



PRINCE ACADEMY

OF HIGHER EDUCATION

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SAMPLE PAPER- SET-2 (2024-25)

Time : 03 : 00 Hours

CLASS :- XII-PHYSICS (042)

M.M. : 70

General Instructions:

- (1) There are 33 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.
- (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.

SECTION - A

1. Two charged metallic spheres with radii R_1 and R_2 are brought in contact and then separated. The ratio of final charges Q_1 and Q_2 on the two spheres respectively will be.

(a) $\frac{Q_1}{Q_2} = \frac{R_2}{R_1}$

(b) $\frac{Q_1}{Q_2} = \frac{R_1}{R_2}$

(c) $\frac{Q_1}{Q_2} = \frac{R_1}{R_2}$

(d) $\frac{Q_1}{Q_2} = \frac{R_1}{R_2}$

2. Match Electromagnetic waves listed in column I with Production method/device in column II.

Column-I Electromagnetic waves	Column-II Production method/device
(A) Microwaves	(i) LC oscillator
(B) Infrared	(ii) Magnetron
(C) X-rays	(iii) Vibration of atoms/ molecules
(D) Radio waves	(iv) Bombarding large atomic number metal target with fast moving electrons

The correctly matched combination is an option :

(a) (A)-(i), (B)-(ii), (C)-(iii), (D)-(iv)

(b) (A)-(ii), (B)-(iii), (C)-(iv), (D)-(i)

(c) (A)-(ii), (B)-(i), (C)-(iv), (D)-(iii)

(d) (A)-(iii), (B)-(iv), (C)-(i), (D)-(ii)

3. A copper ball of density 8.0 g/cc and 1 cm in diameter is immersed in oil of density 0.8 g/cc. The charge on the ball if it remains just suspended in oil in an electric field of intensity $600 \hat{j}$ V/m acting in the upward direction is. (Take $g = 10 \text{ m/s}^2$)

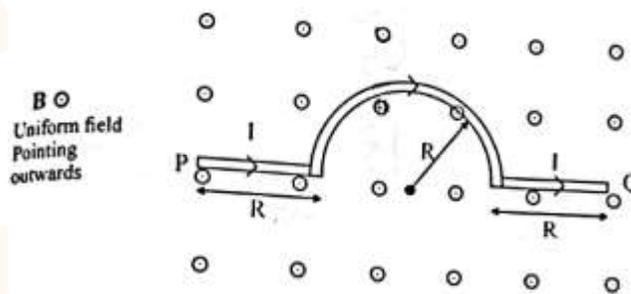
(a) $2 \times 10^{-6} \text{ C}$

(b) $2 \times 10^{-6} \text{ C}$

(c) $1 \times 10^{-6} \text{ C}$

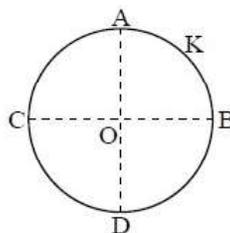
(d) $1 \times 10^{-6} \text{ C}$

4. For a full wave rectifier, if the input frequency is 50 Hz, the output frequency will be
 (a) 50 Hz (b) 100 Hz (c) 25 Hz (d) 0 Hz
5. For an astronomical telescope having objective lens of focal length 10 m and eyepiece lens of focal length 10 cm, telescope's the tube length and magnification respectively are
 (a) 20 cm, 1 (b) 1000 cm, 1 (c) 1010 cm, 1 (d) 1010 cm, 100
6. Using light from a monochromatic source to study diffraction in a single slit of width 0.1 mm, the linear width of central maxima is measured to be 5 mm on a screen held 50 cm away. The wavelength of light used is
 (a) 2.5×10^{-7} m (b) 4×10^{-7} m (c) 5×10^{-7} m (d) 7.5×10^{-7} m
7. Radiation of frequency $2\nu_0$ is incident on a metal with threshold frequency ν_0 . The correct statement of the following
 (a) No photoelectrons will be emitted
 (b) All photoelectrons emitted will have kinetic energy equal to $h\nu_0$
 (c) Maximum kinetic energy of photoelectrons emitted can be $h\nu_0$
 (d) Maximum kinetic energy of photoelectrons emitted will be $2h\nu_0$
8. The kinetic energy of an electron in ground level hydrogen atom is K units. The value of its potential energy and total energy respectively are
 (a) $-2K$; $-K$ (b) $+2K$; $-K$ (c) $-K$; $+2K$ (d) $+K$; $+2K$
9. A wire carrying current I, bent as shown in the figure, is placed in a uniform field B that emerges normally out from the plane of the figure. The force on this wire is.



