SATISH SCIENCE ACADEMY

DHANORI PUNE-411015

PHYSICS

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. In a half-wave rectifier, the rms value of the ac component of the wave is **[1]**

   a) more than dc value b) equal to dc value

   c) zero d) less than dc value

2. Identify the set in which all the three materials are good conductors of electricity: **[1]**

   a) Cu, Hg and NaCl b) Cu, Ag and Au

   c) Cu, Si and diamond d) Cu, Ge and Hg

3. An astronomical telescope of ten fold angular magnification has a length of 44 cm. The focal length of the objective is **[1]**

   a) 44 cm b) 440 cm

   c) 4 cm d) 40 cm

4. A bar-magnet of the pole-strength 2 Amp-m is kept in a magnetic field of induction 4×10^{-5} Wb/m^2 such that the axis of the magnet makes an angle 30° with the direction of the field. If the couple acting on the magnet is found to be 80×10^{-7} Nm, then the distance between the poles of the magnet is: **[1]**

   a) 20 cm b) 4 m

   c) 2 m d) 8 m

5. Two capacitors of capacitances C_1 and C_2 are connected in parallel. If a charge Q is given to the combination, the ratio of the charge on the capacitor C_1 to the charge on C_2 will be **[1]**

a) $\sqrt{\frac{C_1}{C_2}}$ b) $\frac{C_2}{C_1}$

c) $\frac{C_1}{C_2}$ d) $\sqrt{\frac{C_2}{C_1}}$

6. A constant current is flowing through a solenoid. An iron rod is inserted in the solenoid along its axis. Which of the following quantities will not increase? **[1]**

a) The magnetic field at the centre b) The self-inductance of the solenoid

c) The rate of heating d) The magnetic flux linked with the solenoid

7. A coil of resistance 400 Ω is placed in a magnetic field. If the magnetic flux ϕ (Wb) linked with the coil varies with times t (sec) as $\phi = 50t^2 + 4$, the current in the coil at t = 2 sec is: **[1]**

a) 0.1 A b) 1 A

c) 0.5 A d) 2 A

8. Magnetism in substances is caused by **[1]**

a) hidden magnets b) orbital motion of electrons only

c) due to spin and orbital motions of electrons both d) spin motion of electrons only

9. Angular width (θ) of central maximum of a diffraction pattern of a single slit does not depend upon **[1]**

a) wavelength of light used b) distance between slit and screen

c) width of the slit d) frequency of light used

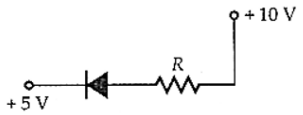
10. Two point charges q_1 and q_2 are at separation r. The force acting between them is given by $F = K\frac{q_1 q_2}{r^2}$. The constant K depends upon **[1]**

a) only on the system of units b) neither on only on the system of units nor on only on medium between charges

c) only on medium between charges d) both on only on the system of units and only on medium between charges

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

A.



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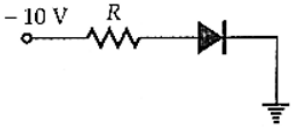

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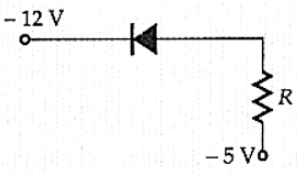
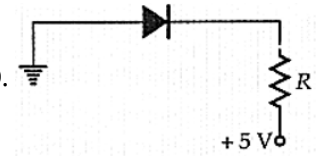


D. 

a) A, C and D
b) B and C
c) C and A
d) C only

12. A fish at a depth of 12 cm in water is viewed by an observer on the bank of a lake. Through what height is the image of fish raised? ($\mu = \frac{4}{3}$) **[1]**

a) 9 cm
b) 3 cm
c) 12 cm
d) 3.8 cm

13. **Assertion (A):** Mass of moving photon varies inversely as the wavelength. **[1]**

Reason (R): Energy of the particle = Mass $\times$ (speed of light)^2

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:** In the absence of an externally applied electric field, the displacement per unit volume of a polar dielectric material is always zero. **[1]**

Reason: In polar dielectrics, each molecule has a permanent dipole moment but these are randomly oriented in the absence of an externally applied electric field.

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):** In alternating current, the direction of motion of free electrons changes periodically. **[1]**

Reason (R): Alternating current changes its direction after a certain is always constant.

