COMMON PRE-BOARD EXAMINATION 2023-24

Subject: PHYSICS (042)

Class XII

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. $e = 1.6 \times 10^{-19}$ C
    iv. $\mu_0 = 4\pi \times 10^{-7}$ Tm$\boldsymbol{A^{-1}}$
    v. $h = 6.63 \times 10^{-34}$ Js
    vi. $\varepsilon_0 = 8.854 \times 10^{-12}$ $\boldsymbol{C^2N^{-1}m^{-2}}$
    vii. Avogadro's number = 6.023 X $\mathbf{10^{23}}$ per gram mole

SECTION A

1. A hollow metallic sphere of radius 5cm is charged so that the potential on its surface is 10V. The potential at the centre of the sphere is 1

(a) 0V

(b) 10V

(c) Same as at a point 5cm away from the surface

(d) Same as at a point 25cm away from the surface

2. When 10^{14} electrons are removed from a neutral metal sphere, the charge on the sphere becomes 1

(a) 16μC

(b) -16μC

(c) 32μC

(d) -32μC

3. Which of these particles (having the same kinetic energy) has the shortest de-Broglie wavelength? 1

(a) Electron

(b) Alpha particle

(c) Proton

(d) Neutron

4. The time period of an electron in n^{th} Bohr's orbit is proportional to 1

(a) n^3

(b) n^2

(c) n

(d) 1/n

5. An electric current pass through a long straight wire at a distance 5cm from the wire. The magnetic field is B. The field at 20cm from the wire would be 1

(a) B/16

(b) B/4

(c) B/3

(d) B/2

6. Which of the following is not a diamagnetic material? 1

(a) Bismuth

(b) Copper

(c) Nitrogen (STP)

(d) Sodium

7. A galvanometer of resistance 25Ω gives full scale deflection for a current of 10mA. What resistance is to be connected in its series so that it can work as voltmeter of range 10V? 1

(a)10000Ω

(b)10025Ω

(c)975Ω

(d)9975Ω

8. Two long straight wires are set parallel to each other. Each carries a current i in the same direction and the separation between them is 2r. The intensity of the magnetic field midway between them is 1

(a)$\frac{\mu_o i}{2r}$

(b) $\frac{4\mu_o i}{r}$

(c)zero

(d) $\frac{\mu_o i}{4r}$

9. If the rms current in a 50Hz ac circuit is 5A, the value of the current 1/300s after its value become zero is 1

(a) $5\sqrt{2}$ A

(b) $5\sqrt{\frac{3}{2}}$ A

(c) $\frac{5}{6}$ A

(d) $\frac{5}{\sqrt{2}}$A

10. If $\vec{E}$ and $\vec{B}$ represent electric and magnetic field vectors of the electromagnetic wave, the direction of propagation of electromagnetic wave is along 1

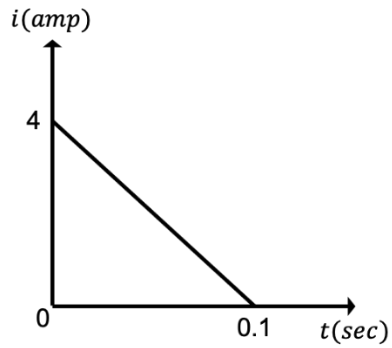
(a) $\vec{E}$

(b) $\vec{B}$

(c) $\vec{B}$x$\vec{E}$

(d) $\vec{E}$x$\vec{B}$

11. In a coil of resistance 10Ω, the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in weber is 1



(a) 8

(b) 2

(c) 6

(d) 4

12. Which of the following series in the spectrum of hydrogen atom lies in the visible region of the electromagnetic spectrum? 1

(a) Paschen series

(b) Balmer series

(c) Lyman series

(d) Brackett series

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:** Though radiation of a single frequency is incident on a metal surface, the energies of the emitted photoelectrons are different. 1

Reason: The energy of electrons emitted from inside the metal surface is lost in collision with other atoms in the metal.

14. **Assertion:** Silicon is preferred over germanium for making semiconductor devices. 1

Reason: The energy gap for germanium is more than the energy gap of silicon.

15. **Assertion:** Two equipotential surfaces can never intersect. 1

Reason: Potential at all points of an equipotential surface is uniform.

