Marks 3

- An atomic absorption spectrometer with a path length of 1.0 cm is used to measure the concentrations of copper in tap water. The results are shown below. The standard solution contains 5.0 ppm Cu.

Sample	Absorbance reading
Standard solution (5.0 ppm Cu)	22.3
Unknown tap water	14.5

Assuming the Beer-Lambert Law is applicable, what is the concentration of Cu in the unknown tap water?

Answer:

What is the absorption process that AAS measures?

Marks 3

- The diagram on the left of page 15 depicts the three lowest energy levels of the hydrogen atom. Consider an excited hydrogen atom with an electron in the 3*s* orbital.

  (A) Indicate all possible jumps this electron can make as the atom returns to the ground state. One possible jump (a) is shown for you as an example.

  (B) Calculate the energy associated with each of these jumps and mark it on the diagram on the right on page 15. Label the transitions. Again, jump (a) is shown as an example.

Working

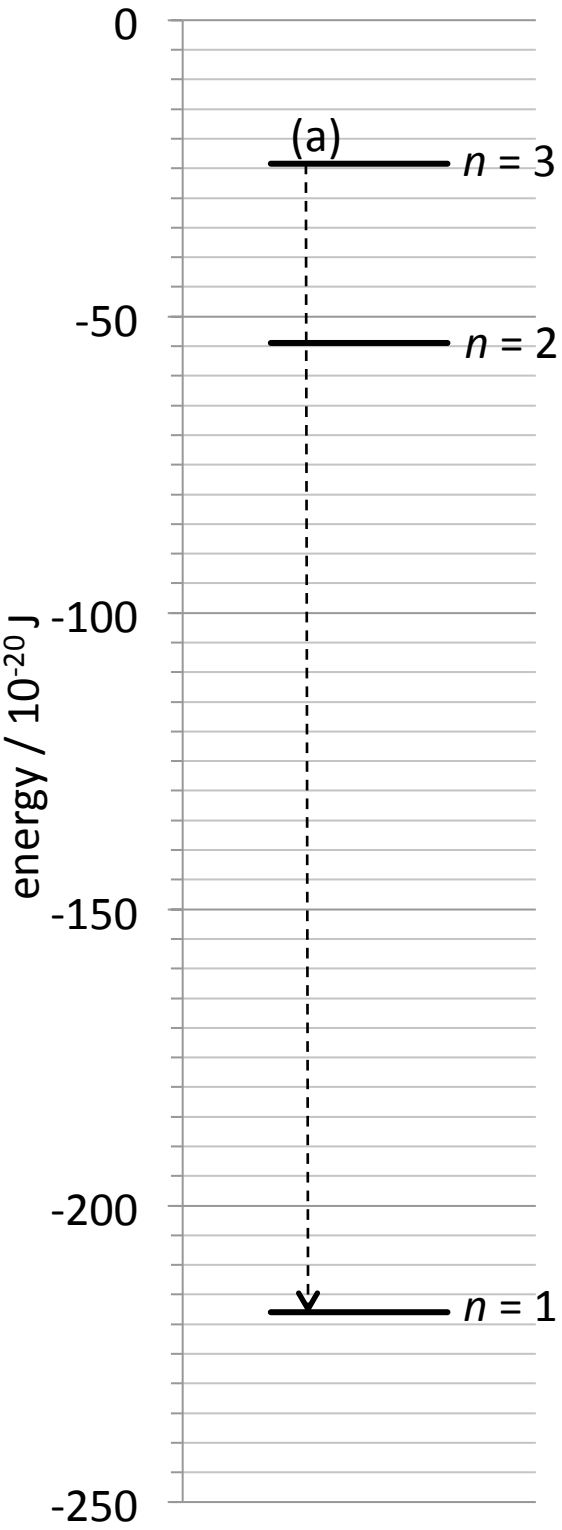
List all of the transitions that are in the visible region and identify the colour associated with each. For reference, the relationship between colours and wavelengths is shown below.

