The candidate will be randomly assigned one special relativity topic (1–8) and two general relativity topics (9–16) from the list below and will be asked to write an exhaustive report on the topics drawn.

1 Galilean transformations, Galilean principle of relativity, and Maxwell's equations.

2 The wave equation and the origin of the Lorentz group, examples of Lorentz transformations.

3 The Minkowski spacetime: metric, causality, inverse Cauchy-Schwarz inequality.

4 Time dilation, the twin paradox, Lorentz contraction.

5 Particles in special relativity: worldlines and proper time.

6 Four-velocity, four-acceleration, photons in special relativity.

7 Doppler effect, aberration of light.

8 Four-momentum conservation, decay of particles, Compton effect.

9 Introduction to tensor calculus: scalars, vectors, covectors, operations with tensors.

10 Covariant derivatives, the Levi-Civita connection, local inertial coordinates.

11 The curvature tensor and its properties.

12 The geodesic equation.

13 Basic principles of general relativity, Einstein equations, the energy-momentum tensor of dust.

14 Newtonian limit for the geodesic equations and for the Einstein field equations.

15 The Schwarzschild black hole - derivation.

16 The Schwarzschild black hole - static observers, energy of test particles, photons.