homework#5

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Started: September 22, 2009 2:14 PM
Questions: 26

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1. HW5 (Q1) (Points: 0)

****The laser tutorial, due this Wed, is integrated in this week's Vista online HW. You can also hand-in a "hard copy" of the laser tutorial and leave questions 15-21 blank. ****

Select one problem for which you had the wrong answer. Please feel free to use either a homework or exam problem.

In the text box below:

i) identify the question number you are correcting
ii) state (copy) your original wrong answer,
iii) explain where your original reasoning was incorrect, the correct reasoning for the problem, and how it leads to the right answer.
If you got all the answers correct!!! Great ... then state which was your favorite / most useful homework problem and why.

New Insert equation

Save Answer

2. HW5 (Q2) (Points: 1)

As part of this HW, you will work through the requirements needed to make a laser, and think about how you can rework a laser design given adverse conditions. You will be working with the Laser Simulation to really discover and understand the requirements and operational considerations yourself.

A laser involves the various processes by which light interacts with atoms:
absorption, spontaneous emission, and stimulated emission. Which of the following descriptions accurately describes each process:

The process in which the electron naturally jumps down from a higher energy state to a lower state and spits out a photon corresponding to the energy difference as it does so:

1. Absorption
2. Spontaneous emission
3. Stimulated emission

Save Answer

3. HW5 (Q3) (Points: 1)

The process by which the light is absorbed and the energy causes the atomic electron to go to a higher energy level:

1. Absorption
2. Spontaneous emission
3. Stimulated emission

Save Answer

4. HW5 (Q4) (Points: 1)

The process where a photon hits an atom that is already in a higher energy level and this causes the atom to spit out a photon that is identical to the one that hit the atom resulting in two identical photons:

1. Absorption
2. Spontaneous emission
3. Stimulated emission

Save Answer

5. HW5 (Q5) (Points: 1)

A laser is created by producing a lot of photons created by stimulated emission.
What characteristics make light produced by stimulated emission so special compared to light produced through spontaneous emission? (check all that apply)

1. Photons are traveling exactly in the same direction.
2. Photons' electromagnetic waves are oscillating exactly in phase.
3. Photons are all exactly the same color.
4. Photon has more energy

Save Answer

6. HW5 (Q6) (Points: 1)

Open the One Atom Panel in the Laser Simulation and start exploring the two-level atom. Questions 6-13 are considering only the two-level atom (which is a good
approximation to the behavior of real atoms when the conditions are such that the atoms are being excited to only one excited energy level).

For absorption to occur, the photon energy needs to:

1. be equal to or greater than the energy difference between the two levels
2. exactly match the energy difference between the two levels
3. be equal to or less than the energy difference between the two levels.

Save Answer

7. HW5 (Q7) (Points: 1)

When the conditions are such that there is a lot of stimulated emission, there is a net increase in the number of photons compared to the number emitted by the lamp.

- 1. True
- 2. False

Save Answer

8. HW5 (Q8) (Points: 1)

In stimulated emission, the direction of the emitted photon is independent of the direction of the stimulating photon:

- 1. True
- 2. False

Save Answer

9. HW5 (Q9) (Points: 1)

In spontaneous emission, the photon is emitted in a random direction:

- 1. True
- 2. False

Save Answer

10. HW5 (Q10) (Points: 1)

Decreasing the lifetime of the upper energy level, (check all that apply)

- 1. increases the average amount of time before an excited atom will undergo spontaneous emission
- 2. decreases the average amount of time before an excited atom will undergo spontaneous emission
- 3. increases the likelihood of spontaneous emission, and decreases the likelihood of stimulated emission
- 4. decreases the likelihood of spontaneous emission, and increases the likelihood of stimulated emission
- 5. increases the energy of that level
- 6. decreases the energy of that level
- 7. increases the wavelength of the photon needed to create stimulated emission of an atom in that level
- 8. decreases the wavelength of the photon needed to create stimulated emission of an atom in that level

Save Answer

11. HW5 (Q11) (Points: 1)

Changes that will increase the likelihood that the excited atom will undergo stimulated emission include: (check all that apply)