Fill in the blank with the correct answer from the options given below.

- (a) $4BIR$, directed vertically downward (b) $3BIR$, directed vertically upward
 (c) $BI(2R + \pi R)$, vertically downward (d) $2\pi BIR$, from P to Q
10. A thin conducting ring of radius R is given a charge $+Q$. The electric field at the centre O of the ring due to the charge on the part AKB of the ring is E. The electric field at the centre due to the charge on the part ACDB of the ring is



- (a) $3E$ along KO (b) E along OK (c) E along KO (d) $3E$ along OK

11. In a circuit, L, C and R are connected in series with alternating voltage source of frequency f. The current leads the voltage by 45° . The value of C is

- (a) $\frac{1}{2\sqrt{2}\omega L \omega R}$ (b) $\frac{1}{\omega(2\omega L \omega R)}$ (c) $\frac{1}{2\sqrt{2}\omega L \omega R}$ (d) $\frac{1}{\omega(2\omega L \omega R)}$

12. If n, e, ρ and m have their usual meanings, then the resistance of a wire of length l and cross-sectional area A is given by

- (a) $\frac{ne^2 A}{2m\rho}$ (b) $\frac{ml}{ne^2 \rho}$ (c) $\frac{m\rho}{ne^2 l}$ (d) $\frac{ne^2 \rho}{2ml}$

Direction (Q: 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 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

13. Assertion (A): A charge moving in magnetic field experiences a force.

Reason (R): Magnetic field is always associated with moving charge which interacts with the external magnetic field.

14. Assertion (A): Kinetic energy of photoelectrons emitted by a photo sensitive surface depends upon the intensity of incident photons.

Reason (R): The emission of electrons from metallic surface is possible with frequency of incident photon below the threshold frequency.

15. Assertion (A): An electron in hydrogen atom passes from $n = 3$ to $n = 1$ level. The maximum number of photons emitted is 3.

Reason (R): The number of photons emitted can be calculated using the expression $\frac{n(n-1)}{2}$.

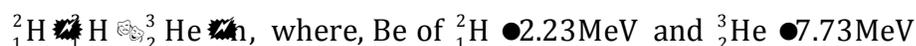
16. Assertion (A): The difference of masses between nucleus and its constituents is called mass defect.

Reason (R): The mass of nucleus is never equal to sum of mass of its neutrons and protons.

SECTION - B

17. The number density of free electrons in a copper conductor estimated is $8.5 \times 10^{28} \text{ m}^{-3}$. How long does an electron take to drift from one end of a wire 3.0 m long to its other end? The area of cross-section of the wire is $2.0 \times 10^{-6} \text{ m}^2$ and it is carrying a current of 3.0 A.

18. Calculate the energy in fusion reaction :



OR

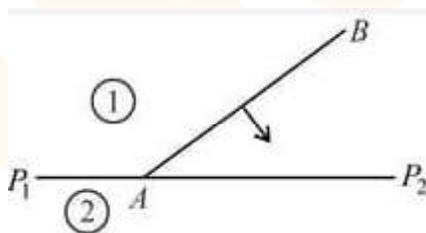
The ground state energy of hydrogen atom is -13.6 eV. If an electron makes a transition from an energy level -1.51 eV to -3.4 eV, calculate the wavelength of the spectral line emitted and name the series of hydrogen spectrum to which it belongs.

