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. At which temperature, a pure semiconductor behaves slightly as a conductor? **[1]**

   a) both low and room temp. b) room temp.

   c) low temp. d) high temp.

2. Two unequal resistors are connected in series across a battery. Then the **[1]**

   a) potential difference across the bigger resistor is greater. b) power dissipated in both resistors is the same.

   c) potential difference across each resistor is the same. d) current in the smaller resistor is larger.

3. Which of the following pairs of media has the least value of critical angle? **[1]**

   a) Glass to air b) Glass to water

   c) Diamond to water d) Diamond to air

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

   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) $\frac{1}{3}$

5. The work done to move a charge along an equipotential surface from A to B **[1]**

a) is a negative quantity. b) is a positive quantity.

c) cannot be defined. d) is zero.

6. The resistance of an ideal voltmeter is **[1]**

a) zero b) 100 Ω

c) 500 Ω d) infinity

7. When a coi is joined to a cell grows with a time constant τ. The current will reach 10% less than it's steady-state value in time **[1]**

a) τ b) $\tau \ln(8)$

c) $\tau \ln(10)$ d) 0.9τ

8. A closely wound solenoid of 2000 turns and area of cross-section $1.6 \times 10^{-4} \mathrm{m}^2$, carrying a current of 4.0 A, is suspended through its centre allowing it to turn in a horizontal plane. What is the magnetic moment associated with the solenoid? **[1]**

a) 3.18 Am^2 b) 2.08 Am^2

c) 1.28 Am^2 d) 4.38 Am^2

9. Two beams of light will not give rise to an interference pattern, if: **[1]**

a) they are coherent b) they have the same wavelength

c) they are not monochromatic d) they are linearly polarized perpendicular to each other

10. Match Column I with Column II with appropriate matching. **[1]**

Column I	Column II
a. λ	i. L^2MT^{-2}
b. ρ	ii. electric field intensity
c. Torque	iii. $\frac{q}{V}$
d. electric field	iv. $\frac{q}{L}$

a) (a) - (iii), (b) - (i), (c) - (iv), (d) - (ii) b) (a) - (iv), (b) - (i), (c) - (ii), (d) - (iii)

c) (a) - (iv), (b) - (iii), (c) - (i), (d) - (ii) d) (a) - (ii), (b) - (iv), (c) - (i), (d) - (iii)

11. In the given Fig., V_o is the potential barrier across a p-n junction, when no battery is connected across the junction **[1]**

a) 1 corresponds to forward bias and 3 corresponds to reverse bias of junction.

b) 3 corresponds to forward bias of junction and 1 corresponds to reverse bias of junction

c) 3 and 1 both correspond to reverse bias of junction.

d) 1 and 3 both correspond to forward bias of junction

12. A telescope, when in normal adjustment, has a magnifying power of 6 and the objective and the eye-piece are 14 cm apart The focal lengths of the eye-piece and the objective respectively are **[1]**

a) 2 cm and 14 cm

b) 3 cm and 12 cm

c) 2 cm and 12 cm

d) 3 cm and 14 cm

13. **Assertion (A):** An electron and a photon possessing same wavelength, will have the same momentum. **[1]**
Reason (R): Electron and photon possess same energy.

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:** An applied electric field will polarize the polar dielectric material. **[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):** The film which appears bright in reflected system will appear dark in the transmitted light and vice-versa. **[1]**
Reason (R): The conditions for film to appear bright or dark in reflected light are just reverse to those in the transmitted light.

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):** When capacitive reactance is smaller than the inductive reactance in LCR current, e.m.f. leads the current. **[1]**
Reason (R): The phase angle is the angle between the alternating e.m.f. and alternating current of the 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 $2\mu C$ and $-2\mu C$ are placed at points A and B, 6 cm apart. **[2]**

a. Identify an equipotential surface of the system.

b. What is the direction of electric field at every point on this surface?

18. A bar magnet is placed in a uniform magnetic field with its magnetic moment making an angle θ with the field. **[2]**

i. Write an expression for the torque acting on the magnet and hence define its magnetic moment.

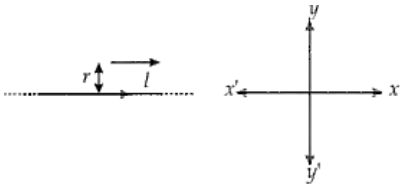
ii. Write an expression for the potential energy of the magnet in this orientation. When is this energy minimum?

19. a. Explain the formation of energy bands in crystalline solids. **[2]**

b. Draw the energy band diagrams of (i) a metal and (ii) a semiconductor.

