Ch. 21 Homework

Qs	6, 7, 9 – 12, 15, 16, 17
Ps	1, 2
Review	11, 14, 15, 17, 23, 28

Review

(11.) Rutherford's model was a "planetary" model in which electrons circled the nucleus in orbits. Bohr improved on this by finding that electrons can only have certain orbits (those with specific allowed radii) about the nucleus, & thus certain allowed energies. An allowed energy level is one in which the electron will be stable & not lose its energy as it orbits.

(14.) The ground state of an electron is its lowest allowed energy. The orbit which gives it the lowest possible energy it can have is associated with the ground state. An electron in an excited state is a in a higher energy orbit. It will eventually lose its energy & fall to the ground state. An electron can stay in the ground state forever, it cannot lose any more energy.

(15.) A photon is a packet of electro-magnetic radiation, or light, which is either absorbed or emitted as electrons jump from one allowed energy state to another. This photon carries the energy which corresponds to the difference between the two energy levels of the atom.

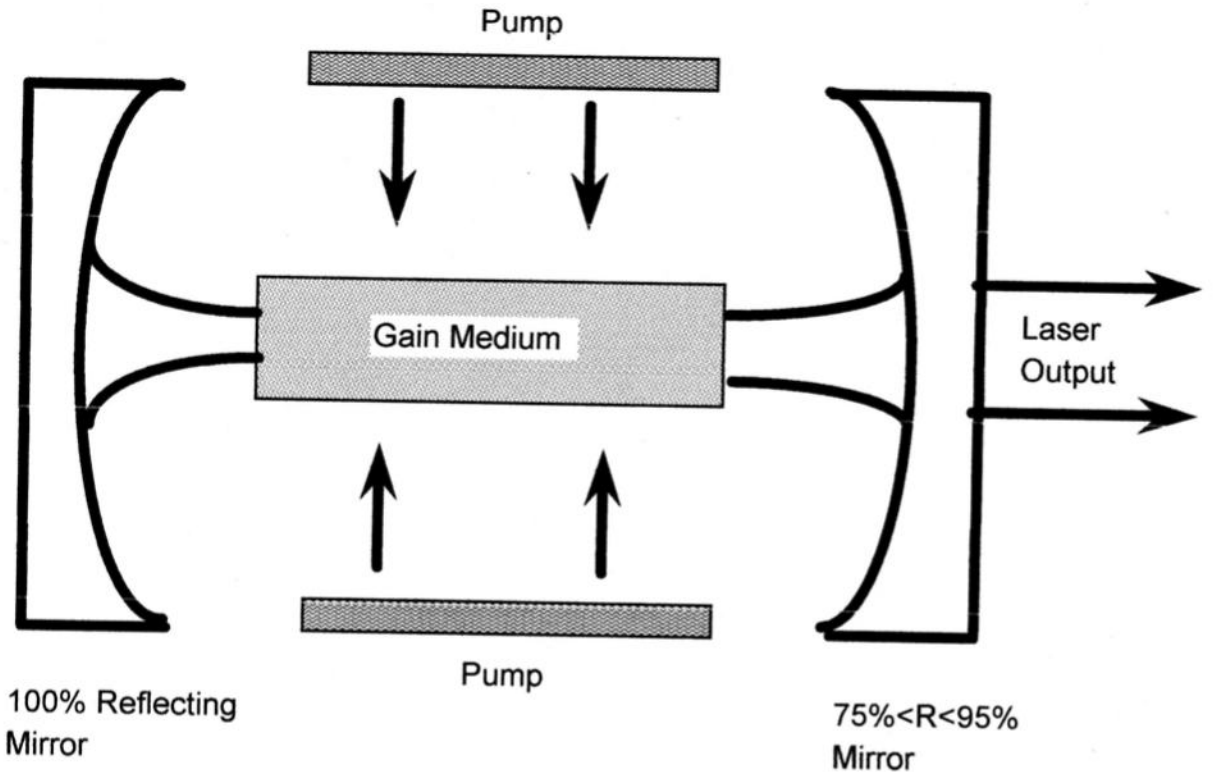
Ch. 21 HW

Review

(17.) When an electron jumps from a higher energy level to a lower one, it emits a photon.
When an electron jumps from a low energy state to a higher one, it absorbs the photon to gain enough energy.
This only happens if the energy of the photon is the correct amount needed for the transition.

(23.) If an element has a lot of energy pumped into it, like with a high voltage, the electrons in the atoms get excited to high energy states. When the electrons drop down to lower energy states, they give off photons or light of different colors. A prism can separate the different colors from purple to red so you can see them separately. Each energy transition gives off a different color of light. All the transitions of the element give different colors & the collection of colors is called the spectrum. Each line, or color, represents one transition of an electron from a higher energy level to a lower energy level. Each element has a unique spectrum, like a finger print.

