CONCEPT ACADEMY

CBSE Sample Paper 1

Class XII Exam 2023-24

Physics

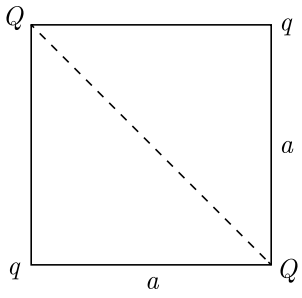
Time: 3 Hours **Max. Marks: 70**

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 MCQ 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. In the figure, if net force on Q is zero then value of $\frac{Q}{q}$ is:



(a) $\sqrt{2}$ (b) $2\sqrt{2}$

(c) $\frac{1}{2\sqrt{2}}$ (d) $\frac{1}{\sqrt{2}}$

2. Two plates of a parallel plate capacitor are 1 cm apart and potential difference between them is 10 V. The electric field between the plates is

(a) $10\,\text{N-C}^{-1}$ (b) $250\,\text{N-C}^{-1}$

(c) $500\,\text{N-C}^{-1}$ (d) $1000\,\text{N-C}^{-1}$

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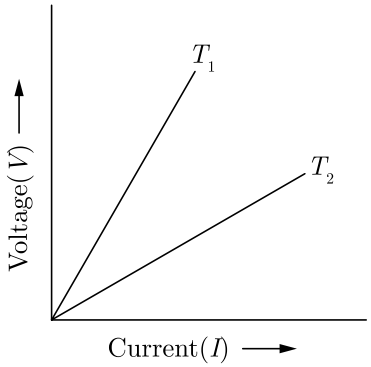
3. The voltage V and current I graphs for a conductor at two different temperatures T_1 and T_2 are shown in the figure. The relation between T_1 and T_2 is



(a) $T_1 > T_2$ (b) $T_1 \approx T_2$

(c) $T_1 = T_2$ (d) $T_1 < T_2$

4. A circular coil of radius r carries a current I. The magnetic field at its center is B. At what distance from the centre, on the axis of the coil, the magnetic field will be $B/8$

(a) $\sqrt{2}\,R$ (b) $2R$

(c) $\sqrt{3}\,R$ (d) $3R$

5. An electric current passes through a long straight copper wire. At a distance 5 cm from the straight wire, the magnetic field is B. The magnetic field at 20 cm from the straight wire would be

(a) $\frac{B}{6}$ (b) $\frac{B}{4}$

(c) $\frac{B}{3}$ (d) $\frac{B}{2}$

6. If a bar magnet is dropped down in an infinitely long vertical copper tube, then the magnet will move continuously

(a) increasing velocity and acceleration

(b) increasing velocity but constant acceleration

(c) decreasing velocity and ultimately comes to rest

(d) increasing velocity and ultimately acquires a constant terminal velocity

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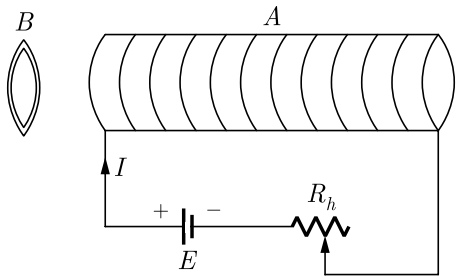
7. An aluminium ring B faces an electromagnet A. Which of the following statement is correct?



(a) if I increases, A will repel B

(b) if I decreases, A will repel B

(c) if I increases, A will attract B

(d) whether I increases or decreases B will not experience any force

8. Which scientist experimentally proved the existence of electromagnetic waves?

(a) Marconi

(b) Heinrich Rudolf Hertz

(c) James Clerk Maxwell

(d) Jagdish Chander Bose

9. Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon

(a) currents in the coils

(b) materials of the wires of the coils

(c) relative position and orientation of the coils

(d) rates at which the currents are changing in the coils

10. What happens if a monochromatic light used in the Young's double slit experiment is replaced by white light?

(a) no fringes are observed

(b) all bright fringes become white

(c) all bright fringes are coloured between violet and red

(d) only central fringe is white and all other fringes are coloured

11. A particle of mass m and charged q is accelerated through a potential V. The De-Broglie wavelength of the particle will be:

