We study several different models of extended bodies in gravitational fields. Firstly, we revisit the glider model of a dumbbell-like oscillating body. We develop an independent scheme to integrate the equations of motion. We study the radial fall of a Newtonian spring, calculate the position shifts of the spring and find the critical value of the spring constant which cannot overcome the tidal forces. We argue that the relativistic glider model is unphysical due to its behaviour in the critical regions.

Secondly, we show that Dixon's theory of extended bodies predicts a geodesic motion of the centre of mass in maximally symmetric spacetimes. We prove that a system of test particles can be described by a conserved stress-energy tensor and we evaluate the position shifts of the glider model in the maximally symmetric spacetimes, showing its disagreement with Dixon's theory. We thus conclude again that the glider model must be rejected.

And thirdly, we study a model of an extended body consisting of interacting particles, which is in accord with Dixon's theory. We calculate the position shifts for this model and show that the model does not predict any measurable swimming effect. Finally, we estimate the numerical error of the calculation by finding the position shifts of the model in maximally symmetric spacetimes.