APEEJAY COMMON PREBOARD EXAMINATION

CLASS: XII (SESSION 2022-23)

SUBJECT: PHYSICS

TIME: **3 HOURS** **Max Marks: 70**

GENERAL INSTRUCTIONS:

1. There are 35 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. All the sections are compulsory.
3. Section A contains **eighteen** MCQs of **1 mark** each, Section B contains **seven** questions of **two marks** each, Section C contains **five** questions of **three marks** each, section D contains **three** long questions of **five marks** each and Section E contains **two** case study based questions of **4 marks** each.
4. There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

SECTION: A

1. The potential energy for the system of two charged particles is negative. Choose the correct option.
   A. particles will attract each other
   B. particles will repel each other
   C. particles will attract and repel periodically
   D. information given is not sufficient to predict the answer

2. The electric potential on the axis of an electric dipole at a distance r from its centre is V. Then the potential at a point at the same distance on its equatorial line will be
   A. 2V B. -V C. V/2 D. Zero

3. A wire of resistance R_1 is drawn out so that its length is increased by twice of its original length. The ratio of new resistance to original resistance is
   A. 9 : 1 B. 1 : 9 C. 4 : 1 D. 1 : 4

4. An ionized gas contains both positive and negative ions. If it is subjected simultaneously to an electric field along the + x direction and a magnetic field along the + z direction, then
   A. positive ions deflect towards + y direction and negative ions towards – y direction
   B. all ions deflect towards + y direction
   C. all ions deflect towards - y direction
   D. positive ions deflect towards - y direction and negative ions towards + y direction

5. Two particles X and Y having equal charges, after being accelerated through the same potential difference enter a region of uniform magnetic field and describe circular paths of radii $r_1$and r_2 respectively. The ratio of mass of X to that of Y is

A. $\left(\frac{r_1}{r_2}\right)^{\frac{1}{2}}$ B. $\left(\frac{r_2}{r_1}\right)$ C. $\left(\frac{r_1}{r_2}\right)^2$ D. $\left(\frac{r_1}{r_2}\right)$

6. A magnetic needle lying parallel to a magnetic field requires W units of work to turn it through 60^0. The torque needed to maintain the needle in this position will be

   A. $\sqrt{3}$ W B. W C. $(\sqrt{3}/2)$ W D. 2 W

7. An iron cored coil is connected in series with an electric bulb with an AC source. When iron piece is taken out of the coil, the brightness of the bulb will

   A. increase B. decrease C. remains same D. Fluctuate

8. The equation of electric field in an electromagnetic wave is $\mathbf{E} = \mathbf{E_0} \sin(kz + \omega t)$. Choose the correct answer

   A. the wave is travelling in the -z direction
   B. the wave is travelling in + z direction
   C. magnetic field must be in the yz plane
   D. electric field must be in the xz plane

9. Two circular loops made of copper wire of equal radii are placed coaxially at some separation. The first is cut and a battery is inserted in between to drive a current in it. The current changes slightly because of the variation in resistance with temperature. During this period, the two loops

   A. attract or repel each other depending on the sense of the current
   B. repel each other
   C. do not exert any force on each other
   D. attract each other

10. Suppose β_1 and β_2 are the fringe width of interference fringes when red light and blue light is used in Young's double slit experiment respectively. Assuming all the other factors remains unchanged then

    A. $\beta_1 < \beta_2$ B. $\beta_1 > \beta_2$ C. $\beta_1 = \beta_2$
    D. given information is not sufficient to predict the answer

11. In the photoelectric effect experiment electrons are not ejected when the metal surface is exposed to green colour light. To eject the electrons from the surface of the metal one should use light of which colour

    A. Yellow B. Red C. Orange D. Blue

12. The radius of the innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. The radius of the n = 3 orbit is

    A. 1.01×10^{-10} m B. 1.59×10^{-10} m C. 2.12×10^{-10} m D. 4.77×10^{-10} m

13. If F_1, F_2 and F_3 are the nuclear force between proton-proton, neutron-neutron and neutron-proton respectively separated by the same distance. Choose the correct option

