SATISH SCIENCE ACADEMY

DHANORI PUNE-411015

PHYSICS

Class 12 - Physics

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

General Instructions:

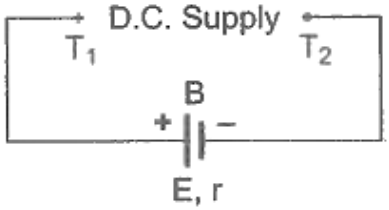
1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. All the sections are compulsory.
4. **Section A** contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark 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.

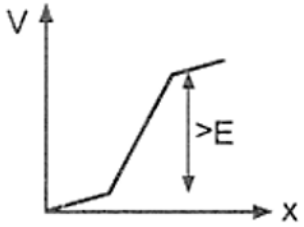
Section A

1. The intrinsic semiconductor becomes an insulator at: **[1]**

   a) -100 C
   b) 300 K
   c) 0 C
   d) 0 K

2. An accumulator battery B of emf E and internal resistance r is being charged from a DC supply whose terminals are T_1 and T_2. The connecting wires have uniform resistance. Moving from T_1 to T_2 through B, the potential V is plotted against distance x. The correct curve is: **[1]**



a)


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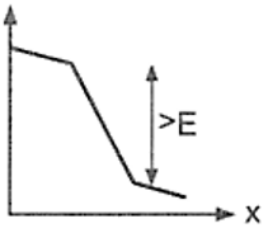
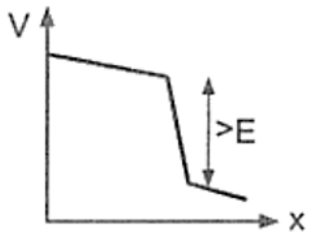
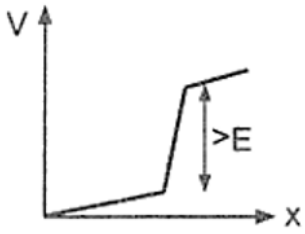


c)

d)





3. A concave lens of glass, refractive index 1.5, has both surfaces of the same radius of curvature R. On immersion in a medium of refractive index 1.75, it will behave as a **[1]**

a) divergent lens of focal length 3.5 R

b) divergent lens of focal length 3.0 R

c) convergent lens of focal length 3.0 R

d) convergent lens of focal length 3.5 R

4. A paramagnetic sample shows a net magnetisation of 8 Am^{-1} when placed in an external magnetic field of 0.6T at a temperature of 4K. When the same sample is placed in an external magnetic field of 0.2 T at a temperature of 16K, the magnetisation will be **[1]**

a) 6 Am^{-1}

b) $\frac{2}{3}Am^{-1}$

c) 2.4 Am^{-1}

d) $\frac{32}{3}Am^{-1}$

5. A 40 F capacitor in a defibrillator is charged to 3000 V. The energy stored in the capacitor is sent through the patient during a pulse of duration 2 ms. The power delivered to the patient is **[1]**

a) 90 kW

b) 180 kW

c) 45 kW

d) 360 kW

6. A voltmeter of range 2V and resistance 300 Ω cannot be converted to an ammeter of range: **[1]**

a) 8 mA

b) 10 A

c) 1 A

d) 5 mA

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

a) Induced magnetism

b) Faraday's effect

c) Electromagnetic induction

d) Induced current

8. An aeroplane having a wingspan of 35m files due north with the speed of 90 m/s, given B = 4× 10^{-5} T. The potential difference between the tips of the wings will be **[1]**

a) 0.126 V

b) 1.26 V

c) 0.013 V

d) 12.6 V

9. What is the path difference for destructive interference? **[1]**

a) $\frac{(n+1)\lambda}{2}$

b) n λ

c) n (λ + 1)

d) $\frac{(2n+1)\lambda}{2}$

10. A point charge +q is placed at the mid point of a cube of side L. The electric flux emerging from the cube is **[1]**

a) zero

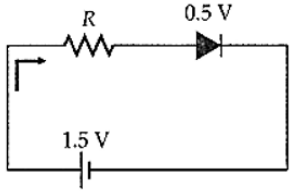
b) $\frac{qL^2}{\epsilon_o}$

c) $\frac{q}{6L^2\epsilon_o}$

d) $\frac{q}{\epsilon_o}$

11. The diode used in the circuit shown in the figure has a constant voltage drop at 0.5 V at all currents and a maximum power rating of 100 milliwatts. What should be the value of the resistor R, connected in series with **[1]**

diode for obtaining maximum current?



a) 20 Ω
b) 6.76 Ω
c) 5 Ω
d) 5.6 Ω

12. The minimum distance between an object and its real image formed by a convex lens of focal length f is: **[1]**

a) 4f
b) f
c) 2f
d) 3f

13. **Assertion (A):** Matter has nature. **[1]**
Reason (R): Light has dual nature.

