Sample Paper (CBSE)

PHYSICS (Theory)

Time Allowed: 3 hours   *Maximum Marks: 70*

General Instructions:

(i)   All questions are compulsory.

(ii)   This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(iii)   Section A contains five questions of one mark each, Section B contains five questions of two marks each, Section C contains twelve questions of three marks each, Section D contains one value based question of four marks and Section E contains three questions of five marks each.

(iv)   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 of five marks each weightage. You have to attempt only one of the choices in such questions.

(v)   You may use the following values of physical constants wherever necessary:

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

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

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

$\mu_o = 4\,\pi \times 10^{-7}$ T mA^{-1}

$\dfrac{1}{4\pi\epsilon_o} = 9 \times 10^9$ N m^2 C^{-2}

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

Mass of Neutrons $= 1.675 \times 10^{-27}$ kg

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

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

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

Section A

1. In which orientation, a dipole placed in a uniform field is in stable and unstable equilibrium? 1

2. A beam of alpha particles projected along +x-axis, experiences a force due to a magnetic field along the +y-axis. What is the direction of magnetic field? 1

3. A converging lens of refractive index 1.5 is kept in a liquid medium having the same refractive index. What would be the focal length of the lens in the medium? 1

4. Figure shows a plot of three curves a, b and c showing the variation of photocurrent (I) versus collector plate potential for three different intensities I_1, I_2 and I_3 having frequencies v_1, v_2 and v_3 respectively incident on a photosensitive surface. Which two curves have same frequency of incident radiations but different intensities? 1
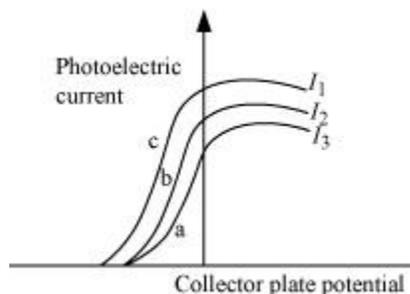
5. What is the ratio of number of holes and the number of conduction electrons in an n-type extrinsic semiconductor? 1

Section B

6. 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 2d/3, 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. 2

7. Three cells of emf 2V, 1.8 V and 1.5 V are connected in series. Their internal resistances are 0.05 Ω, 0.7 Ω and 1 Ω respectively. If this battery is connected to an external resistance of 4 Ω, calculate
   a. The total current flowing in the circuit.
   b. The potential difference across the terminals of the cell of emf 1.5 V while in use. 2

8. Draw a neat labeled ray diagram of a compound microscope. Briefly explain its working. 2

9. Define the term magnetic dipole moment of a current loop. Write the expression for the magnetic moment when an electron revolves at a speed v around an orbit of radius r in hydrogen atom. 2

10. How much current is drawn by the primary coil of a transformer which steps down 220 V to 22 V to operate device with an impedance of 220 ohm. 2

Section C

11. a. Define the quality factor in an a.c. circuit. Why should the quality factor have high value in receiving circuits?

b. When current in a coil changes with time, how is the back emf induced in the coil related to it?   3

12. What is the frequency range of gamma radiations? Write down its two uses. Why microwaves are used in radar?   3

13. For a ray of monochromatic light passing through a glass prism, draw a graph to show the variation of the angle of deviation with angle of incidence. When does the ray suffer minimum deviation?   3

14. Which type of biasing gives a semiconductor diode a very high resistance? With the help of diagram, explain the working of a transistor as an oscillator.   3

15. Write down the advantages of AM over FM transmission.   3

16. You are given n resistors each of resistance r. These are first connected to get minimum resistance. In the second case, these are again connected differently to get maximum possible resistance. Compute the ratio between the minimum and maximum values of resistance so obtained.   3

17. A 100 mH inductor, a 25 µF capacitor and a 15 Ω resistor are connected in series to a 120 V, 50 Hz a.c. source. Calculate

a. Impedance of the circuit at resonance

b. Current at resonance

c. Resonant frequency   3

18. What are coherent sources of light? Deduce an expression for the intensity at a point on the screen in Young's double slit experiment.   3

19. a. An electron, an alpha particle and a proton have the same kinetic energy. Which one of these particles has the largest de-Broglie wavelength?

