ARYAN INSTITUTE

Sample Question Paper

Class - 12th

Subject – Physics

General Instructions :

(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.

Time : 3 hrs. **Max. Marks** : 70

SECTION - A

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

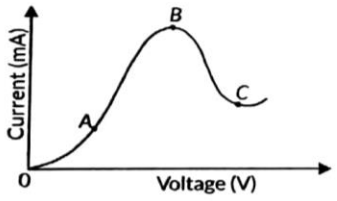
1. What is the shape of the wavefront of a point source at infinity?

   OR

   Why is the diffraction of sound waves more evident in daily experience than that of light wave?

2. We know that electric field is discontinuous across the surface of a charged conductor. Is electric potential also discontinuous there?

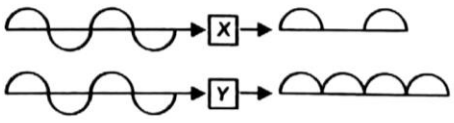
3. The graph shown in the figure represents a plot of current versus voltage for a given semiconductor. Identify the region, if any, over which the semiconductor has a negative resistance.



4. How does the width of depletion region of a *p-n* junction vary if the reverse bias applied to it is decreased?

   OR

   An a.c. signal is fed into two circuits '*X*' and '*Y*' and the corresponding output in the two cases have the waveforms as shown in figure.
   Identify the circuits '*X*' and '*Y*'.



5. Two charges q_1 and q_2, separated by a small distance, satisfy the equation $q_1 + q_2 = 0$. What does it tell about the charges?

6. Define the term "threshold frequency", in the context of photoelectric emission.

   OR

   Photons of energies 1 eV and 2 eV are successively incident on a metallic surface of work function 0.5 eV. What is the ratio of kinetic energy of most energetic photoelectrons in the two cases?

7. Can a metal sphere of radius 1 m hold a charge of 1C? Why?

8. Calculate the de-Broglie wavelength of the electron orbiting in the $n = 2$ state of hydrogen atom.

9. In a series *LCR* circuit, the voltage across an inductor, capacitor and resistor are 20 V, 20 V and 40 V respectively. What is the phase difference between applied voltage and the current in the circuit?

   OR

   A capacitor blocks dc. Why?

10. State the conditions under which Ohm's law is not obeyed in a conductor.

For question numbers 11-14, 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) 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.

11. **Assertion (A) :** Capacity of a parallel plate capacitor increases when distance between the plates is decreased.

    Reason (R) : Capacitance of capacitor is inversely proportional to distance between them.

12. **Assertion (A) :** A single lens produces a colour image of an object illuminated by white light.

    Reason (R) : The refractive index of material of lens is different for different wavelength of light.

13. **Assertion (A) :** Charging is due to transfer of electrons.
Reason (R) : Mass of a body decreases slightly when it is negatively charged.

14. **Assertion (A) :** It is essential that all the lines available in the emission spectrum will also be available in the absorption spectrum.
Reason (R) : The spectrum of hydrogen atom is only absorption spectrum.

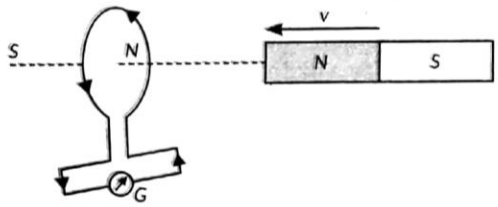
SECTION - B

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. Lenz's law : In 1833, German physicist Heinrich Lenz gave a general law for determining the direction of induced emf and hence that of induced current in a circuit.

Lenz's law states that the direction of induced current in a circuit is such that it opposes the cause or the change which produces it.

Thus, if the magnetic flux linked with a closed circuit increases, the induced current flows in such a direction so as to create a magnetic flux in the opposite direction of the original magnetic flux. If the magnetic flux linked with the closed circuit decreases, the induced current flows in such a direction so as to create a magnetic flux in the direction of the original flux. When the north pole of a bar magnet is moved towards a closed coil, the induced current in the coil flows in the anticlockwise direction, as seen from the magnet side (in figure) closely. The face of the coil towards the magnet develops north polarity and thus, it opposes the motion of the north pole of the magnet towards the coil which is actually the cause of the induced current in the coil.



