SAMPLE QUESTION PAPER

BLUEPRINT

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)	1(3)	–	**8(16)**
2.	Current Electricity	1(1)	1(2)	–	–	
3.	Magnetic Effects of Current and Magnetism	2(2)	1(2)	–	–	**8(17)**
4.	Electromagnetic Induction and Alternating Current	1(1)	2(4)	1(3)	1(5)	
5.	Electromagnetic Waves	3(3)	–	–	–	**10(18)**
6.	Optics	2(2)	2(4)	3(9)	–	
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. The energy of an electron in n^{th} orbit of the hydrogen atom is given by $E_n = -\frac{13.6}{n^2}$ eV . Calculate the energy required to raise an electron from the first orbit to the second orbit.

2. Define temperature coefficient of resistivity.

OR

If the temperature of a good conductor decreases, how does the relaxation time of electrons in the conductor change?

3. The magnifying power of a telescope is 9. When it is adjusted for parallel rays the distance between the objective and eyepiece is 20 cm. Find the focal length of lenses.

4. Two equal balls having equal positive charge 'q' coulombs are suspended by two insulating strings of equal length. What would be the effect on the force when a plastic sheet is inserted between the two?

5. A charge Q is placed at the origin. The electric potential due to this charge at a given point in space is V. What is the work done by an external force in bringing another charge q from infinity up to the point ?

6. A positively charged particle moving due East enters a region of uniform magnetic field directed vertically upwards. Which path this particle will follow?

OR

A particle of mass m, charge Q and kinetic energy T enters in a transverse uniform magnetic field of induction $\vec{B}$. After 3 seconds, what will be the kinetic energy of the particle?

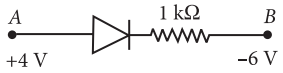
7. For a transparent medium relative permeability and permittivity, μ_r and ε_r are 1.0 and 1.44 respectively. Calculate the velocity of light in this medium.

OR

What is the ratio of amplitude of magnetic field to the amplitude of electric field for an electromagnetic wave propagating in vacuum?

8. When light travels from a rarer to a denser medium, the speed decreases. Does this decrease in speed imply a reduction in the energy carried by the wave ?

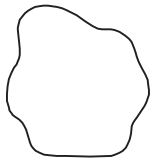
9. Consider the junction diode as ideal. The value of current flowing through *AB* is



OR

Name some factors on which barrier potential of a *p-n* junction depends.

10. As a result of change in the magnetic flux linked to the closed loop as shown in the figure, an e.m.f. *V* volt is induced in the loop. What is the work done in taking a charge *Q* coulomb once along the loop?



For question numbers 11, 12, 13 and 14, two statements are given-one labelled Assertion (A) and the other labelled 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 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 and R is also false

11. Assertion (A) : Magnetic moment is measured in joule/tesla or amp m^2.

Reason (R) : Joule/tesla is equivalent to amp m^2.

12. Assertion (A) : When a charged particle moves in a circular path. It produces electromagnetic wave.

Reason (R) : Charged particle has acceleration.

13. Assertion (A) : The majority current carriers diffuse from a region of higher concentration to a region of lower concentration.

Reason (R) : The direction of diffusion current in a junction diode is from *n*-region to *p*-region.

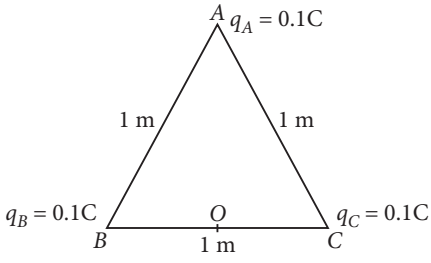
14. Assertion (A) : The electric field and magnetic field have equal average values in linearly polarised plane em wave.

Reason (R) : The electric energy and magnetic energy have equal average values in linearly polarised plane em wave.

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. An electric potential (also called the electric field potential, potential drop, or the electrostatic potential) is the amount of work needed to move a unit of electric charge from a reference point to a specific point in an electric field without producing an acceleration. The potential energy for a positive charge increases when it moves against an electric field and decreases when it moves with the electric field; the opposite is true for a negative charge. Unless the unit charge crosses a changing magnetic field, its potential at any given point does not depend on the path taken.



Three charges of +0.1C each are placed at the vertices of an equilateral triangle of each side 1m.

