

CBSE
Class XII Physics
Sample Paper 3

Time: 3 Hours

Maximum Marks: 70

General Instructions:

1. All questions are compulsory. There are 33 questions in all.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. Section A contains ten very short answer questions and four assertion reasoning MCQs of 1 mark each, Section B has two case based questions of 4 marks each, Section C contains nine short answer questions of 2 marks each, Section D contains five short answer questions of 3 marks each and Section E contains three long answer questions of 5 marks each.
4. There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions

$$c = 3 \times 10^8 \text{ m/s}$$

$$h = 6.63 \times 10^{-34} \text{ Js}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$$

$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

$$\text{mass of neutron} = 1.675 \times 10^{-27} \text{ kg}$$

$$\text{mass of proton} = 1.673 \times 10^{-27} \text{ kg}$$

$$\text{Avogadro's number} = 6.023 \times 10^{23} \text{ per gram mole}$$

$$\text{Boltzmann constant} = 1.38 \times 10^{-23} \text{ JK}^{-1}$$

Section A

Directions (Q1-Q10) Select the most appropriate option from those given below each question.

1. The work done in bringing a unit positive charge from infinite distance to a point at distance x from a positive charge Q is W . What is the potential at that point?

OR

What is the value of dielectric Dielectric constant for a metal?

2. At room temperature 27°C , the resistance of a heating element is $100\ \Omega$. What will be the temperature of the element if the resistance is found to be $117\ \Omega$, provided the temperature coefficient of the material of the resistor is $1.70 \times 10^{-4}/^{\circ}\text{C}$.
3. In an L-R circuit, reactance and resistance are equal. By how much phase voltage differ current?
4. Which of the following is not a condition for sustained interference of light?
 - a) Two sources of light should emit light continuously.
 - b) Light waves should have different wavelength.
 - c) Two sources must lie close to each other.
 - d) Two sources must be very narrow.
5. What is the relation between n and n_h in n-type semiconductors?
6. A parallel plate capacitor with air as dielectric is charged by a DC source to a potential V . Without discharging the capacitor from its source, air is replaced by another dielectric medium of dielectric constant K . What would be the new energy stored in the capacitor (taking initial stored energy as U)
7. Magnetic field due to a current-carrying solenoid is
 - a) $\mu_0 n I$
 - b) $\frac{\mu_0 n I}{2r}$
 - c) zero
 - d) $\frac{\mu_0 n I}{2}$

OR

A charged particle of mass m and charge q travels on a circular path of radius r i.e., perpendicular to the magnetic field B . Find time taken by particle to complete one revolution?

8. What is the dimensional formula for current density?
9. Find the ratio of nuclear radii of the gold isotope $^{197}_{79}\text{Au}$ and the silver isotope $^{107}_{47}\text{Ag}$.

OR

Find the energy of photon of wavelength 450 nm .

10. What would happen to the width of the interference fringes in Young's double slit experiment, if the frequency of the source is increased?

OR

In Young's double slit experiment the two source S1 and S2 illuminated by two independent but identical sources, is it possible to observe interference pattern. Give reason for your answer.

For question numbers 11, 12, 13 and 14, 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 but 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

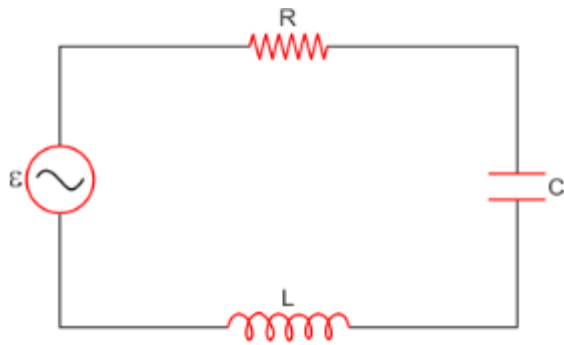
Directions (Q11–Q15) Fill in the blanks with the appropriate answer.

