Sample Paper 2022-23

SAMPLE PAPER 1

Class 12 - Physics

Time Allowed: 3 hours **Maximum Marks: 70**

General Instructions:

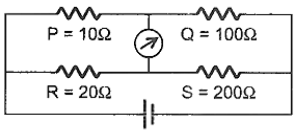
1. There are 35 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
3. Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, 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. When the temperature of a semiconductor is increased, its electrical conductivity: **[1]**

a) decreases
b) increases at first and then decreases
c) increases
d) remains the same

2. Figure below shows a balanced Wheatstone net. Now, it is disturbed by changing P to 11 ohms. Which of the following steps will not bring the bridge to balance again? **[1]**



a) Increasing R by 2 ohm
b) Increasing Q by 10 ohm
c) Increasing S by 20 ohm
d) Making product RQ = 2200 $(ohm)^2$

3. An object is placed at a distance of 40 cm infront of a concave mirror of focal length 20 cm. The image produced is: **[1]**

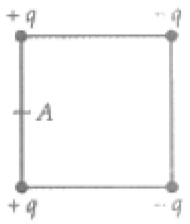
a) real, inverted and smaller in size
b) real, inverted and of same size
c) virtual and inverted
d) real and erect

4. A silicon specimen is made into a p-type semiconductor by doping on an average one indium atom per 5×10^7 silicon atoms. If the number density of atoms in the silicon specimen is 5×10^{26} atoms/metre^3, then the number of acceptor atoms in silicon per cubic centimetre will be: **[1]**

a) 2.5×10^{30}
b) 1.0×10^{15}

c) 2.5×10^{36} d) 1.0×10^{13}

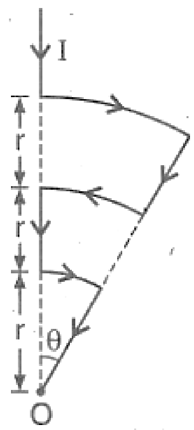
5. Four electric charges + q, + q, -q and - q are placed at the corners of a square of side 2 L (see figure). The electric potential at point A, midway between the two charges + q and + q is **[1]**



a) zero b) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}(1+\sqrt{5})$

c) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$ d) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$

6. Shown in the figure is a conductor carrying a current I. The magnetic field intensity at the point O (common centre of all the three arcs) is: **[1]**



a) Zero b) $\frac{11\mu_0 I\theta}{24\pi r}$

c) $\frac{\mu_0 I\theta}{24\pi r}$ d) $\frac{5\mu_0 I\theta}{24\pi r}$

7. A 50 Hz alternating current of peak value 1 ampere flows through the primary coil of a transformer. If the mutual inductance between the primary and secondary be 1.5 H, then the mean value of the induced voltage is: **[1]**

a) 150 volt b) 300 volt

c) 75 volt d) 225 volt

8. In a Geiger-Marsden experiment. Find the distance of the closest approach to the nucleus of a 7.7 MeV α-particle before it comes momentarily to rest and reverses its direction. (Z for gold nucleus = 79): **[1]**

a) 40 fm b) 30 fm

c) 10 fm d) 20 fm

9. Waves that cannot be polarised are: **[1]**

a) light waves b) electromagnetic waves

c) longitudinal waves d) transverse waves

10. An electric dipole placed In a non-uniform electric field may not experience **[1]**

a) Only a force but no torque b) Both a torque and a net force

c) No torque and no net force d) Only a torque but no net force

11. The manifestation of band structure in solids is due to: **[1]**

a) Boltzmann's law
b) Pauli's exclusion principle
c) Bohr's correspondence principle
d) Heisenberg's uncertainly principle

12. A thin lens made of glass (refractive index = 1.5) of focal length f = 16 cm is immersed in a liquid of refractive index 1.42. If its focal length in liquid is f_1, then the ratio $\frac{f_1}{f}$ is closest to the integer: **[1]**

a) 5
b) 9
c) 17
d) 1

13. For photoelectric emission, tungsten requires light of 2300 $\overset{\circ}{A}$. If light of 1800 $\overset{\circ}{A}$ wavelength is incident, then emission: **[1]**

a) takes place
b) may or may not take place
c) does not take place
d) depends on frequency

14. In a certain region of space with volume 0.2 m^3, the electric potential is found to be 5 V throughout. The magnitude of the electric field in this region is: **[1]**

a) zero
b) 1 N/C
c) 5 N/C
d) 0.5 N/C

15. In a Young's double slit experiment the intensity at a point where the path difference is $\frac{\lambda}{6}$ (λ being the wavelength of light used) is I. If I_0 denotes the maximum intensity, $\frac{I}{I_0}$ is equal to: **[1]**

a) $\frac{1}{2}$
b) $\frac{1}{\sqrt{2}}$
c) $\frac{\sqrt{3}}{2}$
d) $\frac{3}{4}$

16. **Assertion (A):** ${}_{Z}X^{A}$ undergoes 2α, 2β- particles and 2γ-rays, the daughter product is ${}_{Z\text{-}2}Y^{A-8}$. **[1]**

Reason (R): In α-decay the mass number decreases by 4 and atomic number decreases by 2. In β-decay the mass number remains unchanged, but atomic number increases by 1.

