8 Fig. 8.1 shows the three lowest-frequency lines in the part of the emission spectrum for hydrogen that relates to electron transitions to the ground state (level $n = 1$).

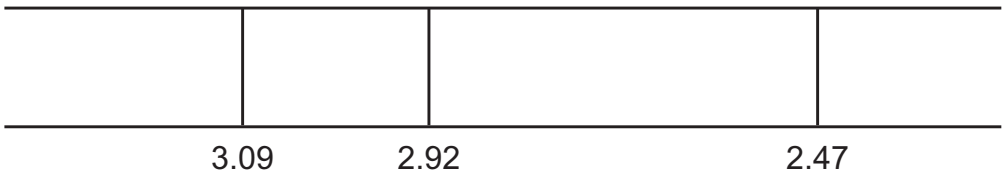

Fig. 8.1 (not to scale)

The numbers represent the frequencies, in 10^{15} Hz, associated with the spectral lines.

(a) Use the photon model of electromagnetic radiation to explain how the existence of spectral lines in the emission spectrum provides evidence for discrete electron energy levels in the hydrogen atom.

.....

.....

.....

.....

..... [3]

(b) The energy of the ground state (level $n = 1$) in a hydrogen atom is –13.6 eV.

(i) Calculate the energy, in J, of the ground state.

energy = ... J [1]

(ii) Show that the energy difference between levels $n = 1$ and $n = 2$ is 10.2 eV.

[2]

(iii) Complete Table 8.1 to show the energy differences from the ground state, and the energies of the levels up to $n = 4$, in the hydrogen atom. Use the space for any working.

Table 8.1

level	(energy difference from $n = 1$) / eV	energy / eV
$n = 4$		
$n = 3$		
$n = 2$	10.2	
$n = 1$	0.0	–13.6

[4]

[Total: 10]