(a) $\frac{Vh}{\sqrt{2qm}}$ (b) $\frac{q}{\sqrt{2mV}}$

(c) $\frac{h}{\sqrt{2qmV}}$ (d) $\frac{mh}{\sqrt{2qV}}$

12. The minimum angular momentum of electron in Hydrogen atom will be

(a) $\frac{h}{\pi} Js$ (b) $\frac{h}{2\pi} Js$

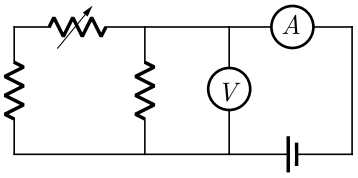
(c) $h\pi Js$ (d) $2\pi h\ Js$

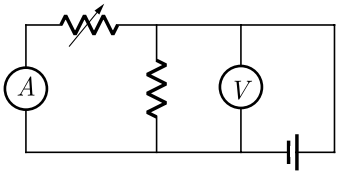
13. If elements with principal quantum $n > 4$ were not allowed in nature, the number of possible elements would have been

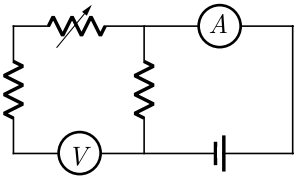
(a) 4 (b) 32

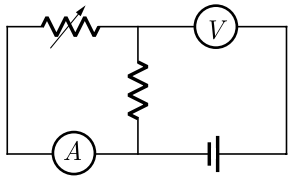
(c) 60 (d) 64

14. Which of the following set up can be used to verify the Ohm's law?

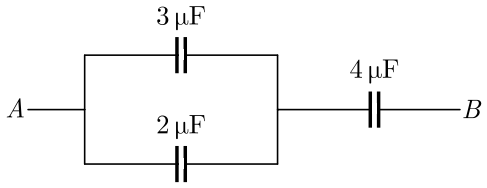
(a) 

(b) 

(c) 

(d) 

15. The equivalent capacity between A and B is



(a) $\frac{20}{9}\,\mu F$ (b) $9\,\mu F$

(c) $1\,\mu F$ (d) $\frac{1}{9}\,\mu F$

16. **Assertion :** The resistivity of a semi-conductor increases with temperature.
Reason : The atoms of semi-conductor vibrate with larger amplitude as higher temperatures thereby increasing its resistivity.

(a) Both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(b) Both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(c) The Assertion is correct but Reason is incorrect.

(d) Both the Assertion and Reason are incorrect.

17. **Assertion :** In Young's experiment, the fringe width for dark fringes is different from that for white fringes.
Reason : In Young's double slit experiment the fringes are performed with a source of white light, then only black and bright fringes are observed.

(a) Both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(b) Both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(c) The Assertion is correct but Reason is incorrect.

(d) Both the Assertion and Reason are incorrect.

18. **Assertion :** Photo-sensitivity of a metal is high if its work function is small.
Reason : Work function $= hf_0$ where f_0 is the threshold frequency.

(a) Both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(b) Both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

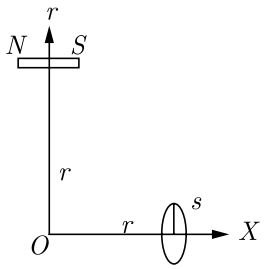
(c) The Assertion is correct but Reason is incorrect.

(d) Both the Assertion and Reason are incorrect.

SECTION-B

19. A capacitor of capacitance C is being charged by connecting it across a DC source along with an ammeter. Will the ammeter show a momentary deflection during the process of charging? If so, how would you explain this momentary deflection and the resulting continuity of current in the circuit? Write the expression for the current inside the capacitor.

20. A small magnet of magnetic moment M, is placed at a distance r from the origin O with its axis parallel to X-axis as shown. A small coil, if one turn is placed on the X-axis, at the same distance from the origin, with the axis of the coil coinciding with X-axis. For what value of current in the coil does a small magnetic needle, kept at origin, remains undefiled ? What is the direction of current in the coil ?



21. What is Einstein's mass-energy equivalence? What is its importance?

or

A chain reaction dies out sometimes. Why?

22. You are given two converging lenses of focal length 1.25 cm and 5 cm to design a compound microscope. If it is desired to have a magnification of 30, then find out the separation between the objective and eyepiece.

23. Draw the voltage-current characteristic curve of a diode and mark its important parameter.

or

Draw $V-I$ characteristics of a $p-n$ junction diode. Answer the following questions, giving reasons:

(i) Why is the current under reverse bias almost independent of the applied potential upto a critical voltage?

(ii) Why does the reverse current show a sudden increase at the critical voltage?

24. Draw a graph showing the variation of intensity against the position x on the screen in Young double slit experiment.