19. (a) Plot a graph showing the variation of photocurrent with intensity of light.
 (b) The work function for the given metals Na and Mo are 2.75 eV and 4.17 eV respectively. Which of these will not give photoelectric emission from a radiation of wavelength 3300 \AA from a laser beam. What happens when the source is brought closer ?
20. An alternating potential of 100 V and 50 Hz is applied across a series circuit having an inductance of 5 H, a resistance of 100Ω and a variable capacitance. At what value of capacitance will the current in the circuit be in phase with the applied voltage ?

OR

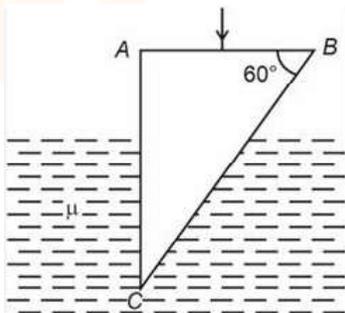
A series LCR circuit is connected to an a.c. source. Using the phasor diagram, derive the expression for the impedance of the circuit. Plot a graph to show the variation of current with frequency of the source, explaining the nature of its variation.

21. Define the term 'wavefront of light'. A plane wavefront AB propagating from denser medium (1) into a rarer medium (2) is incident on the surface P_1P_2 separating the two media as shown in fig. Using Huygen's principle, draw the secondary wavelets and obtain the refracted wavefront in the diagram. Also prove Snell's law of refraction of light.



SECTION - C

22. (a) A ray of light is incident normally on the face AB of a right-angled prism of refractive index $\frac{4}{3}$. The prism is partly immersed in a liquid of unknown refractive index. Find the value of refractive index of the liquid so that the ray grazes along the face BC after refraction through the prism.



- (b) Trace the path of the rays if they were incident normally on the face AC.

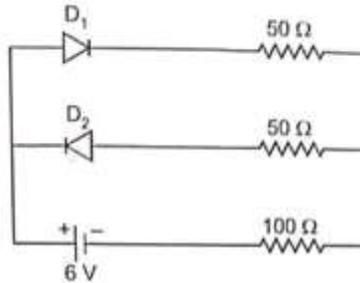
OR

A compound microscope uses an objective lens of focal length 4 cm and eyepiece lens of focal length 10 cm. An object is placed at 6 cm from the objective lens. Calculate the magnifying power of the compound microscope. Also calculate the length of the microscope.

23. Explain, with the help of a circuit diagram, the working of a p-n junction diode as a half-wave rectifier.

OR

The circuit shown in the figure contains two diodes each with a forward resistance of $50\ \Omega$ and infinite backward resistance. Calculate the current in the $100\ \Omega$ resistance.



24. (a) Using Huygen's construction of secondary wavelet explain how a diffraction pattern is obtained on a screen due to a narrow slit on which a monochromatic beam of light is incident normally.
(b) Show that the angular width of the first diffraction fringe is half that of the central fringe.
25. A long straight wire of circular cross-section of radius 'a' carries a steady current I. The current is uniformly distributed across the cross-section. Apply Ampere's circuital law to calculate the magnetic field at a point, r distance away from the axis of the current carrying wire for (i) $r < a$ and (ii) $r > a$.
26. Define the distance of closest approach. A proton travelling with speed u moves toward the thin gold foil. The distance of closest approach is 41.3×10^{-15} m. What will be the distance of closest approach, if the speed of proton is double ?
27. (a) Define electric flux and write its SI unit. What is meant by negative flux ?
(b) State and explain Gauss's theorem in electrostatics and apply it to calculate the electric field intensity at a point near an infinite plane sheet of uniform charge density ?

OR

What do you mean by polarization of charge ? On introducing a dielectric slab between the plates of capacitor, explain the effect on electric field between the plates of a capacitor and also define the dielectric constant on the basis of these fields.

