COMMON PRE-BOARD EXAMINATION 2024-25

Subject: PHYSICS (042)

Class XII

Date:

Time : 3 Hrs. Max. Marks: 70

General Instructions:

Read the following instructions carefully :

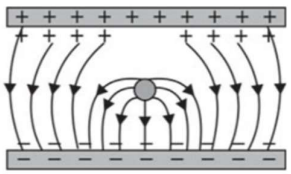
1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. All the sections are compulsory.
4. **Section A** contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark 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.
7. You may use the following values of physical constants where ever necessary

i. $c = 3 \times 10^8$ m/s
ii. $m_e = 9.1 \times 10^{-31}$ kg
iii. $m_p = 1.7 \times 10^{-27}$ kg
iv. $e = 1.6 \times 10^{-19}$ C
v. $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}
vi. $h = 6.63 \times 10^{-34}$ Js
vii. $\varepsilon_0 = 8.854 \times 10^{-12}\ C^2 N^{-1} m^{-2}$
viii. $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 Nm^2C^{-2}$
ix. Avogadro's number = 6.023×10^{23} per gram mole
x. Boltzmann constant = 1.38×10^{-23} J/K

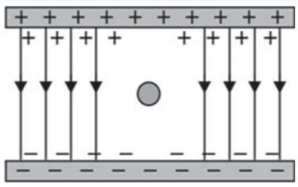
SECTION A

1. Which of the diagrams correctly represents the electric field between two charged plates if a neutral conductor is placed between the plates ? 1

(A)



(B)



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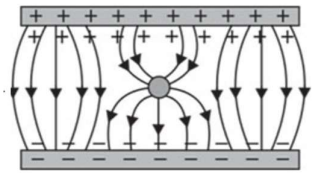

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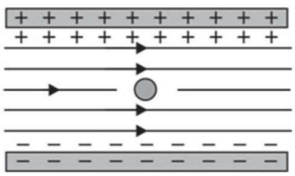
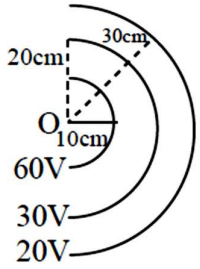


2. The figure shows some concentric equipotential surfaces. The correct choice related to the electric field and its direction is- 1



(A) E $\propto \frac{1}{r}$ and radially inward

(B) E $\propto \frac{1}{r^2}$ and radially outward

(C) E $\propto \frac{1}{r}$ and radially outward

(D) E $\propto \frac{1}{r^2}$ and radially inward

3. A strip of copper and another of germanium are cooled from room temperature to 80K. The resistance of – 1

(A) each of these increases

(B) each of these decreases

(C) copper strip increases and that of germanium decreases

(D) copper strip decreases and that of germanium increases

4. The magnetic susceptibility for a diamagnetic material is - 1

(A) Small and negative

(B) Small and positive

(C) Large and negative

(D) Large and positive

5. $\vec{E}$ and $\vec{B}$ represent the electric and magnetic field of an electromagnetic wave respectively. The direction of propagation of the wave is along 1

(A) $\vec{B}$

(B) $\vec{E}$

(C) $\vec{E} \times \vec{B}$

(D) $\vec{B} \times \vec{E}$

6. An ac voltage v = v_0 sin ωt is applied to a series combination of a resistor R and an element X. The instantaneous current in the circuit is $I = I_0 \sin\left(\omega t + \frac{\pi}{4}\right)$. Then which of the following is correct – 1

(A) X is a capacitor and $X_C = \sqrt{2}$ R

(B) X is an inductor and X_L = R

(C) X is an inductor and $X_L = \sqrt{2}$ R

(D) X is a capacitor and X_C = R

7. An air bubble in a glass slab of refractive index, 1.5 (near normal incidence) is 5 cm deep when viewed from one surface and 3 cm deep when viewed from the opposite face. The 1

thickness of the slab is –

(A) 8 cm
(B) 10 cm
(C) 12 cm
(D) 16 cm

8. An interference pattern is observed by Young's double slit experiment. If now the separation between coherent sources is halved and the distance of screen from coherent sources is doubled, the new fringe width 1

(A) becomes double
(B) becomes one – fourth
(C) remains the same
(D) becomes four times

9. The electromagnetic radiations used to kill germs in water purifiers are called – 1

(A) Infrared waves
(B) X-rays
(C) Gamma rays
(D) Ultraviolet rays

10. According to Huygens principle, the amplitude of secondary wavelets is – 1

(A) equal in both the forward and the backward directions.
(B) maximum in the forward direction and zero in the backward direction.
(C) large in the forward direction and small in the backward direction.
(D) small in the forward direction and large in the backward direction.