b. An electromagnetic wave of wavelength λ is incident on a photosensitive surface of negligible work function. If the photo-electrons emitted from this surface have de-Broglie wavelength λ_1, then prove that   3

$$\lambda = \frac{2mc}{h}\lambda_1^2$$

20. The wavelength of the first line of Lyman series of hydrogen is identical to that of the second line of Balmer series in hydrogen-like ion X. Calculate energies of first four levels of X. Given that ground state binding energy of hydrogen atom -13.6 eV.   3

21. What do you mean by activity of a radioactive material? Two radioactive nuclei X and Y initially contain an equal number of

atoms. Their half life is 1 hour and 2 hours respectively. Calculate the ratio of their rates of disintegration after two hours.   3

22. Identify the logic gate represented by the circuit and write its truth table. Draw its logic symbol.   3
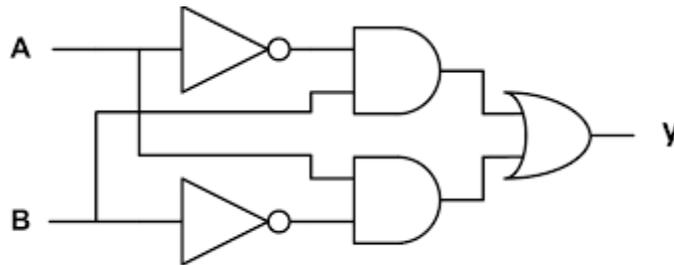
Section D

23. Monica was watching her favorite TV serial suddenly the picture started shaking on TV screen. She asked her brother to check the dish antenna. Her brother found no problem in dish. Monica noticed the same problem in TV picture again after some time. At the same time she heard the sound of low flying air craft passing over their house. She asked her brother again. He explained the cause of shaking picture on TV screen when air craft passes over head.

a. Name the values used by Monica's brother?

b. Why the picture on the TV screen was shaking when air craft was passing over head?

c. Which mode of communication is used for the transmission of T.V. signals?   4

Section E

24. Draw a labeled diagram of Van de Graff generator. State its
     working principle to show how by introducing a small charged
     sphere into a larger sphere, a large amount of charge can be
     transferred to the outer sphere. State the use of this machine
     and also point out its limitations.   5

OR

State Gauss's theorem in electrostatics. Apply this theorem to
derive an expression for electric field intensity at a point near
an infinitely straight charged wire.   5

25. a. Explain the principle, construction and working of a
        cyclotron with the help of a schematic diagram.
     b. What is cyclotron frequency? Write its expression.   5

OR

a. Find the force between two parallel conductors carrying
   current in (i) the same direction (ii) in opposite direction
   and hence define one ampere.
b. A long straight wire AB carries a current I. A proton travels
   with a speed v, parallel to the wire, at a distance d from it
   in a direction opposite to the current. What is the force
   experienced by the proton and what is its direction?   5

26. a. Give two differences between fringes formed in single slit

diffraction and Young's double slit experiment.

b. State the condition under which the phenomenon of diffraction of light takes place. Derive an expression for the width of central maximum due to diffraction of light at a single slit. **5**

OR

a. What is an unpolarised light? Explain with the help of a suitable ray diagram, how an unpolarised light can be polarized by reflection from a transparent medium. Write the expression for Brewster angle in terms of the refractive index of the denser medium.

b. An unpolarised beam of light of intensity I_0 is incident on a combination of two polaroids. Find the net intensity of light of intensity transmitted by the combination, when the pass axis of the two polaroids are inclined to each other at an angle of 60°. **5**

ANSWERS

1. For stable equilibrium the angle between dipole moment and electric field is zero and for unstable equilibrium it is 180°.

