** Let A be a vector from the origin to a point P fixed in space. Let r be a vector from the origin to a variable point Q, having coordinates, (x,y,z). Show that $A \bullet r = A^2$ is an equation for the plane perpendicular to A and passing through the point P.

*** The unit vectors for spherical coordinates are given as er, eθ, eφ and are related to the usual i, j, k unit vectors by the following three equations:
(1) $e_r = \sin(\theta)\cos(\varphi)\, i + \sin(\theta)\sin(\varphi)\, j + \cos(\theta)\, k$
(2) $e_\theta = \cos(\theta)\cos(\varphi)\, i + \cos(\theta)\sin(\varphi)\, j - \sin(\theta)\, k$
(3) $e_\varphi = -\sin(\varphi)\, i + \cos(\varphi)\, j$
Derive complete general expressions for r, v and a in terms of er, eθ, eφ

*** Ship A is located 4.0 km north and 2.5 km east of ship B, at initial time, t=0. Ship A has a velocity of 22km/hr toward the south, and ship B has a velocity of 40 km/h in a direction 37° north of east. (a) Using unit vector notation with (i , j) defining (east, north), what is the velocity of A relative to B? (b) Derive an expression for the position of A relative to B as a function of t. (c) At what time will the separation between the ships be the least? (d) What is this minimal separation?

** Take the answer to parts (a) and (b) of the previous problem and re-express them in the coordinate system of ship B, where the positive y-axis is taken to be in the direction of the ship's forward motion (bow), and the positive x-axis is taken to be starboard, which is to the right of the ship when facing forward. You can use a rotation matrix for this if you want, and get the vectors in question expressed in terms of (i′ , j′).