25. Two point charges having equal charges separated by 1 m distance experience a force of 8 N . What will be the force experienced by them, if they are held in water, at the same distance? (Given: $K_{\text{water}} = 80$)

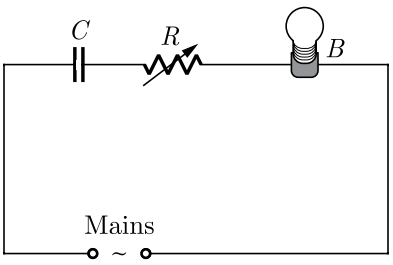
Continue on next page.....

SECTION-C

26. Give some points of similarities and differences between Biot-Savart law for the magnetic field and Coulomb's law for the electrostatic field.

27. A horizontal conducting rod 10 m long extending from east to west is falling with a speed 5.0 ms^{-1} at right angle to the horizontal component of the Earth's magnetic field, 0.3×10^{-4} $Wb - m^{-2}$. Find the instantaneous value of the emf induced in the rod.

28. A capacitor C, a variable resistor R and a bulb B are connected in series to the AC mains in the circuit as shown in the figure. The bulb glows with some brightness. How will the glow of the bulb change if (i) a dielectric slab is introduced between the plates of the capacitor keeping resistance R to be the same (ii) the resistance R is increased keeping the same capacitance?



or

State the condition under which the phenomenon of resonance occurs in a series LCR circuit. Plot a graph showing the variation of current with frequency of an AC source in series LCR circuit.

29. 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? Give reason to justify your answer.

or

(a) Give a brief description of the basic elementary process involved in the photoelectric emission in Einstein's picture.

(b) When a photosensitive material is irradiated with the light of frequency v, the maximum speed of electrons is given by V_{max}. A plot of V_{max}^2 is found to vary with frequency v as shown in the figure.

Use Einstein's photoelectric equation to find the expressions for (i) Planck's constant and (ii) work function of the given photosensitive material, in terms of the parameters l, n and mass m of the electron.

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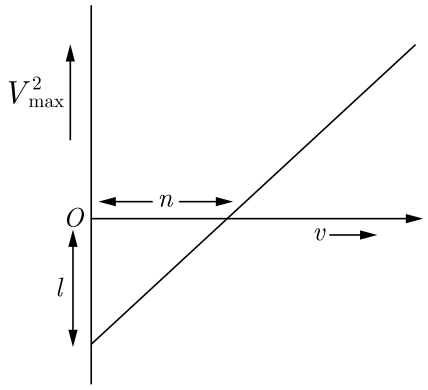


30. The electron in a given Bohr orbit has a total energy of -1.5 eV. Calculate its
(i) kinetic energy
(ii) potential energy
(iii) wavelength of radiation emitted, when this electron makes a transition to the ground state.
[Given, energy in the ground state $=-13.6$ eV and Rydberg's constant $= 1.09 \times 10^7\ m^{-1}$]

SECTION-D

31. A slab of material of dielectric constant K has the same area as that of the plates of a parallel plate capacitor but has the thickness d/2, where d is the separation between the plates. Find out the expression for its capacitance when the slab is inserted between the plates of the capacitor.

or

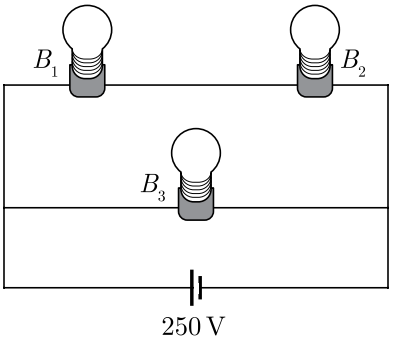
1. Define capacitance of a capacitor.
2. Derive expression for stored energy between plates of parallel plate capacitor. Show that energy-density between plates of the capacitor can be expressed as $1/2\,\varepsilon_0\ E^2$, when $E =$ Electric field between plates.

32. 1. Derive an expression for the current density in terms of the drift speed of electrons.
2. Derive Ohm's law on the basis of the theory of electron drift.
3. Derive an expression for the resistivity of a conductor in terms of number density of free electrons and relaxation time.

Continue on next page.....

or

A 100 W bulb B_1 and two 60 W bulbs B_2 and B_3, are connected to a 250 V source as shown in the figure. Now W_1, W_2 and W_3 are the output powers of the bulbs B_1, B_2 and B_3 respectively. What is the relation between the output powers of bulbs?



