Physics with Synno – Matter – Lesson 10

M.7.8 Emission Spectra

Demo: Spectroscopes and sodium lamp

Earlier in this topic it was stated that electrons could move between energy levels in an atom. Each atom has its own series of energy levels.

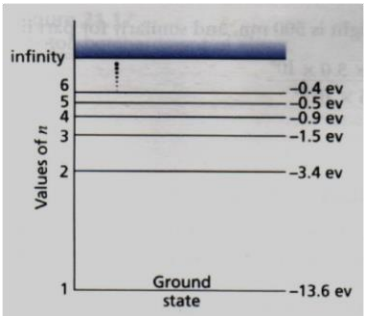


Figure 21.13 (*above*)
Energy levels of hydrogen with the ionisation level taken as zero.

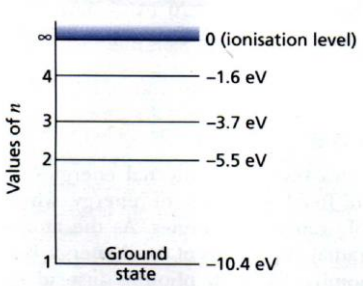


Figure 21.14
Energy levels for mercury, with the ionisation level taken as zero.

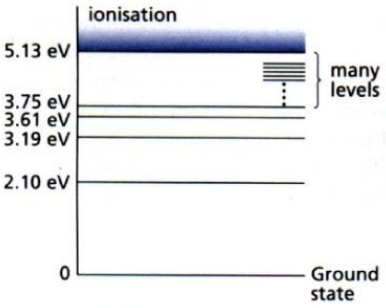


Figure 21.15
Energy levels for sodium.

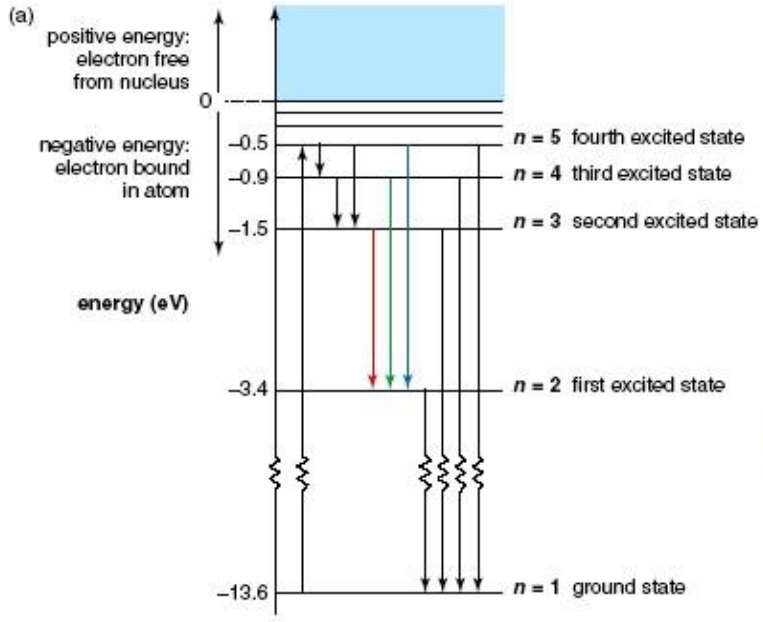
If an electron moves from a higher energy level to a lower one the energy will be given out in the form of a photon. The energy of the photon given out is given by:

E_{photon} = Energy of higher level – Energy of lower level = $h\,f$

h is Plank's constant

$h = 6.626 \times 10^{-34}\ J\,s$

$h = 4.136 \times 10^{-15}\ eV\,s$



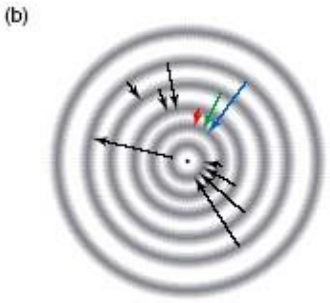


Figure 11.9 (a) Atomic energy level view of the spectral series of hydrogen, and (b) electron orbit view of the spectral series of hydrogen as illustrated in (a).