16. **Assertion:** When monochromatic light travels from one medium to another, its wavelength changes but its frequency remains same. 1

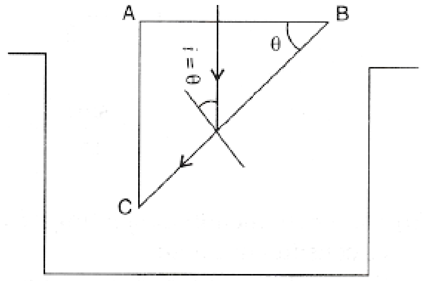
Reason: Frequency is a characteristic of the source of waves But wavelength is characteristic of medium.

SECTION B

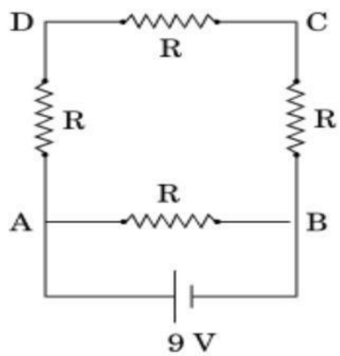
17. Draw energy band diagrams of an n-type and p-type semiconductor at temperature T>0K. Mark the donor and acceptor energy levels with their energies. 2

18. Define the term intensity of radiation in photon picture. 2
Plot a graph showing the variation of photocurrent vs collector potential for three different intensities $I_1>I_2>I_3$, two of which (I_1 and I_2) have the same frequency v and third has frequency $v_1>v$.

19. Calculate the value of θ, for which light incident normally on face AB grazes along the face BC. (Given: $n_g=3/2$, $n_w=4/3$) 2



20. A 16Ω resistance wire is bent to form a square. A source of emf 9V is connected across one of its sides as shown. Calculate the current drawn from the source. Find the potential difference between the ends C and D 2



21. Draw a schematic ray diagram of a reflecting telescope. Write its two important advantages over refracting telescope. 2

(OR)

A mobile phone lies along the principal axis of a concave mirror. Show, with the help of a suitable diagram, the formation of its image. Explain why magnification is not uniform.

SECTION C

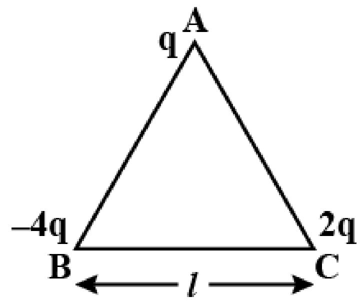
22. A given coin has a mass of 3g. Calculate the nuclear energy that would be required to separate all the neutrons and protons from each other. For simplicity assume that the coin is entirely made of ${}^{63}_{29}Cu$ atoms (of mass 62.92960u). The masses of proton and neutrons are 1.00783u and 1.00867u respectively. 3

(OR)

How long can an electric lamp of 100W be kept glowing by fusion of 2.0kg of deuterium? Take the fusion reaction as

$$ {}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + n + 3.27MeV $$

23. Three point charges q, -4q and 2q are placed at the vertices of an equilateral triangle ABC of side '*l*' as shown in the figure. Obtain the expression for the magnitude of the resultant electric force acting on charge q. Also find the amount of work done to separate the charges at infinite distance. 3



24. Find the ratio between the wavelengths of the most energetic spectral lines in the Balmer and Paschen series of the hydrogen spectrum. 3

25. A heating element using nichrome connected to a 230 V supply draws an initial current of 3.2 A which settles after a few seconds to a steady value of 2.8 A. What is the steady temperature of the heating element if the room temperature is 27.0°C? Temperature coefficient of resistance of nichrome averaged over the temperature range involved is 1.70×10^{-4} $°C^{-1}$. 3

26. State Biot- Savart's law. Derive the expression for magnetic field at the centre of a circular coil carrying current I. 3

27. (a) How are electromagnetic waves produced? 3

(b) Draw a sketch of a plane EM wave propagating along X-axis depicting the directions of the oscillating electric and magnetic fields.

(c) A thin ozone layer in the upper atmosphere is crucial for human survival on Earth. Why?

28. A long solenoid of radius r consists of n turns per unit length. A current $I = I_0 \sin \omega t$ flows in the solenoid. A coil of N turns is wound tightly around it near its centre. What is: 3
(a) the induced emf in the coil?
(b) the mutual inductance between the solenoid and the coil?

SECTION D

Case Study Based Questions

29. **Read the following paragraph and answer the question that follows:** 4

A semiconductor diode is basically a pn junction with metallic contacts provided at the ends for the application of an external voltage. It is a two-terminal device. When an external voltage is applied across a semiconductor diode such that p-side is connected to the positive terminal of the battery and n-side to the negative terminal, it is said to be forward biased. When an external voltage is applied across the diode such that n-side is positive and p-side is negative, it is said to be reverse biased. An ideal diode is one whose resistance in forward biasing is zero and the resistance is infinite in reverse biasing. When the diode is forward biased, it is found that beyond forward voltage called knee voltage, the conductivity is very high. When the biasing voltage is more than the knee voltage the potential barrier is overcome and the current increases rapidly with increase in forward voltage. When the diode is reverse biased, the reverse bias voltage produces a very small current about a few microamperes which almost remains constant with bias. This small current is reverse saturation current.

