

1) When light is spread out into its separate colors this is called **spectrum**. The light from a tungsten filament lamp produces a continuous spectrum. If the light is from a gas discharge tube we observe a line spectrum when the light is passed through a slit. i.e. only certain lines of discrete colors are present, separated by gaps. These spectra are called emission-spectra.

- (a) Explain the continuous spectrum of the light emitted by the heated W filament.
- (b) Explain the emission spectrum of Hydrogen using the Bohr's model and the energy diagram from the figure below (Fig. 1-3). Discuss the difference between an emission and an absorption spectrum.
- (c) Calculate the wavelength corresponding to the lines for the Balmer series of the Hydrogen (transitions between $m=3,4,5\dots$ to $n=2$, see figure 4. Which lines belong to the visible part of the spectrum?

Fig.1

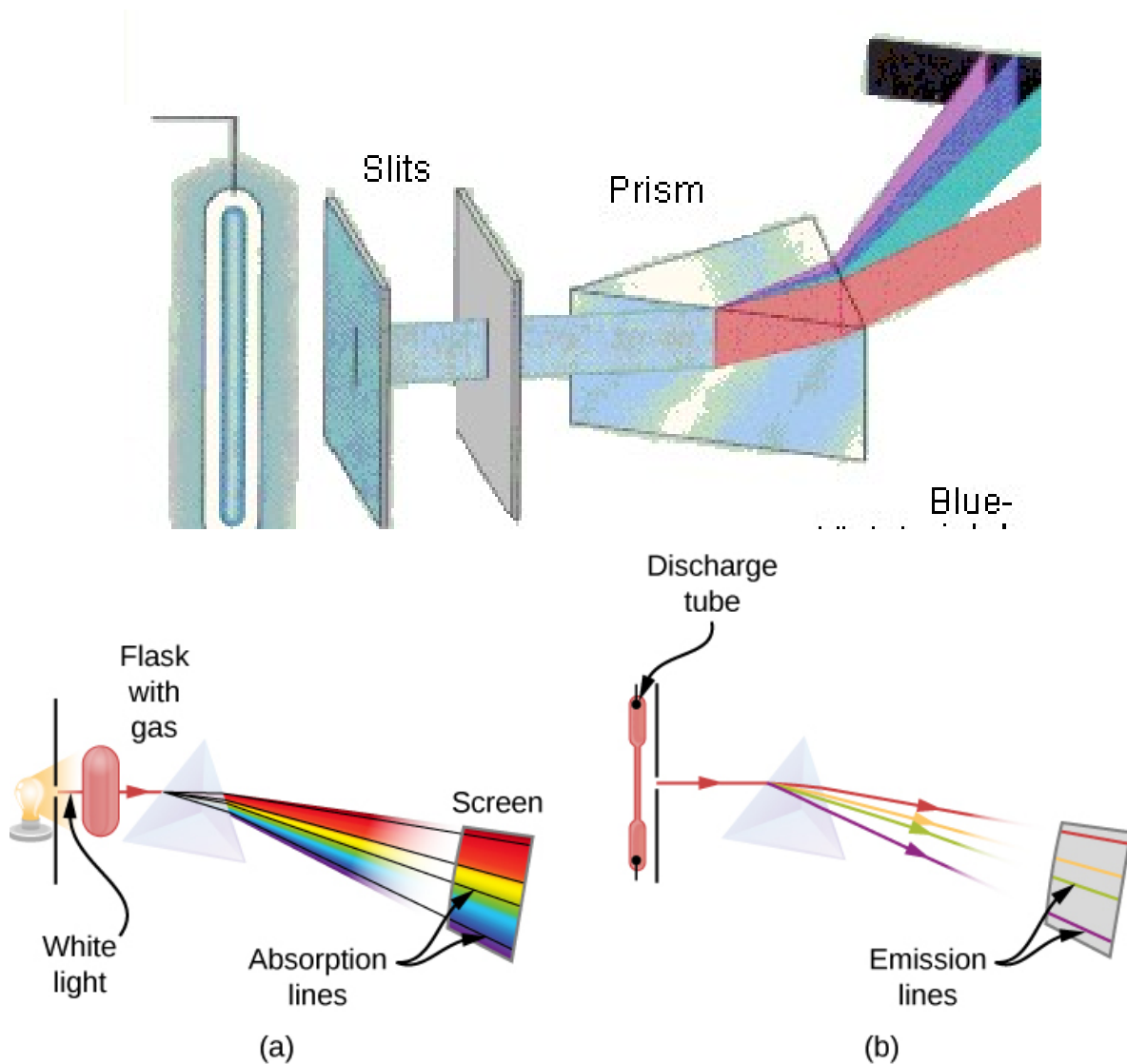


Fig. 2

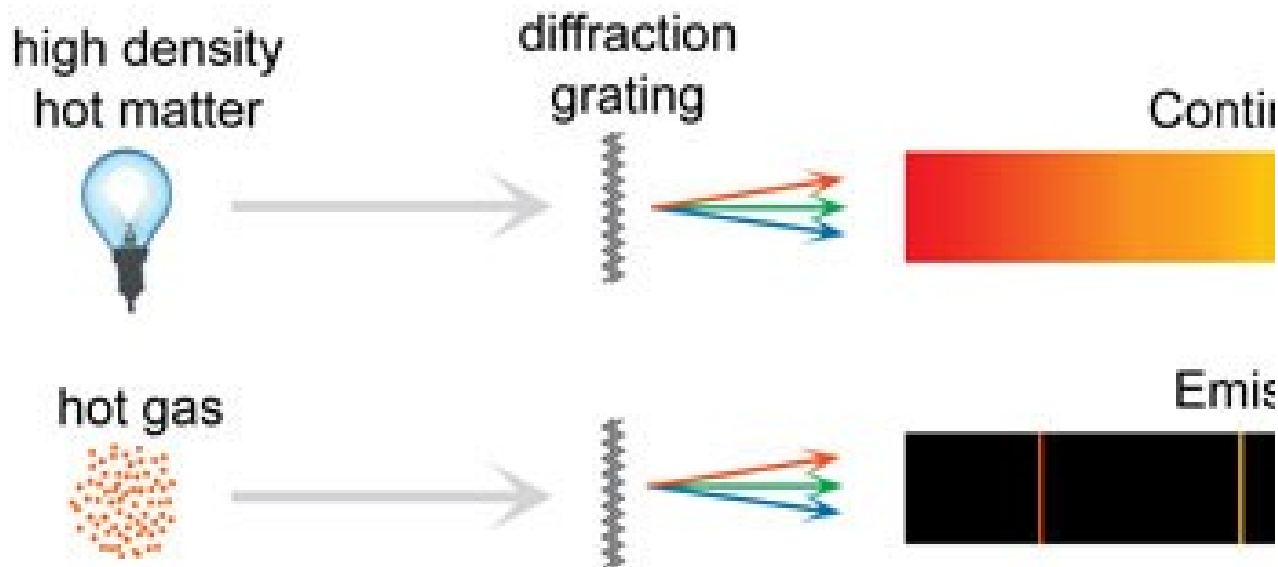


Fig.3

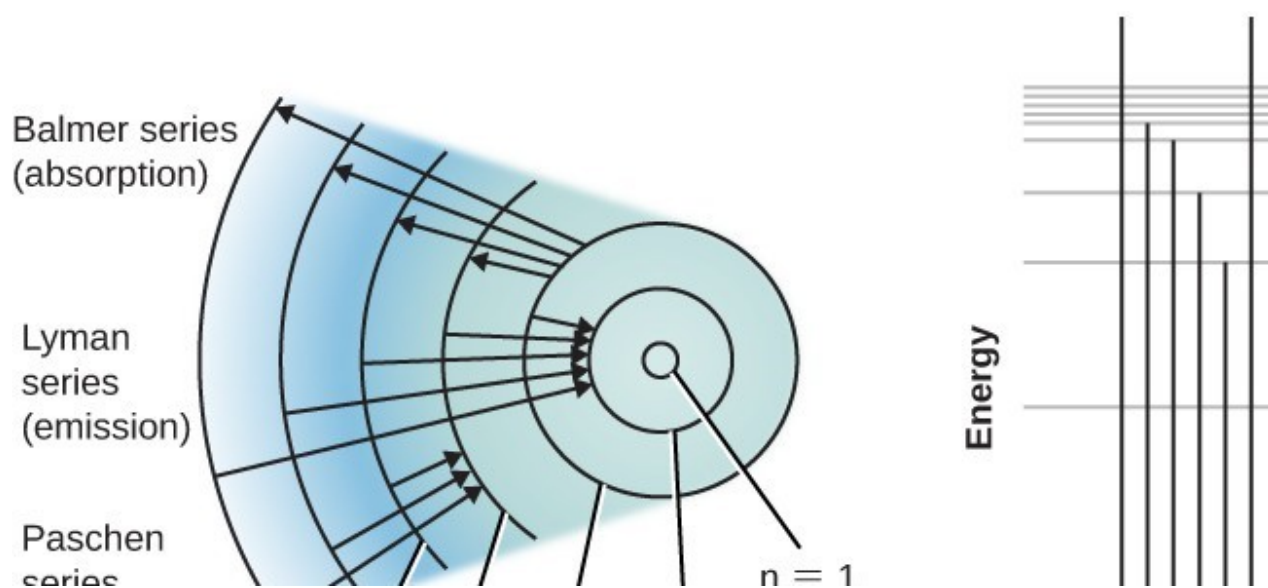
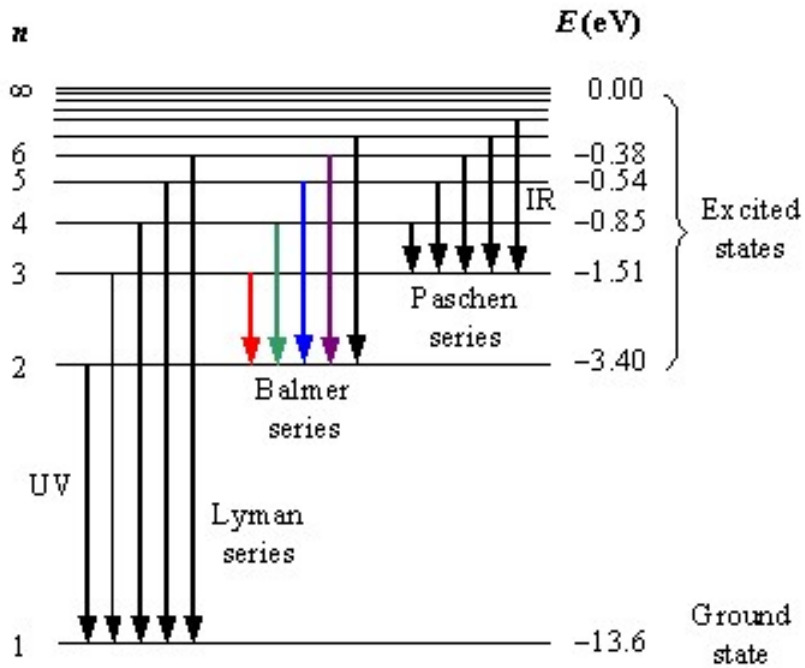


Fig. 4



Energy levels of the hydrogen atom with some of the transitions between them that give rise to the spectral lines indicated.

