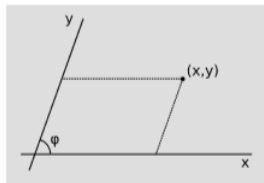


## 7.E: Coordinates (Exercises)

### Q1

Example 7.4.2 discussed polar coordinates in the Euclidean plane. Use the technique demonstrated in section 7.3 to find the metric in these coordinates.

### Q2



Oblique Cartesian coordinates are like normal Cartesian coordinates in the plane, but their axes are at an angle  $\varphi \neq \pi/2$  to one another. Show that the metric in these coordinates is

$$ds^2 = dx^2 + dy^2 + 2\cos\varphi dx dy \quad (7.E.1)$$

### Q3

Let a 3-plane  $U$  be defined in Minkowski coordinates by the equation  $x = t$ . Is this plane spacelike, timelike, or lightlike? Find a covector  $S \rightarrow$  that is normal to  $U$  in the sense described in section 7.6, describing it in terms of its components. Compute the vector  $S$ , also in component form. Verify that  $S \rightarrow S = 0$ . Show that  $\rightarrow S$  is tangent to  $M$ .

### Q4

For the oblique Cartesian coordinates defined in problem Q2, use the determinant of the metric to show that the Levi-Civita tensor is

$$\epsilon = \begin{pmatrix} 0 & \sin\varphi \\ -\sin\varphi & 0 \end{pmatrix} \quad (7.E.2)$$

### Q5

Use the technique demonstrated in Example 7.6.6, to find the volume of the unit sphere.

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