********* Recipe for a Great Laser! **********



2 MIRRORS to contain the light. One is partially reflecting to let light out to be used.

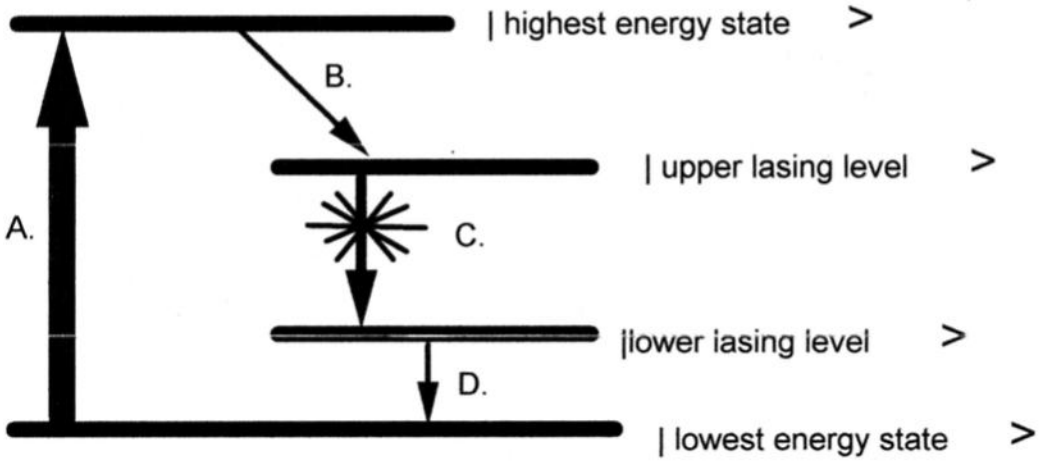
GAIN MEDIUM that is excited to high energy states by the PUMP. The electrons in the gain medium then drop to lower energy states and give off photons during the transition. This is called a SPONTANEOUS EMISSION event. Some of these photons are then caught between the two mirrors.

The pump can be a flashlamp, an electrical current, or another laser.

Light bounces back and forth between the two mirrors. It interacts with the excited atoms in the gain medium and "tickles" the excited electrons. They are then stimulated to emit their light in the same direction as and with the same phase as the light already bouncing back and forth in the cavity. This is called STIMULATED EMISSION. Stimulated emission happens more frequently than spontaneous emission (by a factor of 10^{14}) and thus the light in the cavity is amplified.

A laser is a device which produces Light Amplified by Stimulated Emission of Radiation.

Energy Level Diagram for Gain Medium



Ch. 21 HW

Phy 101

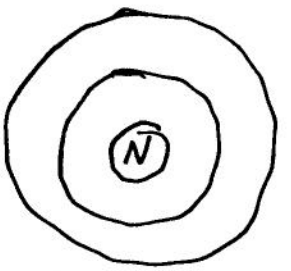
(4)

Questions

(6.) Ultraviolet light is very energetic. It can be absorbed by the electrons in some materials so they are excited to high energy states. When they drop back to the ground state, they often do so by jumping several times giving off photons in the visible region of the spectrum.

(7.) Different lasers have different colors because the gain material in them is different. The different elements in the gain material (like Ar, Ne, sapphire, Nd) have different energy level structures & so give off different colored photons when they electrons drop to the ground state.

(9.)



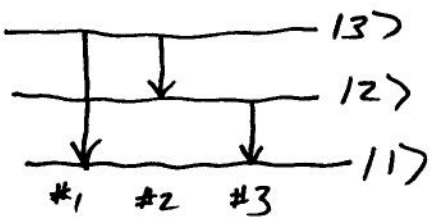
Two allowed orbits. This translates to two energy levels

——— |2⟩

——— |1⟩

The electron can only be in state #1 or #2. Only 1 photon is involved in this single transition.

(10.)



3 photons can be emitted.

Photon #1 from state |3⟩ to state |1⟩ has most energy.

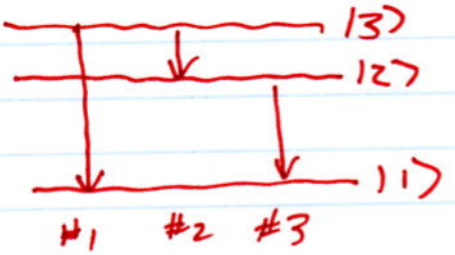
Ch. 21 HW

Phy101

(5)

Questions

(11.)

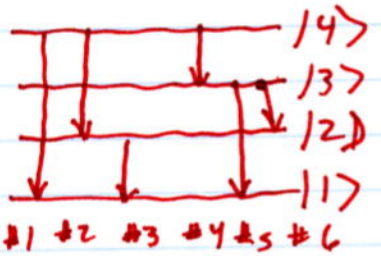


3 transitions

$E = hf = \frac{hc}{\lambda}$

The energy of a photon is inversely proportional to its wavelength. More energy means shorter λ. Long λ means low energy.
∴ photon #2 has lowest energy & longest λ.

(12.)



6 possible transitions

Longest λ means lowest E.

Since all levels are equally spaced photons #3, 4, & 6 are all the lowest E & longest λ.
The highest E photon is #1, so it has highest f.

(15.) If half the alpha particles bounced back, then one would have to consider the nucleus as being much larger or that electrons are very large or both.

Ch.21 HW

Questions

(16.) Yes, the visible photons correspond to a 3 level energy system. 2 separately absorbed photons can get an electron into the upper state & it can emit either 1 UV photon or 2 visible photons to return to ground state.

(17.)

Light from a light bulb spreads in all directions & light from a laser is a narrow beam (collimated) So on a small piece of paper much more light from the laser would strike the paper than from a light bulb.

Problems

		Protons	Electron	Neutrons
(1.)	a) H	1	1	0
& (2.)	b.) C	6	6	~6
	c) S	16	16	~16
	d) Ca	20	20	~20
	e) I	53	53	~74

$$\begin{array}{r} 127 \\ -\ 53 \\ \hline 74 \end{array}$$