20. According to the classical electromagnetic theory, calculate the initial frequency of the light emitted by the electron revolving around a proton in hydrogen atom. **[2]**

21. A particle of mass m and charge q is in motion at speed v parallel to a long straight conductor carrying current I as shown below: **[2]**



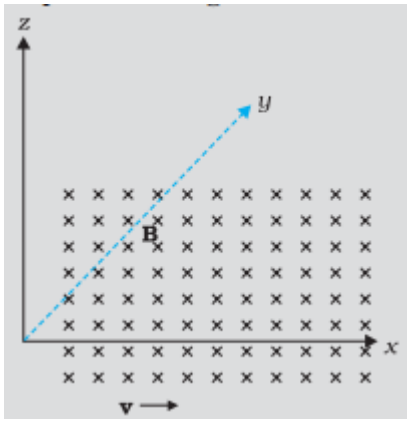
Find the magnitude and direction of the electric field required so that the particle goes undeflected.

OR

If the magnetic field is parallel to the positive y-axis and the charged particle is moving along the positive x-axis (Fig.), which way would the Lorentz force be for

a. an electron (negative charge),

b. a proton (positive charge).



Section C

22. Use Kirchhoff's rules to obtain conditions for the balance conditions in a Wheatstone bridge. **[3]**

23. a. Explain the formation of a p-n junction. **[3]**

b. Can we take one slab of p-type semiconductor and physically join it to another n-type semiconductor to get a p-n junction? Explain.

24. Ultra-violet light of wavelength 200 nm from a source is incident on a metal surface. If the stopping potential is -2.5 V, **[3]**

a. Calculate the work function of the metal, and

b. How would the surface respond to a high intensity red light of wavelength 6328 A produced by a laser?

25. Draw a plot showing the variation of binding energy per nucleon with mass number A. Write two important conclusions which you can draw from this plot. Explain with the help of this plot, the release in energy in the processes of nuclear fusion and fission. **[3]**

26. State Bohr's postulate to explain stable orbits in a hydrogen atom. Prove that the speed with which the electron **[3]**

revolves in n^{th} orbit is proportional to (1/n)

27. In a diffraction pattern due to a single slit, how will the angular width of central maximum change, if **[3]**

a. Orange light is used in place of green light,

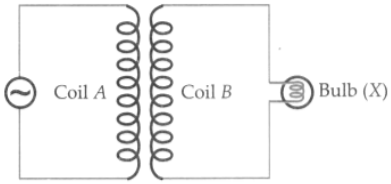
b. the screen is moved closer to the slit,

c. the slit width is decreased?

Justify your answer in each case.

28. Figure given below shows an arrangement by which current flows through the bulb (X) connected with coil B, when a.c. is passed through coil A. **[3]**

Explain the following observations:



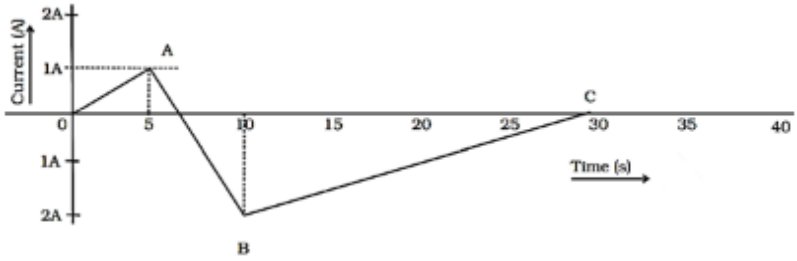
i. Bulb lights up.

ii. Bulb gets dimmer if the coil 'B' is moved upwards.

iii. If a copper sheet is inserted in the gap between the coils how the brightness of the bulb would change?

OR

A (current vs time) graph of the current passing through a solenoid is shown in Figure. For which time is the back electromotive force (u) a maximum. If the back emf at t = 3s is e, find the back emf at t = 7 s, 15s, and 40s. OA, AB, and BC are straight line segments.



Section D

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

Maxwell showed that the speed of an electromagnetic wave depends on the permeability and permittivity of the medium through which it travels. The speed of an electromagnetic wave in free space is given by $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$. The fact led Maxwell to predict that light is an electromagnetic wave. The emergence of the speed of light from purely electromagnetic considerations is the crowning achievement of Maxwell's electromagnetic theory. The speed of an electromagnetic wave in any medium of permeability μ and permittivity ε will be $\frac{c}{\sqrt{K\mu_r}}$ where K is the dielectric constant of the medium and μ_r is the relative permeability.