33. (a) How is a wavefront defined ? Distinguish between a plane wavefront and a spherical wavefront. Using Huygen's constructions draw a figure showing the propagation of a plane wave refracting at a plane surface separating two media. Hence verify Snell's law of refraction.

When a light wave travels from a rarer to a denser medium, the speed decreases. Does it imply reduction its energy ? Explain.

(b) When monochromatic light travels from a rarer to a denser medium, explain the following.

(i) Is the frequency of reflected and refracted light same as the frequency of incident light ?

(ii) Does the decrease in speed imply a reduction in the energy carried by light wave ?

or

(a) In Young's double slit experiment, two slits are 1 mm apart and the screen is placed 1 m away from the slits. Calculate the fringe width when light of wavelength 500 nm is used.

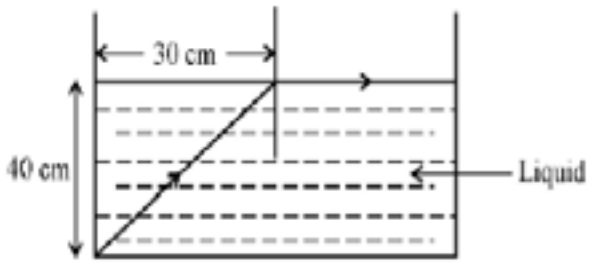
(b) What should be the width of each slit in order to obtain 10 maxima of the double slits pattern within the central maximum of the single slit pattern ?

(c) The intensity at the central maxima in Young's double slit experiment is I_0. Find out the intensity at a point where the path difference is $\frac{\lambda}{6}, \frac{\lambda}{4}$ and $\frac{\lambda}{3}$.

SECTION-E

34. Total internal reflection (TIR) is the optical phenomenon in which waves arriving at the interface (boundary) from one medium to another (e.g., from water to air) are not refracted into the second ("external") medium, but completely reflected back into the first ("internal") medium. It occurs when the second medium has a higher wave speed (i.e., lower refractive index) than the first, and the waves are incident at a sufficiently oblique angle on the interface. For example, the water-to-air surface in a typical fish tank, when viewed obliquely from below,

reflects the underwater scene like a mirror with no loss of brightness.
TIR occurs not only with electromagnetic waves such as light and microwaves, but also with other types of waves, including sound and water waves. If the waves are capable of forming a narrow beam , the reflection tends to be described in terms of "rays" rather than waves; in a medium whose properties are independent of direction, such as air, water or glass, the "rays" are perpendicular to the associated wave fronts.
Repeated total internal reflection of a 405nm laser beam between the front and back surfaces of a glass pane. The colour of the laser light itself is deep violet; but its wavelength is short enough to cause fluorescence in the glass, which re-radiates greenish light in all directions, rendering the zigzag beam visible.
Refraction is generally accompanied by partial reflection. When waves are refracted from a medium of lower propagation speed (higher refractive index) to a medium of higher speed e.g., from water to air the angle of refraction (between the outgoing ray and the surface normal) is greater than the angle of incidence (between the incoming ray and the normal). As the angle of incidence approaches a certain threshold, called the critical angle, the angle of refraction approaches 90°, at which the refracted ray becomes parallel to the boundary surface. As the angle of incidence increases beyond the critical angle, the conditions of refraction can no longer be satisfied, so there is no refracted ray, and the partial reflection becomes total. For visible light, the critical angle is about 49° for incidence from water to air, and about 42° for incidence from common glass to air.



1. What is refractive index of a medium? (in terms of speed of light)
2. In the above diagram, calculate the speed of light in the liquid of unknown refractive index?

3 What is refractive index of a medium (in terms of real and apparent depth)?

or

4 What is the relation between refractive index and critical angle for a medium?

35. A pure semiconductor germanium or silicon, free of every impurity is called intrinsic semiconductor. At room temperature, a pure semiconductor has very small number of current carriers (electrons and holes). Hence its conductivity is low. When the impurity atoms of valance five or three are doped in a pure semiconductor, we get respectively n-type or p-type extrinsic semiconductor. In case of doped semiconductor $n_e n_h = n_i^2$. Where n_e and n_h are the number density of electron and hole charge carriers in a pure semiconductor. The conductivity of extrinsic semiconductor is much higher than that of intrinsic semiconductor.
Answer the following questions :

1. What is n-type semiconductor?
2. Do pure semiconductors obey Ohm's law?
3. Why do semiconductors behave as conductors at room temperature?

or

4. Why does a semiconductor behaves as an insulator at very low temperature?

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