

PAPER 64

STRING THEORY

*Attempt **FOUR** questions. The questions are of equal weight.*

You may not start to read the questions
printed on the subsequent pages until
instructed to do so by the Invigilator.

- 1** Derive the classical equations of motion for a relativistic string from the Polyakov action, commenting on the invariances of the action and their significance.

- 2** In the covariant quantization of the Nambu-Goto action, show that there is a physical state of the form $(L_{-2} + \mu L_{-1}^2)|k\rangle$ if the dimension of space-time, $d = 26$. What is its norm? Give an outline account of how the No-Ghost Theorem leads to the elimination of negative norm squared states for $d \leq 26$.

- 3** Give a sketch of the path-integral approach to the quantization of the Polyakov action for the bosonic string.

- 4** Discuss quantization of a closed string when a number of the dimensions of space are compactified to form circles of radius R_j , $1 \leq j \leq M$. Show that, if any of the radii R_j takes a certain value, the theory acquires additional massless vector particles.

- 5** Explain how the incorporation of anticommuting fields into string theory leads to the presence in the theory of space-time fermions.