Transition o m->n	3->2	4->2	5->2	6->2	7->2
Name	H _α	H _β	H _γ	H _δ	H _ε
Frequency (ν)					
Wavelength (λ)					
Color					

$$E_n = -\frac{1}{4\pi\epsilon_0} \frac{m_e e^4}{2\hbar^2 n^2}$$

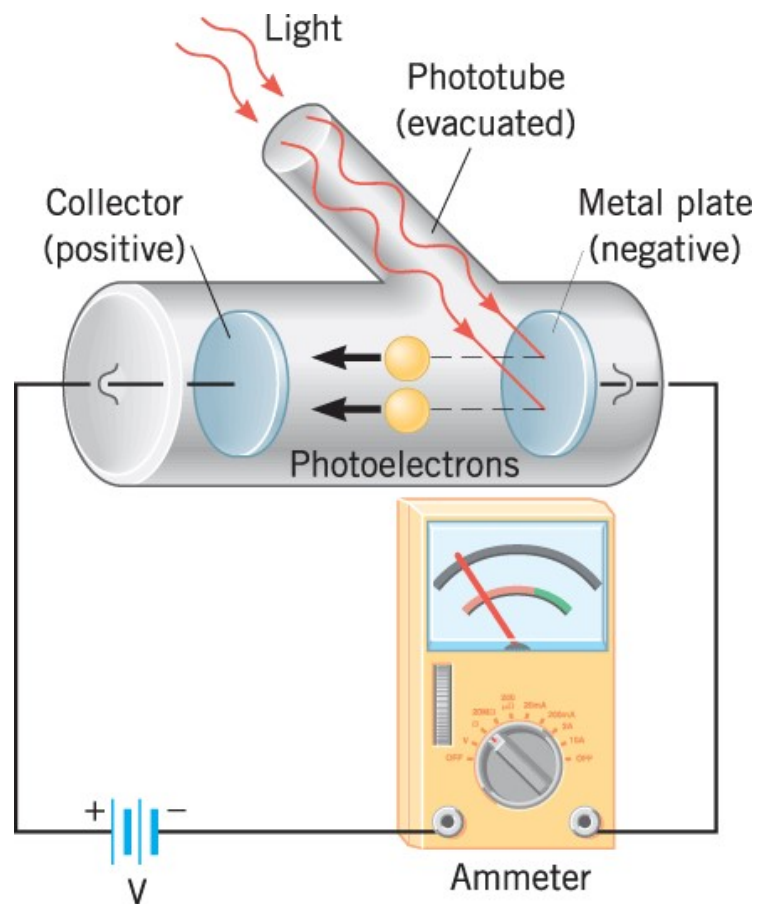
$$1\text{eV} = 1.6 \cdot 10^{-19} \text{ J}$$

$$h\nu_{mn} = \frac{hc}{\lambda_{mn}} = E_m - E_n = -13.6\text{eV} \left(\frac{1}{m^2} - \frac{1}{n^2} \right)$$

2) A LASER pointer with a power of 5mW emits red light ($\lambda=650\text{nm}$). (a) What is the magnitude of the momentum of each photon? (b) How many photons does the LASER pointer emit each second?

3) The photoelectric effect

The photoelectric work-function W of Aluminum is $W=4.08\text{eV}$. (a) Find the cut-off frequency and the corresponding cut-off wavelength for photoemission from Al. (b) Find the maximum photoelectron kinetic energy and the stopping potential when UV light of 200 nm illuminates the Al plate.



Homework

1/ In what ways do photons resemble other particles such as electrons? In what ways do they differ? Do photons have mass? Do they have electric charge? Can they be accelerated? What mechanical properties do they have?

2/ According to the photon model, light carry its energy in packets called quanta or photons. Why then don't we see a series of flashes when we look at things?

3/ Most black-and-white photographic film (with the exception of some special-purpose films) is less sensitive to red light than blue light and has almost no sensitivity to infrared. How can these properties be understood on the basis of photons?

4/ Human skin is relatively insensitive to visible light, but ultraviolet radiation can cause severe burns. Does this have any- thing to do with photon energies? Explain.

5/ In a photoelectric-effect experiment, which of the following will increase the maximum kinetic energy of the photoelectrons? (a) Use light of greater intensity; (b) use light of higher frequency; (c) use light of longer wavelength; (d) use a metal surface with a larger work function. In each case justify your answer.