S.R. Study Material

S R SAMPLE PAPER3

Class 12 - Physics

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

General Instructions:

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.

Section A

1. A Ge specimen is doped with Al. The concentration of acceptor atoms is $\approx 10^{21}$ atoms m^{-3}. Given that the intrinsic concentration of electron-hole pair is $\approx 10^{19}$ m^{-3}, the concentration of electrons in the specimen is **[1]**

a) 10^{17} m^{-3} b) 10^{2} m^{-3}

c) 10^{15} m^{-3} d) 10^{4} m^{-3}

2. The internal resistance of the primary cell is 4 Ω. It generates a current of 0.2 A in an external resistance of 21 Ω. The rate at which chemical energy is consumed which is providing the current is: **[1]**

a) 5 J/s b) 0.42 J/s

c) 0.24 J/s d) 1 J/s

3. A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of virtual image from the surface of sphere is **[1]**

a) 2 cm b) 4 cm

c) 6 cm d) 12 cm

4. The universal property among all substances is **[1]**

a) ferromagnetism b) non-magnetism

c) diamagnetism d) paramagnetism

5. A capacitor of capacitance C_1 is charged upto potential V and then connected in parallel to an uncharged capacitor of capacitance C_2. The final potential difference across each capacitor will be: **[1]**

a) $\left(1+\frac{C_2}{C_1}\right)V$ b) $\left(1-\frac{C_2}{C_1}\right)V$

c) $\frac{C_1V}{C_1+C_2}$ d) $\frac{C_2V}{C_1+C_2}$

6. A wire of length l carries current i along x-axis. A magnetic field exists given by $B=B_0(\hat{i}+\hat{j}+\hat{k})$ T. The magnitude of the magnetic force acting on the wire is: **[1]**

a) $\sqrt{2}ilB_0$ b) $2ilB_0$

c) ilB_0 d) $\sqrt{3}ilB_0$

7. A dynamo works on the principle of: **[1]**

a) Induced magnetism b) Faraday's effect

c) Electromagnetic induction d) Induced current

8. Two similar magnets of magnetic moments M_1 and M_2 are taken and vibrate in a vibration magnetometer with their **[1]**

i. like poles together

ii. unlike poles together. If the ratio of the time periods is $\frac{1}{2}$, then the ratio of M_1 and M_2 $\left(\text{i.e., } \frac{M_1}{M_2}\right)$ is

a) 0.5 b) $\frac{5}{3}$

c) 2 d) $\frac{1}{3}$

9. What speed should a galaxy move with respect to us so that the sodium line at 589.0 nm is observed at 589.6 nm? **[1]**

a) 336 km/s b) 326 km/s

c) 356 km/s d) 306 km/s

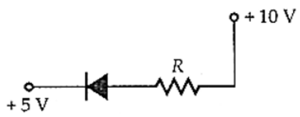
10. A half ring of radius R has a charge per unit length equal to λ. The field at the center is **[1]**

a) zero b) $\frac{2\lambda}{4\pi\varepsilon_0 R}$

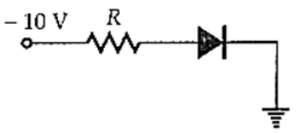
c) $\frac{\lambda}{4\pi\varepsilon_0 R}$ d) None of these

11. In the following figure, the diodes which are forward biased, are **[1]**

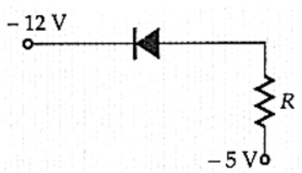
A.



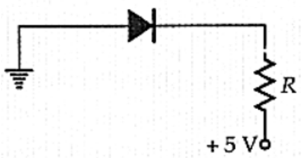
B.



C.



D.



a) A, C and D

b) B and C

c) C and A

d) C only

12. A bird flies down vertically towards a water surface. To a fish inside the water, vertically below the bird, the bird will appear to **[1]**

a) move faster than its actual speed

b) be at its actual distance

c) move slower than its actual speed

d) be closer than its actual distance

13. **Assertion (A):** A photocell is called an electric eye. **[1]**

Reason (R): When light is incident on some semiconductor, its electrical resistance is reduced.

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.

14. **Assertion:** Two protons placed at different distances, between the plates of a parallel plate capacitor experience the same force. **[1]**

Reason: The electric field between the plates of the capacitor is constant.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

15. **Assertion (A):** For best contrast between maxima and minima in the interference pattern of Young's double-slit experiment, the intensity of light emerging out of the two slits should be equal. **[1]**

Reason (R): The intensity of the interference pattern is proportional to the square of the amplitude.

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.

16. **Assertion (A):** At resonance, LCR series circuit has a minimum current. **[1]**

Reason (R): At resonance, in LCR series circuit, the current and emf are not in phase with each other.