(i)The increase in the width of the depletion region in a p-n junction diode is due to:

(a) increase in forward current

(b) forward bias only

(c) reverse bias only

(d) both forward bias and reverse bias

(ii) In half wave rectification, if the input frequency is 60 Hz, then the output frequency would be

(a) Zero

(b) 30 Hz

(c) 60 Hz

(d) 120 Hz

(iii) A pure Si crystal has $5x10^{28}$ atoms/m^3. It is doped by 1 ppm concentration of As atom. The number of holes per unit volume is (consider $n_i = 1.5 \times 10^{16}\ m^{-3}$)

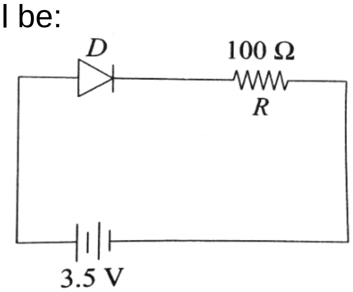
(a) $4.5x10^9\ m^{-3}$

(b)$4x10^9\ m^{-3}$

(c)$2x10^9\ m^{-3}$

(d)$2.25x10^{10}\ m^{-3}$

(iv) In the given figure, a diode D is connected to an external resistance R = 100 Ω and an e.m.f. of 3.5 V. If the barrier potential developed across the diode is 0.5 V, the current in the circuit will be:



(a) 40 mA

(b) 20 mA

(c) 35 mA

(d) 30 mA

30. A convex or converging lens is thicker at the centre than at the edges. It converges a beam of light on refraction through it. It has a real focus. Convex lens is of three types: Double convex lens, Plano convex lens and Concavo-convex lens. Concave lens is thinner at the centre than at the edges. It diverges a beam of light on refraction through it. It has a virtual focus. Concave lenses are of three types: Double concave lens, Plano concave lens and Convexo-concave lens. 4

(i) The radius of curvatures of two surface of a convex lens is R. For what value of μ of its material will its focal length become equal to R?

(a) 1

(b) 1.5

(c) 2

(d) infinite

(ii) An object is placed in front of a lens which forms its erect image of magnification 3. The power of the lens is 5D. The distance of the image from the lens is

(a) -40cm

(b) 40cm

(c) -80cm

(d) 80cm

(iii) The focal length of a concave lens of μ=1.5 is 20cm in air. It is completely immersed in water μ=4/3. Its focal length in water will be

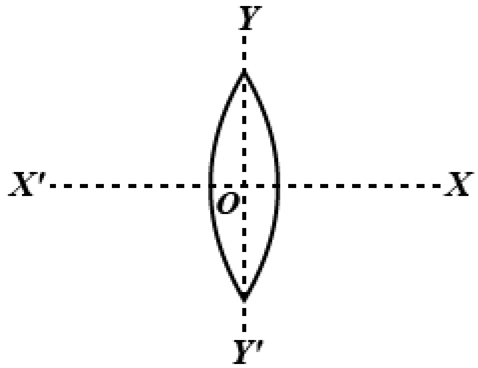
(a) 20cm

(b) 40cm

(c) 60cm

(e) 80cm

(iv) An equiconvex lens is cut into two halves along (i) XOX' and (ii) YOY' as shown in the figure. Let f,f' and f'' be the focal lengths of the complete lens, of each half of the lens in case (i) and case (ii) respectively. The correct statement from the following is



(a) f'=2f and f''=f

(b) f'=f and f''=f

(c) f'=2f and f''=2f

(d) f'=f and f''=2f

SECTION E

31. (a) Draw the labelled ray diagram for the formation of image by compound microscope. Derive an expression for its total magnification, when the final image is formed at near point. 5

(b) A compound microscope has an objective of focal length 1.25cm and eyepiece of focal length 5cm. A small object is kept 2.5cm from the objective. If the final image is at infinity, find the distance between the objective and the eyepiece.

