3. A ring of radius 50 cm has a uniform linear charge density of $+10\ \text{nC m}^{-1}$. A small charged object having mass 1 mg and carrying charge of $-5.0\ \text{nC}$ is initially at a point on the axis of the ring and at a distance of 5.0 mm from the centre of the ring.

(a) How long does the object take to reach the centre of the ring for the first time?

[8 marks]

[0.467 s]

(b) What is the kinetic energy of the charged object when it is at the centre of the ring?

[3 marks]

[1.412×10^{-10} J]

[For a uniformly charged ring with radius R, and carrying a total charge of $+Q$, the electric field on the axial point, at a distance x from the centre of the ring is $\vec{E} = \frac{Q}{4\pi\varepsilon_0} \frac{x}{\left(R^2 + x^2\right)^{\frac{3}{2}}} \hat{i}$ where $\hat{i}$ is a unit vector along the axis of the ring and pointing away from the centre of the ring].