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 but R is true.

17. **Assertion (A):** The sky waves are not used in the transmission of television signals. **[1]**
Reason (R): Sky waves are mechanical waves.

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 but R is true.

18. **Assertion (A):** Reduction factor (K) of a tangent galvanometer helps in reducing deflection to current. **[1]**
Reason (R): Reduction factor increases with increase of current.

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 but R is true.

Section B

19. Determine the number density of donor atoms which have to be added to an intrinsic germanium semiconductor to produce an n-type semiconductor of conductivity 5 Ω^{-1} cm^{-1}, given that the mobility of electron in n-type Ge is 3900 cm^2 /Vs. Neglect the contribution of holes to conductivity. **[2]**

20. Determine the speed of the electron in n = 3 orbit of He^+ ion. **[2]**

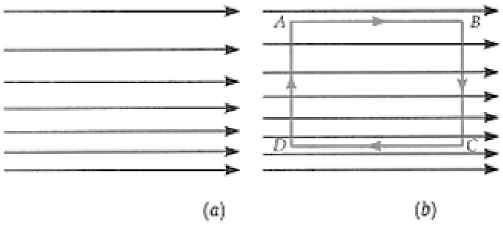
21. Use the formula λ_m T = 0.29 cm K to obtain the characteristic temperature ranges for different parts of the electromagnetic spectrum. What do the numbers that you obtain tell you? **[2]**

OR

Briefly explain, how does an accelerating charge act as a source of an electromagnetic wave?

22. What are holes? Give their important characteristics. **[2]**

23. Is it possible to create an electric field in which all the lines of force are parallel lines and whose density increases gradually in a direction perpendicular to the lines of force, as shown in Fig.? **[2]**

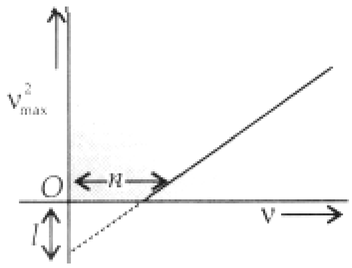


OR

A parallel plate capacitor of capacitance C is charged to a potential V by a battery. Without disconnecting the battery, the distance between the plates is tripled and a dielectric medium of k = 10 is introduced between the plates of the capacitor. Explain giving reasons, how will the following be affected:

i. the capacitance of the capacitor,
ii. charge on the capacitor,
iii. the energy density of the capacitor.

24. State Einstein's photoelectric equation explaining the symbols used. **[2]**



Light of frequency ν is incident on a photosensitive surface. A graph of the square of the maximum speed of the electrons (V_2max) vs. ν is obtained as shown in the figure. Using Einstein's photoelectric equation, obtain expressions for

i. Planck's constant,
ii. Work function of the given photosensitive material in terms of parameters l, n, and mass of the electron m.

25. A radioactive nucleus A undergoes a series of decays according to the following scheme **[2]**

$$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$$

The mass number and atomic number of A_4 are 172 and 69, respectively. What are these numbers for A?

Section C

26. Hydrogen atom in its ground state is excited by means of monochromatic radiation of wavelength $975\overset{o}{A}$. **[3]**

i. How many different lines are possible in the resulting spectrum?

ii. Calculate the longest wavelength amongst them. You may assume the ionization energy for hydrogen atom as 13.6 eV.

27. A double-slit apparatus is immersed in a liquid of refractive index 1.33. It has slit separation of 1.0 mm, and distance between the plane of slits and screen is 1.33 m. The slits are illuminated by a parallel beam of light whose wavelength in air is 6300 $\overset{\circ}{A}$. **[3]**

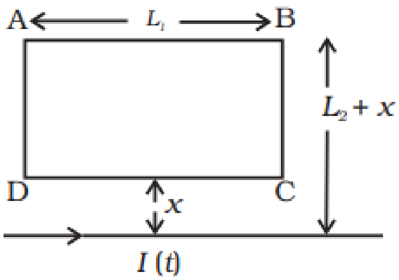
i. Calculate the fringe width.
ii. One of the slits of the apparatus is covered by a thin glass sheet of refractive index 1.53. Find the smallest thickness of the sheet to bring the adjacent minimum on the axis.

28. The current flowing through an inductor of self-inductance L is continuously increasing. Plot a graph showing the variation of: **[3]**

i. Magnetic flux versus the current
ii. Induced emf versus dI/dt
iii. Magnetic potential energy stored versus the current.

