Lessons 1-3 – *How Long is a Day?*

Open the GeoGebra app on your desktop and https://www.geogebra.org/m/a4v7fzkt

Day Length Formula

1. Go to the *Frames of Reference* chapter in the link

2. Open *Sun Always to the Right*
3. Watch the animation – what features do you notice?
    a. Is the rate of movement constant? Where might you have seen this type of motion before?
    b. What are the extremes of motion?

4. Pause the animation and experiment with the slider for yourself…

5. Have a go at the following questions:
    a. In what frame of reference does this happen (what doesn't move)?
    b. What does T represent in this diagram? What does its start value represent?
    c. What is a "solar zenith locus"?
    d. What do the arrows mean?
    e. The Tropic of Cancer is at approximately 23.5° latitude
        i. What latitude is the Tropic of Capricorn at?
        ii. How are the tropics defined?
    f. How are the polar (Arctic and Antarctic) circles defined?
        i. What are their latitudes?
    g. The longest day of the year occurs on Summer Solstice; the shortest on Winter Solstice. In the Northern hemisphere, Summer Solstice is around 21st June every year.
        i. When is Winter Solstice in the Northern hemisphere?
            1. What is the value of T at that time?
        ii. When do you think the Vernal (spring) Equinox and Autumnal Equinox are?
            1. What are the values of T at those times?
    h. Now select the correct value of T to show each of:
        i. Summer solstice in the Northern hemisphere
        ii. Winter solstice in the Northern hemisphere
        iii. Winter solstice in the Southern hemisphere
        iv. Vernal Equinox
        v. Autumnal Equinox

6. Now consider switching to a frame of reference in which the polar axis does not move…open *Polar Axis Frames*
    a. What is meant by "High Noon"?
    b. What could the moving brown dot represent?

c. What does the darkened region represent?
d. What is the common name for α?
e. Play the animation for T (at the same time) – compare the view on the left-hand side with that of the last applet…how do they differ?
f. Look at the compass in the view on the right. Now answer the question on the presentation slide…

7. Open *Finding the Length of the Day* in the *Trigonometry Problems* chapter and follow the on-screen instructions…
    a. Slide the slider until you find an appropriate view.
    b. What information do you need to determine the time elapsed between sunrise and sunset?
    c. Draw and label a suitable diagram to find an expression for A in terms of θ and α. Go back to the previous applet if it is more helpful.
    d. Use your expression for A to determine Δt, the difference in times between sunset and sunrise for a given value of *T*.

8. Open *Finding the Polar Tilt in the Sun's Direction* in the same folder. Move the black spot labelled "N".
    a. What does it represent?
    b. What does θ represent?
    c. What do you think Ω represents? What is its value?
    d. Slide the sliders until you find a view most useful to you. How does this diagram help you find out how θ it depends on *T*?
    e. Draw and label a suitable diagram and have a go at deriving a formula for $\theta(T)$

9. Open https://www.geogebra.org/m/xtfhmumb. This is GeoGebra's 3D software. Click on and experiment with the shapes by dragging –
    a. what does it tell you about the intersection of a plane and the centre of a sphere?
    b. can you input an equation of a plane that intersects the sphere without going through its centre? What would this tell you about such intersections?

10. Now open *Earth 3D Simulation (Using 2D Equations)* in the same folder and experiment with the sliders. Ensure you are fully familiar with the effects of T, t and α.

<u>Which Capital City?</u>

11. In the GeoGebra app on your desktop, create a slider for α – think about the values it can have and enter in the relevant information.

12. Enter a suitable expression for y in terms of x that will show how Δt varies with T for a given value of α. Remember the roles of $\theta(T)$ and Ω in formulating your expression.

13. Open the Excel file *Data to Dump into GeoGebra.xls*.

14. Select the Spreadsheet view in GeoGebra.

15. Copy and paste the Excel data into the first two columns.

16. In the third column, write "=(A1,A2)" and see what happens.

17. Click and drag this formula down to the end of the list, then select the whole column, right-click and uncheck "show label"

18. These are the data for a capital city somewhere on Earth. Using your graph (and Google!), can you suggest which city/cities these data come from?