Answer on Question #75621, Physics / Electromagnetism

Question A wheel having mass m has charge +q and -q on diametrically opposite points. It remains in equilibrium on a rough inclined plane in the presence of vertical electric field E. The value of E is .
Ans: mg/2q

Solution We can consider this wheel as dipole

$$p = qd$$

where d is diameter of the wheel. The torque create by field is

$$\tau = \vec{p} \times E = pE \sin\alpha = qdE \sin\alpha$$

where α is angle of inclination of the plane. It is written for point where wheel touches the plane. We can also compute torque of the gravitational force:

$$\tau_g = F \times r = mg \cdot d/2 \cdot \sin\alpha$$

Here we assumed that gravitational force is applied to the center of the wheel. Wheel is balanced, hence these torques are equal, from this we obtain

$$\tau = \tau_g$$

$$qdE \sin\alpha = mg \cdot d/2 \cdot \sin\alpha$$

$$E = \frac{mg}{2q}$$