SATISH SCIENCE ACADEMY

DHANORI PUNE-411015

PHY

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.

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Section A

1. The electrical conductivity of semiconductor increases when electromagnetic radiation of wavelength shorter than 2800 nm is incident on it. The band gap in (eV) for the semiconductor is: **[1]**

   a) 0.5 eV b) 0.7 eV

   c) 2.5 eV d) 1.2 eV

2. The rate of increase of thermo emf with the temperature at the neutral temperature of a thermocouple: **[1]**

   a) is negative b) is zero

   c) depends upon the choice of the two materials of the thermocouple d) is positive

3. To print a photograph from a negative, the time of exposure to light from a lamp placed 60 cm away is 2.5 s. What exposure time is required if the lamp is placed 1.2 m away? **[1]**

   a) 5 s b) 10 s

   c) 15 s d) 20 s

4. Which of the following has its permeability less than that of free space? **[1]**

   a) Copper b) Nickel

   c) Copper chloride d) Aluminium

5. Electric potential V at any point x, y, z in space is given by $V = 6z^2$. The value of the electric field at the point (2, -1, 3) is **[1]**

a) -36 b) 24

c) -12 d) 12

6. The resistance of the coil of ammeter is R. The shunt resistance required to increase its range four fold should have a resistance equal to **[1]**

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

c) $\frac{R}{4}$ d) 4R

7. A moving conductor coil produces an induced emf. This is in accordance with: **[1]**

a) Lenz's law b) Coulomb's law

c) Ampere's law d) Faraday's law

8. Points A and B are situated perpendicular to the axis of a 2 cm long bar magnet at large distances x and 3x from its centre on opposite sides. The ratio of the magnetic fields at A and B will be approximately equal to **[1]**

a) 2 : 9 b) 1 : 9

c) 9 : 1 d) 27 : 1

9. In a single-slit diffraction experiment, the width of the slit is halved. The width of the central maximum, in the diffraction pattern, will become: **[1]**

a) four times b) one-fourth

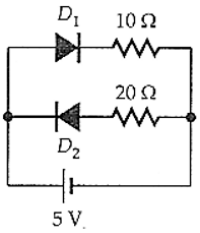
c) twice d) half

10. When the distance between two charged particles is halved, the Coulomb force between them becomes **[1]**

a) one-fourth b) one-half

c) four times. d) double

11. Two ideal diodes are connected to a battery as shown in the circuit. The current supplied by the battery is **[1]**



a) zero b) 0.5 A

c) 0.75 A d) 0.25 A

12. A thin convergent glass lens (μ_g = 1.5) has a power of +5.0 D. When this lens is immersed in a liquid of refractive index μ_1 it acts as a divergent lens of focal length 100 cm. The value of $\mu_1$must be **[1]**

a) $\frac{4}{3}$ b) $\frac{5}{3}$

c) $\frac{5}{4}$ d) $\frac{6}{5}$

13. **Assertion (A):** Though the light of a single frequency (monochromatic) is incident on metal, the energies of emitted photoelectrons are different. **[1]**

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Reason (R): The energy of electrons emitted from inside the metal surface is lost in a collision with the other atoms in the metal.

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 (A):** Two equipotential surfaces cannot cut each other. **[1]**
Reason (R): Two equipotential surfaces are parallel to 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.

15. **Assertion (A):** Newton's rings are formed in the reflected system. When the space between the lens and the glass plate is filled with a liquid of refractive index greater than that of glass, the central spot of the pattern is dark. **[1]**
Reason (R): The reflections in Newton's ring cases will be from a denser to a rarer medium and the two interfering rays are reflected under similar conditions.

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):** Quality factor of a series LCR circuit is Q = $\frac{1}{R}\sqrt{\frac{L}{C}}$ **[1]**
Reason (R): As bandwidth decreases, Q increases in a resonant LCR circuit.