11. The transition of electron that gives rise to the formation of the second spectral line of the Balmer series in the spectrum of hydrogen atom corresponds to 1

(A) $n_f = 2$ and $n_i = 3$
(B) $n_f = 3$ and $n_i = 4$
(C) $n_f = 2$ and $n_i = 4$
(D) $n_f = 2$ and $n_i = \infty$

12. A pure Si crystal having 5×10^{28} atoms/m^3 is doped with 1 ppm concentration of antimony. If the concentration of holes in the doped crystal is found to be 4.5×10^9 m^{-3}, the concentration (in m^{-3}) of intrinsic charge carriers in Si crystal is about 1

(A) 1.2×10^{15}
(B) 1.5×10^{16}
(C) 3.0×10^{15}
(D) 2.0×10^{16}

For Questions 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 options as given below.

(A) If both Assertion and Reason are true and Reason is 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.

13. **Assertion (A) :** When a bar of copper is placed in an external magnetic field, the field lines get concentrated inside the bar. 1
Reason (R) : Copper is a paramagnetic material.

14. **Assertion (A) :** Photoelectric effect demonstrates the particle nature of light and the photocurrent depends on the intensity of incident radiation. 1
Reason (R) : The number of photoelectrons is proportional to the frequency of light.

15. **Assertion (A) :** Hydrogen atom consists of only one electron but its emission spectrum has many lines. 1
Reason (R) : Only Lyman series is found in the absorption spectrum of hydrogen atom whereas in the emission spectrum, all the series are found.

16. **Assertion (A) :** $^{56}_{28}Fe$ is the most stable nuclei. 1
Reason (R) : Binding energy is greatest for $^{56}_{28}Fe$ nuclei.

SECTION-B

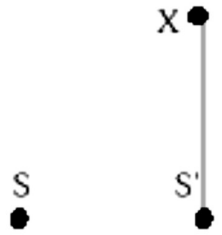
17. What is the shortest wavelength present in the Paschen series of hydrogen spectrum? 2

18. Explain briefly why and how a galvanometer is converted to an ammeter. 2

19. The equivalent capacitance of the combination between A and B in the given figure is 4uF. 2

(i) Calculate capacitance of the capacitor C.
(ii) Calculate charge on each capacitor if a 12V battery is connected across terminals A and B.

20. (a) Two waves from two coherent sources S and S' superimpose at X as shown in the figure. If X is a point on the second minima and SX – S'X is 4.5 cm. Calculate the wavelength of the waves. 2



OR

(b) In a diffraction pattern due to a single slit, how will the angular width, θ of central maximum change if,

(i) Orange light is used instead of green light
(ii) The screen is moved closer to the slit

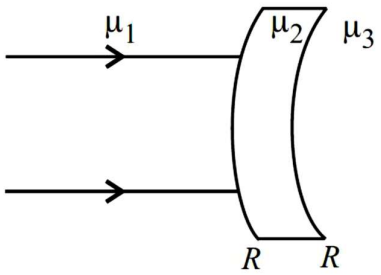
Justify your answer in each case.

21. Draw a graph showing the variation of potential energy between a pair of nucleons as a function of their separation and write two important conclusions which you can draw regarding the nature of the nuclear forces. 2

SECTION-C

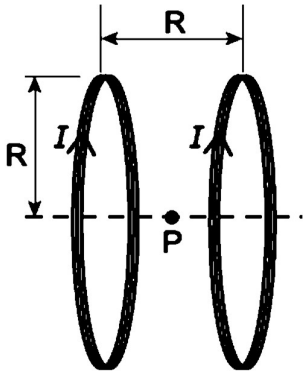
22. Derive expression for force per unit length acting between two parallel current carrying straight conductors and hence define the SI unit of current. 3

23. A parallel beam of light is incident on a thin lens as shown in figure. The radius of curvature of both surfaces is R. Determine the focal length of this system. 3

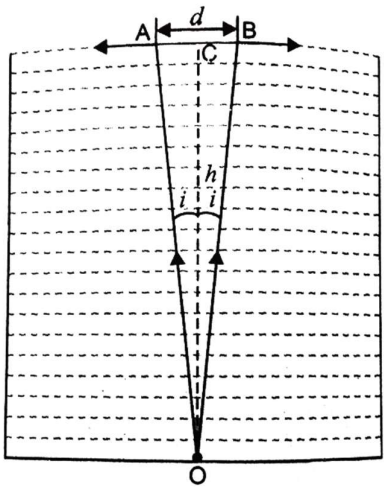


24. (a) Draw the energy band diagram of p-type semiconductor at T > 0K 3
(b) Suggest a method to convert a full wave rectifier to a half wave rectifier by changing the connecting wires. Draw the circuit diagram and explain your answer.

25. (a) State Biot – Savart law. 3
(b) Two identical coils, each with N turns and radius R are placed coaxially at a distance R as shown in the figure. If I is the current passing through the loops in the same direction, then find the magnitude of magnetic field at a point P at a distance of R/2 from the centre of each coil.



