[vectors & uncertainty + electrostatics i] .quiz

1) traveling around

Johannes Kepler is traveling with his car. At the start point, he is lucky because it's a sunny day, so he measures the latitude simply using the sun. And for longitude he uses his sun-clock, and his pocket atomic clock which shows Greenwich time. He gets latitude = N48.80483° and longitude = E9.17101°. When he arrives at the destination it's dark, but no clouds, so he easily use stars and finds latitude = N48.82061° and longitude = E9.21597°.

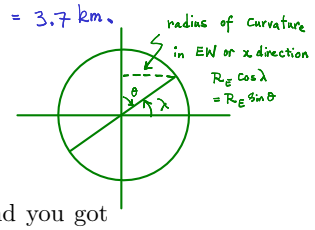
$\Delta\varphi, \Delta\lambda$ are really small

$\Rightarrow$ We can use Euclidean geometry for part c

a) Find the length he travelled toward north or south.
b) Find the length he travelled toward west or east.
c) And of course, find the total distance.

a) $\Delta\lambda = 48.82061 - 48.80483^\circ = .01578^\circ = 2.75 \times 10^{-4}$ rad $\rightarrow \Delta y = R_E \Delta\lambda = 1.76$ km.

b) $\Delta\varphi = 9.21597^\circ - 9.17101^\circ = .04496^\circ = 8.66 \times 10^{-4}$ rad $\rightarrow \Delta x = (R_E \cos\lambda)\Delta\varphi = 3.7$ km.



c) $d = \sqrt{(\Delta x)^2 + (\Delta y)^2} = 4.1$ km.

2) "I have a lower response time"

In the uncertainty experiment, your friend got the response time $A = 0.2929 \pm 0.0045$sec and you got $B = 0.3053 \pm 0.0049$ sec. Your friend claims that he has lower response time.

a) Find the expected uncertainty (or error) of $A - B$.
b) Does data show an evidence supporting your friend's claim? Why?

a) $\sigma_{A-B}^2 = \sigma_A^2 + \sigma_B^2 = (4.5\text{ ms})^2 + (4.9\text{ ms})^2 \rightarrow \sigma_{A-B} = 6.7$ ms.

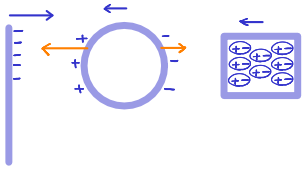
b) Yes, $|A-B| = .124\text{ s} > 6.7$ ms.

3) charge distribution on objects

Francis Hauksbee charges a rod using a piece of fur. And we call the charge on the rod negative. An ordered tuple {first object, second object, third object, ...} means that we put these objects in this specific order. In each of the following cases, draw a schematic figure, show the distribution of the charges qualitatively, and draw the net force on each object using an arrow. Remember that the length of this arrow would represent the magnitude of the force.

a) {rod, neutral copper sphere, piece of paper}.
b) {rod, neutral sphere, neutral sphere, positively charged tape}.

a)



b)