Structure of The Atom Assignment

1. A spectrum with bright lines at certain wavelengths and no light for the rest. For each element the combination of wavelengths produced is unique, so the elements can be identified from the spectrum.

2.

a) 

b) infra-red visible ultraviolet

c) smaller transitions in the atom will produce a line of lower frequency on the spectrum (the position of the transition isn't important, it is only the size of the jump itself that relates to the energy it produces)

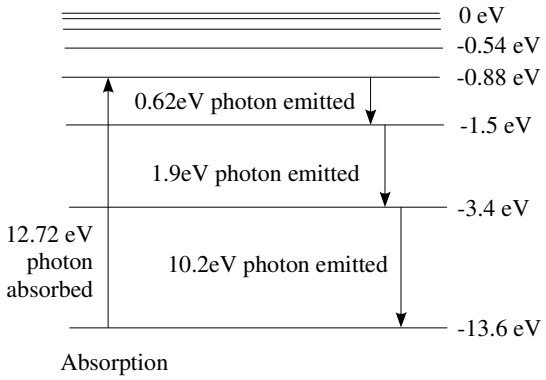
3. The energy from the ground state to the 0 eV (E_∞) / the energy needed to free the electron from the atom of gas. The work function is the minimum energy needed to free an electron from solid metal.

4. The intensity increases and the peak and dominant frequencies move to higher frequencies.

5. Hydrogen is in ground state at room temperature, and all transitions possible from ground state are UV.

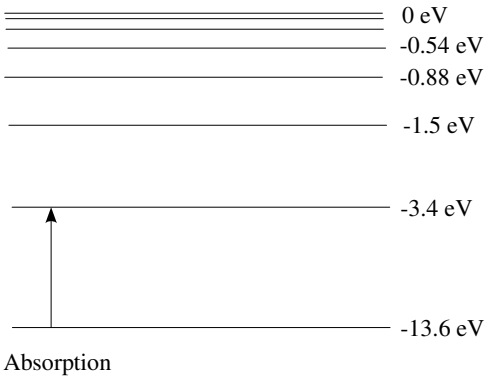
6. The sun's atmosphere is very hot so the hydrogen gas present in it can be excited above the ground state. Transitions from the n=2 state upwards correspond to frequencies of visible light, allowing absorption to occur.

7. A high energy photon is absorbed and the energy is re-emitted as multiple lower energy photons.



8. Spontaneous emission results over time as a result of an atom's tendency to return to the ground state. Stimulated emission is as a result of the interaction of an incoming photon, and the emitted photon is always a copy of the incoming photon.

9.



10.

(a) $E = hf$

$= 6.63\times10^{-34} \times 4.74\times10^{14} = 3.14\times10^{-19}$ J

$\dfrac{3.14\times10^{-19}}{1.60\times10^{-19}} = 1.96$ eV

(b) $v = f\lambda$

$\therefore \lambda = \dfrac{v}{f} = \dfrac{3.00\times10^{8}}{4.74\times10^{14}} = 6.33\times10^{-7}$ m

(c) Visible

(d)

(i) A laser relies on stimulated emission of photons from excited atoms. A population inversion means that more atoms are excited than not, so the level of stimulated emission is greater than the level of absorption.

(ii) A non-ground energy state (level) where the atom tends to stay for a period of time before spontaneous emission occurs.

(iii) $n = 3$

(e) A potential difference provides a flow of electrons through the cavity, exciting the atoms to their metastable state. Photons are emitted which stimulate more photons and so on. There are mirrors at each end of the tube allowing more stimulated emission to occur, and one mirror is half-silvered to allow the amplified light to escape as a laser beam.

(f) Coherent and monochromatic, can also be unidirectional and of high intensity.

(g) (two feasible uses)

(h) Laser beams can have a high intensity, so safety is very important:

- Avoid exposing the skin to the laser beam
- Avoid exposing the eyes to the laser beam (safety glasses matched to that frequency are one way to avoid exposure)
- Beware of reflecting surfaces
- Some lasers have a very high potential difference so there is a danger of electrical shock
- Some laser beams may be invisible (e.g. infrared or ultraviolet) but are no less dangerous