26. A jar of height, h is filled with a transparent liquid of refractive index μ. At the centre of the jar on the bottom surface is a dot. Find the minimum diameter of a disc, such that when it is placed on the top surface symmetrically about the centre, the dot is invisible. 3



27. With the help of relevant circuit diagram, explain the forward and reverse bias of a p-n junction. Also draw the forward and reverse characteristics of the diode. 3

28. (a) (i) Define electric flux and write its SI unit. 3

(ii) Use Gauss law to obtain the expression for the electric field due to a uniformly charged infinite plane sheet.

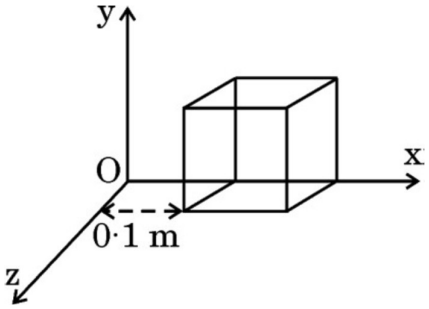
OR

(b) A cube of side 0·1 m is placed, as shown in the figure, in a region where electric field, $E = 500\ x\ \hat{\imath}$ exists. Here x is in meters and E in N/C.

Calculate :

(i) the flux passing through the cube, and

(ii) the charge within the cube.



SECTION-D
Case Study Based Questions

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

AURORA BOREALIS

In certain polar regions, a splendid display of colors is seen in the sky. The appearance of dancing green pink lights is fascinating, and equally puzzling. Consider a charged particle of mass m and charge q, entering a region of magnetic field B with an initial velocity v. Let this velocity have a component parallel to the magnetic field and a component normal to it. There is no force on a charged particle in the direction of the field.

During a solar flare, a large number of electrons and protons are ejected from the sun. Some of them get trapped in the earth's magnetic field and move in helical paths along the field lines. The field lines come closer to each other near the magnetic poles. Hence the density

of charges increases near the poles. These particles collide with atoms and molecules of the atmosphere. Excited oxygen atoms emit green light and excited nitrogen atoms emits pink light. This phenomenon is called Aurora Borealis.

(i) If the velocity of a charged particle has both perpendicular and parallel components while moving through a magnetic field, what is the path followed by the particle? 1

(A) Linear
(B) Circular
(C) Helical
(D) Elliptical

(ii) A circular coil of radius 5 cm and 50 turns carries a current of 3 ampere. The magnetic dipole moment of the coil is nearly 1

(A) 1.0 Am^2
(B) 1.2 Am^2
(C) 0.5 Am^2
(D) 0.8 Am^2

(iii) Three wires of equal lengths are bent in the form of loops. One of the loops is circle, another is a semi-circle and the third one is a square. They are placed in a uniform magnetic field and same electric current is passed through them. Which of the following loop configuration will experience greater torque ? 1

(A) Circle
(B) Semi-circle
(C) Square
(D) Same torque for all shapes

(iv) (a) A proton enters a current carrying solenoid with uniform velocity v along the axis of the solenoid then 1

(A) velocity increases
(B) proton is repelled backwards
(C) proton moves along the helical path
(D) force experienced by the proton is zero

OR

(b) A straight wire is kept horizontally along east-west direction. If a steady current flows in the wire from east to west, the magnetic field at a point above the wire will point towards

(A) East
(B) West
(C) North
(D) South

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

Wave-Particle Duality of Matter

Wave and particle light and other electromagnetic radiation sometimes act like wave and sometimes like particles. Interference and diffraction demonstrate wave behavior, while emission and absorption of photons demonstrate the particle behavior. In 1924, the French physicist Prince Louis Victor de Broglie put forward the bold hypothesis that moving

particles of matter should display wave-like properties under suitable conditions. His reasoning, freely paraphrased, went like this: Nature loves symmetry. Light is dualistic in nature, behaving in some situations like waves and in other like particles. If nature is symmetric, this duality should also hold for matter. Electrons and protons, which we usually consider as particles may in some situations behave like wave. If a particle acts like a wave, it should have a wavelength and a frequency. The relation was proposed by de Broglie in his Ph.D. thesis for which he was awarded the Noble Prize in Physics in 1929.

