

PHYSICS

(Paper II)

Time Allowed : Three Hours
Maximum Marks : 300

QUESTION PAPER SPECIFIC INSTRUCTIONS

(Please read each of the following instructions carefully before attempting questions)

There are EIGHT questions divided in two Sections.

Candidate has to attempt FIVE questions in all.

Question Nos. 1 and 5 are compulsory and out of the remaining, any THREE are to be attempted choosing at least ONE question from each Section.

The number of marks carried by a question/part is indicated against it.

Wherever any assumptions are made for answering a question, they must be clearly indicated.

Word limit in questions, wherever specified, should be adhered to.

Questions 3 and 4 of this paper could not be traced in any available source and are not reproduced.

SECTION 'A'

1. Answer any three of the following:
 - (a) A hydrogen atom is in the following state:

$$\psi_{nlm}(r,0) = (\sqrt{1/14})[2\psi_{100}(r) - 3\psi_{200}(r) + \psi_{322}(r)]$$

[?]

 - (a)(i) What is the probability of finding the system in the state (200)? 10
 - (a)(ii) What are $\langle H \rangle$ and $\langle L_z \rangle$? 10
 - (b)(i) Calculate the Zeeman shift observed in the normal Zeeman effect when a spectral line of wavelength 5000 Å is subjected to the magnetic field of 0.4 Wb m⁻². 10
 - (b)(ii) Show that for the ground state of hydrogen atom the mean value of r [?] is $3/2 a_0$, where a_0 being Bohr radius constant. 10
 - (c) Water vapor shows Infrared absorption bands at 1595 cm⁻¹, at 3652 cm⁻¹ and at 3756 cm⁻¹. If the Raman spectrum is observed with the Argon Ion Laser 514.5 nm, at what wavelengths would you expect to find the Raman Stokes lines? 20
 - (d)(i) Calculate the wavelength of neutrons at a temperature of 20 °C. 12
 - (d)(ii) What are the term symbols for atoms with the following S (total spin) and L (total orbital) quantum numbers, $S=1/2$, $L=3$? 8
 2. (a) If x and p_x are two conjugate variables, show that [the rest of Question 2 and Questions 3 and 4 are missing from the only available source] 60

SECTION 'B'

5. (a) [The stem of Question 5 and the beginning of this part are missing from the only available source] ...duce 4 watts and the amount of energy that is released in the complete fissioning of 1 kg of ²³⁵U. (Assume energy released per fission of ²³⁵U is 200 MeV.) 20
 - (b)(i) Which of the following reactions are allowed and forbidden under the conservation of strangeness, conservation of baryon number and conservation of charge?

$$\pi^+ + n \rightarrow \Lambda + K^+$$

$$\pi^+ + n \rightarrow K + K^+$$

$$\pi^- + p \rightarrow \Lambda + K^+$$
10

$$\pi^- + p \rightarrow \pi^+ + \Lambda$$

- (b)(ii) By drawing E vs. **k** curve, distinguish between metal, insulator and semiconductor. **10**
- (c) A transistor with $\beta=50$, $V_{BE}=0.7$ [?] V, $V_{CC}=22.5$ V and $R_C=5.6$ k Ω is used in biasing circuit as shown in the figure. It is designed to establish the quiescent potential at $V_{CE}=12$ V, $I_C=1.5$ [?] mA and stability factor $S \leq 3$. Find the values of resistors R_E , R_1 and R_2 , where symbols have their usual meanings.
 [Figure: Voltage-divider bias circuit of an npn transistor. A +22.5 V supply line at the top; R_1 from the supply line to the base node and R_2 from the base node to ground; R_C from the supply line to the collector; the emitter (current I_E , arrow pointing out of the emitter) goes to ground through R_E .] **20**
- (d)(i) The following information is included on the data sheet for an N-channel JFET: $I_{DSS}=20$ mA, $V_p=-8$ V and $g_{mo}=5000$ μ S. Determine the value of drain current and trans-conductance at $V_{GS}=-4$ V. **10**
- (d)(ii) Calculate the binding energy per nucleon for ${}^4_2\text{He}$ and ${}^{16}_8\text{O}$. **10**
6. (a) Write down the Bethe-Weizsäcker mass formula. Explain various terms of the formula. **40**
- (b) Explain how energy is released in stars. **20**
7. (a) Describe in detail one experiment for the detection of neutrino. **20**
- (b) What is the difference between neutrino and anti-neutrino? How is helicity of neutrino determined? **20**
- (c) Show that the condition of periodicity of lattice leads to the Bloch theorem. What is a Bloch function? **20**
8. (a) Draw a circuit diagram of an R-C phase shift oscillator. Explain its working. Derive an expression for its frequency. **30**
- (b) Give the two forms of the De Morgan's theorem. **10**
- (c) What is the principle used in 'half-adder'? Give the truth table for it. **20**