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):** Electric field inside a conductor is zero. **[1]**
Reason (R): The potential at all the points inside a conductor is same.

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):** For identical coherent waves, the maximum intensity is four times the intensity due to each wave **[1]**
Reason (R): Intensity is proportional to the square of 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):** It is advantageous to transmit electric power at high voltage. **[1]**
Reason (R): High voltage implies high 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

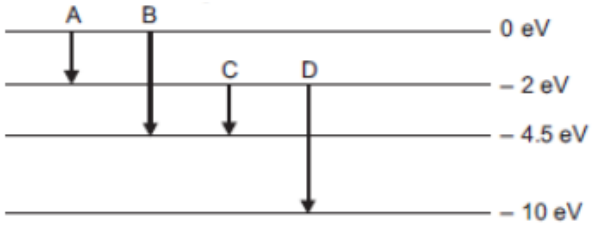
17. a. In what ways are matter waves different from electromagnetic waves? **[2]**
b. If the kinetic energy of a particle is reduced to one-fourth $\left(\frac{1}{4}\right)$ of its initial value, how many times will the de Broglie wavelength associated with it become?

18. A bar magnet with poles 25 cm apart and of pole strength 14.4 Am rests with its centre on a frictionless pivot. It is held in equilibrium at 60° to a uniform magnetic field of induction 0.25 T by applying a force F, at right angles to its axis, 12 cm from its pivot. Calculate F. What will happen if the force F is removed? **[2]**

19. Distinguish between intrinsic and extrinsic semiconductors. Although in an extrinsic semiconductor $n_e \neq n_h$, yet **[2]**

it is electrically neutral. Why?

20. a. The energy levels of an atoms are shown in fig. Which of them will result in the transion of a photon of wavelength 275nm? **[2]**



b. Which transition corresponds to emission of radiation of maximum wavelength?

21. What torque acts on a 40 turn coil of 100 cm^2 area carrying a current of 10 A held with its axis at right angles to a uniform magnetic of 0.2 T? **[2]**

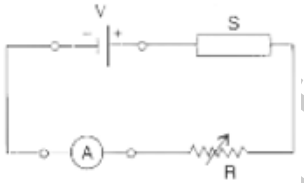
OR

The coil of a moving coil galvanometer has an effective area of 5×10^{-2} m^2. It is suspended in a magnetic field of 2×10^{-2} Wb m^{-2}. If the torsional constant of the suspension fibre is 4×10^{-9} Nm deg^{-1}, find its current sensitivity in degree per-microampere.

Section C

22. A cell of emf 'E' and internal resistance 'r' is connected across a variable load resistor R. Draw the plots of the terminal voltage V versus (i) R and (ii) the current I. **[3]**
It is found that when R = 4 Ω, the current is 1 A when R is increased to 9 Ω, the current reduces to 0.5 A. Find the values of the emf E and internal resistance r.

23. i. In the following diagram S is a semiconductor. Would you increase or decrease the value of R to keep the reading of the ammeter A constant when S is heated? Give reason for your answer. **[3]**



ii. Draw the circuit diagram of a photodiode and explain its working. Draw its $\frac{I}{V}$ characteristics.

24. a. State two important features of Einstein's photoelectric equation. **[3]**

b. Radiation of frequency 10^{15} Hz is incident on two photosensitive surfaces P and Q. There is no photoemission from surface P. Photoemission occurs from surface Q but photoelectrons have zero kinetic energy. Explain these observations and find the value of work function for surface Q.

25. Draw a plot of potential energy of a pair of nucleons as a function of their separations. Mark the regions where the nuclear force is **[3]**

i. attractive and

ii. repulsive.

Write any two characteristic features of nuclear forces.

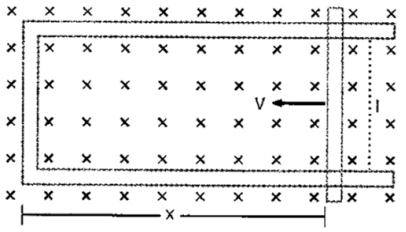
26. The number of particles scattered at 60° is 100 per minute in an α-particle scattering experiment, using gold foil. Calculate the number of particles per minute scattered at 90° angle. **[3]**

27. a. The interference pattern is not observed in Young's double slit experiment when the two sources S_1 and S_2 are far apart. Explain. **[3]**

b. Mention the conditions for the two sources to be coherent.

c. What is the effect on the interference pattern in a Young's double slit experiment, if the source of wavelength λ is replaced by another source of wavelength 1.5 λ, with the interference pattern still observable?