Given, $\frac{1}{4\pi\varepsilon_0} = 9\times10^9$ N m^2 C^{-2}.

(i) Which of the following statement is true?

(a) Electrostatic force is a conservative force.

(b) Potential at a point is the work done per unit charge in bringing a charge from any point to infinity.

(c) Electrostatic force is non-conservative.

(d) Potential is the product of chrge and work.

(ii) Find the electrostatic potential energy of the system of charges.

(a) 27×10^7 J (b) 45×10^7 J (c) 18×10^5 J (d) 32×10^{-3} J

(iii) Suppose the charge at one of the vertex is moved to the mid point of the line joining the other two charges. Then find the new potential energy of the system.

(a) 27×10^7 J (b) 45×10^7 J (c) 18×10^5 J (d) 32×10^{-3} J

(iv) Work done in moving this charge is

(a) 27×10^7 J (b) 45×10^7 J (c) 18×10^7 J (d) 32×10^{-3} J

(v) The time required to move this charge

(a) 27 hr (b) 45 hr (c) 60 hr (d) 50 hr

16. When the beam of the light enlightens the surface of the metals like sodium, potassium, caesium and rubidium then their electrons start emitting. The phenomenon of emission of electrons is known as the photoelectric emission. In other words, the photoelectric emission is the process through which the free electrons are liberated from the surface of metals when it absorbs light. The photoelectric emission depends on the frequency of light and not on the intensity of light. The maximum kinetic energy of the emitted photoelectrons is given by $K_{max} = h\nu - f_0$. If the frequency of the incident light is ν_0 (called threshold frequency), the photoelectrons are emitted from metal without any kinetic energy. So $h\nu_0 = \phi_0$.

(i) The work function of Sodium is greater than that of Potassium. If both the surfaces are irradiated with photons of same wavelength, then the K.E. of the emitted photoelectrons in the sodium surface as compared to the K.E. of the photoelectrons in the Potassium surface will be

(a) same (b) less

(c) more (d) cannot be determined.

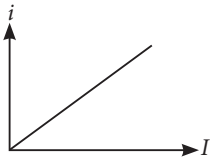
(ii) A light of wavelength 550 nm falls on a metal surface of work function 1.4 eV. The maximum kinetic energy of photoelectron emitted is : (taking $h = 6.6 \times 10^{-34}$ Js)

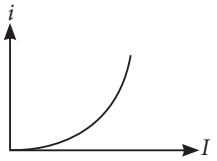
(a) 0.413 eV (b) 0.645 eV (c) 1.65 eV (d) 0.943 eV

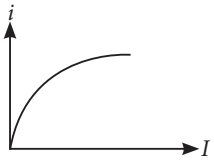
(iii) The threshold wavelength for photoelectric emission in Tungsten is 240 nm. What wavelength of light must be used in order that the emitted photoelectrons have a K.E. MAX of 1.2 eV.

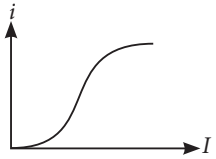
(a) 200 nm (b) 230 nm (c) 350 nm (d) 195 nm

(iv) The variation of photoelectric current (i) with the intensity of the incident radiation (I) can be represented by :

(a) 

(b) 

(c) 

(d) 

(v) Which of the following statements is correct regarding the photoelectric experiment?

(a) The photocurrent increases with intensity of light.

(b) Stopping potential increases with increase in intensity of incident light.

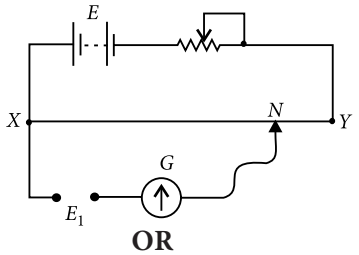
(c) The photocurrent increases with increase in frequency.

(d) All of these.

SECTION - C

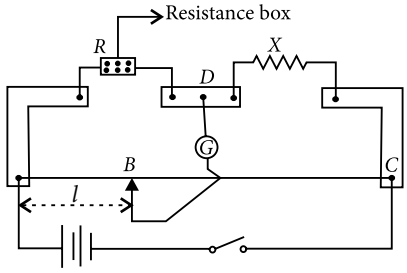
All questions are compulsory. In case of internal choices, attempt anyone.