A. $F_1 = F_2 = F_3$ B. $F_1 > F_2 > F_3$ C. $F_1 < F_2 < F_3$ D. $F_1 = F_2 \neq F_3$

14. The frequencies at which the current amplitude in an LCR series circuit becomes $1/\sqrt{2}$ times its maximum value, are 212 $rads^{-1}$ and 232 $rads^{-1}$. The value of resistance in the circuit is R = 5Ω. The self inductance in the circuit is

A. 350 mH B. 200 mH C. 125 mH D. 400 mH

15. The electric potential varies as $V(x) = -2x^2 + 20$. The magnitude of electric field at the point $x = 1$ m in SI unit is

A. 2 V/m B. 1 V/m C. 4 V/m D. 8 V/m

16. 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 and 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

ASSERTION (A) : A diode is used to convert AC voltage to pulsating DC voltage.

REASON (R) : Diode has almost zero resistance in forward biased and almost infinite resistance in reverse biased.

17. 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 and 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

ASSERTION (A) : The photoelectrons produced by a monochromatic light beam incident on a metal surface have a spread in their kinetic energies.

REASON (R) : The energy of electrons emitted from inside the metal surface, is lost in collision with the other atoms in the metal.

18. 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 and 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

ASSERTION (A) : When two bulbs lights up simultaneously, then we do not observe interference fringe pattern on the screen

REASON (R) : The two bulbs are coherent sources of light and interference is shown by noncoherent sources of light

SECTION : B

19. Electromagnetic waves with wavelength
    A. λ_1 is used in mobile and television communications
    B. λ_2 is used in ovens to cook food
    C. λ_3 is used to study the structure of crystals using crystal diffraction technique.

    Name the part of the electromagnetic spectrum to which these radiations belong. Also, arrange the radiation in the increasing order of photon energies.

20. A magnetised needle in a uniform magnetic field experiences a torque but no net force. An iron nail near a bar magnet, however, experiences a force of attraction in addition to a torque. Why?
21. Calculate the ratio of nuclear radii of polonium to that of Aluminium. (Mass number of Polonium and Aluminium is 216 u and 27 u respectively)

OR

Prove the Bohr's quantization condition from De-Broglie's principle.

22. A convex lens is made up of material of refractive index 1.5. The lens is dipped in two different liquids of refractive index 1.23 and 1.72 one by one and parallel beam of light is allowed to fall on the lens in both cases. Draw the ray diagrams in each case.
23. Define the terms 'Depletion region' and 'Barrier potential' for a p-n junction. Explain why an n-type semiconductor crystal is electrically neutral?

OR

The following figure (Fig.1) shows the energy band diagrams of three different types of materials X, Y and Z. An LED is connected with a 6 V battery in series with the wires made from each type of materials one by one. Arrange the materials in the increasing order of the brightness of LED. The dimensions of wires made from the three materials are identical.

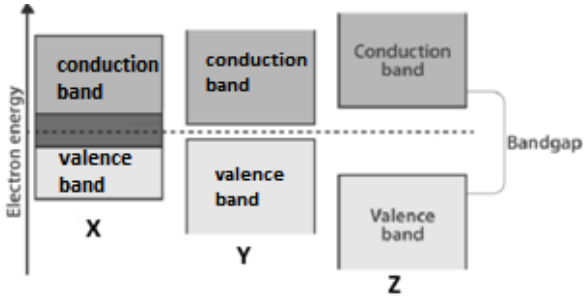

Fig. 1

24. While studying ray optics, wave properties of light and diffraction effects are ignored. Why? A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is

observed on a screen 1 m away. It is observed that the first minimum is at a distance of 2.5 mm from the centre of the screen. Find the width of the slit.

25. A point charge causes an electric flux of -1.0 x 10^3 Nm^2 /C to pass through a spherical Gaussian surface of 10.0 cm radius centred on the charge. (a) If the radius of the Gaussian surface were doubled, how much flux would pass through the surface? (b) What is the value of the point charge?