(i) The kinetic energy of a proton and that of an α-particle are 4 eV and 1 eV respectively. The ratio of the De-Broglie wavelengths associated with them will be 1

(A) 2:1
(B) 1:1
(C) 1:2
(D) 4:1

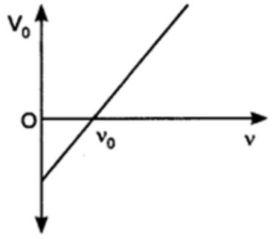
(ii) In a photoelectric experiment, the wavelength of the incident radiation is reduced from 6000 Å to 4000 Å, while the intensity of radiation remains the same, then 1

(A) The cut-off potential will decrease
(B) The cut-off potential will increase
(C) The photoelectric current will increase
(D) The kinetic energy of the emitted electrons will decrease

(iii) Monochromatic light of wavelength 667 nm is produced by a helium neon laser. The power emitted is 9 mW. The number of photons arriving per second on the average at a target irradiated by this beam is 1

(A) 3×10^{16}
(B) 9×10^{15}
(C) 3×10^{19}
(D) 9×10^{17}

(iv) (a) The stopping potential, V_o for photoelectric emission from a metal surface is plotted along with the y-axis and frequency, υ of incident light along the x-axis. A straight line is obtained as shown. Planck's constant is given by 1



(A) product of the slope of the line and charge on the electron
(B) intercept along y-axis divided by the charge on the electron
(C) product of the intercept along x-axis and mass of the electron
(D) the slope of the line

OR

(b) Light of frequency $6{\cdot}4\times10^{14}$ Hz is incident on a metal of work function 2·14 eV. The maximum kinetic energy of the emitted electrons is about

(A) 0·25 eV

(B) 0·51 eV
(C) 1·02 eV
(D) 0·10 eV

SECTION-E

31. I (a) Obtain an expression of drift velocity of free electrons in a conductor. The electron drift arises due to the force experienced by electrons in the electric field inside the conductor. But force should cause acceleration. Why then do the electrons acquire a steady average drift speed ? 5

(b) The thickness of a conductor continuously decreases from its end A to another end B. It is connected across the terminals of a battery. What will be the effect on the value of

(i) current density and

(ii) electric field

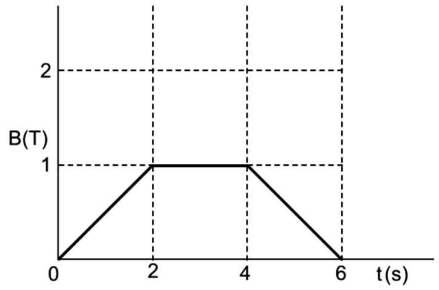
OR

II (a) Two cells of emf E_1 and E_2 and internal resistance r_1 and r_2 are connected in parallel. Derive the expression for the (i) emf and (ii) internal resistance of a single equivalent cell that can replace this combination.

(b) A storage battery of emf 8.0 V and internal resistance 0.5 is being charged by a 120 V dc supply using a series resistor of 15.5 ohm. What is the current during charging?

32. I (a) Define mutual inductance. Two circular loops, one of small radius r and other of larger radius R, such that R >> r, are placed coaxially with centers coinciding. Obtain the mutual inductance of the arrangement. 5

(b) The magnetic field through a circular loop of wire 12 cm in radius in radius and 8.5 Ω resistance, changes with time as shown in figure. The magnetic field is perpendicular to the plane of the loop. Calculate the induced current in the loop in each of the three time intervals.



OR

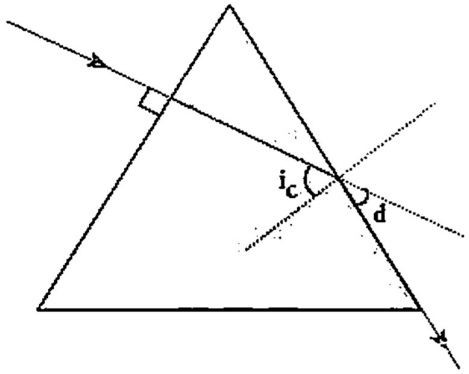
II (a) Using the phasor diagram for a series capacitive LCR circuit connected to an ac source, $v = v_o \sin \omega t$, obtain the expressions for impedance of the circuit and instantaneous current.

(b) A capacitor of unknown capacitance, a resistor of 100 Ω and an inductor of inductance, $L = \left(\frac{4}{\pi^2}\right)$ henry are connected in series to an ac source of 200 V and 50 Hz. Calculate the

value of capacitance and rms current of the circuit when the current is in phase with the voltage.

33 I (a) Draw a ray diagram showing refraction of a ray of light through a triangular glass prism. Hence, obtain the relation for the refractive index (μ) in terms of angle of prism (A) and angle of minimum deviation (δ_m). 5

(b) Light ray falls at normal incidence on the first face and emerges gracing the second face for an equilateral prism.



(i) What is the angle of deviation produced?
(ii) What is the refractive index of the material of the prism?

OR

II (a) With the help of a labelled ray diagram obtain the magnification of a compound microscope when the final image is formed at least distance of distinct vision.

(b) The focal lengths of objective and eyepiece of a compound microscope are 1.0 cm and 2.5 cm respectively. Find the tube length of the microscope for obtaining a magnification of 300 when the final image is formed at infinity.