17. The diagram below shows a potentiometer set up. On touching the jockey near to the end *X* of the potentiometer wire, the galvanometer pointer deflects to left. On touching the jockey near to end *Y* of the potentiometer, the galvanometer pointer again deflects to left but now by a larger amount. Identify the fault in the circuit and explain, using appropriate equations or otherwise, how it leads to such a one-sided deflection.



OR

Following circuit was set up in a meter bridge experiment to determine the value *X* of an unknown resistance.

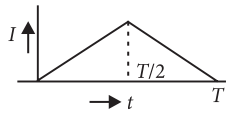


(a) Write the formula to be used for finding *X* from the observations.

(b) If the resistance *R* is increased, what will happen to balancing length?

18. A point *Q* lies on the perpendicular bisector of an electrical dipole of dipole moment *p*. If the distance of *Q* from the dipole is *r* (much larger than the size of the dipole), then find the electric field at *Q*.

19. The current (*I*) in the inductance is varying with time according to the plot shown in figure.



Which one of the following show the correct variation of voltage with time in the coil ?

20. Two point charges 2 μC and –2μC are placed at points *A* and *B,* 6 cm apart.

(i) Draw equpotential surfaces of the system.

(ii) Why do the equipotential surfaces get closer to each other near the point charges?

21. In the Bohr model of a hydrogen atom, the centripetal force is furnished by the coulomb attraction between the proton and the electron. If a_0 is the radius of the ground state orbit, *m* is the mass and *e* is the charge on the electron and ε_0 is the vacuum permittivity, what the speed of the electron?

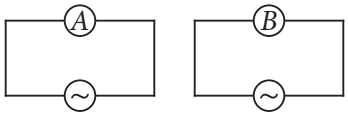
OR

Obtain the expression for the ratio of the de-Broglie wavelengths associated with the electron orbiting in the second and third excited states of hydrogen atom.

22. A disc is placed on a surface of pond which has refractive index 5/3. A source of light is placed 4 m below the surface of liquid. Find the minimum radius of disc needed so that light is not coming out?

23. In Young's double slit experiment, the path difference between two interfering waves at a point on the screen is $\frac{5\lambda}{2}$, λ being wavelength of the light used. Which dark fringe will lie at this point?

24. Device *A* and *B* are connected independently to a variable frequency alternating voltage source as shown. The current in *A* is ahead of the applied voltage whereas it lags behind the voltage in *B*.



(i) Identify the devices *A* and *B*

(ii) How will the current in each of these devices change on decreasing the frequency of the applied voltage? Give reasons to support your answer in each case.

25. State Biot - Savart's law and express this law in the vector form.

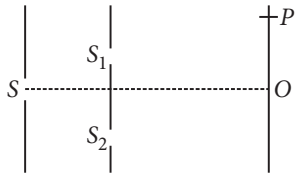
OR

Write the expression for Lorentz magnetic force on a particle of charge '*q*' moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$. Show that no work is done by this force on the charged particle.

SECTION - D

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

26. In a modified set-up of Young's double slit experiment, it is given that $SS_2 - SS_1 = \lambda/4$, *i.e.* the source '*S*' is not equidistant from the slits S_1 and S_2.



(a) Obtain the conditions for constructive and destructive interference at any point *P* on the screen in terms of the path difference $\delta = S_2P - S_1P$.

(b) Does the observed central bright fringe lie above or below '*O*'? Give reason to support your answer.

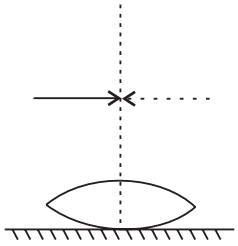
27. (i) State Gauss's law.

(ii) A thin straight infinitely long conducting wire of linear charge density 'λ' is enclosed by a cylindrical surface of radius '*r*' and length '*l*'. Its axis coinciding with the length of the wire. Obtain the expression for the electric field, indicating its direction, at a point on the surface of the cylinder.

28. Draw a ray diagram to show the image formation in a refracting type astronomical telescope in the near point adjustment. Write down the expression for its magnifying power. Why should the diameter of the objective of telescope be larger?

