8 Fig. 8.1 shows the lowest four energy levels of an electron in an isolated atom.
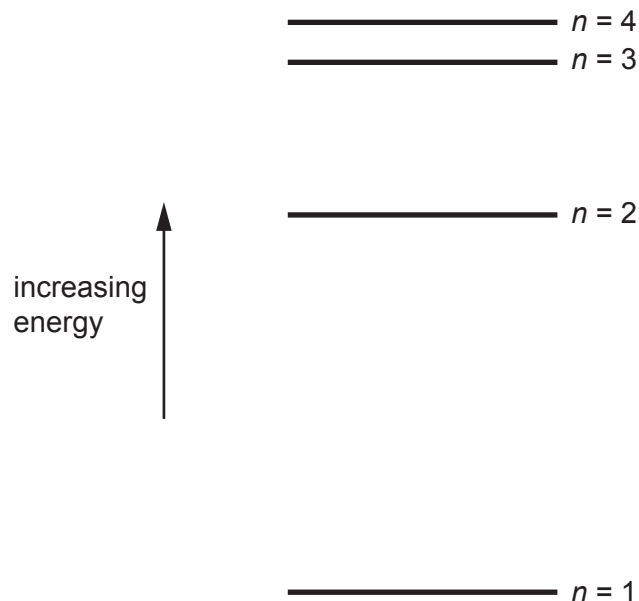
$$\text{―――――――――} \quad n = 4$$
$$\text{―――――――――} \quad n = 3$$

↑
increasing
energy

$$\text{―――――――――} \quad n = 2$$

$$\text{―――――――――} \quad n = 1$$

Fig. 8.1

Fig. 8.2 shows the lines in the emission spectrum of the atom that correspond to the transitions of the electron from $n = 3$ to $n = 1$ and from $n = 4$ to $n = 1$.
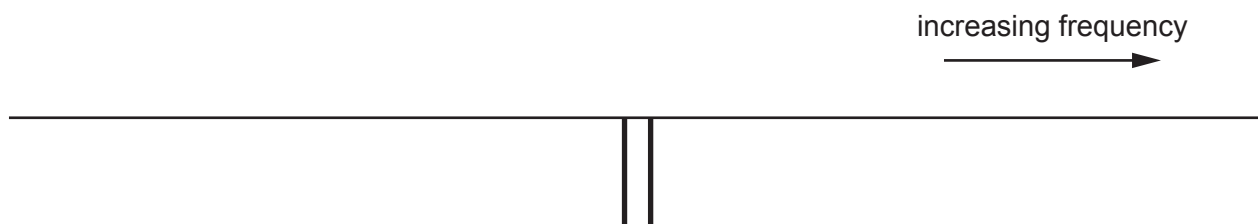
increasing frequency
→

Fig. 8.2

(a) Explain, with reference to photons, why there is a single frequency of electromagnetic radiation that corresponds to each of these transitions.

....

....

.... [2]

(b) (i) On Fig. 8.2, draw a line that corresponds to the transition of the electron from $n = 2$ to $n = 1$. Label this line A. [2]

(ii) On Fig. 8.2, draw a line that corresponds to the transition of the electron from $n = 3$ to $n = 2$. Label this line B. [2]

(c) The frequency of radiation represented by line A is f_A.
The frequency of radiation represented by line B is f_B.
The energy of the ground state ($n = 1$) is E_1.

Determine an expression, in terms of f_A, f_B, E_1 and the Planck constant h, for the energy E_3 of the energy level $n = 3$.

$E_3 = $ .... [2]