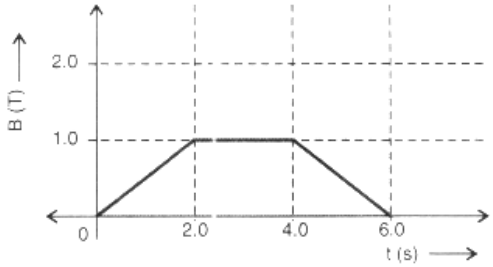
28. i. A rod of length l is moved horizontally with a uniform velocity v in a direction perpendicular to its length through a region in which a uniform magnetic field is acting vertically downward. Derive the expression for the emf induced across the ends of the rod. **[3]**



ii. How does one understand this motional emf by invoking the Lorentz force acting on the free charge carriers of the conductor? Explain.

OR

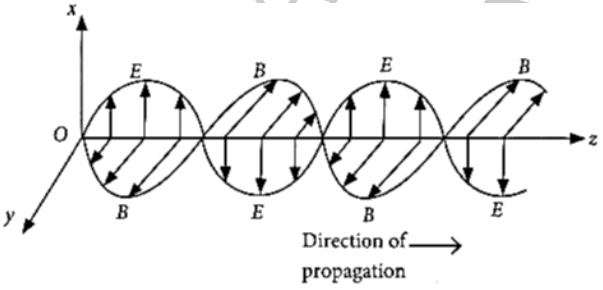
The magnetic field through a single loop of wire, 12 cm in radius and 8.5 ohm resistance, changes with time as shown in the figure. The magnetic field is perpendicular to the plane of the loop. Plot induced current as a function of time.



Section D

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

A stationary charge produces only an electrostatic field while a charge in uniform motion produces a magnetic field, that does not change with time. An oscillating charge is an example of accelerating charge. It produces an oscillating magnetic field, which in turn produces an oscillating electric fields and so on. The oscillating electric and magnetic fields regenerate each other as a wave which propagates through space.



(a) Magnetic field in a plane electromagnetic wave is given by $\vec{B} = B_0 \sin(kx + \omega t)\hat{j}$ T

Expression for corresponding electric field will be (Where c is speed of light.)

a) $\vec{E} = B_0 c \sin(kx + \omega t)\,\hat{k}$ V/m

b) $\vec{E} = -B_0 c \sin(kx - \omega t)\,\hat{k}$ V/m

c) $\vec{E} = -B_0 c \sin(kx + \omega t)\,\hat{k}$ V/m

d) $\vec{E} = \frac{B_0}{c} \sin(kx + \omega t)\,\hat{k}$ V/m

(b) The electric field component of a monochromatic radiation is given by $\vec{E} = 2E_0\hat{i} \cos kz \cos \omega t$. Its magnetic field $\vec{B}$ is then given by

a) $-\frac{2E_0}{c}\,\hat{j} \sin kz \sin \omega t$

b) $\frac{2E_0}{c}\,\hat{j} \sin kz \sin \omega t$

c) $\frac{2E_0}{c}\ \hat{j}$ sin kz cos ωt

d) $\frac{2E_0}{c}\ \hat{j}$ cos kz cos ωt

(c) A plane em wave of frequency 25 MHz travels in a free space along x-direction. At a particular point in space and time, E = (6.3 $\hat{j}$) V/m. What is magnetic field at that time?

a) 0.089 μT

b) 0.124 μT

c) 0.021 μT

d) 0.095 μT

OR

A plane electromagnetic wave travels in free space along x-axis. At a particular point in space, the electric field along y-axis is 9.3 V m^{-1}. The magnetic induction (B) along z-axis is

a) 3.1×10^{-8} T

b) 3×10^{-5} T

c) 3×10^{-6} T

d) 9.3×10^{-6} T

(d) A plane electromagnetic wave travelling along the x-direction has a wavelength of 3 mm. The variation in the electric field occurs in the y-direction with an amplitude 66 V m^{-1}. The equations for the electric and magnetic fields as a function of x and t are respectively

a) $E_y = 11\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$, $B_y = 11 \times 10^{-7}\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