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

17. How do you convince yourself that electromagnetic waves carry energy and momentum? **[2]**

18. A bar magnet 30 cm long is placed in the magnetic meridian with its north pole pointing geographical south. The neutral point is found at a distance of 30 cm from its centre. Calculate the pole strength of the magnet. Given B_H = 0.34 G. **[2]**

19. Draw energy band diagrams of n-type and p-type semiconductors at temperature T > 0K, depicting the donor and acceptor energy levels. Mention the significance of these levels. **[2]**

20. Which level of the double ionised lithium (Li^{2+}) has the same energy as the ground state energy of the hydrogen **[2]**

atom? Compare the orbital radius of the two levels.

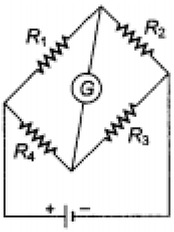
21. A 5.0 MeV proton is falling vertically downward through a region of magnetic field 1.5 T acting horizontally from south to north. Find the magnitude and the direction of the magnetic force exerted on the proton. Take mass of the proton as 1.6×10^{-27} kg. **[2]**

OR

The free electrons in a conductor are always in a state of continuous motion. Even then no magnetic force acts on them in a conductor unless a current is passed through it. Why?

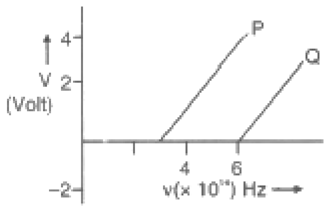
Section C

22. For the circuit diagram of a Wheatstone bridge shown in the figure, use Kirchhoff's laws to obtain its balance condition. **[3]**



23. Explain the formation of depletion layer and barrier potential in a p-n junction diode. **[3]**

24. In the study of a photoelectric effect the graph between the stopping potential V and frequency of the incident radiation on two different metals P and Q is shown below. **[3]**



i. Which one of the two metals has higher threshold frequency?
ii. Determine the work function of the metal which has greater value.
iii. Find the maximum kinetic energy of electron emitted by light of frequency 8×10^{14} Hz for this metal.

25. Distinguish between nuclear fission and fusion. Show how in both these processes energy is released. Calculate the energy release in MeV in the deuterium-tritium fusion reaction: ${}_1^2H + {}_1^3H \rightarrow {}_2^4He +_0 n^1$ **[3]**

Using the data:

$m\left({}_1^2H\right)$ = 2.014102 u

$m\left({}_1^3H\right)$ = 3.016049 u

$m\left({}_2^4He\right)$ = = 4.002603 u

m_n = 1.008665 u

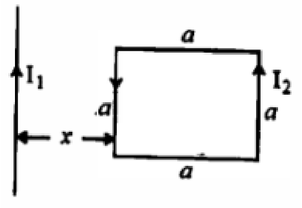
1amu = 931.5 $\frac{MeV}{c^2}$

26. **[3]**
a. In Geiger-Marsden experiment, calculate the distance of closest approach for an alpha particle with energy 2.56×10^{-12} J. Consider that the particle approaches gold nucleus (Z = 79) in head-on position.
b. If the above experiment is repeated with a proton of the same energy, then what will be the value of the distance of closest approach?

27. In a Young's double experiment, the slits are 1.5 mm apart. When the slits are illuminated by a monochromatic light source and the screen is kept 1 m apart from the slits, width of 10 fringes is measured as 3.93 mm. Calculate the wavelength of light used. What will be the width of 10 fringes when the distance between the slits and the screen is increased by 0.5 m. The source of light used remains the same. **[3]**

28. i. Define mutual inductance and write its S.I. unit. **[3]**

ii. A square loop of side 'a' carrying a current I_2 is kept at distance x from an infinitely long straight wire carrying a current I_1 as shown in the figure. Obtain the expression for the resultant force acting on the loop.



OR

Define the term self-inductance of a solenoid. Obtain the expression for the magnetic energy stored in an inductor of self-inductance L to build up a current I through it.

Section D

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

An electromagnetic wave transports linear momentum as it travels through space. If an electromagnetic wave transfers a total energy U to a surface in time t, then total linear momentum delivered to the surface is $p = \frac{U}{c}$. When an electromagnetic wave falls on a surface, it exerts pressure on the surface. In 1903, the American scientists Nichols and Hull succeeded in measuring radiation pressures of visible light where other had failed, by making a detailed empirical analysis of the ubiquitous gas heating and ballistic effects.

(i) The pressure exerted by an electromagnetic wave of intensity I(W m^{-2}) on a non-reflecting surface is (c is the velocity of light)

a) $\frac{I}{c}$ b) $\frac{I}{c^2}$

c) Ic^2 d) Ic

(ii) Light with an energy flux of 18 W/cm^2 falls on a non-reflecting surface at normal incidence. The pressure exerted on the surface is:

a) 2 N/m^2 b) 6×10^{-4} N/m^2

c) 2×10^{-4} N/m^2 d) 6 N/m^2

(iii) Radiation of intensity 0.5 W m^{-2} are striking a metal plate. The pressure on the plate is