11. Assertion: An electric lamp connected in series with a variable capacitor and ac source, its brightness increases with increase in capacitance.
Reason: Capacitive reactance decrease with increase in capacitance of capacitor. in a conductor
12. Assertion: Bohr had to postulate that the electrons in stationary orbits around the nucleus do not radiate.
Reason: According to classical physical all moving electrons radiate.
13. Assertion: The drift velocity of electrons in a metallic wire will decrease, if the temperature of the wire is increased.
Reason: On increasing temperature, conductivity of metallic wire decreases.
14. Assertion: The strength of photoelectric current depends upon the intensity of incident radiation.
Reason: A photon of energy E possesses a mass equal to $m = \frac{E}{c^2}$ and momentum equal to $p = \frac{E}{c}$

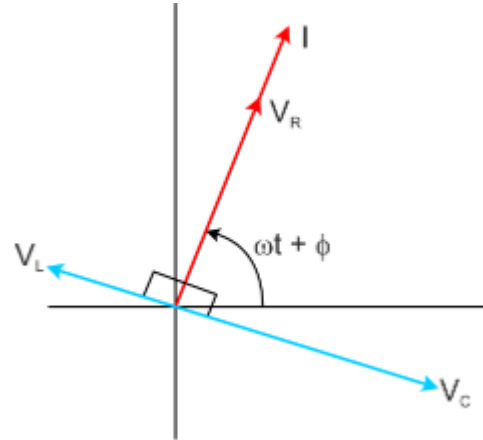
Section B

Questions 15 and 16 are Case Study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.

15. A series LCR circuit is connected to an a.c. source of variable frequency. A suitable phasor diagram for the amplitude of the current and phase angle has been mentioned below. Answer the following questions based on the concept of LCR circuit



Series LCR circuit
connected to an AC source

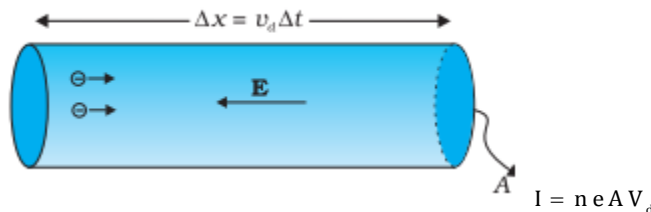


1. If $X_c > X_L$, and ϕ is positive, the circuit is predominantly
 - i. Inductive
 - ii. Capacitive
 - iii. Neutral
 - iv. None of these
2. If $X_c < X_L$, and ϕ is negative, the circuit is predominantly
 - i. Inductive
 - ii. Capacitive
 - iii. Neutral
 - iv. None of these
3. At resonant frequency
 - i. $\omega = \sqrt{\frac{L}{C}}$
 - ii. $\omega = \frac{1}{\sqrt{LC}}$
 - iii. $\omega = \sqrt{LC}$
 - iv. None of these
4. At resonant frequency the impedance of the LCR circuit is
 - i. Maximum
 - ii. Minimum
 - iii. $Z = \sqrt{R^2 + (X_c - X_L)^2}$
 - iv. None of these
5. The ratio $\frac{\omega_0 L}{R}$ is also called the quality factor, Q of the circuit .The larger the value of Q
 - i. The sharper the resonance
 - ii. The less sharp the resonance
 - iii. Resonance is independent of the value of Q
 - iv. None of these

16. Drift velocity is defined as the average velocity with which free electrons gets drifted in a direction opposite to that of electric field. Let's say m is the mass of the electron and e be the charge of electron then acceleration $a = eE/m$. As per the first equation of motion $V = u + at$. The average initial velocity $u = 0$ and final velocity $v = V_d$, time taken $t = \tau$ (relaxation time) then $V_d = a \tau$. On substituting the value of a we get $V_d = eE \tau / m$. Because of the drift, there will be net transport of charges across any area perpendicular to E . Consider a planar area A , located inside the conductor such that the normal to the area is parallel to E . Then because of the drift, in an infinitesimal amount of time Δt , all electrons to the left of the area at distances upto $|V_d| \Delta t$ would have crossed the area. If n is the number of free electrons per unit volume in the metal, then there are $n \Delta t |V_d| A$ such electrons. Since each electron carries a charge $-e$, the total charge transported across this area A to the right in time Δt is $-ne A |V_d| \Delta t$. E is directed towards the left and hence the total charge transported along E across the area is negative of this. The amount of charge crossing the area A in time Δt is by definition $I \Delta t$, where I is the magnitude of the current. Hence,

$$I \Delta t = ne A V_d \Delta t$$

$$I = ne A V_d$$



Now consider the following situation, Potential difference V is applied across the ends of copper wire of length l and diameter D .