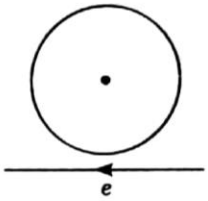
(i) Lenz's law is a consequence of the law of conservation of
(a) charge
(b) mass
(c) momentum
(d) energy

(ii) The polarity of induced emf is given by
(a) Ampere's circuital law
(b) Biot-Savart law
(c) Lenz's law
(d) Fleming's right hand rule

(iii) According to Lenz's law of electromagnetic induction
(a) the induced e.m.f is not in the direction opposing the change in magnetic flux so as to oppose the cause which produces it.
(b) the relative motion between the coil and magnet produces change in magnetic flux
(c) only the magnet should be moved towards coil
(d) only the coil should be moved towards magnet.

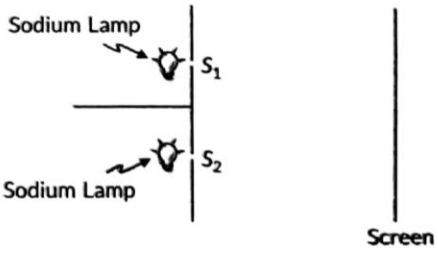
(iv) Two identical circular coils *A* and *B* are kept on a horizontal tube side by side without touching each other. If the current in the coil *A* increases with time, in response, the coil *B*
(a) is attracted by *A* (b) remains stationary
(c) is repelled (d) rotates

(v) Near a circular loop of conducting wire as shown in the figure an electron moves along a straight line. The direction of the induced current if any in the loop is



(a) variable (b) clockwise
(c) anticlockwise (d) zero

16. Interference of Light Waves : Interference is based on the superposition principle. According to this principle, at a particular point in the medium, the resultant displacement produced by a number of waves is the vector sum of the displacements produced by each of the waves. If two sodium lamps illuminate two pinholes S_1 and S_2, the intensities will add up and no interference fringes will be observed on the screen. Here the source undergoes abrupt phase change in times of the order of 10^{-10} seconds. In young's double slit experiment, the two sources of light must be obtained from a single source by some method. Then the relative phase difference between the two light waves from the sources will remain constant with time.



(i) Consider the given statements in case of Young's double slit experiment.
(1) A slit *S* is necessary if we use an ordinary extended source of light.
(2) A slit *S* is not needed if we use an ordinary but well collimated beam of light.
(3) A slit *S* is not needed if we use a spatially coherent source of light.
Which of the given statements are correct?

(a) (1), (2) and (3) (b) (1) and (2) only
(c) (2) and (3) only (d) (1) and (3) only

(ii) In Young's double slit experiment, two disturbances arriving at a point P have phase difference of $\frac{\pi}{3}$. The intensity of this point expressed as a fraction of maximum intensity I_0 is

(a) $\frac{3}{2}I_0$ (b) $\frac{1}{2}I_0$ (c) $\frac{4}{3}I_0$ (d) $\frac{3}{4}I_0$

(iii) Two slits in Young's double slit experiment have widths in the ratio 81 : 1. The ratio of the amplitudes of light waves is

(a) 3 : 1 (b) 3 : 2 (c) 9 : 1 (d) 6 : 1

(iv) In Young's double slit experiment, the slits are separated by 0.28 mm and the screen is placed 1.4 m away. The distance between the central and fourth bright fringe is measured to be 1.2 cm. The wavelength of light used in the experiment is

