CBSE Sample Paper-01
Class – XII Physics (Theory)

Time allowed: 3 hours **M. M: 70**

General Instructions:

a) All the questions are compulsory.
b) There are **26** questions in total.
c) Questions **1** to **5** are very short answer type questions and carry **one** mark each.
d) Questions **6**to **10** carry **two** marks each.
e) Questions **11** to **22** carry **three** marks each.
f) Question No. **23** carry **four** marks each.
g) Questions **24** to **26** carry **five** marks each.
h) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions in five marks each. You have to attempt only one of the choices in such questions.
i) Use of calculators is **not** permitted. However, you may use log tables if necessary.
j) You may use the following values of physical constants wherever necessary:

$c = 3x10^8 m/s$

$h = 6.63x10^{-34} Js$

$e = 1.6x10^{-19} C$

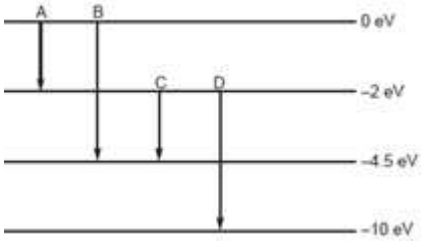
$\mu_o = 4\pi x10^{-7} TmA^{-1}$

$\frac{1}{4\pi\varepsilon_0} = 9x10^9 Nm^2C^{-2}$

$m_e = 9.1x10^{-31} kg$

1. Explain why two field lines never cross each other at any point?
2. The earth's core is known to contain iron. Yet geologists do not regard this as a source of the earth's magnetism. Why?
3. What do mean by alternating current AC.
4. How the photocurrent Varies with intensity of light.
5. What is the minimum & maximum value of modulation index?
6. What do you mean by an ideal dipole and what is the nature of electric field symmetry of the dipole?
7. What is the magnetic moment of an electron orbiting in a circular orbit of radius r with a speed v?
8. Velocity of light in a liquid is $1.5\times10^8 m/s$ and in air it is $3\times10^8 m/s$. If a ray of light passes from liquid into the air, calculate the value of critical angle.
9. Name a device that converts the change in intensity of illumination into changes in electric current. Give three applications of this device.
10. Define Hertz antenna and Marconi antenna.
11. (a) What is meant by energy density of a parallel plate capacitor? Derive its expression also.
    (b) What is the area of the plates of a 2 Farad parallel plate air capacitor, given that the separation between the plates is 0.5 cm?
12. (a) For the given carbon resistor, let the first strip be yellow, second strip be red, third strip be orange and forth be gold. What is its resistance? (b) What are thermistors?

13. State Ampere's circuital law. Also find the expression for the magnetic field due to the infinite long straight wire carrying current by using this law.
14. (a) What do you mean by hypermetropia? What are its possible cause and how it is corrected?
    (b) A hypermetropic person whose near point is at 100 cm wants to read a book at 25 cm. Find the nature and power of the lens needed.
15. Light falls from glass (n = 1.5) to air. Find the angle of incidence from which the angle of deviation is 90^0?
16. (a) Represent the AM process graphically.
    (b) Write its two advantages
17. Prove that a convex lens produces an n times magnified image when the object distances from the lens have magnitude $\left(f \pm \frac{f}{n} \right)$. Here f is the magnitude of the focal length of the lens. Hence find the two values of object distance for which a convex lens of power 2.5 D will produce an image that is four times as large as the object.
18. Calculate the de-Broglie wavelength of a beam of electrons, accelerated through a potential difference of 10 kV.
19. (a) The energy levels of a hypothetical hydrogen-like atom are shown below diagram. Find out the transition, from the ones shown in the diagram, which will result in the emission of a photon of wavelength 275 nm.