UV	violet	blue	green	yellow	orange	red	IR
400	450	490	560	590	630	700 nm	

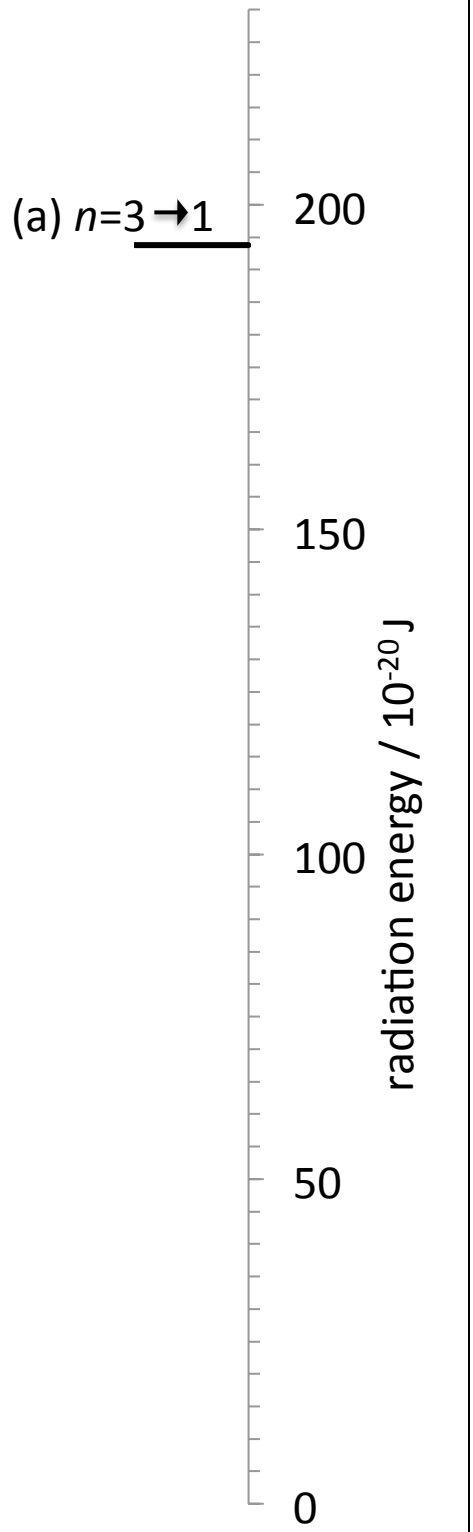
If the corresponding transitions were obtained from He^+ instead of H, would they occur at longer or shorter wavelengths? Give a reason for your answer.