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. Two charges 5×10^{-8} C and -3×10^{-8} C are located 16 cm apart. At what point (s) on the line joining the two charges is the electrical potential zero? Take the potential at infinity to be zero. **[2]**

18. Name the three types of magnetic materials which behave differently when placed in a non-uniform magnetic field. Give two properties for each of them. **[2]**

19. A semiconductor has the electron concentration of 8×10^{13} cm^{-3} and hole concentration of 4×10^{13} cm^{-3}. Is the semiconductor p-type or n-type? Also calculate the resistivity of this semiconductor. Given electron mobility = 24,000 cm^2 V^{-1} s^{-1} and hole mobility = 200 cm^2 V^{-1} s^{-1}. **[2]**

20. In Rutherford's nuclear model of the atom, the nucleus (radius about 10^{-15} m) is analogous to the sun about which the electron move in orbit (radius $\approx 10^{-10}$ m) like the earth orbits around the sun. If the dimensions of the solar system had the same proportions as those of the atom, would the earth be closer to or farther away from the sun than actually, it is? The radius of the earth's orbit is about 1.5×10^{11} m. The radius of the sun is taken as 7×10^{8} m. **[2]**

21. A circular loop carrying a current 5 A, produces a magnetic field of π mT, at its centre. Find the value of the magnetic moment of the loop. **[2]**

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OR

A horizontal overhead power line carries a current of 90 A in east to west direction. What is the magnitude and direction of the magnetic field due to the current 1.5 m below the line?

Section C

22. i. You are required to select a carbon resistor of resistance $47\text{k}\Omega \pm 10\%$ from a large collection. What should be the sequence of colour bands used to code it? **[3]**

ii. Write the characteristics of manganin which make it suitable for making standard resistance.

23. Draw a circuit diagram of a full-wave rectifier. Explain its working principle. Draw the input/output, wave-forms indicating clearly the functions of the two diodes used. **[3]**

24. a. Plot a graph to show the variation of stopping potential with frequency of incident radiation in relation to photoelectric effect. **[3]**

b. Use Einstein's photoelectric equation to show how from this graph, (i) Threshold frequency, and (ii) Planck's constant can be determined.

25. i. In a typical nuclear reaction, e.g. **[3]**

$_1^2H + _1^2H \longrightarrow _2^3He + n + 3.27$

Although number of nucleons is conserved, yet energy is released. How? Explain.

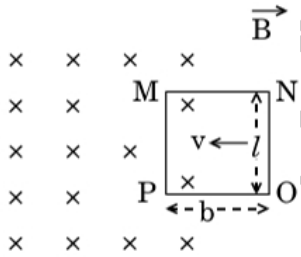
ii. Show that nuclear density in a given nucleus is independent of mass number A.

26. What do you mean by wave nature of an electron? How was quantisation of angular momentum of the orbiting electron in Bohr's model of hydrogen atom explained by de Broglie hypothesis? **[3]**

27. a. Is the speed of light in glass independent of the colour of light? Give reason. **[3]**

b. A small bulb is placed at the bottom of a tank containing water to a depth of 70 cm. Find the area of the surface of water through which light from the bulb can emerge out. Given refractive index of water is $\frac{4}{3}$.

28. The figure shows a rectangular conducting frame MNOP of resistance R placed partly in a perpendicular magnetic field $\vec{B}$ and moved with velocity $\vec{v}$ as shown in the figure. **[3]**



Obtain the expressions for the

a. force acting on the arm **ON** and its direction, and

b. power required to move the frame to get a steady emf induced between the arms MN and PO.

OR

A magnetic field B is confined to a region r $\leq$ a and points out of the paper (the z-axis), r = 0 being the centre of the circular region. A charged ring (charge = Q) of radius b, b > a and mass m lies in the x-y plane with its centre at the origin. The ring is free to rotate and is at rest. The magnetic field is brought to zero in time Δt. Find the angular velocity ω of the ring after the field vanishes.

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 = $\frac{U}{c}$.

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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.