    (b) Which of these transitions corresponds to the emission of radiation of (i) maximum and (ii) minimum wavelength?
20. Draw plot of the variation of amplitude versus ω for an amplitude modulated wave. Define modulation index. State its importance for effective amplitude modulation.
21. Distinguish between nuclear fusion and fission
22. In a diode AM demodulation the output circuit consists of R = 1 $k\Omega$ and C= 10pF.a carrier signal of 100 kHz, is to be demodulated. Is the given set-up good for this purpose? If not suggest a value of C that would make the diode circuit good for demodulating this carrier signal.
23. Ram had gone out of station, on a vacation for one week. After coming back, he tried to start his car but failed. He realized that he needs to charge the battery of his car. He went to the workshop to hire a battery charger. Ram connected the black lead of the battery charger to the positive terminal of the car battery and the red lead to the negative terminal of the car battery. The car battery was not charged. Ram thought over it and decided to reverse the leads. Now he was successful in charging the car battery.
    (a) What according to you are the values displayed by Ram?
    (b) How should a battery charger be connected to a car battery?
24. (a) Derive the expression for the torque on an electric dipole placed in a uniform electric field.
    (b) A pendulum bob of mass 80 mg carrying a charge of 2×10^{-8} C is at rest in a horizontal uniform electric field of 2×10^4 V/m. Find the tension in the thread of the pendulum and the angle it makes with the vertical.
25. (a) Write the laws of electromagnetic induction.

(b) An express train takes 16 hours to cover the distance of 960 km. The rails are separated by 130 cm and the vertical component of the earth's magnetic field is 4×10^{-5} T. (i) Find the induced emf across the width of the train. (ii) If the leakage resistance between the rails is 100 ohm, find the retarding force on the train due to the magnetic field.

26. (i) Define the term drift velocity.

(ii) On the basis of electron drift, derive an expression for resistivity of a conductor in terms of number density of free electrons and relaxation time. On what factors does resistivity of a conductor depend?

(iii) Why alloys like constantan and manganin are used for making standard resistors?

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Solutions

1. If two field lines cross each other at a point, then electric field intensity will show two directions at that point. This is not possible. Hence, two field lines never cross each other.
2. Earth's core contains molten iron. This form of iron is not ferromagnetic. Hence, this is not considered as a source of earth's magnetism.
3. The electrical main supply in our homes and offices is a voltage that varies like a sin wave with time. Such a voltage is called an alternating voltage and the current driven by it is called alternating current AC.
4. Photocurrent increases with the intensity of light.
5. modulation index $\mu \leq 1$
6. An electric dipole whose size is very small or negligible is called an ideal dipole. The nature of symmetry of electric field is cylindrical.
7. We know that the orbiting electron behaves as a current loop. The current due to orbital motion of the electron is

   $I = \frac{e}{T} = \frac{e}{2\pi r/v} = \frac{ev}{2\pi r}$

   Area of the current loop (A) = πr^2

   Magnetic moment of current loop = IA = $\frac{ev}{2\pi r} \times \pi r^2 = \frac{evr}{2}$
8. v = 1.5 × 10^8 m/s, c = 3 × 10^8 m/s $\mu = \frac{c}{v} = \frac{1}{SinC}$

   $\text{Sin C} = \frac{v}{c} = \frac{1.5\times10^8}{3\times10^8} = 0.5$

   $C = \text{Sin}^{-1}(0.5) = 30°$
9. A photoelectric cell converts changes in intensity illumination into changes in electric current. The applications of photoelectric cell are (i) in burglar alarm, (ii) in fire alarm and (iii) in the reproduction of sound from films in cinema halls.
10. A Hertz antenna is a straight conductor of length equal to half the wavelength of radio signals to be transmitted or received. This antenna is not grounded.
    A Marconi antenna is a straight conductor of length equal to quarter of the wavelength of radio signals to be transmitted or received. It held vertically with its lower end touching with the ground.
11. (a) It is defined as the total energy stored per unit volume of the capacitor.
    Expression:

    $u = \frac{\text{total energy(U)}}{\text{volume(V)}} = \frac{\frac{1}{2}CV^2}{Ad} = \frac{1}{2}\left(\frac{\in_0 A}{d}\right)\left(\frac{E^2d^2}{Ad}\right)$

    $u = \frac{1}{2}\in_0 E^2$

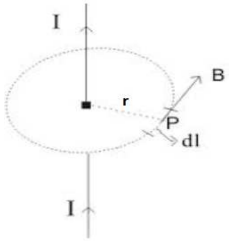
    (b) C = 2 Farad, d = 0.5 cm = 5 × 10^{-3} m, $\in_0$ = 8.85 × 10^{-12} $C^2N^{-1}m^{-2}$, A = ?

