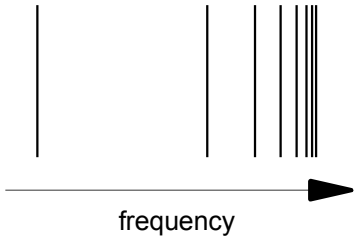
ATOMIC HYDROGEN SPECTRUM

1. *Briefly*, how is an atomic hydrogen spectrum obtained experimentally?

2. This diagram shows the pattern of lines in the Lyman series of the atomic hydrogen spectrum.

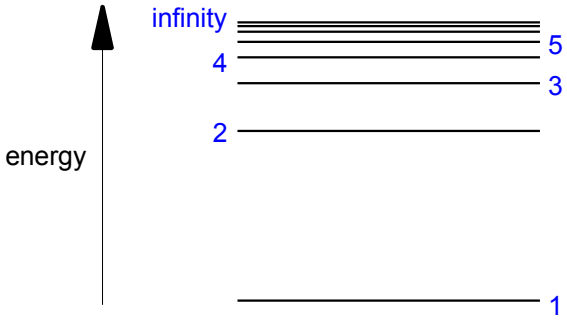


a) Which part of the electromagnetic spectrum (UV, visible or IR) is the Lyman series found in?

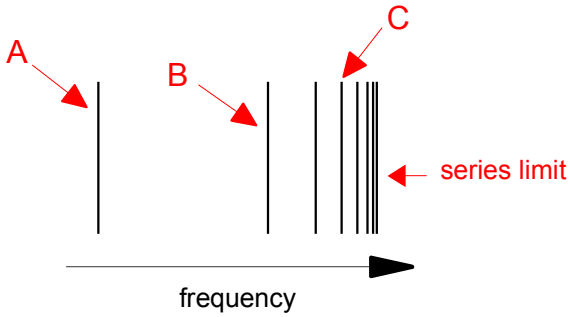
b) Why does the series consist of a number of individual lines rather than a continuous spectrum?

c) Which of the lines in the Lyman series has the lowest energy of light? Explain your answer.

d) The diagram shows the arrangement of the various electron energy levels in a hydrogen atom (not to scale).



Lines in an emission spectrum are produced when an electron falls from a higher level to a lower one. Which falls are responsible for the lines A, B and C in this diagram of the Lyman series?



e) Which fall corresponds to the series limit of the Lyman series?

f) What fall would correspond to the series limit of the Balmer series?

g) What fall would produce the lowest frequency line in the Balmer series?

3. The Rydberg equation enables you to calculate the frequency of a line in the hydrogen spectrum. The version of the Rydberg equation in terms of frequency is

$$\nu = c.R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

a) Calculate the frequency of the line produced when an electron falls back from the infinity level to the 1-level.

$c = 2.998 \times 10^8$ m s^{-1}; $R_H = 1.097 \times 10^7$ m^{-1}

b) Write the equation which relates the energy gap between two levels and the frequency of light emitted.

c) Ionisation of a hydrogen atom happens when an electron is promoted from the ground state (the 1-level) to the infinity level. Use the equation you have written in (b) to calculate the energy needed to move an electron from the 1-level to the infinity level. State clearly any assumptions you are making.

h (Planck's constant) = 6.626×10^{-34} J s

d) Calculate the ionisation energy of hydrogen in kJ mol^{-1}.

The Avogadro constant (L) = 6.022×10^{23} mol^{-1}