2. From Fleming's left hand rule, the direction of magnetic field is along –Z axis.

3. Infinity

4. a and b

5. Less than 1

6.

$$C = \frac{3\epsilon_0 AK}{d(2+K)}$$

7. a. Current in the circuit $I = \frac{\text{total emf}}{\text{tatal resistance}} = 0.92$ A

   b. The potential difference across the terminals of the cell of emf 1.5 V=ε-Ir=0.58 V

8.
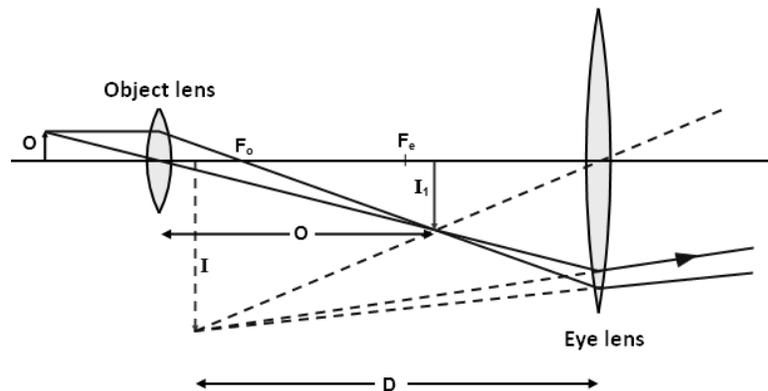
9. Magnetic dipole moment of current loop is the product of current I and area A enclosed by the loop of current. The expression for the magnetic moment when an electron revolves at a speed v around an orbit of radius r in hydrogen atom is given by

$$M = n\left(\frac{eh}{4\pi m}\right)$$

10. Using the equation

$$\frac{I_p}{I_s} = \frac{E_s}{E_p}$$

We get $I_p = 10^{-2}\ A$

11. a. The quality factor in an a.c. circuit is defined as the ratio of the voltage developed across the inductance or capacitance at resonance to the impressed voltage, which is the voltage applied across R. The quality factor should have high value in receiving circuits because higher the value of Q, the narrower and sharper is the resonance.
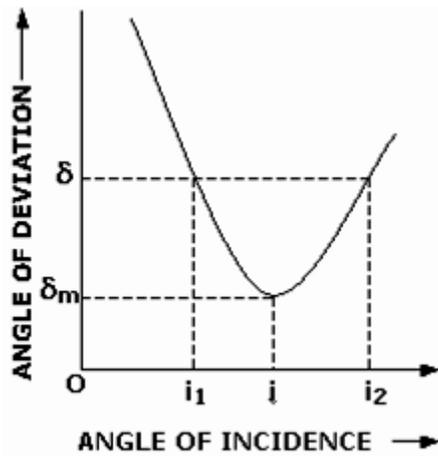
b. $e = -L\dfrac{dI}{dt}$

12. The frequency range of gamma radiations is 3×10^{19} Hz to 5×10^{20} Hz.

Uses:

a. Radiotherapy

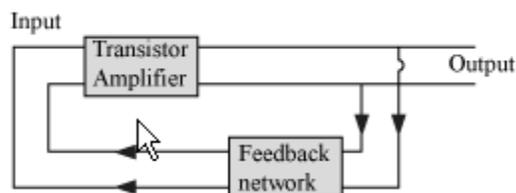b. Producing nuclear reactions.

Because they can travel in a particular direction in the form of a beam.
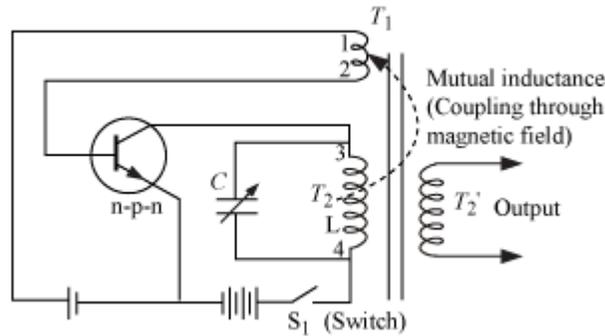
13.

The ray suffers minimum deviation, when there is only one angle of incidence.

14. Reverse biasing gives a semiconductor diode a very high resistance.

Block Diagram of Feedback Oscillator

Circuit Diagram of Transistor Oscillator

15. FM transmission requires much wider channel and much smaller area of reception.

16. For minimum possible resistance:

$$\frac{1}{R_{min}} = \frac{1}{r} + \frac{1}{r} + \cdots n\ times = \frac{n}{r}$$

Therefore, $R_{min} = \frac{r}{n}$

For maximum possible resistance:

$$R_{max} = r + r + \cdots . n\ times = nr$$

$$\therefore \frac{R_{min}}{R_{max}} = \frac{1}{n^2}$$

17. Using the equations:

$$Z = R\ at\ resonance, I_v = \frac{E_v}{R}\ and\ v = \frac{1}{2\pi\sqrt{LC}}$$

We get,

   a. $Z = 15\ \Omega$

   b. $I_v = 8A$

   c. $v = 100.7\ Hz$

18. Two sources of light are said to be coherent if they emit light waves of same frequency or wavelength and of a stable phase difference.

