

**M3H PROBLEMS 5. 15.11.2013**

Q1 (*Polar equation of a conic*).

Show that the equation of a conic with focus the origin, directrix the line  $L : y = \ell$  and eccentricity  $e$  is

$$\frac{1}{r} = \frac{1}{\ell}(1 + e \cos \theta).$$

Q2 (*Inverse Square Law of Gravity and conical orbits*).

(i) Find the components of velocity and acceleration along and perpendicular to the radius vector in polar coordinates.

(ii) Show that the force being *central* (along the radius vector) is equivalent to *Kepler's Second Law*: the radius vector sweeps out equal areas in equal times.

(iii) Show that *Newton's Inverse Square Law of Gravity* is equivalent to the differential equation

$$\frac{d^2u}{d\theta^2} + u = b. \tag{DE}$$

Solve (DE), and identify its solution as a conic.

(iv) Which authors and periods are involved in your proof?

NHB