a) 0.212×10^{-8} N m^{-2} b) 0.132×10^{-8} N m^{-2}

c) 0.166×10^{-8} N m^{-2} d) 0.083×10^{-8} N m^{-2}

OR

The radiation pressure of the visible light is of the order of

a) 10^{-4} N/m b) 10^{-6} N/m^2

c) 10^{-8} N d) 10^{-2} N m^2

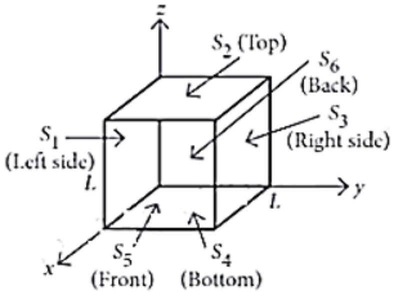
(iv) A point source of electromagnetic radiation has an average power output of 1500 W. The maximum value of electric field at a distance of 3 m from this source (in V m^{-1}) is

a) 500 b) $\frac{500}{3}$

c) $\frac{250}{3}$ d) 100

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

Net electric flux through a cube is the sum of fluxes through its six faces. Consider a cube as shown in figure, having sides of length L = 10.0 cm. The electric field is uniform, has a magnitude $E = 4.00 \times 10^3 NC^{-1}$ and is parallel to the xy plane at an angle of 37^o measured from the +x -axis towards the +y -axis.



(i) Electric flux passing through surface S_6 is

a) $-24\ Nm^2\ C^{-1}$ b) $32\ Nm^2\ C^{-1}$

c) $-32\ Nm^2\ C^{-1}$ d) $24\ Nm^2\ C^{-1}$

(ii) Electric flux passing through surface S_1 is

a) $-32\ Nm^2\ C^{-1}$ b) $-24\ Nm^2\ C^{-1}$

c) $32\ Nm^2\ C^{-1}$ d) $24\ Nm^2\ C^{-1}$

(iii) The surfaces that have zero flux are

a) S_2 and S_4 b) S_3 and S_6

c) S_1 and S_2 d) S_1 and S_3

(iv) The total net electric flux through all faces of the cube is

a) $24\ Nm^2\ C^{-1}$ b) $8\ Nm^2\ C^{-1}$

c) $-8\ Nm^2\ C^{-1}$ d) zero

OR

The dimensional formula of surface integral $\oint \vec{E} \cdot d\vec{S}$ of an electric field is

a) $[M^{-1}\ L^3\ T^{-3}\ A]$ b) $[M\ L^2\ T^{-2}\ A^{-1}]$

c) $[M\ L^3\ T^{-3}\ A^{-1}]$ d) $[M\ L^{-3}\ T^{-3}\ A^{-1}]$

Section E

31. A thin equiconvex lens (radius of curvature of either face being 33 cm) is placed on a horizontal plane mirror and a pin held 20 cm vertically above the lens coincides in position with its own image. The space between the lower surface of the lens and the mirror is filled with a liquid and then, to coincide with the image as before, the pin has to be raised to a distance of 25 cm from the lens. Find the refractive index of the liquid. **[5]**

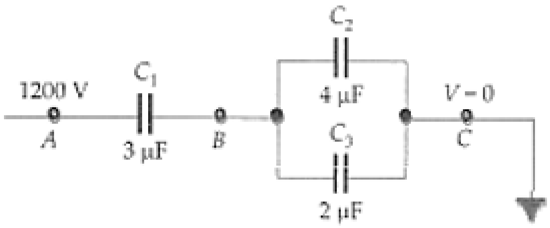
OR

a. State Huygen's principle. Using this principle draw a diagram to show how a plane wavefront incident at the interface of the two media gets refracted when it propagates from a rarer to a denser medium. Hence verify Snell's law of refraction.
b. When monochromatic light travels from a rarer to a denser medium, explain the following, giving reasons:

i. Is the frequency of reflected and refracted light the same as the frequency of incident light?

ii. Does the decrease in speed imply a reduction in the energy carried by the light wave?

32. In the circuit shown in Fig. If the point C is earthed and point A is given a potential of +1200 V, find the charge on each capacitor and the potential at point B. **[5]**



OR

i. A. Why does the electric field inside a dielectric slab decrease when kept in an external electric field?
   B. Derive an expression for the capacitance of a parallel plate capacitor filled with a medium of dielectric constant K.

ii. A charge q = 2 μC is placed at the centre of a sphere of radius 20 cm. What is the amount of work done in moving 4 μC from one point to another point on its surface?

iii. Write a relation for polarisation $\vec{P}$ of a dielectric material in the presence of an external electric field.

33. An emf ε = 100 sin 314 t is applied across a pure capacitor of 637 μF. Find **[5]**

i. the instantaneous current I

ii. instantaneous power P

iii. the frequency of power and

iv. the maximum energy stored in the capacitor.

OR

A circuit containing a 80 mH inductor and a 60 μF capacitor in series is connected to a 230 V, 50 Hz supply. The resistance of the circuit is negligible.

a. Obtain the current amplitude and rms values.

b. Obtain the rms values of potential drops across each element.

c. What is the average power transferred to the inductor?

d. What is the average power transferred to the capacitor?

e. What is the total average power absorbed by the circuit? [‘Average’ implies ‘averaged over one cycle’.]