OR

A rectangular loop of wire ABCD is kept close to an infinitely long wire carrying a current I(t) = I_0 (1 - $\frac{t}{T}$) for $0 \leq t \leq T$ and I(0) = 0 for t > T (Figure). Find the total charge passing through a given point in the loop, in time T. The resistance of the loop is R.



29. Identify the type of waves which are produced by the following way and write one application for each: **[3]**

i. Radioactive decay of the nucleus.
ii. Rapid acceleration and decelerations of electrons in aerials.
iii. Bombarding a metal target by high energy electrons.

OR

i. How are electromagnetic waves produced? Explain.
ii. A plane electromagnetic wave is travelling through a medium along the +ve z-direction. Depict the electromagnetic wave showing the directions of the oscillating electric and magnetic fields.

30. If χ stands for the magnetic susceptibility of a given material, identify the class of materials for which **[3]**

i. $-1 \leq x < 0$
ii. $0 < \chi < \varepsilon_r$, (ε stands for a small positive number).

a. Write the range of relative magnetic permeability of these materials.
b. Draw the pattern of the magnetic field lines when these materials are placed in an external magnetic field.

Section D

31. Consider a sphere of radius R with charge density distributed as **[5]**

ρ(r) = kr for r $\leq$ R
= 0 for r > R

a. Find the electric field at all points r.

b. Suppose the total charge on the sphere is 2e where e is the electron charge. Where can two protons be embedded such that the force on each of them is zero? Assume that the introduction of the proton does not alter the negative charge distribution?

OR

i. Use Gauss theorem to find the electric field due to a uniformly charged infinitely large plane thin sheet with surface charge density σ.

ii. An infinitely large thin plane sheet has a uniform surface charge density $+\sigma$. Obtain the expression for the amount of work done in bringing a point charge q from infinity to a point, distance r, in front of the charged plane sheet.

32. a. Draw a labelled ray diagram of an astronomical telescope to show the image formation of a distant object. Write the main considerations required in selecting the objective and eyepiece lenses in order to have large magnifying power and high resolution of the telescope. **[5]**

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

OR

i. Draw a labelled ray diagram to obtain the real image formed by an astronomical telescope in normal adjustment position. Define its magnifying power.

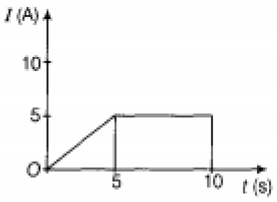
ii. You are given three lenses of power 0.5 D, 4D and 10 D to design a telescope.

a. Which lenses should be used as objective and eyepiece? Justify your answer.

b. Why is the aperture of the objective preferred to be large?

33. i. Deduce the relation between current I flowing through a conductor and drift velocity v_d of the electrons. **[5]**

ii. Figure shows a plot of current I flowing through the cross-section of a wire versus the time t. Use the plot to find the charge flowing in 10 through the wire.



Section E

34. **Read the text carefully and answer the questions:** **[4]**

An electron with speed v_0 << c moves in a circle of radius r_0 in a uniform magnetic field. This electron is able to traverse a circular path as magnetic field is perpendicular to the velocity of the electron. A force acts on the particle perpendicular to both $\vec{v}_0$ and q. This force continuously deflects the particle sideways without changing its speed and the particle will move along a circle perpendicular to the field. The time required for one revolution of the electron is T_0.

(i) If the speed of the electron is doubled to $2v_0$ What will be the radius of the circle if the initial radius is r_0?

(ii) If the speed of particle gets doubled, what will be the new time period of particle?

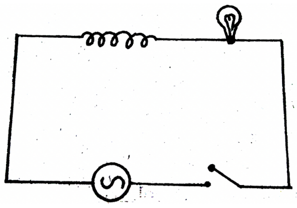
(iii) A charged particles is projected in a magnetic field $\vec{B} = (2\hat{i} + 4\hat{j}) \times 10^2$ T. The acceleration of the particle is found to be $\vec{a} = (x\hat{i} + 2\hat{j})\text{ms}^{-2}$. Find the value of x

OR

What will be the trajectory of electron If the direction of velocity of the electron makes an acute angle with the direction of magnetic field?

35. **Read the text carefully and answer the questions:** **[4]**

A light bulb and an open coil inductor are connected to an ac source through a key as shown in the figure. The switch is closed and after some time, an iron rod is inserted into the interior of the inductor. The glow of the light bulb (a) increases, (b) decreases, (c) is unchanged, as the iron rod is inserted.



(i) A bulb and a capacitor are connected in series to an a.c. source of variable frequency. How will the brightness of the bulb change on increasing the frequency of the a.c. source? Give reason.

(ii) Define capacitor reactance. Write its SI units.

(iii) A capacitor behaves like a perfect conductor for high frequency a.c. Explain, why?

OR

Why does it happen? Give your answer with reasons.