$C = \frac{\epsilon_0 A}{d}$

$A = \frac{Cd}{\epsilon_0} = \frac{2\times5\times10^{-3}}{8.85\times10^{-12}} = 1.13 \times 10^9\ m^2.$

12. (a) As we know that the numbers for yellow, red and orange are 4, 2 and 3. Gold represents tolerance of ± 5%.
    Thus, the value of resistance is $42 \times 10^3\ \Omega$ ± 5%.
    (b) A thermistor is a heat sensitive device whose resistivity changes very rapidly with change of temperature.
13. It states that the line integral of magnetic field induction $\vec{B}$ around a closed path in vacuum is equal to μ_0 times the total current I threading the closed path. Expression for the magnetic field:

    Consider an infinite long straight wire lying in the plane of paper. Let I be the current flowing through it from X to Y. A magnetic field is produced which is has the same magnitude at all the points that are at the same distance from the wire, i.e., the magnetic field has cylindrical symmetry around the wire.



    Let P be a point at a perpendicular distance r from the straight wire and $\vec{B}$ be the magnetic field at point P. Now consider an ampereian loop as a circle of radius r, perpendicular to the plane of paper with centre on the wire such that point P lies on the loop. The magnitude of the magnetic field is same at all points on this loop. The magnetic field is tangential to the circumference of the circular loop. The line integral $\vec{B}$ round the closed loop is:

$$\oint \vec{B}.d\vec{l} = \oint B\,dl\,Cos0° = B\oint dl = B\,2\pi r$$

    Now by using the Ampere's circuital law

$$\oint \vec{B}.d\vec{l} = \mu_0 I$$

$$B\,2\pi r = \mu_0 I$$

    Or

$$B = \frac{\mu_0 I}{2\pi r} = \frac{\mu_0}{4\pi}\frac{2I}{r},$$

14. (a) It is the defect of human eye by virtue of which the eye can see clearly the far off objects but the nearby objects cannot be seen clearly. In case of hypermetropia, the near point shifts away from the eye.
    The main causes of this defect is:
    (i) contraction in the size of the eye ball (ii) increase in the focal length of eye lens.
    To correct this defect, the person has to use the spectacles with convex lens of suitable focal length.
    (b) u = - 25 cm, v = - 100 cm, f = ?
    By using lens equation,

$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$$

$$\frac{1}{f}=\frac{1}{25}-\frac{1}{100}=\frac{3}{100}$$

f = 100/3 = 33.3 cm

P = 100/f = 100/(100/3) = 3 D.

15. Since

$$\sin i_e=\frac{1}{n}=\frac{1}{1.5}=0.6667$$

$$i_e=41.8^0$$

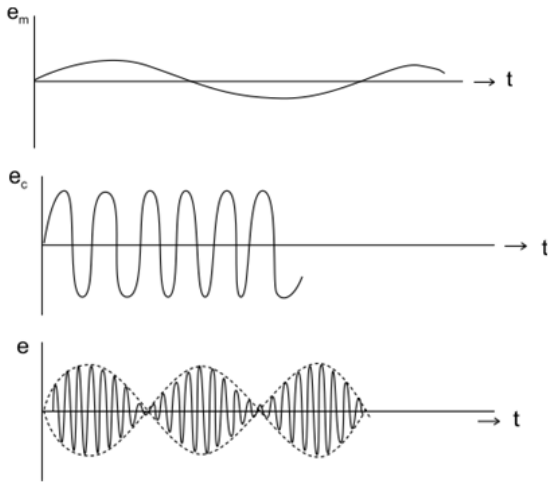
Deviation = $90^0 - i_c = 90^0 - 41.8^0 = 48.2^0$

This is the maximum attainable deviation in refraction.

In reflection deviation = $180^0 - 2i$

Therefore $i = 45^0$

16.



Advantages:

(i) For speech transmission

(ii) Short range distance communication.

17. $m = \frac{f}{u+f}$

When image is real, m = – *n*.

$$\therefore\ -n=\frac{f}{u+f}\ \ or\ \ u+f=-\frac{f}{n}\ \ or\ \ u=-\left(f+\frac{f}{n}\right)....(i)$$

When image is virtual, *m* = *n*.

$$\therefore\ \ n=\frac{f}{u+f}\ \ or\ \ u+f=-\frac{f}{n}\ \ or\ \ u=-\left(f-\frac{f}{n}\right)....(ii)$$

It follows from (i) and (ii) that the magnitude of the object distance is $\left(f\pm\frac{f}{n}\right)$.

