BPhO Computational Challenge

2022 A Standard Atmosphere

Welcome to the **British Physics Olympiad Computational Challenge 2022.** The goal is to build *computer models* based upon the instructions in the **Challenge Presentation document**. These can be achieved using a *spreadsheet* such as Microsoft Excel, although you are encouraged to use a *programming language* of your choice* for the more sophisticated models (particularly for task 3).

The challenge runs from **Easter 2022 till August 2022.** To submit an entry you will need to fill in a web form. There may be a small administration charge of, payable online as per other BPhO competition entries.

The deliverable of the challenge is to produce a **screencast** of ***maximum length two minutes*** which describes your response to the challenge, i.e. the graphs and the code & spreadsheets and your explanation of these. Your video should make it really clear *how you* have arrived at your solutions to the tasks set. This is what we need evidence for in your video. All credit is for 'show your working' !

The videos must be uploaded to **YouTube**, and we recommend you set these as *Unlisted* with *Comments disabled*. **Your entry will comprise a YouTube link.** To produce the screencast, we recommend the Google Chrome add-on **Screencastify.**

You can enter the challenge **individually** or in **pairs**. If you opt for the latter, *both* of you must make equal contributions to the screencast.

Gold, **Silver** or **Bronze** e-certificates will be emailed to each complete entry, and the **top five** Golds will be invited to present their work at a special ceremony. You should receive a result by December 2022. Note no additional feedback will be provided, and the decision of the judges is final.

Bronze:	Most of the initial spreadsheet-based challenge elements completed.
Silver:	All the spreadsheet-based elements completed, and a commendable attempt at the programming-based elements. At least tasks 1 and 2, with a good attempt at task 3.
Gold:	All elements completed to a high standard, with possible extension work such as the construction of apps (i.e. programs with graphical user interfaces), significant development of the models, attempt at extension work, short research papers etc. All three tasks.

*MATLAB or Python is recommended, although any system that can easily execute code in loops and plot graphs will do. e.g. Octave, Java, Javascript, C#, C++, Mathematica... Use what you can access and feel comfortable with. These Programming resources might be a helpful start.

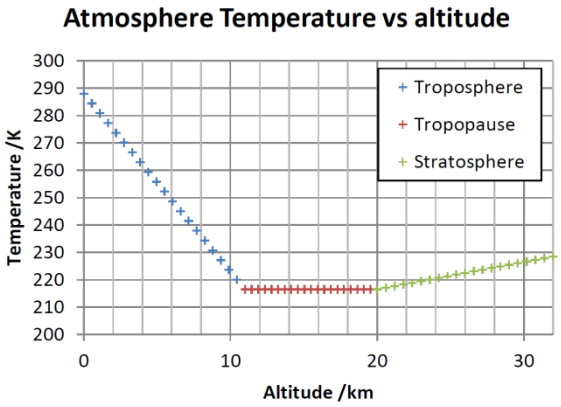
INSTRUCTIONS *** First download the Challenge Presentation from the BPhO website ***

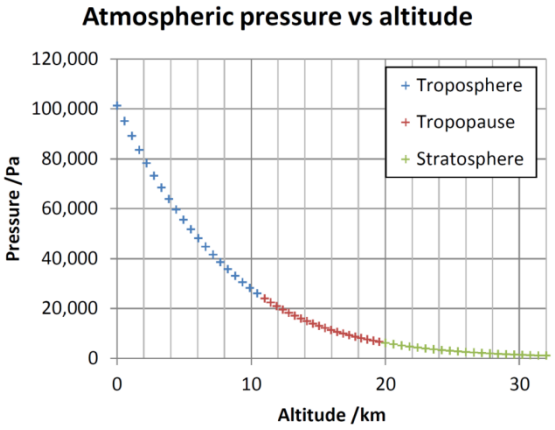
Summary of tasks (each will have Bronze, Silver and Gold aspects - although each task is more involved than the previous).

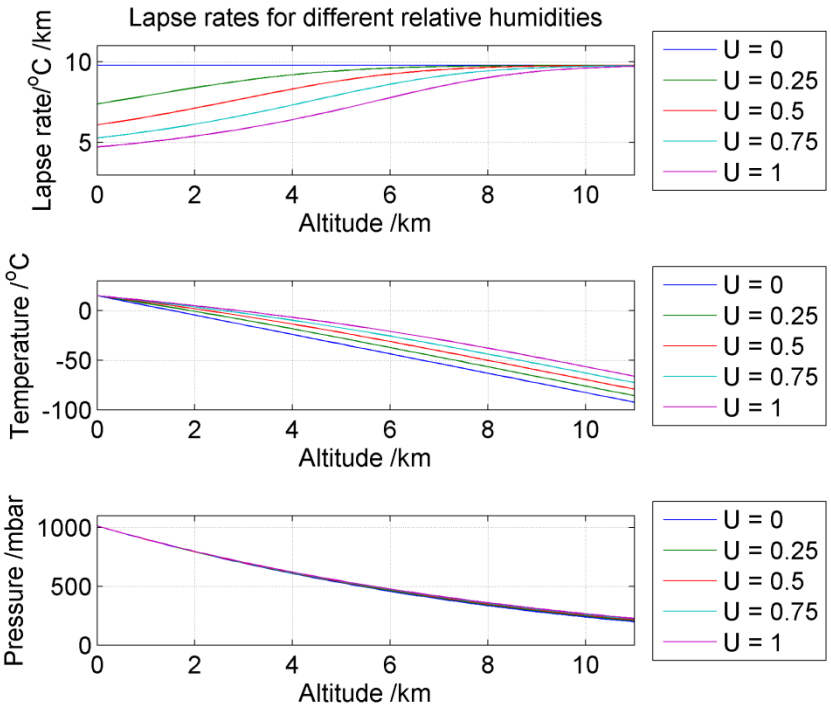
TASK 1: Plot temperature vs altitude for the International Standard Atmosphere (ISA) model

TASK 2: Plot pressure vs altitude for the ISA model for *dry air.* Note difference between *isothermal* layers (e.g. *tropopause*) and layers with a *constant lapse rate* (*troposphere*, *stratosphere*).

TASK 3: Develop an equation for the gradient of a graph of atmospheric pressure vs altitude for an ideal gas comprising dry air *and* water vapour (within the troposphere). Solve this using a *numerical method.* Also determine variation of *lapse rate*, *boiling point* and *dew point* with altitude as well as pressure and temperature. Plot these relationships for different relative humidity values.







POSSIBLE EXTENSION OPPORTUNITIES:

- Compare the ISA for Earth with the atmospheres of *other planets in the Solar System*. Note these may have a very different gas mixture to the Earth's atmosphere.
- Write a **graphical user interface** (GUI) for the atmosphere model and encode this as an 'app'. Coding up an iOS/Android smartphone app will particularly impress the judges! Inputs such as humidity *U* could be fixed numbers, or perhaps variables that could be dynamically varied via a slider or perhaps a swipe gesture on a smartphone or tablet.

AF 20/4/2022