(a) 6×10^{-7} m (b) 3×10^{-7} m
(c) 1.5×10^{-7} m (d) 5×10^{-6} m

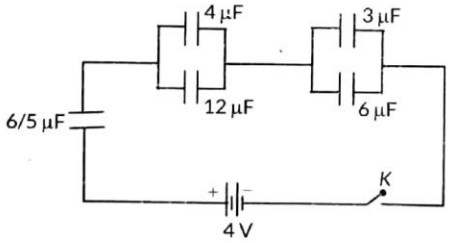
(v) In Young's double slit experiment, the 10^{th} maximum of wavelength λ_1 is at a distance y_1 from its central maximum and the 5^{th} maximum of wavelength λ_2 is at a distance y_2 from its central maximum. The ratio y_1/y_2 will be

(a) $\frac{2\lambda_1}{\lambda_2}$ (b) $\frac{2\lambda_2}{\lambda_1}$ (c) $\frac{\lambda_1}{2\lambda_2}$ (d) $\frac{\lambda_2}{2\lambda_1}$

SECTION - C

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

17. Find: (i) the equivalent capacitance and (ii) the total energy stored in the system of capacitors given in the network. The charging battery has an emf of 4 V.



18. When four hydrogen nuclei combine to form a helium nucleus estimate the amount of energy in MeV released in this process of fusion (Neglect the masses of electrons and neutrons). Given:
(i) Mass of ^1_1H = 1.007825 u
(ii) mass of helium nucleus = 4.002603 u,
1 u = 931 MeV/c^2

OR

Draw a plot of potential energy of a pair of nucleons as a function of their separation. Write three important conclusions which you can draw regarding the nature of nuclear forces.

19. Two small spheres each having mass m kg and charge q coulomb are suspended from a point by insulating threads each l metre long, but of negligible mass. If θ is the angle, each string makes with the vertical when equilibrium has been attained, show that

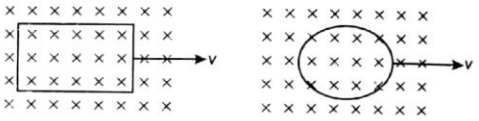
$$q^2 = (4mgl^2 \sin^2\theta . \tan\theta)4\pi\varepsilon_0$$

OR

An uniform electric field in a region is given by $\vec{E} = E_0 x\hat{i}$ where E_0 is constant. What is the electric flux linked with a cubical surface, with side of length 'a' placed with its corner at origin of coordinate axes and sides along the positive axes.

20. The forbidden energy gap in semiconductors, insulators and metals are E_s, E_i, and E_m respectively. Arrange these in descending order. The band gap in silicon is 1.12 eV. What is the maximum wavelength of light that can be emitted by it?

21. A rectangular coil and a circular coil having the same area, are moved out of a uniform magnetic field region, to a field free region, with a constant velocity $\vec{v}$. Would the induced emf remain constant in the two loops as they move out of the field region? Justify your answer.



22. You are given two nuclei $_3X^7$ and $_3Y^4$.
(i) Are they the isotopes of the same element? Why?
(ii) Which one of the two is likely to be more stable? Give reason.

23. The wavelength of the second line of the Balmer Series in the hydrogen spectrum is 4861 Å. Calculate the wavelength of the first line and second line.

24. The two slits in Young's double slit experiment are separated by a distance of 0.03 mm. An interference pattern is produced on a screen 1.5 m away. The 4^{th} bright fringe is at a distance of 1 cm from the central maximum. Calculate the wavelength of light used.

OR

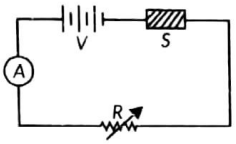
Define the term 'coherent sources' which are required to produce interference pattern in Young's double slit experiment. If one of two identical slits producing interference in Young's experiment is covered with glass, so that the light intensity passing through it is reduced to 50%, find the ratio of the maximum and minimum intensity of the fringe in the interference pattern.

25. Even though an electric field $\vec{E}$ exerts a force $q\vec{E}$ on a charged particle, yet the electric field of an EM wave does not contribute to the radiation pressure (but transfers energy). Explain.

SECTION - D

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

26. The diagram shows a piece of a pure semiconductor *S*, in series with a variable resistor *R*, and a source of constant voltage *V*. Would you increase or decrease the value of *R* to keep the reading of ammeter (*A*) constant, when semiconductor *S* is heated? Give reason.



27. A double convex lens made of glass of refractive index 1.5 has both radii of curvature of magnitude 20 cm. An object 2 cm high is placed at 10 cm from the lens. Find the position, nature and size of the image.

OR

An old person wears eye lens of power 2 D to read book at 25 cm. He observes one day that with same lens he must hold the book 40 cm from his eye to see clearly. What are his near points before and after with eye lens?

28. Radiations of frequency 10^{15} Hz are incident on two photosensitive surfaces *A* and *B*. Following observations are recorded.

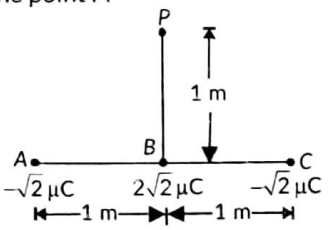
Surface *A* : No photo-emission takes place.

Surface *B* : Photo-emission takes place but photo-electrons have zero energy. Explain the above observations on the basis of Einstein's photoelectric equation. How will the observation with surface *B* change when the wavelength of incident radiation is decreased?

OR

A proton and an alpha particle are accelerated through the same potential. Which one of the two has (i) greater value of de Broglie wavelength associated with it, and (ii) less kinetic energy? Justify your answers.

29. Three charges $-\sqrt{2}\mu C, 2\sqrt{2}\mu C$ and $-\sqrt{2}\mu C$ are arranged along a straight line as shown in the figure. Calculate the total field intensity due to all three charges at the point *P*.



30. '*n*' identical cell of EMF ε and internal resistance *r* are connected in series to a resistor *R*.
    (i) Deduce an expression for the internal resistance *r* of the cell in terms of the current *I* flowing through the circuit.
    (ii) How does the internal resistance of the cell vary with temperature?

SECTION - E

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

31. (a) Draw a ray diagram to show the formation of the image of an object placed on the axis of a convex refracting surface of radius of curvature '*R*', separating the two media of refractive indices 'n_1' and 'n_2' ($n_2 > n_1$). Use this diagram to deduce the relation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$, where *u* and *v* represent respectively the distance of the object and the image formed.

    (b) A convex lens of focal length f_1 is kept in contact with a concave lens of focal length f_2. Find the focal length of the combination.

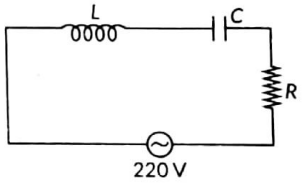
OR

    (a) Draw a ray diagram showing the image formation by an astronomical telescope when the final image is formed at infinite.

    (b) (i) A small telescope has an objective lens of focal length 140 cm and an eyepiece of focal length 5.0 cm. Find the magnifying power of the telescope for viewing distant objects when the telescope is in normal adjustment and the final image is formed at the least distance of distinct vision.

    (ii) Also find the separation between the objective lens and the eye-piece in normal adjustment.

32. Figure shows a series *LCR* circuit connected to a variable frequency 220 V source. Given *L* = 4.0 H, *C* = 100 μF and *R* = 40 Ω



    (i) Calculate the resonant frequency of the circuit.
    (ii) Obtain the impedance of the circuit and amplitude of the current at resonating frequency.
    (iii) Determine r.m.s. potential drop across *L*.

OR

    (a) Define capacitive reactance.
    (b) Calculate the rms value of the current in an ac circuit containing a capacitor of 40 μF and a resistor of 10 ohms in series. The power supply in the circuit is rated 230V, 50Hz.

33. Using Biot Savart's law, find an expression for the magnetic field at the centre of a circular coil of *N* turns and radius *R*, carrying current *I*.

Sketch the magnetic field lines for a circular loop, clearly indicating the direction of the field.

OR

Derive an expression for the force experienced by a current carrying straight conductor placed in a magnetic field. Under what condition is this force maximum?