PHYSICS

Time : 3 hrs **Max. 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.

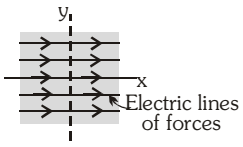
5. There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

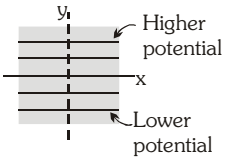
6. Use of calculators is not allowed.

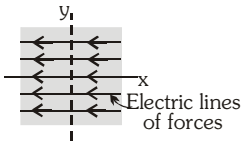
SECTION – A

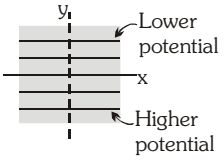
1. List I gives certain situations in which electric field is represented by electric lines of forces in x-y plane. List II gives corresponding representation of equipotential lines in x-y plane. Match the figures in List I with the figures in List II and indicate your answer. **[1]**

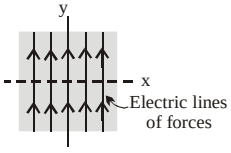
List - I **List - II**

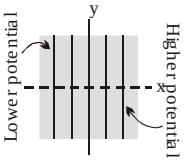
(P) 

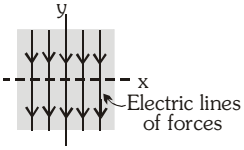
(1) 

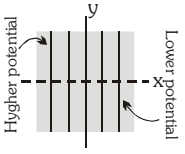
(Q) 

(2) 

(R) 

(3) 

(S) 

(4) 

Codes	P	Q	R	S
(A)	1	2	3	4
(B)	4	3	2	1
(C)	3	4	2	1
(D)	2	1	3	4

2. Gaus's law is given by $\in_0 \oint_s \vec{E}.d\vec{s} = q$, if net charge enclosed by a Gaussian surface is zero then: **[1]**

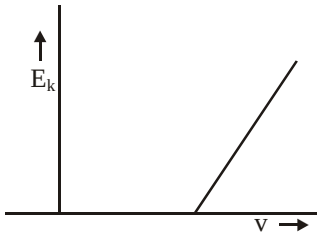
(A) E must be zero on the surface

(B) Number of incoming and outgoing electric lines are equal

(C) there is a net incoming of electric lines

(D) none

3. Graph is plotted between maximum kinetic energy of electron with frequency of incident photon in Photo electric effect. The slope of curve will be equal to: **[1]**



(A) Charge of electron (B) Work function of metal

(C) Planck's constant (D) Ratio of Planck constant and charge of electron

4. Which of the following statements is correct? **[1]**

(A) Lyman series is continuous spectrum

(B) Balmer series lies in ultraviolet region

(C) Paschen series lies in infrared region

(D) Brackett series lies in visible region

5. A circular loop has a radius of 5 cm. and it is carrying a current of 0.1 A. its magnetic moment is- **[1]**

(A) 1.32×10^{-4} amp-m^2 (B) 2.62×10^{-4} amp-m^2

(C) 5.25×10^{-4} amp-m^2 (D) 7.85×10^{-4} amp-m^2

6. Substances in which the magnetic moment of a single atom is not zero, are known as - **[1]**

(A) Diamagnetic (B) Ferromagnetic

(C) Paramagnetic (D) (B) and (C) both

7. The hot wire ammeter can measure - **[1]**

(A) D.C. current (B) A.C. current (C) None of above (D) both (A) & (B)

8. When the number of turns in a coil is doubled without any change in the length of the wire, its self-inductance becomes- **[1]**

(A) Four times (B) Doubled (C) Halved (D) Unchanged

9. A step down transformer connected to an ac mains supply of 220 V is made to operate 11V, 44 W lamp. Ignoring power losses in the transformer, what is the current in the primary circuit? **[1]**

(A) 0.2 A (B) 0.4 A (C) 2A (D) 4A

10. If $\vec{E}$ and $\vec{B}$ are the electric and magnetic field vectors of electromagnetic waves then the direction of propagation of electromagnetic wave is along the direction of - **[1]**