SECTION : C

26. Write the principle of moving coil galvanometer. A galvanometer coil has a resistance of 12 **Ω** and the metre shows full scale deflection for a current of 3 mA. How will you convert the metre into a voltmeter of range 0 to 18 V? Explain with the help of proper circuit diagram.
27. A horizontal straight wire AB 10 m long extending from east to west (end A of the wire points in the east direction) is falling with a speed of 5.0 m s^{-1}, at right angles to the horizontal component of the earth's magnetic field, 0.30 × 10^{-4} Wb m^{-2}. (a) What is the instantaneous value of the emf induced in the wire? (b) What is the value of current flowing in the wire? (c) Which end of the wire is at the higher electrical potential?
28. An alternating emf source with a certain emf amplitude is connected, in turn, to a resistor, a capacitor, and then an inductor. Once connected to one of the devices, the driving frequency f_d is varied and the amplitude I of the resulting current through the device is measured and plotted. Which of the three plots in Fig. 2 corresponds to which of the three devices? Explain your answer with proper reasoning. Also, draw the phasor diagrams of voltage and current for L, C and R.

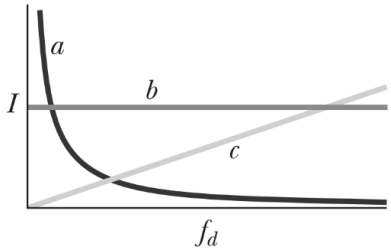

Fig. 2

OR

An AC source generating a voltage V = V_o sin ωt is connected to a capacitor of capacitance C. Find the expression for the current I flowing through it. On the basis of the expression of current, explain why a capacitor blocks DC current.

29. Explain any one observation of the photoelectric effect experiment which was not explained by classical electromagnetic wave theory of light. An ultraviolet lamp emits light of wavelength 400 nm at the rate of 400 W. An infrared lamp emits light of wavelength 700 nm, also at the rate of 400 W. (a) Which lamp emits photons at the greater rate and (b) what is that greater rate?

OR

The graph (Fig. 3) shows the variation of photocurrent for a photosensitive metal

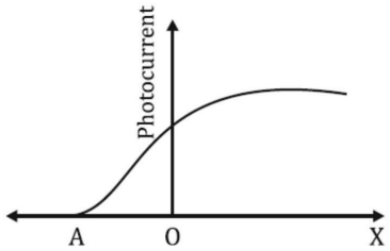

Fig. 3

(a)What does X and A on the horizontal axis represent?

(b)Draw this graph for three different values of frequencies of incident radiation ν_1, ν_2 and ν_3 ($\nu_3 > \nu_2 > \nu_1$) for the same intensity.

(c) Draw this graph for three different values of intensities of incident radiation I_1, I_2 and I_3 ($I_3 > I_2 > I_1$) having the same frequency

30. A hydrogen atom in a state having a binding energy of -0.85 eV makes transition to a state with excitation energy 10. 2 eV. (a) Identify the quantum numbers n of the upper and the lower energy states involved in the transition. (b) Find the wavelength of the emitted radiation (c) Name the series and identify the region of electromagnetic spectrum in which the wavelength of the emitted photon belongs.

SECTION : D

31. Define Electric field and write its SI unit. Draw the electric field lines for a pair of positive charges and a dipole. Two uniformly large parallel thin plates having charge densities + σ and – σ are kept in the X-Z plane at a distance 'd' apart. Prove that the electric field in the region between the plates is constant and zero outside the plates. If a particle of mass m and charge q remains stationary between the plates, what is the magnitude and direction of this field?

OR

Derive the expression for the capacitance of a parallel plate capacitor of plate area A and distance d between the plates. Fig. 4 shows two identical capacitors C_1 and C_2 each of 1.5 μF capacitance, connected to a battery of 2 V. In the Fig. 4, calculate the net capacitance of the capacitor and the total charge stored in the system. Initially switch 'S' is closed. After sometime 'S' is left open and dielectric slabs of dielectric constant K = 2 are inserted to fill completely the space between the plates of the two capacitors. How will the

(i) charge and

(ii) potential difference between the plates of the capacitors be affected after the slabs are inserted? Give reasons for your answer.

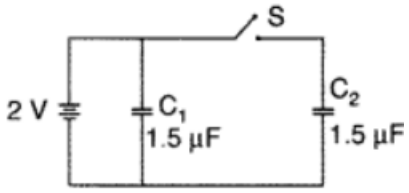

Fig. 4

32. (a) Explain the term 'drift velocity' of electrons in a conductor. Hence obtain the expression for the current through a conductor in terms of 'drift velocity'. In a conductor, electrons move with a very high speed of the order of 10^5 m/s, but we do not feel any electric shock when we touch the metallic objects. Why?