Marks 3

Energy levels of H atom

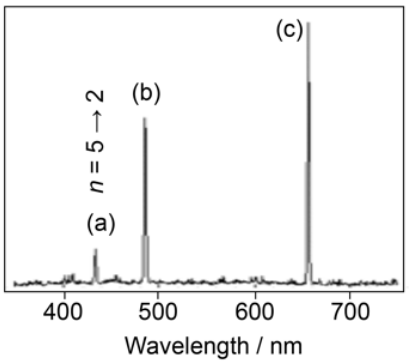


Atomic Spectrum of H atom

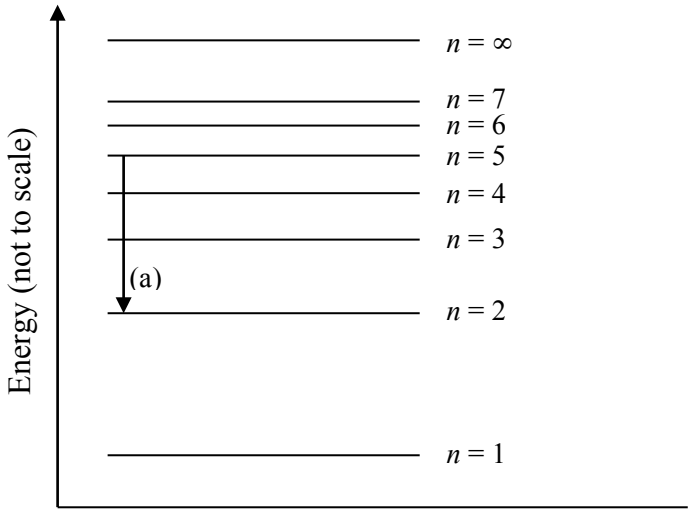


Marks 4

- The emission spectrum of an H atom in the visible region of the electromagnetic spectrum is shown below, showing three clear transitions, labelled (a), (b) & (c). The quantum numbers associated with one of the transitions is assigned for you.



Complete the energy level diagram below to illustrate the energy levels of an H atom associated with all three transitions



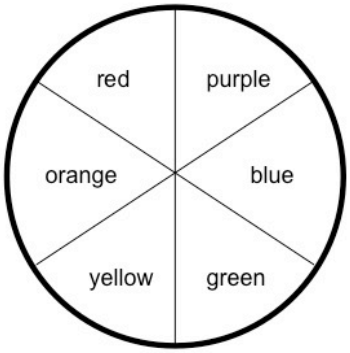
Calculate the wavelength (in nm) of transition (a).

Answer:

Marks

- Nitrogen dioxide, NO_2, is formed in the atmosphere from industrial processes and automobile exhaust. It is an indicator of poor quality air and is mostly responsible for the brown haze seen in large cities. This question about NO_2 extends over many pages, but each sub-question is essentially independent of the others.

a) NO_2 is a pungent red-orange coloured gas. According to the colour wheel for human vision, reproduced below, what colour light does NO_2 absorb? **1**



Answer:

b) An atmospheric chemist, monitoring pollution in Sydney, measured the absorption of light at 425 nm due to NO_2. Measured over a distance of 100 m, 425 nm light was attenuated by 5 % (*i.e.* 95 % transmission). What is the concentration of NO_2 in the atmosphere? Give your answer in mol L^{-1}. **3**
Data: $\varepsilon(NO_2, 425\ nm) = 300\ M^{-1}\ cm^{-1}$.

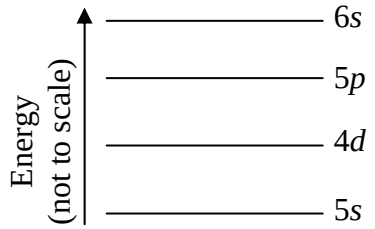
Answer:

Marks
10

- Both strontium and strontianite are named after Strontian, a village in Scotland near which the mineral was first discovered. Strontium displays crimson (red) colouration in a flame. Give the ground state configuration for Sr.

Indicating only valence electrons, the electronic transition $5s5p \rightarrow 5s^2$ in strontium brings about 460 nm photons. Can this transition be responsible for the crimson colour of Sr flames? Explain.

Another transition, $5s4d \rightarrow 5s^2$, occurs at 496 nm. Show the transitions responsible for 460 nm and 496 nm photons on the energy level diagram to the right.



Calculate, in eV, the energy gap between the 4*d* and 5*p* orbitals of strontium.

Answer:

Explain why the 4*d* orbitals of strontium are of a higher energy than the 5*s* orbitals.

Electron spins cannot flip easily during a transition. Explain why the excited state of Sr, 5*s*5*p* with parallel spins, is long-lived.

Page Total:

- Calculate the energy (in J) and the wavelength (in nm) of the photon of radiation absorbed when the electron in B^{4+} jumps from the $n = 3$ state to the $n = 4$ state.

Marks 3

Energy:	Wavelength:

- Explain why the atomic radius of elements are observed to decrease from left to right across a period.

2

- Explain why samples must be atomised for atomic absorption spectrometry, but not for X-ray spectrometry.

2