1. When V is doubled the drift velocity of electron gets
 - i. Half
 - ii. Doubled
 - iii. Quadrupled
 - iv. Remain unchanged
2. When length(l) is doubled the drift velocity of electron gets
 - i. Half
 - ii. Doubled
 - iii. Quadrupled
 - iv. Remain Unchanged
3. When the diameter D is doubled the drift velocity of electron gets
 - i. Half
 - ii. Doubled
 - iii. Quadrupled
 - iv. Remain Unchanged
4. Mobility' of charge carriers in a conductor

- i. $\mu = \frac{e \tau}{m}$
 - ii. $\mu = \frac{e E}{m}$
 - iii. $\mu = \frac{n e A V_d}{m}$
 - iv. None of these
5. With increases in temperature the drift velocity of electrons in a metallic conductor will
- i. Decreases
 - ii. Increases
 - iii. Remains constant
 - iv. None of these

Section C

All questions are compulsory. In case of internal choices, attempt anyone.

17. Write the distinguishing features between a diffraction pattern due to a single slit and the interference fringes produced in Young's double slit experiment? (2)
18. Why is the NAND gate called a universal gate? How can it be used to realise a basic OR gate? (2)
19. What is modulation? What are the different types of modulation? (2)

OR

Distinguish between frequency modulation and amplitude modulation.

20. Nuclear density of hydrogen is $2.3 \times 10^{17} \text{ kg/m}^3$. Given $A = 56$ for iron, find its nuclear density. (2)
21. An electric bulb B and a parallel plate capacitor C are connected in series to the AC mains. The bulb glows with some brightness. How will the glow of the bulb be affected on introducing a dielectric slab between the plates of the capacitor? Give reasons in support of your answer. (2)

OR

15.0 μF capacitor is connected to a 220V, 50Hz source. Find the capacitive reactance and the rms current in the circuit. If the frequency is doubled, what happens to the capacitive reactance and the current? (2)

22. Find the current flowing through a copper wire of length 0.2 m, area of cross-section 1 mm^2 , when connected to a battery of 4 V. Given that electron mobility = 4.5×10^{-6}

$\text{m}^2 \text{V}^{-1} \text{s}^{-1}$ and charge on electron = $1.6 \times 10^{-19} \text{ C}$. The number of density of electrons in copper is $8.5 \times 10^{28} \text{ m}^{-3}$. (2)

23. On which factors does the internal resistance of a cell depend? (2)
24. In Young's double slit experiment using monochromatic light of wavelength λ , the intensity at a point on the screen where the path difference is λ is K units. What is the intensity of light at a point where the path difference is $\lambda/3$? (2)
25. An electron, α -particle and a proton have the same de Broglie wavelength. Which of these particles has (i) minimum kinetic energy, (ii) maximum kinetic energy, and why? (2)

OR

Why does photoelectric emission not take place if the frequency of incident radiation is less than the threshold value?

Section D

All questions are compulsory. In case of internal choices, attempt anyone.

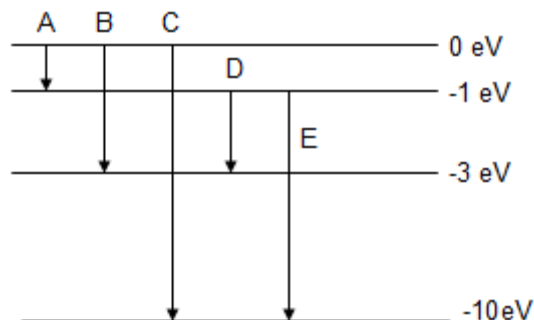
26. Explain how a transistor can be used as a switch. (3)
27. Magnetic field at the centre of a circular loop of area A carrying current I is B. What is the magnetic moment of this loop? (3)
28. A parallel plate capacitor is charged to potential V by a source of emf E. After removing the source, the separation between the plates is doubled. How will the following change
(i) electric field
(ii) potential difference
(iii) capacitance of the capacitor (3)
29. For a transistor, the current amplification factor is 0.8 when the transistor is connected in common emitter configuration. Calculate the change in the collector current when the base current changes by 6 mA. (3)

OR

When a transistor amplifier of current gain of 75 is given an input signal, $V_i = 2 \sin(157t + \pi/2)$, the output signal is found to be $V_o = 200 \sin(157t + 3\pi/2)$.