Example 1: Using energy levels for sodium are shown in fig 21.15 on the previous page. What is the energy of the photon emitted when an atom of sodium falls from:

i) The 2.10 eV level to the ground state?

$E_{photon} = 2.10 - 0 = 2.10$ eV

ii) The 3.75 eV level to the 2.10 eV level?

$E_{photon} = 3.75 - 2.10 = 1.65$ eV

Example 2: What is the minimum energy required to ionise a hydrogen atom? (fig 21.13 above)

$E_{photon} = 0 - (-13.6) = 13.6$ eV

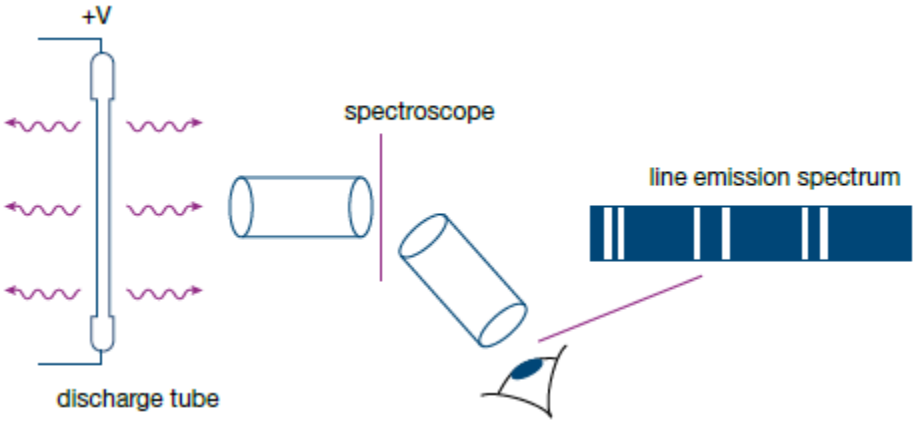
What is the frequency of the photon associated with this energy?

$$13.6 = 4.136 \times 10^{-15} \times f$$
$$f = \frac{13.6}{4.136 \times 10^{-15}}$$
$$f = 3.2 \times 10^{15}\ Hz$$

M.7.8.1 Producing Emission Spectra

Video: Emission and Absorption Spectra

An emission spectra can be produced by applying a voltage to a gas. This will cause the gas to emit light. The frequencies of the light emitted depends on the gas thus each element has its own emission spectra.



The frequency of the light emitted corresponds to the difference in energy levels in the atom.

Applying a voltage to the gas excites electrons into a higher energy level and when they drop back to the lower level the energy is released as a photon of light. Metal vapour lamps produce this type of spectrum.