An expression for the intensity at a point on the screen in Young's double slit experiment is given by:

$$I = a_1^2 + a_2^2 + 2a_1 a_2 cos\varphi$$

19. An electron has the largest de-Broglie wavelength as $\lambda = \dfrac{h}{\sqrt{2mK}}$

20. Using the equations:

$$\frac{1}{\lambda} = R_H \left(\frac{1}{1^2} - \frac{1}{n_i^2} \right)$$

$$E_n = -\frac{13.6}{n^2} eV$$

The energies of first four levels of X are -54.4 eV, -13.6 eV, -6.04 eV and -3.4 eV.

21. The activity of a radioactive material is defined as the rate at which the nuclei of its atoms in the sample disintegrate.

The ratio of rates of disintegration of X and Y after two hours is 1.

22. XOR gate

Truth table for XOR Gate

| INPUTS		OUTPUTS
A	B	Y = A ⊕ B
0	0	0
0	1	1
1	0	1
1	1	0

Logic symbol of XOR gate is

23.   a. Critical thinking and problem solving

b. Low lying aircrafts reflect TV signals. As a result of which there is an interference between direct signals received by antenna and reflected signal and hence the picture on TV shakes.

c. The T.V. signals have the frequency range 80 MHZ to 200 MHz. The reception of T.V. signal is possible either by using communication satellite or by using tall receiver antennas.

24.

Van de Graaff Generator
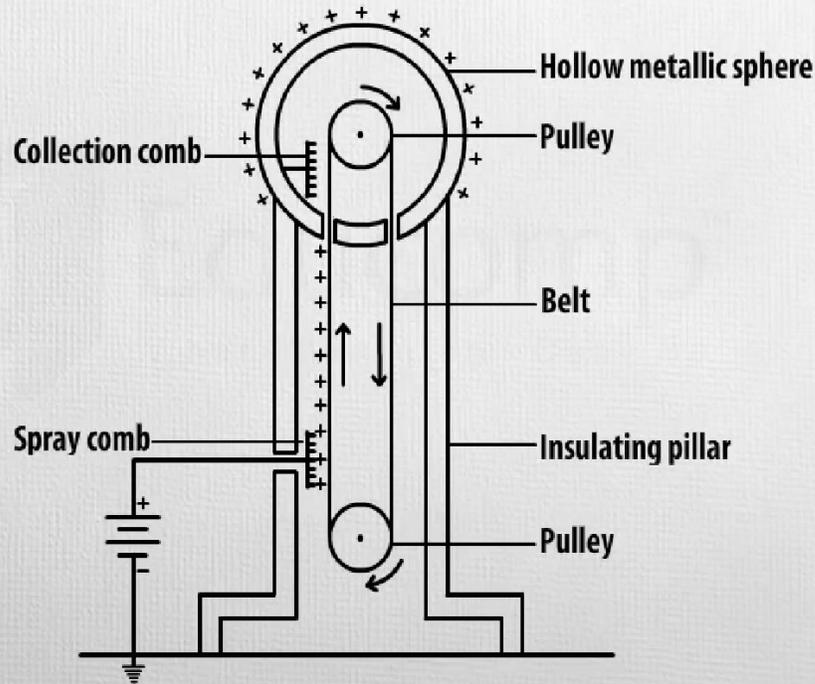
Potential difference is given by:

$$V = V_A - V_B = \frac{q}{4\pi\epsilon_0}\left(\frac{1}{r} - \frac{1}{R}\right)$$

