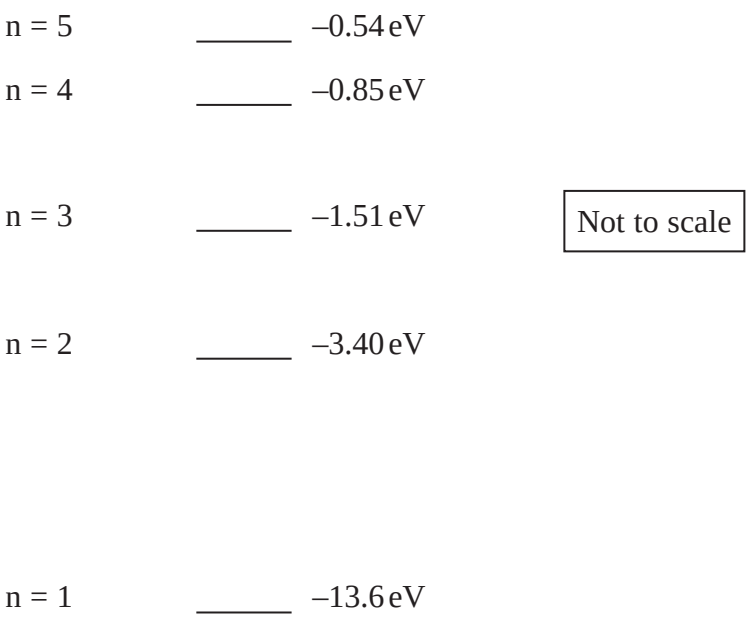
**18** In 1864, William Huggins and William Miller used dark lines in the spectrum of the Sun to identify elements in the Sun's atmosphere.

*(a) Explain how gases in the Sun's atmosphere cause dark lines in the spectrum corresponding to different elements.

**(6)**

(b) The diagram shows some energy levels of a hydrogen atom.




The absorption spectrum for hydrogen includes a set of lines that all derive from transitions involving the n = 2 energy level. One of these lines is known as the hydrogen-alpha line.

Deduce the transition involved in the formation of the hydrogen-alpha line.

wavelength of hydrogen-alpha line = 656.46 nm

**(4)**

(c) In 1868, William Huggins analysed light from the star Sirius A. The wavelength of the hydrogen-alpha line for light from Sirius A was slightly different from the hydrogen-alpha line observed from a source in a laboratory.

Huggins suggested that this difference could be explained using the Doppler effect and could be used to determine the speed and direction of the star's motion relative to the Earth.

(i) Assess Huggins's suggestion.

**(3)**

(ii) Sirius A has a component of velocity away from the Earth of $5.5\,km\,s^{-1}$.

The wavelength of the hydrogen-alpha line observed from a source in the laboratory is 656.46 nm.

Calculate the wavelength of the hydrogen-alpha line as seen in the spectrum of Sirius A.

**(2)**

Wavelength = .....

**(Total for Question 18 = 15 marks)**