28. Draw energy band diagrams of n-type and p-type semiconductors. Also write two differences between n-type and p-type semiconductors.

SECTION - D

29. **Read the following paragraph and answer the questions that follow.**

In 1887, German physicist Heinrich Hertz noticed that shining a beam of ultraviolet light onto a metal plate could cause it to shoot sparks. It is due to the emission of negatively charged particles called electrons from the metal surface into the surrounding space.

Hallwachs and Lenard also observed that when ultraviolet light fell on the emitter plate, no electrons were emitted at all when the frequency of the incident light was smaller than a certain minimum frequency.

Experimental study shows that different metals required different minimum frequencies of light for the emission of electron. When brightness of the incident light increases, more electrons were produced, without increasing their energy, and increasing the frequency of the light produced electrons with higher energies, but without increasing the number produced. This is known as the photoelectric effect, and it would be understood in 1905 by a young scientist named Albert Einstein.

(i) If the wavelength of em radiation is doubled, what will happen to the energy of photons?

- (a) Halved (b) Doubled (c) One-fourth (d) Four times

(ii) Why are alkali metals most suited as photosensitive metals?

- (a) Due to high frequency (b) Due to zero rest mass
(c) Due to high work function (d) Due to low work function

(iii) Which of the following is unit of work function?

- (a) Electron volt (b) Hertz (c) Watt (d) Ohm

(iv) If in a photoelectric experiment, the wavelength of incident radiation is reduced from 6000 \AA to 4000 \AA then,

- (a) the stopping potential will decrease.
(b) the stopping potential will increase.
(c) the kinetic energy of emitted electrons will decrease.
(d) the value of work function will decrease.

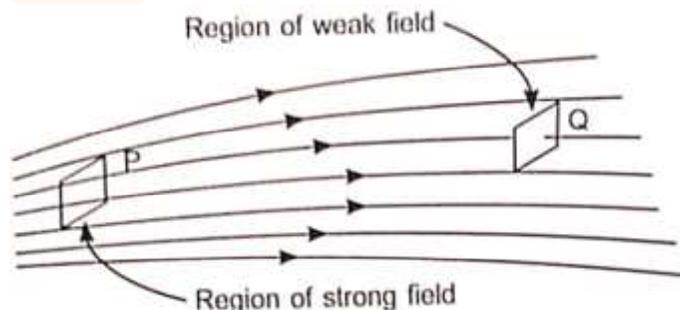
OR

(iv) The stopping potential for photoelectrons

- (a) does not depend on the frequency of the incident light.
(b) does not depend upon the nature of the cathode material.
(c) depends on both the frequency of the incident light and the nature of the cathode material.
(d) depends upon the intensity of the incident light.

30. **Read the following paragraph and answer the questions that follow.**

Electric field strength is proportional to the density of lines of force i.e., electric field strength at a point is proportional to the number of line of force cutting a unit area element placed normal to the field at that point. As illustrated in given figure, the electric field at P is stronger than at Q.



(i) Which of the following statements is not valid in case of conductors in electrostatic field?

- (a) The static electric field intensity inside a conductor is zero.
(b) The static electric field intensity at the surface of a conductor is everywhere directed normal to the surface.

(c) The conductor surface is an equipotential surface.

(d) None of the above.

(ii) A charge Q is located at $(0, 0, 3)$ and $-Q$ is located at $(0, 0, -3)$. The electric field intensity (E) at point $(4, 0, 0)$ is in

(a) negative X-direction

(b) positive Y-direction

(c) positive Z-direction

(d) negative Z-direction

(iii) Electric field intensity due to infinite sheet of charge σ is

(a) zero

(b) unity

(c) $\sigma/2\epsilon_0$

(d) $\sigma/2\epsilon_0$

(iv) Which among the following gives the information on field strength, direction and nature of the charge?

(a) Electric current

(b) Electric flux

(c) Electric field

(d) Electric potential

OR

(iv) Which of the following is false about electrostatic field lines?