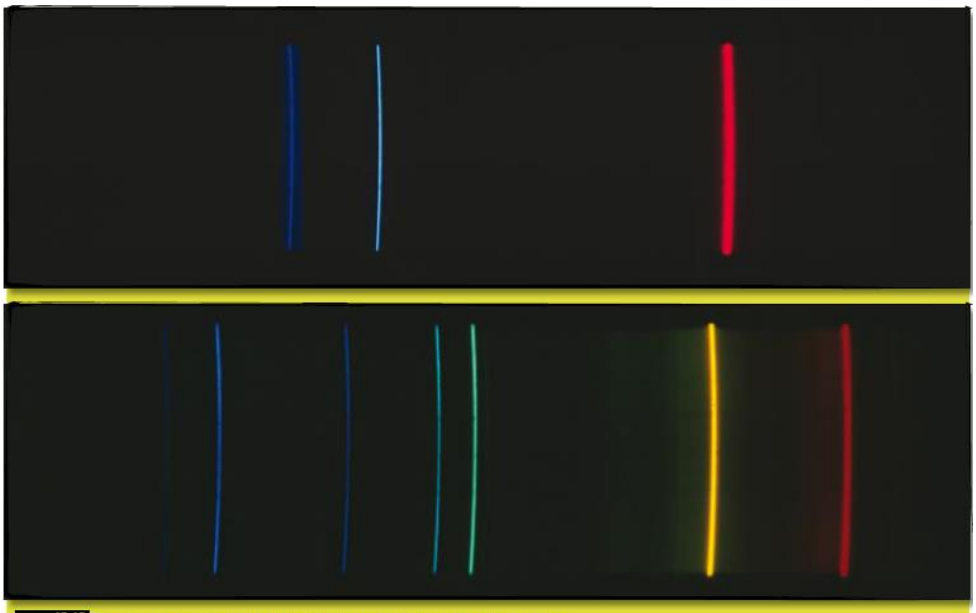
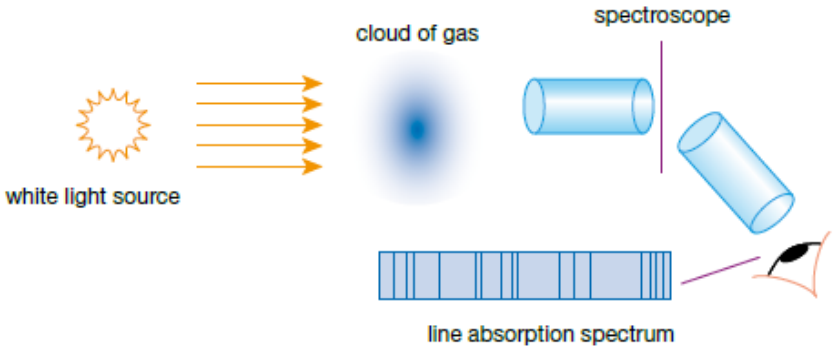


Figure 12.12 The emission spectra of hydrogen and helium, showing only the principal lines.

M.7.8.2 Absorption Spectra

When light is passed through a cool gas an absorption spectrum is created. Some of the frequencies of light are absorbed by the gas.



The absorption spectrum is unique for each type of gas. The missing frequencies correspond to the line in the emission spectrum of that gas.
Astronomers use absorption spectra to determine the chemical composition of stars.

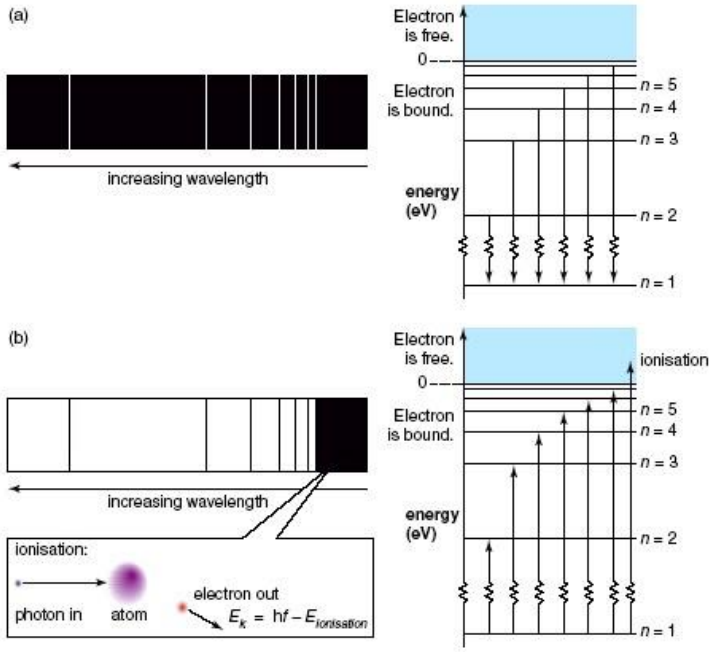


Figure 11.12
(a) Emission spectrum and (b) absorption spectrum of hydrogen atoms at room temperature. In the absorption spectrum, transfer of photon energy to eject an electron is labelled 'ionisation'. All wavelengths less than the limiting value (that is, photons with energy greater than the limiting value) can be absorbed.

Read: Text Page 246 - About the Bohr Model

Problem Set # 10: Text Page 249 All Questions

Revision Text Page 198 All Questions
Text Page 223 All Questions
Text Page 250 All Questions