(b) Explain how the resistivity of a Silicon and copper changes when we increase the temperature.

OR

(a) State Kirchoff's first and second rule. Write the fundamental laws on which Kirchoff's first and second rule is based.

(b) Draw the diagram of wheatstone bridge circuit and write the balancing condition of bridge.

(c) In the following circuit, the cells E_1 and E_2 have emfs 4 V and 8 V and the internal resistance 0.5 ohm and 1 ohm respectively. Calculate the current in each resistance.

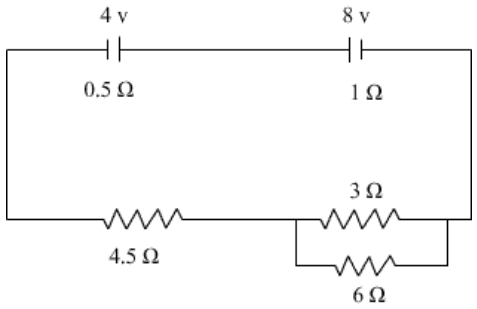

Fig. 5

33. (a) Use Huygens's geometrical construction to show how a plane wavefront at t = 0 propagates and produces a wavefront at a later time.

(b) Using Huygens's principle, verify Snell's law of refraction for a plane wave propagating from a denser medium to a rarer medium.

(c) Illustrate with the help of diagrams the action of a convex lens and concave mirror on a plane wavefront incident on it.

OR

(a) In a Young's double-slit experiment, deduce the conditions for constructive and destructive interference.

(b) Explain how Young's obtain coherent sources for the interference experiment.

(c) Plot a graph of the intensity distribution vs. path difference in the young's double slit experiment. Compare this with the intensity distribution of fringes due to diffraction at a single slit. What important difference do you observe?

SECTION : E

34. When light traveling in an optically denser medium hits a boundary at an angle (larger than the critical angle for the boundary), the light is completely reflected. This is called total internal reflection. This effect is used in optical fibre to confine light in the core. Light travels through the fibre core, bouncing back and forth off the boundary between the core and cladding. Because the light must strike the boundary with an angle greater than the critical angle, only light that enters the fibre within a certain range of angles can travel down the fibre without leaking out.

A typical fibre used for telecommunications has a cladding made of pure silica, with an index of 1.444 and a core of doped silica with an index around 1.4475. From this information, a simple rule of thumb is that a signal using optical fibre for communication will travel at around 200,000 km per second. Thus, a phone call carried by fibre between Sydney and New York, a 16,000-kilometer distance, means that there is a minimum delay of 80 millisecond between when one caller speaks and the other hears.

(a) Why an optical fibre is better than copper wire for transmitting signals over long distances.

(b) Why the refractive index of core is greater than cladding in an optical fibre?

(c) Light incident from a medium of refractive index $\sqrt{2}$ into air. Calculate the value of critical angle.

OR

Calculate the time taken by the signal to reach from New Delhi to Chennai in an optical fibre of refractive index 1.5. The distance between New Delhi and Chennai is 2200 km.

35. A pn junction diode is one of the simplest semiconductor devices around, and which has the electrical characteristic of passing current through itself in one direction only. However, unlike a resistor, a diode does not behave linearly with respect to the applied voltage. Instead it has an exponential current-voltage relationship and therefore we cannot described its operation by simply using an equation such as Ohm's law. If a suitable positive voltage (forward bias) is applied between the two ends of the PN junction, it can supply free electrons and holes with the extra energy they require to cross the junction as the width of the depletion layer around the pn junction is decreased. By applying a negative voltage (reverse bias) result in the free charges being pulled away from the junction resulting in the depletion layer width being increased. This has the effect of increasing or decreasing the effective resistance of the junction itself allowing or blocking the flow of current through the diode.

(a) A sinusoidal AC voltage is applied to a single diode. Draw the output waveform.

(b) Is there any charge in the depletion region in pn junction? Is there any mobile charge carriers in the depletion region in the pn junction? Explain.

(c)When a diode is forward biased, current increases abruptly after crossing the knee voltage. Explain.

OR

(c) Draw the VI characteristics of a p-n junction diode in forward and reverse bias and label the breakdown voltage and knee voltage.