In which mode is the transistor being used? Justify your result with proper explanation.

30. The energy levels of an atom of an element are shown in the following diagram. Which one of the level transitions will result in the emission of photons of wavelength 620 nm? Support your answer with mathematical calculations. (3)



OR

In the fusion reaction ${}_1\text{H}^2 + {}_1\text{H}^2 \rightarrow {}_2\text{He}^3 + {}_0\text{n}^1$, the masses of deuteron, helium and neutron expressed in amu are 2.015, 3.017 and 1.009, respectively. If 1 kg deuterium undergoes complete fusion, find the amount of total energy released.

Section E

All questions are compulsory. In case of internal choices, attempt anyone.

31. Write the logic symbol and truth table of an AND gate. Explain how this gate is realised in practice by using two diodes. (5)

OR

A transistor is used in common emitter mode in an amplifier circuit. When a signal of 20 mV is added to the base-emitter voltage, the base current changes by 20 μA and the collector current changes by 2 mA. The load resistance is 5 $\text{k}\Omega$. Calculate (a) the factor β , (b) input resistance R_{BE} , (c) transconductance and (d) voltage gain. (5)

32.

- (a) State Lenz's law. Which conservation law can be used to explain this law?
- (b) A wheel with 10 metallic spokes each 0.5m long is rotated with a speed of 120 rev/min in a plane normal to the horizontal component of the Earth's magnetic field at a place where the Earth's field is $0.4 \times 10^{-4} \text{ T}$. What is the induced emf between the axle and the rim of the wheel?
- (c) Two moving coil meters M_1 and M_2 have the following particulars:
- $R_1 = 10 \Omega$, $N_1 = 30$,
 $A_1 = 3.6 \times 10^{-3} \text{ m}^2$, $B_1 = 0.25 \text{ T}$
 $R_2 = 14 \Omega$, $N_2 = 42$
 $A_2 = 1.8 \times 10^{-3} \text{ m}^2$, $B_2 = 0.50 \text{ T}$

(The spring constants are identical for the two meters). Determine the ratio of (a) current sensitivity and (b) voltage sensitivity of M_2 and M_1 . (5)

OR

- (a) An electron and a proton moving with the same speed enter a uniform magnetic field B perpendicularly. Which particle will have larger radius of its circular path? Find the ratio of their radii. The masses of electron and proton are 9.1×10^{-31} kg and 1.67×10^{-27} kg.
- (b) Show that for a moving charged particle in a uniform magnetic field, the kinetic energy of the particle remains constant.
- (c) A coil placed in the plane of the page has a current in the clockwise direction when looking from above. What will be the change in the magnetic field at the centre of the coil if
 - (i) the current through the coil is reduced to half
 - (ii) the radius of the coil is doubled
 - (iii) what will be the direction of the magnetic field

(5)

33.

- (i) When monochromatic light is incident on a surface separating two media, the reflected and refracted light both have the same frequency as the incident frequency. Explain why?
- (ii) When light travels from a rarer to a denser medium, the speed decreases. Does this decrease in speed imply a reduction in the energy carried by the wave?
- (iii) In the wave picture of light, intensity of light is determined by the square of the amplitude of the wave. What determines the intensity in the photon picture of light?
- (iv) Calculate the distance of an object of height 'h' from a concave mirror of radius of curvature 20 cm, so as to obtain a real image of magnification 2. Find the location of image also.
- (v) Using mirror formula, explain why does a convex mirror always produce a virtual image

(5)

OR

Prove that $\frac{-\mu_1}{u} + \frac{\mu_2}{v} = \frac{\mu_2 - \mu_1}{R}$ when refraction occurs from a rarer to a denser medium at a convex refracting spherical surface.