(A) $\vec{E}$ (B) $\vec{B}$ (C) $\vec{E} \times \vec{B}$ (D) none of these

11. In electromagnetic induction, the induced e.m.f. in a coil is independent of- **[1]**

(A) Change in the flux (B) Time

(C) Resistance of the circuit (D) Number of turns

12. According to the Bohr theory of Hydrogen atom, the speed of the electron, its energy and the radius of its orbit varies with the principal quantum number n, respectively, as **[1]**

(1) $\frac{1}{n}, \frac{1}{n^2}, n^2$ (B) $\frac{1}{n}, n^2, \frac{1}{n^2}$

(C) $n^2, \frac{1}{n^2}, n^2$ (D) $n, \frac{1}{n^2}, \frac{1}{n^2}$

ASSERTION & REASON

For Questions 13 to 16, two statements are given–one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

(A) Assertion and Reason are true and Reason is the correct explanation of Assertion.

(B) Assertion and Reason are true but Reason is NOT the correct explanation of Assertion.

(C) Assertion is true but Reason is false.

(D) Both Assertion and Reason are false.

13. **Assertion (A) :** The temperature coefficient of resistance is positive for metals and negative for p-type semiconductor.

Reason (R) : The charge carriers in metals are negatively charged whereas in p-type semiconductors they are positively charged. **[1]**

14. **Assertion (A) :** The photoelectric current increases with increase in intensity of incident radiation, keeping the frequency of the incident radiation and the accelerating potential fixed.

Reason (R) : The number of photoelectrons emitted per second is directly proportional to the intensity of incident radiation. **[1]**

15. **Assertion (A) :** The electrostatic field $\vec{E}$ is a conservative field.

Reason (R) : Line integral of electrostatic field $\vec{E}$ around a closed path is non zero. **[1]**

16. **Assertion (A) :** The angle of minimum deviation for a prism is lesser for red light than that for blue light.

Reason (R) : The refractive index of the material of a prism for blue light is greater than that for red light. **[1]**

SECTION – B

17. Explain flow of current using circuit diagram in P-N junction diode when forward biased ? **[2]**

18. An electron and a photon have got the same de–Broglie wavelength. Prove that total energy of electron is greater than energy of photon. **[2]**

19. A prism of refractive index 1.53 is placed in water of refractive index 1.33. If the angle of prism is 60°, calculate the angle of minimum deviation in water. (sin 35.1° = 0.575) **[2]**

20. At room temperature (0°C) the resistance of a heating element is 100 Ω. Calculate the temperature of the element if the resistance is found to be 117 Ω (the temperature coefficient of resistance of the material is 1.7×10^{-4} °C^{-1}) **[2]**

21. An object is placed at a distance of 1.50 m from a screen and a convex lens placed in between, produces an image magnified 4 times on the screen. What is the focal length and the position of the lens? **[2]**

OR

A small telescope has an objective of focal length 144 cm and an eyepiece of focal length 6.0 cm. What is the magnifying power of the telescope? What is the separation between the objective and the eyepiece? The final image is formed at infinity.

SECTION – C

22. What is energy released by fission of 1 gm U^{235} ? **[3]**

OR

Explain nuclear fission & fusion on the basis of binding energy of nucleus.

23. Two negative charges, each of magnitude q are 2r distance apart. A positive charge q is lying at the mid point of the line joining them. The potential energy of the system is U_1. If the two nearest charges are mutually interchanged and the potential energy becomes U_2, then $\frac{U_1}{U_2}$ will be :- **[3]**

24. Find the ratio of maximum wavelength to minimum wavelength for the lines of Balmer series in hydrogen spectrum. **[3]**

25. Two cells of emfs E_1 and E_2 are connected in series. Their internal resistances are r_1 and r_2 respectively. Compute the equivalent emf and equivalent internal resistance. **[3]**

26. Write Ampere's circuital law. A long straight wire of a circular cross-section (radius a) is carrying steady current. Current is uniformly distributed in the wire. Calculate the magnetic field inside the region (r < a) in the wire. **[3]**

27. Draw propagation diagram of an electromagnetic wave and write any two properties of electromagnetic waves. **[3]**

The amplitude of the magnetic field associated with an electromagnetic wave in vacuum is $B_0 = 50 \times 10^{-8}$ tesla. Write the value of amplitude of the electric field in V/m associated with the wave.