Application: For accelerating charged particles like protons, deuterons, α- particles and other ions.
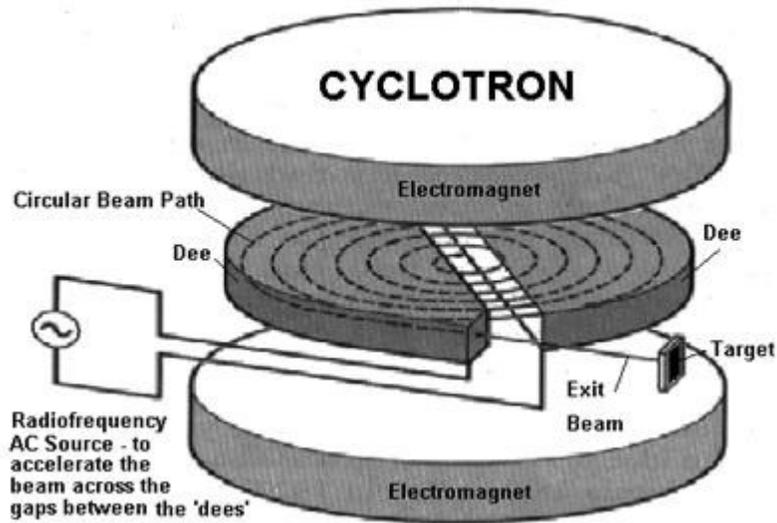
Limitations: Sparking and leakage of charge takes place due to very high electric field at sphere, so high pressure gasses are used around sphere.

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OR

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According to Gauss's theorem, the surface integral of electric field produced by any sources over any closed surface S enclosing a volume V in vacuum is $1/\epsilon_0$ times the total charge Q contained inside S. That is

$$\varphi_E = \oint_S \vec{E} \cdot \vec{ds} = \frac{Q}{\epsilon_0}$$

25. a.

CYCLOTRON

Circular Beam Path

Electromagnet

Dee

Dee

Target

Exit

Beam

Radiofrequency
AC Source - to
accelerate the
beam across the
gaps between the 'dees'

Electromagnet

.

b. Cyclotron frequency is the frequency of oscillation of a heavy charged particle in between two dees of cyclotron. It is given by:

$$v = \frac{Bq}{2\pi m}$$

OR

a. Two parallel conductors carrying currents in the same direction attract each other and if current are in opposite direction then they repel each other. One ampere is the current which when flows through each of the two parallel uniform long conductors placed in free space at a distance of one meter from each other will attract or repel each other with a force of 2×10^{-7} N per meter of their length.

b. Force is acting in the plane of paper away from the wire and is given by:

$$F = \frac{\mu_0 Iev}{2\pi d}$$

26. a.

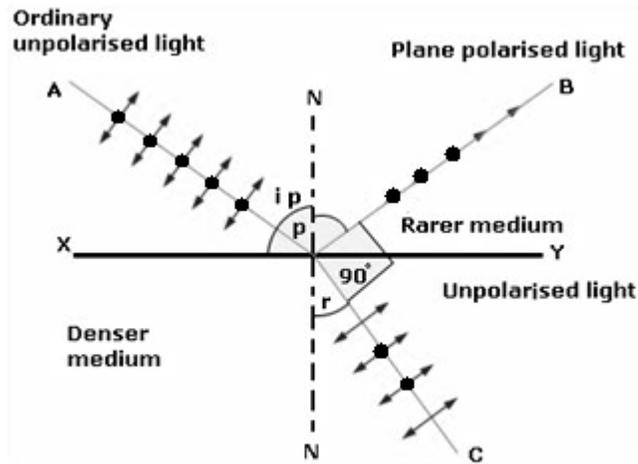| Young's double slit experiment	Single slit diffraction
All the bright fringes are of the same intensity.	The bright fringes are of varying intensity.
Fringes of minimum intensity are perfectly dark.	Fringes of minimum intensity are not perfectly dark.

b. Diffraction of light takes place when size of obstacle is of the order of the wavelength of light.

An expression for the width of central maximum due to diffraction of light at a single slit is given by:

$$\beta_0 = \frac{2D\lambda}{a}$$

OR

a. Light in which the vibrations of electric field vector are symmetrically distributed in all the directions but perpendicular to the direction of propagation of the light is called as an unpolarised light.

Ordinary unpolarised light — Plane polarised light

A — B

N

i p

p — Rarer medium

X — Y

90°

r — Unpolarised light

Denser medium

N — C

$$\mu = \tan i_p$$

b. The net intensity of light of intensity transmitted by the combination, when the pass axis of the two polaroids are inclined to each other at an angle of 60° is $I_0/8$