3. (b) The surface charge density $\sigma(r)$ at a point on a circular thin disc, having diameter 20 cm, can be described by the equation $\sigma(r) = +1.05r \ \mu C \, \text{m}^{-2}$ where r is the distance of the point from the centre of the disc. A point charge of $+10 \, \text{nC}$ is placed on the axis of the disc and at a distance 50 cm from the centre of the disc. What is the magnitude and direction of the electrostatic force acting on this point charge due to the positive charge on the disc?

[7 marks]

$[1.523 \times 10^{-6} \, \hat{\imath} \, \text{N}]$

[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 $\vec{E} = \dfrac{Q}{4\pi\varepsilon_0} \dfrac{x}{\left(R^2 + x^2\right)^{\frac{3}{2}}} \hat{\imath}$ where $\hat{\imath}$ is a unit vector along the axis of the ring and pointing away from the centre of the ring].