Marks 5

- The yellow light emitted from an excited sodium atom has a wavelength of 590 nm. What is the energy of one photon of this light and one mole of photons? Specify appropriate units with your answers.

The energy of a photon is related to its wavelength through Planck's equation:

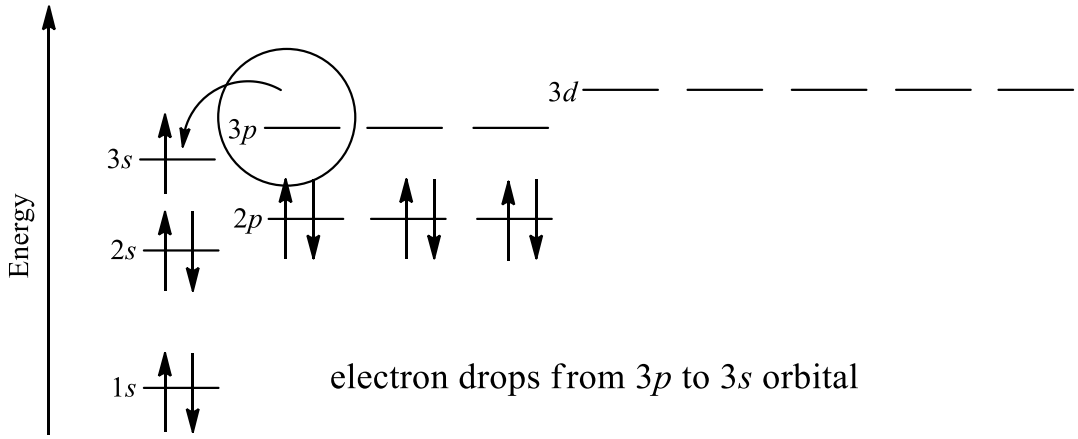
$$E = hc / \lambda$$
$$= (6.626 \times 10^{-34}\ \text{J s}) \times (2.998 \times 10^{8}\ \text{m s}^{-1}) / (590 \times 10^{-9}\ \text{m})$$
$$= 3.4 \times 10^{-19}\ \text{J}$$

The energy of 1 mol is therefore:

$$E = (3.4 \times 10^{-19}\ \text{J}) \times (6.022 \times 10^{23}\ \text{mol}^{-1}) = 200\ \text{kJ mol}^{-1}$$

Energy	of one photon: **3.4×10^{-19} J**	of 1 mol of photons: **200 kJ mol^{-1}**

The yellow light is associated with the longest wavelength transition as the atom returns to the ground state electron configuration. Fill in the following energy level diagram for sodium and indicate the transition associated with the emission of yellow light.



A quantum mechanical model of an atom can explain the emission spectrum of sodium, but the Bohr model of the atom cannot. Why?

A quantum mechanical model includes subshells, but a Bohr model does not. The yellow light is associated with electron movement between subshells.

The emission spectrum of sodium contains many more lines than would be predicted from Bohr's model.