OR

A symmetric biconvex lens of radius of curvature *R* and made of glass of refractive index 1.5, is placed on a layer of liquid placed on top of a plane mirror as shown in the figure. An optical needle with its tip on the principal axis of the lens is moved along the axis until its real, inverted image coincides with the needle itself. The distance of the needle from the lens is measured to be *x*. On removing the liquid layer and repeating the experiment, the distance is found to be *y*. Obtain the expression for the refractive index of the liquid in terms of *x* and *y*.



29. In a single slit diffraction experiment, light of wavelength λ illuminates the slit of width '*a*' and the diffraction pattern is observed on a screen.

(a) Show the intensity distribution in the pattern with the angular position θ

(b) How are the intensity and angular width of central maxima affected when

(i) width of slit is increased, and

(ii) separation between slit and screen is decreased?

30. An alternating emf is applied across a capacitor. Show mathematically that current in it leads the applied emf by a phase angle of $\pi/2$. What is its capacitive reactance? Draw a graph showing the variation of capacitive reactance with the frequency of the a.c. source.

OR

When a circuit element '*X*' is connected across an a.c. source of emf $220\sqrt{2}$ V, a current of $\sqrt{2}$ A flows through it and this current is in phase with the applied voltage. When another element '*Y*' is connected across the same a.c. source, the same current flows in the circuit but it leads the voltage by $\pi/2$ radians.

(i) Name the circuit element *X* and *Y*.

(ii) Find the current that flows in the circuit, when the series combination of *X* and *Y* is connected across same a.c. voltage.

(iii) Plot the graph showing the variation of the net impedance of this series combination of *X* and *Y* as a function of the angular frequency ω of the applied voltage.

SECTION - E

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

31. Define the term "cut off frequency" in photoelectric emission. The threshold frequency of a metal is *f*. When the light of frequency 2*f* is incident on the metal plate, the maximum velocity of photo-electron is v_1. When the frequency of the incident radiation is increased to 5*f*, the maximum velocity of photoelectrons is v_2. Find the ratio $v_1 : v_2$. Describe briefly three experimentally observed features in the phenomenon of photoelectric effect.

OR

(a) Monochromatic radiation emitted when electron on hydrogen atom jumps from first excited to the ground state irradiates a photosensitive material. The stopping potential is measured to be 3.57 V. Calculate the threshold frequency of the material.

(b) If the momentum of an electron is changed by *P*, then the de Broglie wavelength associated with it changes by 0.5%. What will be the initial momentum of electron?

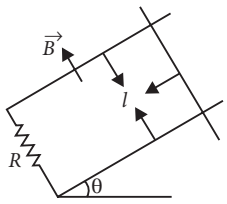
32. (a) A metallic rod of length '*l*' is rotated with a frequency υ with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius *r*, about an axis passing through the centre and perpendicular to the plane of the ring. A constant uniform magnetic field *B* parallel to the axis is present everywhere. Using Lorentz force, explain how emf is induced between the centre and the metallic ring and hence obtain the expression for it.

(b) A rectangular wire loop of sides 8 cm and 2 cm with a small cut is moving out of a region of uniform magnetic field of magnitude 0.3 T directed normal to the loop. What is the emf developed across the cut if velocity of loop is 1 cm s^{-1} in a direction normal to the (i) longer side (ii) shorter side of the loop? For how long does the induced voltage last in each case?

OR

(a) Define self-inductance of a coil. Write its SI unit. Derive the expression for self-inductance of a long solenoid of cross-sectional area '*A*', length '*l*' having '*n*' turns per unit length.

(b) A copper rod of mass m slides under gravity on two smooth parallel rails, with separation l and set at an angle of θ with the horizontal. At the bottom, rails are joined by a resistance R. There is a uniform magnetic field B normal to the plane of the rails, as shown in the figure. Find the terminal speed of the copper rod.



33. (i) With the help of a labelled circuit diagram, explain how a junction diode is used as a full wave rectifier. Draw its input, output wave-forms.

(ii) How do you obtain steady d.c. output from the pulsating voltage ?

OR

(a) Explain, with the help of a circuit diagram, the working of a photodiode. Write briefly how it is used to detect the optical signals.

(b) A p-n photodiode is fabricated from a semiconductor with a band gap of 2.5 eV. Find the maximum wavelength of electromagnetic radiation which can be detected using this photodiode.