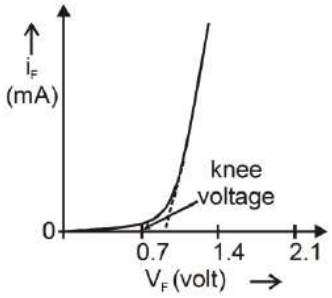
28. Explain Faraday's law of electromagnetic induction and discuss Lenz's explanation for negative sign. **[3]**

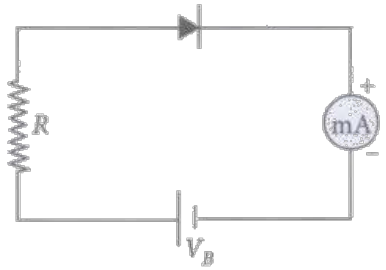
OR

How to convert a galvanometer into ammeter and voltmeter? What are the characteristics of galvanometer?

SECTION – D

29. A silicon p-n junction diode is connected to a resistor R and a battery of voltage V_B through milliammeter (mA) as shown in figure. The knee voltage for this junction diode is V_N = 0.7 V. The p-n junction diode requires a minimum current of 1 mA to attain a value higher than the knee point on the I-V characteristics of this junction diode. Assuming that the voltage V across the junction is independent of the current above the knee point. A p-n junction is the basic building block of many semiconductor devices like diodes. Important process occurring during the formation of a p-n junction are diffusion and drift. In an n-type semiconductor concentration of electrons is more as compared to holes. In a p-type semiconductor concentration of holes is more as compared to electrons.





(i) If V_B = 5 V, the maximum value of R so that the voltage V is above the knee point voltage is- **[1]**

(a) 40 kΩ (b) 4.3 kΩ (c) 5.0 kΩ (d) 5.7 kΩ

(ii) If V_B = 5 V, the value of R in order to establish a current to 6 mA in the circuit is- **[1]**

(a) 833 Ω (b) 717 Ω (c) 950 Ω (d) 733 Ω

(iii) If V_B = 6 V, the power dissipated in the resistor R, when a current of 6 mA flows in the circuit is **[1]**

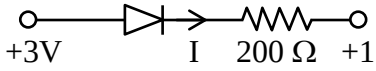
(a) 30.2 mW (b) 30.8 mW (c) 31.2 mW (d) 31.8 mW

(iv) When the diode is reverse biased with a voltage of 6 V and V_{bi} = 0.63 V. Calculate the total potential. **[1]**

(a) 9.27 V (b) 6.63 V (c) 5.27 V (d) 0.63 V

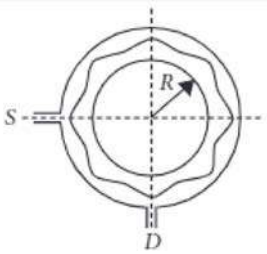
OR

If an ideal junction diode is connected as shown, then the value of the current I is :-



(a) 0.013 A (b) 0.02 A (c) 0.01 A (d) 0.1 A

30. A narrow tube is bent in the form of a circle of radius R, as shown in figure. Two small holes S and D are made in the tube at the positions at right angle to each other. A source placed at S generates a wave of intensity I_o which is equally divided into two parts: one part travels along the longer path, while the other travels along the shorter path. Both the waves meet at point D where a detector is placed.



(i) If a maxima is formed at a detector, then the magnitude of wavelength λ of the wave produced is given by : **[1]**

(a) πR (b) $\frac{\pi R}{2}$ (c) $\frac{\pi R}{4}$ (d) All of these

(ii) If the intensity ratio of two coherent sources used in Young's double slit experiment is 49 : 1, then the ratio between the maximum and minimum intensities in the interference pattern is : **[1]**

(a) 1 : 9 (b) 9 : 16 (c) 25 : 16 (d) 16.9

(iii) The maximum intensity produced at D is given by :- **[1]**

(a) $4I_0$ (b) $2I_0$ (c) I_0 (d) $3I_0$

(iv) In a Young's double slit experiment, the intensity at a point where the path difference is $\frac{\lambda}{6}$ (λ–wavelength of the light) is I. If I_0 denotes the maximum intensity, then I/I_0 is equal to :- **[1]**