Focal length of lens = $\frac{1}{2.5}m=\frac{1}{2.5}\times 100\ cm$

Now, $\pm 4 = \frac{40}{u+40}$

u = – 30cmor – 50 cm

18. The de-Broglie wavelength λ of electron

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}}$$

(Since k=eV and K = $\frac{1}{2}mv^2 = \frac{p^2}{2m'}$ $p = \sqrt{2mK} = \sqrt{2meV}$)

$$\lambda = \frac{h}{\sqrt{2meV}}$$

Putting values of h, m and e we get

$$\lambda = \frac{6.626 \text{ x } 10^{-34}}{\sqrt{2 \text{ x } 9.1 \text{ x } 10^{-31} \text{ x } 1.6 \text{ x } 10^{-19} \text{ x V}}}$$

$$\lambda = \frac{1.227}{\sqrt{V}}$$

Given V = 10 kV = 10 x 10^3 V = 10^4 V

$$\lambda = \frac{1.227}{\sqrt{10^4}} = \frac{1.227}{100} = 0.01227nm$$

$\lambda = 0.01227$ x 10^{-9} m = 0.1227 x 10^{-10} m

19. (a) The energy of photon of wavelength (275 nm) in terms of eV can be given as $E = \left(\frac{\lambda c}{e\lambda}\right)eV$

$$E = \frac{6.6 \text{ x } 10^{-34} \text{ x } 10^8}{1.6 \text{ x } 10^{-19} \text{ x } 275 \text{ x } 10^{-9}}$$

$$E = \frac{19.8}{1.6 \text{ x } 275} \text{ x } 10^2 eV = 435eV$$

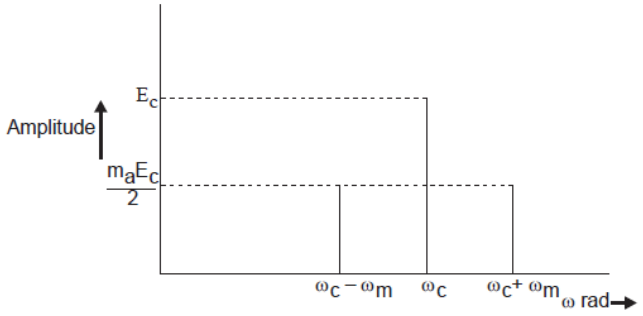
The energy of photon in transition $B\Delta E = [0eV - (-4.5eV)] = 4.5eV$. Hence transition B is possible.

(a) The wavelength of the photon in a transition is given by $\lambda = \frac{\lambda c}{\Delta E}$

(b) Maximum wavelength of photon is possible for transition having minimum ΔE, so transition 'A' is possible with ΔE = 2eV.

(c) Minimum wavelength of the photon is possible for transition having maximum energy difference. So transition D is possible with ΔE =10eV.

20. Plot of variation of amplitude versus ω for amplitude modulated wave is shown below.



Modulation Index – the ratio of amplitude of modulating signal to the amplitude of carrier wave is called modulation index.

$$m_a = \frac{E_m}{E_c}$$

For effective amplitude modulation index determines the distortions, so its value is kept< 1 for avoiding distortions.

21.

S.No	Nuclear Fission	Nuclear Fusion
1	It's a process in which a heavy unstable nucleus disintegrates into two or more lighter and relatively stable nuclei.	It's a process in which two small, lighter nuclei combine to form stable heavy nucleus.
2	The product of nuclear fission is radioactive in nature	The product is stable and non-radioactive in nature.
3	It can be controlled and hence can be used for peaceful purposes.	It is yet to be controlled.

22. Given

R = 1 $k\Omega$ = $10^3\,\Omega$

C = 10pF = 10 x 10^{-12} F = 10^{-11} F

RC = 10^3 x 10^{-11} s = 10^{-8} s

We find that $\frac{1}{f_c}$ is not less than RS as is required for demodulation. Therefore, the arrangement is not good.

For satisfactory arrangement, let us try

$C = 1\mu F = 10^{-6}\,F$

$\therefore RC = 10^3 \text{ x } 10^{-6} s = 10^{-3} s$

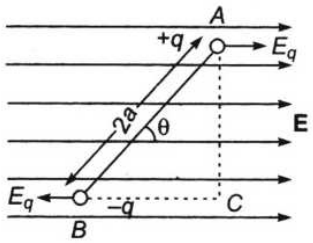
Now $\frac{1}{f_c}(=10^{-5} s) << RC(=10^{-3} s)$

The condition is satisfied. This is good enough for demodulation.

23. (a) Ram is a very active and smart person. He has a scientific temperament. He is not easily discouraged. He applies his mind to solve a problem.

(b) The positive and negative of the battery charger should be connected to the positive and negative respectively of the battery to be charged.