(a) Field lines start from positive charge and end at negative charges.

(b) If there is a single positive charge, field lines will end at infinity.

(c) Two field lines can never cross each other.

(d) Electrostatic field lines form closed loops.

SECTION - E

31. (a) (i) Define coefficient of self-induction. Obtain an expression for self-inductance of a long solenoid of length l , area of cross-section A having N turns.

(ii) Calculate the self-inductance of a coil using the following data obtained when an AC source of

frequency $\frac{200}{\pi}$ Hz and a DC source is applied across the coil.

AC Source		
S.No.	V (Volts)	I (A)
1	3.0	0.5
2	6.0	1.0
3	9.0	1.5

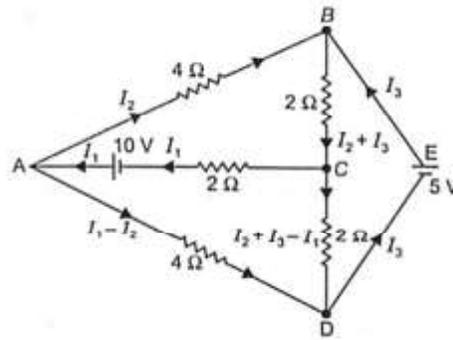
DC Source		
S.No.	V (Volts)	I (A)
1	4.0	1.0
2	6.0	1.5
3	8.0	2.0

OR

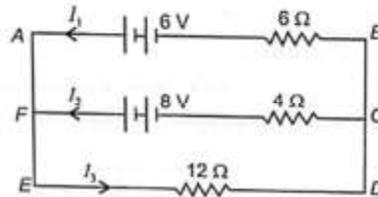
(b) (i) With the help of a labelled diagram, describe the principle and working of an ac generator. Hence, obtain an expression for the instantaneous value of the emf generated.

(ii) The coil of an ac generator consists of 100 turns of wire, each of area 0.5 m^2 . The resistance of the wire is 100Ω . The coil is rotating in a magnetic field of 0.8 T perpendicular to its axis of rotation, at an angular speed of $60 \text{ radian per second}$. Calculate the maximum emf generated and power dissipated in the coil.

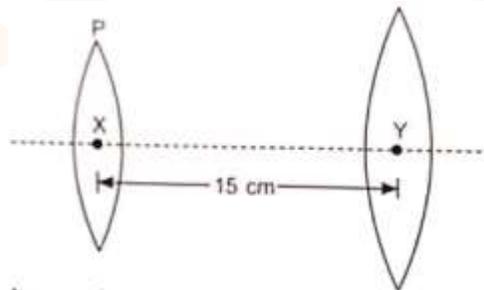
32. (a) State Kirchoff's rules for electrical circuits with diagram.
 (b) Determine the current in each branch of the network shown in the figure.



In the network shown here, find the following.



- (a) Currents I_1 , I_2 and I_3 .
 (b) Terminal potential difference of each battery.
 (Consider 6Ω to be the internal resistance of 6 V battery and 4Ω to be internal resistance of 8 V battery).
33. (a) Two convex lenses P and Q of an astronomical telescope having focal lengths 4 cm and 16 cm respectively are arranged as shown in the figure.



- (i) Which one of the two lenses will you select to use as the objective lens and why?
 (ii) What should be the change in the distance between the lenses to have the telescope in its normal adjustment position?
 (iii) Calculate the magnifying power of the telescope in the normal adjustment position.
 (b) Explain the basic differences between the construction and working of a telescope and a microscope.

OR

- (a) In Young's double slit experiment, deduce the conditions for obtaining constructive and destructive interference fringes. Hence, deduce the expression for the fringe width.
 (b) Show that the fringe pattern on the screen is actually a superposition of single slit diffraction from each slit.
 (c) What should be the width of each slit to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern, for green light of wavelength 500 nm, if the separation between two slits is 1 mm?