(OR)

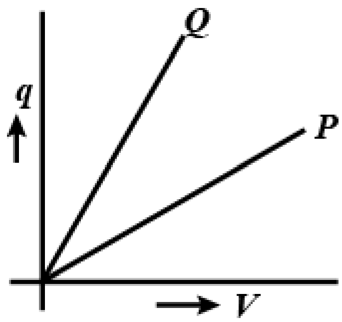
(a) What are coherent sources of light? State two conditions for light sources to be coherent.

(b) If 's' is the size of the source and 'b' its distance from the plane of the two slits, what should be the criterion for the interference fringes to be seen?

(c) Two slits are made 1mm apart and the screen is placed 1m away. 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?

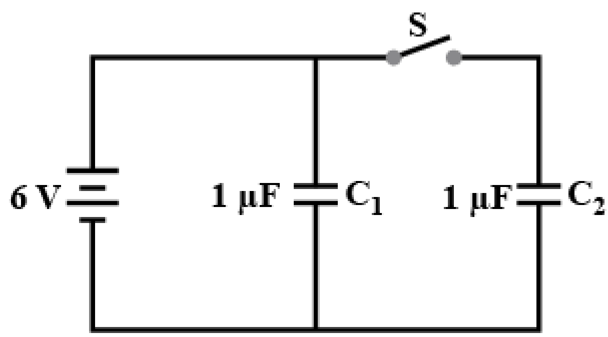
(d) How does the fringe width of interference fringes change, when the whole apparatus of Young's experiment is kept in water (refractive index 4/3)?

32. (a) The given graph shows the variation of charge 'q' with potential difference 'V' for two capacitors C_1 and C_2. The two capacitors have same plate separation but the plate area of C_2 is double that of C_1. Which of the two graphs P and Q corresponds to capacitors C_1 and C_2 and why? 5



(b) Obtain the expression for net capacitance when two capacitors of capacitance C_1 and C_2 are connected in parallel.

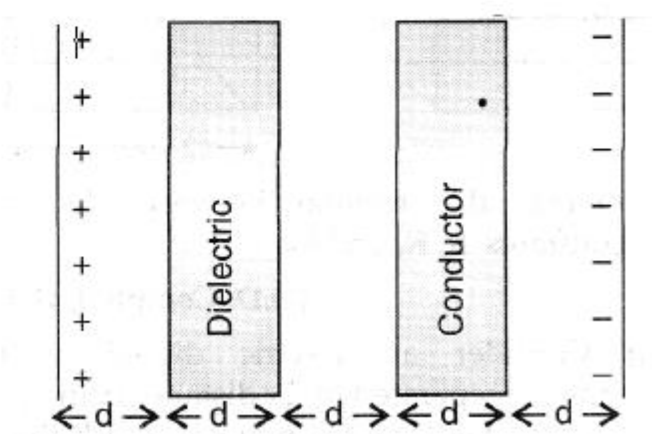
(c) Figure shows two identical capacitors, C_1 and C_2, each of 1μF capacitance connected to a battery of 6V. Initially switch 'S' is closed. After sometimes 'S' is left open and dielectric slabs of dielectric constant K=3 are inserted to fill completely the space between the plates of the two capacitors. How will the (i) charge and (ii) potential difference between the plates of the capacitors be affected after the slabs are inserted?



(OR)

(a) A dielectric slab of thickness 't' is kept between the plates of a parallel plate capacitor with plate separation 'd' (t < d). Derive the expression for the capacitance of the capacitor.

(b) Given two parallel conducting plates of area 'A' and charge densities '+σ' and '-σ'. A dielectric slab of constant 'K' and a conducting slab of thickness 'd' each are inserted between them as shown. (i) find the potential difference between the plates and (ii) plot 'E' Vs 'x' graph, taking x=0 at positive plate and x=5d at negative plate.



33. (a) Describe briefly, with the help of a labelled diagram, the working of a step-up transformer. 5

(b) A step-up transformer converts a low voltage into high voltage. Does it not violate the principle of conservation of energy? Explain.

(c) In an ideal transformer, number of turns in the primary and the secondary are 200 and 1000 respectively. If the power input to the primary is 10kW at 200V, calculate output voltage and current in primary.

(OR)

(a) Using phasor diagram for a series LCR circuit connected to an ac source of voltage, derive the relation for current flowing in the circuit and the phase angle between the voltage across resistor and the net voltage in the circuit.

(b) A 2μF capacitor, 100Ω resistor and 8H inductor are connected in series with an AC source. What should be the frequency of the source such that current drawn in the circuit is maximum?

(c) Draw a graph showing variation of amplitude of circuit current with changing frequency of applied voltage in a series LCR circuit for two different values of resistance R_1 and R_2 ($R_1>R_2$).