(a) 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

(b) 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

(c) 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

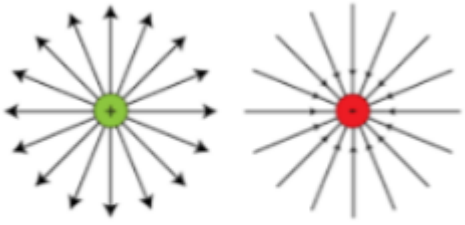
(d) A point source of electromagnetic radiation has an average power output of 1500 W. The maximum value of electric field at a distance of 3 m from this source (in V m^{-1}) is

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

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

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

A charge is a property associated with the matter due to which it experiences and produces an electric and magnetic field. Charges are scalar in nature and they add up like real numbers. Also, the total charge of an isolated system is always conserved. When the objects rub against each other charges acquired by them must be equal and opposite.



Electric field lines of a positive point charge Electric field lines of a negative point charge

(a) The cause of charging is:

a) the actual transfer of atoms b) the actual transfer of protons

c) the actual transfer of electrons d) the actual transfer of neutrons

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(b) Pick the correct statement.

i. The glass rod gives protons to silk when they are rubbed against each other.

ii. The glass rod gives electrons to silk when they are rubbed against each other.

iii. The glass rod gains protons from silk when they are rubbed against each other.

iv. The glass rod gains electrons when they are rubbed against each other.

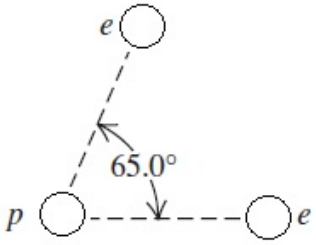
a) Option (i)

b) Option (iv)

c) Option (iii)

d) Option (ii)

(c) If two electrons are each 1.5×10^{-10}m from a proton, as shown in Figure, magnitude of the net electric force they will exert on the proton is



a) 1.97×10^{-8} N

b) 3.83×10^{-8} N

c) 4.63×10^{-8} N

d) 2.73×10^{-8} N

(d) A charge is a property associated with the matter due to which it produces and experiences:

a) electric effects only

b) magnetic effects only

c) both electric and magnetic effects

d) non magnetic effects only

OR

The cause of quantization of electric charges is:

a) transfer of an integral number of electrons

b) transfer of an integral number of neutrons

c) transfer of an integral number of protons

d) transfer of an integral number of Atom

Section E

31. Determine the 'effective focal length' of the combination of the two lenses having focal lengths 30 cm and -20cm if they are placed 8.0 cm apart with their principal axes coincident. Does the answer depend on which side of the combination a beam of parallel light is incident? Is the notion of effective focal length of this system useful at all? **[5]**

OR

i. Using Huygens's construction of secondary wavelets explains how a diffraction pattern is obtained on a screen due to a narrow slit on which a monochromatic beam of light is incident normally.

ii. Show that the angular width of first diffraction fringe is half that of the central fringe.

iii. Explain why the maxima at $\theta = \left(n + \frac{1}{2}\right) \frac{\lambda}{a}$ become weaker and weaker with increasing n.

32. a. Derive an expression for the energy stored in a parallel plate capacitor of capacitance C when charged up to voltage V. How is this energy stored in the capacitor? **[5]**

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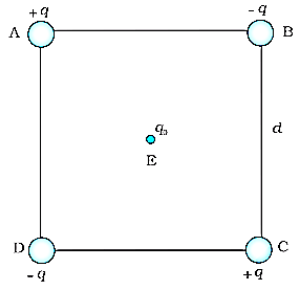
b. A capacitor of capacitance 1 μF is charged by connecting a battery of negligible internal resistance and emf 10 V across it. Calculate the amount of charge supplied by the battery in charging the capacitor fully.

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. Write the function of a transformer. State its principle of working with the help of a diagram. Mention various energy losses in this device. **[5]**

ii. The primary coil of an ideal step-up transformer has 100 turns and transformation ratio is also 100. The input voltage and power are respectively 220 V and 1100 W. Calculate

a. number of turns in secondary

b. current in primary

c. voltage across secondary

d. current in secondary

e. power in secondary

OR

A series LCR circuit is connected to an a.c. source having voltage $V = V_m \sin \omega t$. Derive the expression for the instantaneous current I and its phase relationship to the applied voltage. Obtain the condition for resonance to occur. Define power factor. State the conditions under which it is

i. maximum and

ii. minimum.

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