(a) $\frac{1}{2}$ (b) $\frac{\sqrt{3}}{2}$ (c) $\frac{1}{\sqrt{2}}$ (d) $\frac{3}{4}$

OR

Two identical light waves, propagating in the same direction, have a phase difference d. After they superpose the intensity of the resulting wave will be proportional to :-

(a) cos δ (b) cos (δ/2) (c) $\cos^2(\delta/2)$ (d) $\cos^2\delta$

SECTION – E

31. **(a)** A plane wavefront incident on (i) prism, (ii) convex lens and (iii) concave mirror. Using suitable diagram, explain the nature of wavefront obtained after refraction through the prism and convex lens and the wavefront obtained after reflection from the concave mirror. **[3]**

(b) If two light waves $y_1 = a \cos \omega t$ and $y_2 = a \cos (\omega t + \phi)$ are superimposed to each other, then prove that the resultant intensity will be $I = 4 I_0 \cos^2(\phi/2)$. **[2]**

OR

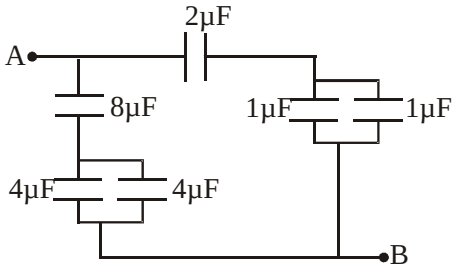
(a) Derive Lens maker's formula $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$. The lower half of the concave mirror's reflecting surface is covered with an opaque material. What will be the effect on the image formed by the mirror? **[3]**

(b) Why reflecting telescope is superior in comparison to refracting telescope? Write two reasons. Magnifying power of a telescope is 8. When it is adjusted for parallel rays the distance between eyepiece and objective lens is 18cm. Determine the focal length of both the lenses. **[2]**

32. **(a)** (i) 10 capacitors each of capacity 10 μ F are joined first in series and then in parallel. Write the value of product of equivalent capacitances. **[1]**

(ii) What will be the value of capacitance of a 4 μF capacitor if a dielectric of dielectric constant 2 is inserted fully between the plates of parallel plate capacitor ? **[1]**

(b) Find the equivalent capacitance between points A and B in given figure. **[3]**



OR

(a) How will the capacitance of a parallel plate capacitor change if : **[2½]**

(i) The area of the plates is doubled?

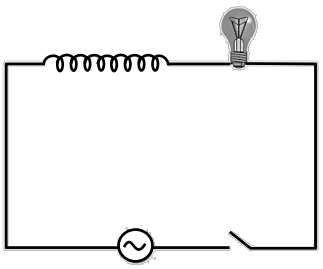
(ii) The separation between the plates is doubled?

(b) The effective capacitance of three capacitors of the same capacitance connected in series is 1μF. Find the **[2½]**

(i) Effective capacitance if they are connected in parallel.

(ii) Ratio of energy stored in the parallel combination of the capacitors to that in the series combination, if the combinations are connected to the same source one by one.

33. **(a)** A light bulb and an open coil inductor are connected to an ac source through a key as shown in Figure.



The switch is closed and after sometime, an iron rod is inserted into the interior of the inductor. The glow of the light bulb (a) increases; (b) decreases; (c) is unchanged, as the iron rod is inserted. Give your answer with reason. **[3]**

(b) An alternating voltage of frequency f is applied to a series LCR circuit. Let f_r be the resonant frequency for the circuit. Will the current in the circuit lag, lead or remain in phase with applied voltage when (i) $f > f_r$ (ii) $f < f_r$? Explain. **[2]**

OR

(a) A rod of length ℓ is moving perpendicular to it's length with uniform velocity v. It passes through a magnetic field B acting vertically inwards. Deduce an expression for induced emf across the ends of rod. **[3]**

(b) The number of turns in primary and secondary coils of a step-up transformer are 100 and 400 respectively. If 120V of alternating voltage is applied in primary, then find out **[2]**

(i) Transformation ratio

(ii) Voltage produced in secondary coil