Logs

- A logarithm is a quantity representing the power to which a fixed number (the base) must be raised to produce a given number
  - The common base is 10 but any number can be used as the base
    - The common base is written as \( \log(x) \)
    - E.g. \( \log(100) = 2 \)
    - Any other number is written as \( \log_{n}(x) \)
    - E.g. \( \log_{2}(8) = 3 \)

- A logarithmic graph is the opposite of an exponential graph (see right)
  - They both are asymptotes; the logarithmic graph is to the y axis whereas the exponential graph is to the x axis

- All numbers lower than one have negative logarithms
  - E.g. \( \log(0.0001) = -4 \)
  - As they get smaller, the logs approach infinity

- The logarithm is not defined for negative numbers or 1
  - E.g. \( \log_{.4}(5) \) and \( \log(-87) \) won’t work

- Logs are defined for all positive numbers and so doesn’t have to be whole
  - E.g. \( \log(500) = 2.699 \)

- Logs are used in scientific applications to compare numbers of vastly different magnitude
  - For example, time scales vary from billions of years to fractions of seconds
  - Here is an example of times that can be compared:
    - Formation of earth – \( 4.6 \times 10^{9} \) YBP
    - Dinosaur extinction – \( 6.5 \times 10^{7} \) YBP
    - Last great ice age – \( 1 \times 10^{4} \) YBP
    - Declaration of independence – \( 2 \times 10^{2} \) YBP:
  - And here they are as their logs (YBP)
    - Formation of earth – 9.633
    - Dinosaur extinction – 7.813
    - Last great ice age – 4.000
    - Declaration of independence – 2.301
  - Note the difference in the ability to see the graphs: