

PHYS2050 – Electromagnetism – 2009

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Assignment 1: marked out of 30 but worth 10% of the final mark

Due date: Friday 28 August 2009, during the Lecture at 10 a.m.

1. Question (10 marks)

Divergence on spherical coordinates

Derive the relation for the divergence of a vector field in spherical coordinates:

$$\operatorname{div} \vec{v}(\vec{r}) = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 v_r) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (v_\theta \sin \theta) + \frac{1}{r \sin \theta} \frac{\partial v_\varphi}{\partial \varphi}$$

2. Question (10 marks)

Cycloid

Calculate the length of the path of a single point on a wheel, when the wheel is rolling one full round:

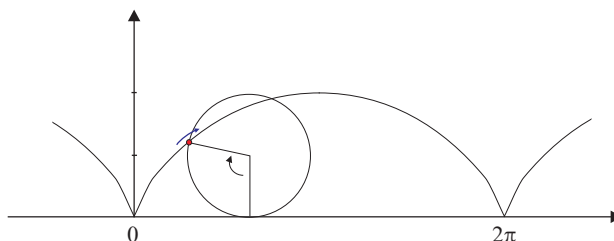


Figure 1: cycloid: path of a single point on a rolling wheel.

3. Question (10 marks)

Hollow, Spherical Shell

A hollow, spherical shell with the inner radius a and the outer radius b carries a charge density of $\rho(r) = k/r^2$ in the region $a \leq r \leq b$. Here, k is a constant.

- Derive the expressions for the electric field in the three regions (i) $r < a$, (ii) $a \leq r \leq b$, and (iii) $r > b$.
- Plot the electric field as a function of r .

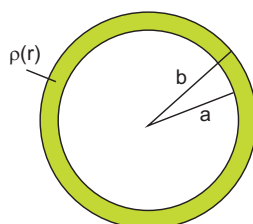


Figure 2: hollow, spherical shell