If no current passes through A and a current of 1 A passes through B, what is the flux through A?

OR

State Lenz's law. Using this law indicate the direction of the current in a closed loop when a bar magnet with north pole in brought close to it. Explain briefly how the direction of the current predicted wrongly results in the violation of the law of conservation of energy.