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. A slab of material of dielectric constant K has the same area as the plates of a parallel-plate capacitor but has a thickness ($\frac{3}{4}$)d, where d is the separation of the plates. How is the capacitance changed when the slab is inserted between the plates? **[2]**

18. Two identical bars, one of paramagnetic material and other of diamagnetic material are kept in a uniform external magnetic field parallel to it. Draw diagrammatically the modifications in the magnetic field pattern in each case. **[2]**

19. Explain the formation of depletion region in a p-n junction. **[2]**

20. Suppose you are given a chance to repeat the alpha particle scattering experiment using a thin sheet of solid hydrogen in place of the gold foil. (Hydrogen is a solid at temperatures below 14 K). What results do you expect? **[2]**

21. Define current sensitivity and voltage sensitivity of a galvanometer. Increasing the current sensitivity may not necessarily increase the voltage sensitivity of a galvanometer. Justify. **[2]**

OR

What is the radius of the path of an electron (mass 9×10^{-31} kg and charge 1.6×10^{-19} C) moving at a speed of 3×10^{7} m/s in a magnetic field of 6×10^{-4} T perpendicular to it? What is its frequency? Calculate its energy in keV. (1 eV = 1.6×10^{-19} J).

Section C

22. A cell of emf E and internal resistance r is connected across a variable resistor R. Plot a graph showing variation of terminal voltage V of the cell versus the current I. Using the plot, show the emf of the cell and its internal resistance can be determined. **[3]**

23. Explain how the barrier potential is formed in a p-n junction. How is it affected in **[3]**
    a. forward bias, and
    b. reverse bias?

24. An electron and a proton are accelerated through the same potential. Which one of the two has (i) greater value of de-Broglie wavelength associated with it and (ii) less momentum? Justify your answer. **[3]**

25. i. What characteristic property of nuclear force explains the constancy of binding energy per nucleon (BE/A) in the range of mass number A lying 30< A<170? **[3]**
    ii. Show that the density of nucleus over a wide range of nuclei is constant and independent of mass number A.

26. Using Bohr's postulates, derive the expression for the radius of the n^{th} orbit in which the electron is revolving in hydrogen atom. How does de-Broglie's hypothesis explain the stability of hydrogen atom? Explain. **[3]**

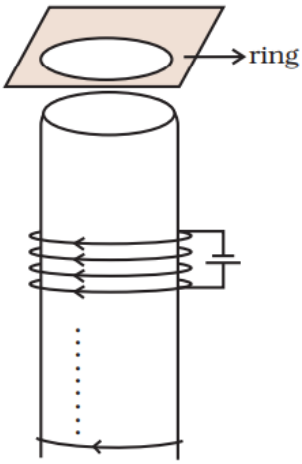
27. i. Write the conditions under which light sources can be said to be coherent. **[3]**
    ii. Why is it necessary to have coherent sources in order to produce an interference pattern?

28. A metallic rod of length l and resistance R is rotated with a frequency ν, with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius l, about an axis passing through the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field B parallel to the axis is present everywhere. **[3]**
    i. Derive the expression for the induced emf and the current in the rod.
    ii. Due to the presence of the current in the rod and of the magnetic field, find the expression for the magnitude and direction of the force acting on this rod.
    iii. Hence obtain the expression for the power required to rotate the rod.

OR

Consider a metal ring kept (supported by a cardboard) on top of a fixed solenoid carrying a current I (see Figure). The centre of the ring coincides with the axis of the solenoid. If the current in the solenoid is switched off, what will

happen to the ring?



Section D

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

All the known radiations from a big family of electromagnetic waves which stretch over a large range of wavelengths. Electromagnetic wave include radio waves, microwaves, visible light waves, infrared rays, UV rays, X-rays and gamma rays. The orderly distribution of the electromagnetic waves in accordance with their wavelength or frequency into distinct groups having widely differing properties is electromagnetic spectrum.

(a) Which wavelength of the Sun is used finally as electric energy?
radio waves, infrared waves, visible light, microwaves

a) microwaves
b) visible light
c) radio waves
d) infrared waves

(b) Which of the following electromagnetic radiations have the longest wavelength?
X-rays, γ-rays, microwaves, radiowaves

a) γ-rays
b) microwaves
c) radiowaves
d) X-rays

(c) Which one of the following is not electromagnetic in nature?
X-rays, gamma rays, cathode rays, infrared rays

a) gamma rays
b) infrared rays
c) X-rays
d) cathode rays

OR

The decreasing order of wavelength of infrared, microwave, ultraviolet and gamma rays is

a) gamma rays, ultraviolet, infrared, microwave
b) microwave, gamma rays, infrared, ultraviolet
c) microwave, infrared, ultraviolet, gamma rays
d) infrared, microwave, ultraviolet, gamma rays.

(d) Which of the following has minimum wavelength?
X-rays, ultraviolet rays, γ-rays, cosmic rays

a) X-rays
b) cosmic rays
c) ultraviolet rays
d) γ-rays

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

Gauss's law and Coulomb's law, although expressed in different forms, are equivalent ways of describing the relation between charge and electric field in static conditions. Gauss's law is $\varepsilon_0\phi = q_{\text{end}}$, when q_{end} is the net charge inside an imaginary closed surface called Gaussian surface. $\phi = \oint \vec{E} \cdot d\vec{A}$ gives the electric flux through the Gaussian surface. The two equations hold only when the net charge is in vacuum or air.