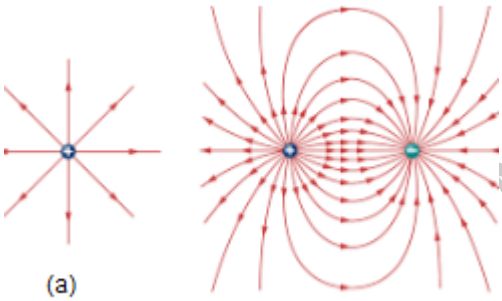
b) $E_y = 66\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$, $B_z = 2.2 \times 10^{-7}\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

c) $E_x = 33\cos \pi \times 10^{11}\left(t - \frac{x}{c}\right)$, $B_x = 11 \times 10^{-7}\cos \pi \times 10^{11}\left(t - \frac{x}{c}\right)$

d) $E_y = 33\cos \pi \times 10^{11}\left(t - \frac{x}{c}\right)$, $B_z = 1.1 \times 10^{-7}\cos \pi \times 10^{11}\left(t - \frac{x}{c}\right)$

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

Electric field lines as a path, straight or curved in an electric field such that tangent to it at any point gives the direction of electric field intensity at the point. Electric field lines are continuous curves they start from a positive charged body and end at the negatively charged body. (Refer image)



(a) Electric field due to a single charge is:

a) cylindrically symmetric

b) symmetric

c) asymmetric

d) spherically symmetric

(b) The SI unit of electric field intensity is:

a) N/C

b) N

c) C/m^2

d) N/m^2

(c) Pick the wrong statement.

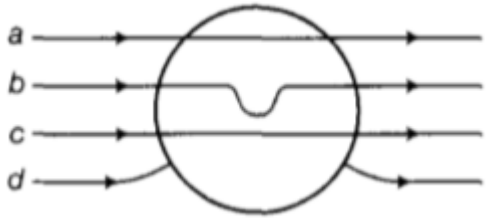
a) Electric field lines are continuous curves.

b) Electric field lines can intersect each other.

c) Electric field lines are always normal to the surface of a conductor.

d) The electrostatic field does not form a closed loop.

(d) A metallic sphere is placed in a uniform electric field as shown in the figure. Which path is followed by electric field lines?



a) path 'd'

b) path 'c'

c) path 'a'

d) path 'b'

OR

Pick the true statements about electric field lines.

a) Electric field lines provide information about the field strength.

b) Electric field lines provide information about the type of charge.

c) All of these.

d) Electric field lines provide information about the direction of the electric field.

Section E

31. i. Draw the labelled ray diagram for the formation of image by an astronomical telescope. **[5]**

ii. Derive the expression for its magnifying power in normal adjustment. Write two basic features which can distinguish between a telescope and a compound microscope.

OR

a. Derive the relation a sin $\theta = \lambda$ for the first minimum of the diffraction pattern produced due to a single slit of width **a** using light of wavelength λ.

b. State with reason, how the linear width of central maximum will be affected if (i) monochromatic yellow light is replaced with red light, and (ii) distance between the slit and the screen is increased.

c. Using the monochromatic light of same wavelength in the experimental set-up of the diffraction pattern as well as in the interference pattern where the slit separation is 1 mm, 10 interference fringes are found to be within the central maximum of the diffraction pattern. Determine the width of the single slit, if the screen is kept at the same distance from the slit in the two cases.

32. a. Deduce the expression for the energy stored in a charged capacitor **[5]**

b. Show that the effective capacitance C of a series combination of three capacitors C_1, C_2 and C_3 is given by $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$.

OR

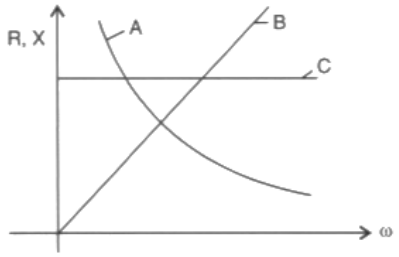
A spherical capacitor has an inner sphere of radius 12 cm and an outer sphere of radius 13 cm. The outer sphere is earthed and the inner sphere is given a charge of $2.5\mu C$. The space between the concentric spheres is filled with a liquid of dielectric constant 32.

a. Determine the capacitance of the capacitor.

b. What is the potential of the sphere?

c. Compare the capacitance of this capacitor with that of an isolated sphere of radius 12 cm. Explain why the latter is much smaller.

33. i. The figure shows the variation of resistance and reactance versus angular frequency. Identify the curve which corresponds to inductive reactance and resistance. **[5]**



ii. Show that series LCR circuit at resonance behaves as a purely resistive circuit. Compare the phase relation between current and voltage in series LCR circuit for (i) $X_L > X_C$, (ii) $X_L = X_C$ using phasor diagrams.

iii. What is an acceptor circuit and where it is used?

OR

Derive an expression for the impedance of an a.c. circuit with an inductor L and a resistor R in series. Also obtain the expression for average power in this circuit.