(a) The dimensions of $\frac{1}{2}\varepsilon_0 E^2$ (ε_0 : permittivity of free space; E = electric field) is

a) MLT^{-1} b) $ML^{-1}T^{-2}$

c) ML^2T^{-2} d) ML^2T^{-1}

(b) Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of the vacuum. If M = mass, L = length, T = time and A = electric current, then

a) $[\varepsilon_0] = ML^2T^{-1}$ b) $[\varepsilon_0] = MLT^{-2}A^{-2}$

c) $[\varepsilon_0] = M^{-1}L^{-3}T^4A^2$ d) $[\varepsilon_0] = M^{-1}L^{-3}T^2A$

(c) An electromagnetic wave of frequency 3 MHz passes from vacuum into a dielectric medium with permittivity $\varepsilon = 4$. Then

a) wavelength is halved and the frequency remains unchanged.

b) wavelength and frequency both remain unchanged

c) wavelength is doubled and the frequency remains unchanged

d) wavelength is doubled and the frequency becomes half

OR

The electromagnetic waves travel with

a) the speed of light $c = 3 \times 10^8$ m s^{-1} in fluid medium.

b) the speed of light $c = 3 \times 10$ m s^{-1} in solid medium

c) the speed of light $c = 3 \times 10^8$ m s^{-1} in free space

d) the same speed in all media

(d) Which of the following are not electromagnetic waves?
cosmic rays, γ-rays, β-rays, X-rays

a) β-rays

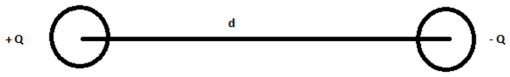
b) X-rays

c) γ-rays

d) cosmic rays

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

Electric dipole consist of a pair of equal and opposite point charges separated by a small distance and its strength is measured by the dipole moment. The field around the dipole in which the electric effect of the dipole can be experienced is called the dipole field.



(a) The electric dipole moment is:

a) a scalar quantity

b) neither scalar nor vector quantity

c) a vector quantity

d) A Plane quantity

(b) Electric field due to the electric dipole is

a) cylindrically symmetric

b) spherically symmetric

c) symmetric

d) asymmetric

(c) The SI unit of dipole moment is:

a) C/m

b) C-m

c) c/m^2

d) $C\text{-}m^2$

(d) Charges ± 20 nC are separated by 5mm. calculate the magnitude of dipole moment:-

a) 10^{-7} C-m

b) 10^{10} C-m

c) 10^{-10} C-m

d) 10^{-8} C-m

OR

When an electric dipole is placed in a uniform electric field, it experiences

a) Neither any force nor any torque

b) Force but no torque

c) Force as well as torque

d) Torque but no net force

Section E

31. An angular magnification of 30X is desired using an objective of focal length 1.25 cm and an eyepiece of focal length 5 cm. How will you set up the compound microscope? **[5]**

OR

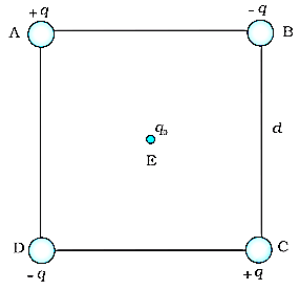
i. There are two sets of apparatus of Young's double-slit experiment. Inset A, the phase difference between the two waves emanating from the slits does not change with time, whereas in set B, the phase difference between the two waves from the slits changes rapidly with time. What difference will be observed in the pattern obtained on the screen in the two setups?

ii. Deduce the expression for the resultant intensity in both the above-mentioned setups (A and B), assuming that the waves emanating from the two slits have the same amplitude a and same wavelength λ.

32. A small sphere of radius a carrying a positive charge q is placed concentrically inside a large hollow conducting shell of radius b (b > a). This outer shell has charge Q on it. Show that if these spheres are connected by a conducting wire, charge will always flow from the inner sphere to the outer sphere irrespective of the magnitude of the two charges. **[5]**

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. An AC source of voltage $V = V_0 \sin \omega t$ is connected to a series combination of L, C and R. Use the phasor diagram to obtain expressions for the impedance of the circuit and phase angle between voltage and current. Find the condition when current will be in phase with the voltage. What is the circuit in the condition called? **[5]**

OR

In the following circuit, calculate:

i. the capacitance of the capacitor, if the power factor of the circuit is unity,

ii. the Q-factor of this circuit. What is the significance of the Q-factor in ac circuit? Given the angular frequency of the ac source to be 100 rad/s. Calculate the average power dissipated in the circuit.