Gaussian spherical surfaces

(a) If there is only one type of charge in the universe, then ($\vec{E} \rightarrow$ Electric field, $d\vec{s} \rightarrow$ Area vector)

a) $\oint \vec{E} \cdot d\vec{s} \neq 0$ on any surface

b) $\oint \vec{E} \cdot d\vec{s}$ could not be defined

c) $\oint \vec{E} \cdot d\vec{s} = 0$ if charge is outside, $\oint \vec{E} \cdot d\vec{s} = \frac{q}{\varepsilon_0}$ if charge is inside

d) $\oint \vec{E} \cdot d\vec{s} = \infty$ if charge is inside

(b) What is the nature of Gaussian surface involved in Gauss law of electrostatic?

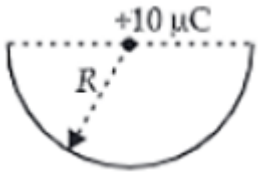
a) Magnetic

b) Scalar

c) Vector

d) Electrical

(c) A charge 10 μC is placed at the centre of a hemisphere of radius R = 10 cm as shown The electric flux through the hemisphere (in MKS units) is



a) 20×10^5

b) 10×10^5

c) 6×10^5

d) 2×10^5

(d) The electric flux through a closed surface area S enclosing charge Q is ϕ. If the surface area is doubled, then the flux is

a) $\frac{\phi}{4}$

b) ϕ

c) $\frac{\phi}{2}$

d) 2ϕ

OR

A Gaussian surface encloses a dipole. The electric flux through this surface is

a) $\frac{q}{\varepsilon_0}$

b) $\frac{q}{2\varepsilon_0}$

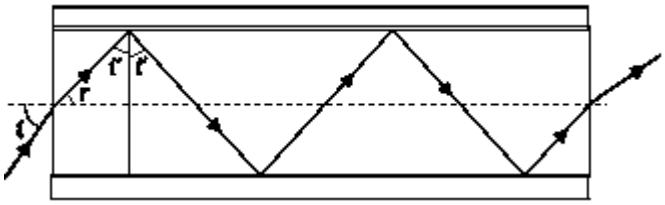
c) zero

d) $\frac{2q}{\varepsilon_0}$

Section E

31. i. Figure shows a cross-section of a light pipe made of a glass fibre of refractive index 1.68. The outer covering of the pipe is made of a material of refractive index 1.44. What is the range of the angles of the incident rays **[5]**

with the axis of the pipe for which total reflections inside the pipe take place as shown in the figure.



ii. What is the answer, if there is no outer covering of the pipe?

OR

i. a. Two independent monochromatic sources of light cannot produce a sustained interference pattern. Give reason.

b. Light waves each of amplitude a and frequency ω, emanating from two coherent light sources superimpose at a point If the displacements due to these waves are given by $y_1 = a \cos \omega t$ and $y_2 = \cos(\omega t + \phi)$, where ϕ is the phase difference between the two, obtain the expression for the resultant intensity at the point

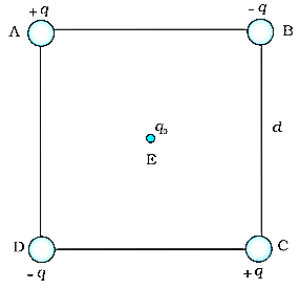
ii. In Young's double-slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ, is K units. Find out the intensity of light at a point, where path difference is $\frac{\lambda}{3}$.

32. i. Derive the expression for the energy stored in parallel plate capacitor. Hence, obtain the expression for the energy density of the electric field. **[5]**

ii. A fully charged parallel plate capacitor is connected across an uncharged identical capacitor. Show that the energy stored in the combination is less than the energy stored initially in the single capacitor.

OR

Four charges are arranged at the corners of a square ABCD of side d, as shown in fig.



a. Find the work required to put together this arrangement.

b. A charge q_0 is brought to the center E of the square, the four charges being held fixed at its corners. How much extra work is needed to do this?

33. i. Describe, with the help of a suitable diagram, the working principle of a step-up transformer. Obtain the relation between input and output voltages in terms of the number of turns of primary and secondary windings and the currents in the input and output circuits. **[5]**

ii. Given the input current 15 A and the input voltage of 100 V for a step-up transformer having 90% efficiency, find the output power and the voltage in the secondary if the output current is 3 A.

OR

Derive an expression for the impedance of a series LCR circuit connected to an ac supply of variable frequency. Plot a graph showing the variation of current with the frequency of the applied voltage. Explain briefly how the phenomenon of resonance in the circuit can be used in the tuning mechanism of a radio or a TV set.