24. (a) Let us consider an electric dipole having two equal and opposite charges + q and – q placed at points A and B which are separated by a distance 2a. It is placed in an uniform electric field region of intensity E at an angle θ with the direction of electric field.



Force on charge + q at A = q $\vec{E}$,along the direction of $\vec{E}$

Force on charge - q at B = q $\vec{E}$,along the direction opposite to $\vec{E}$

As the electric field is uniform, so the net force on the dipole is zero. The forces are equal and opposite to each other acting at two different points. So they form a couple which rotates the dipole in anticlock wise direction.

Now, torque on the dipole = either force × perpendicular distance between the two forces

τ = F × AC

= F × AB Sinθ

= F × 2a Sinθ

= qE × 2a Sinθ

= p × E Sinθ

$\vec{\tau} = \vec{p} \times \vec{E}$

The direction of torque is given by the right handed screw rule and is perpendicular to p vector and E vector both.

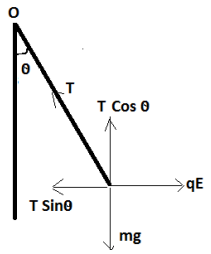
Special cases: (i) If $\theta = 0°$, then $\tau = 0$

(ii) If $\theta = 90°$, then $\tau = pE$

(iii) If $\theta = 180°$, then $\tau = 0$.

(b) Here, m = 80 mg = 80 × 10^{-6} kg, q = 2 × 10^{-8} C, E = 2 × 10^{4} V/m

Let T be the tension in the string and θ be the angle it makes with the vertical.



In the equilibrium condition,

T Sinθ = qE ....(1)

T Cosθ = mg ....(2)

On diving equation (1) by equation (2), we get

$$\tan\theta = \frac{qE}{mg} = \frac{\left(2\times10^{-8}\times2\times10^{-4}\right)}{\left(80\times10^{-6}\times9.8\right)} = 0.5102$$

$\tan\theta = 27°$

Now put the value of θ in equation (1), we get

$$T = \frac{qE}{Sin\theta} = \frac{\left(2\times10^{-8}\times2\times10^{-4}\right)}{Sin27°} = 8.801\times10^{-4}\ N$$

25. **(a):** There are two laws of electromagnetic induction.

First law: Whenever the amount of magnetic flux linked with a circuit changes, an emf is induced in the circuit. The induced emf lasts as long as the change in the magnetic flux continues.
Second law: The magnitude of emf induced in a circuit is directly proportional to the rate of change of magnetic flux linked with the circuit.

e = $\frac{-d\phi}{dt}$

Where, dϕ is the change in magnetic flux in time dt. The negative sign shows that the induced emf opposes any change in magnetic flux associated with the circuit.

If there are N turns in the coil, then the induced emf in the coil is

e = $\frac{-Nd\phi}{dt}$

(b) v = 960 km / 16 h = 60 km/h = 16.67 m/s

Magnetic field B = 4×10^{-5} T, l = 130 cm = 1.3 m

Induced emf, e = Bvl = $4 \times 10^{-5} \times 16.67 \times 1.3 = 8.6 \times 10^{-4}$ V

Leakage current, i = e / R = $8.6 \times 10^{-4} / 100 = 8.6 \times 10^{-6}$ A

Retarding force, F = B i l = $4 \times 10^{-5} \times 8.6 \times 10^{-6} \times 1.3 = 4.47 \times 10^{-10}$ N.

26. (i) The average velocity of all the free electrons in the conductor with which they get drifted towards the positive end of the conductor under the influence of an external electric field is called the drift velocity.

(ii) $v_d = \frac{-eE\tau}{m}$

We have E = $-\frac{v}{l}$, where V is potential difference across the length 'ℓ' of the conductor

$v_d = \frac{eV\tau}{m\ell}$

Current flowing $I = neAv_d$

$I = neAv_d \frac{eV\tau}{m\ell} = \frac{ne^2AV\tau}{m\ell}$

$\frac{I}{V} = \frac{ne^2A\tau}{m\ell} = \frac{1}{R}$ ..... (i)

Also, R = $\rho\frac{\ell}{A}$ ..... (ii)

Comparing (i) and (ii)

$\rho = \frac{m}{ne^2\tau}$

Resistivity of the material of a conductor depends on the relaxation time, i.e., temperature and the number of density of electrons.

(iii) Because constantan and manganin show very weak dependence of resistivity on temperature.