- 1. decreasing the lifetime of the excited state
- 2. increasing the lifetime of the excited state
- 3. increasing the lamp intensity

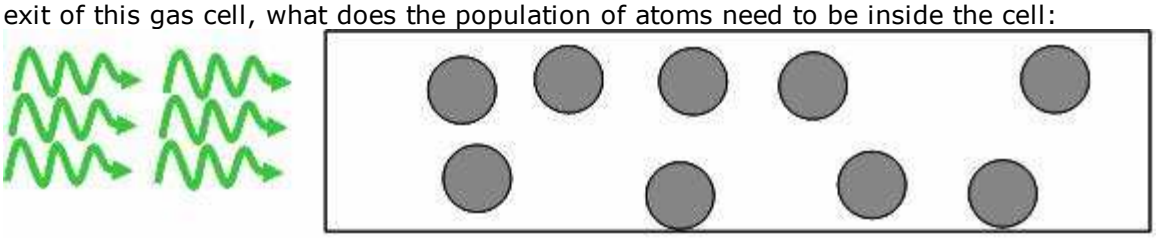
4. decreasing the lamp intensity
5. increasing the wavelength of light coming out of the lamp (assume you start at a wavelength where stimulated emission does occur)
6. decreasing the wavelength of light coming out of the lamp (assume you start at a wavelength where stimulated emission does occur)

Save Answer

12. HW5 (Q12) (Points: 1)

In a laser, a whole bunch of identical photons are created by stimulated emission.

We have an atom with only two relevant energy levels as in the two-level simulation, an excited state and a ground state. We send in these 6 photons (which match
the energy difference between the levels). In order to get a net increase in the number of photons at the exit of this gas cell, what does the population of atoms need to be inside the cell:



1. More than half need to be in the ground state
2. Need half in the ground state, half in the excited state
3. More than half need to be in the excited state

Save Answer

13. HW5 (Q13) (Points: 1)

If we shine a sustained high intensity beam of these green photons through this cell, what will the average population distribution of atoms in the cell look like?

1. All atoms will be in the excited state
2. All atoms will be in the lower state
3. Half the atoms will be in the lower state and half will be in the excited state

Save Answer

14. HW5 (Q14) (Points: 1)

A ruby laser emits a 100MW, 10ns long pulse of light with a wavelength of 690 nm.
How many atoms undergo stimulated emission to generate this pulse? (give answer to two sig digit, such as 1.1E1)
1.

Save Answer

15. HW5 (Q15) (Points: 2)

Question 15-21

It is now time for you to build a laser. Remember the goal of a laser is to build up a lot of identical photons. Play around with the different settings to figure out the requirements to create a laser. Make a laser so powerful that it blows up! (If you cannot, you haven't figured out how to make a laser.) If you go

through this exploration, while paying attention to what is happening as you change different things, the questions below should be easy.
Play with the laser simulation. What are the conditions to make a laser (explain all answers thoroughly!):

What is the minimum number of energy levels and why?

New Insert equation

Save Answer

16. HW5 (Q16) (Points: 2)

What are the conditions necessary to make the laser happen (consider, lifetime, intensity of light source, and frequencies of photons). Again, explain thoroughly.

New Insert equation

Save Answer

17. HW5 (Q17) (Points: 2)

In an operational three level laser system (with ground, 1st level, 2nd levels) , which state has highest population of atoms in it?

New Insert equation

Save Answer

18. HW5 (Q18) (Points: 2)

Which photons are being cloned to make the laser light?

New Insert equation

Save Answer

19. HW5 (Q19) (Points: 2)

Explain the function of the mirrors at each end of a laser. Why do you need them to have a functioning laser? What would happen if one mirror was removed?

New Insert equation

Save Answer

20. HW5 (Q20) (Points: 2)

You are designing a laser system and realize that the intensity of the pumping light source is reduced significantly. How might you correct for this?

New Insert equation

Save Answer

21. HW5 (Q21) (Points: 2)

If the mirrors gets dirty and corroded, reducing their reflectivity, how might you overcome this problem (other than cleaning the mirrors).

New Insert equation

Save Answer

22. HW5 (Q22) (Points: 1)

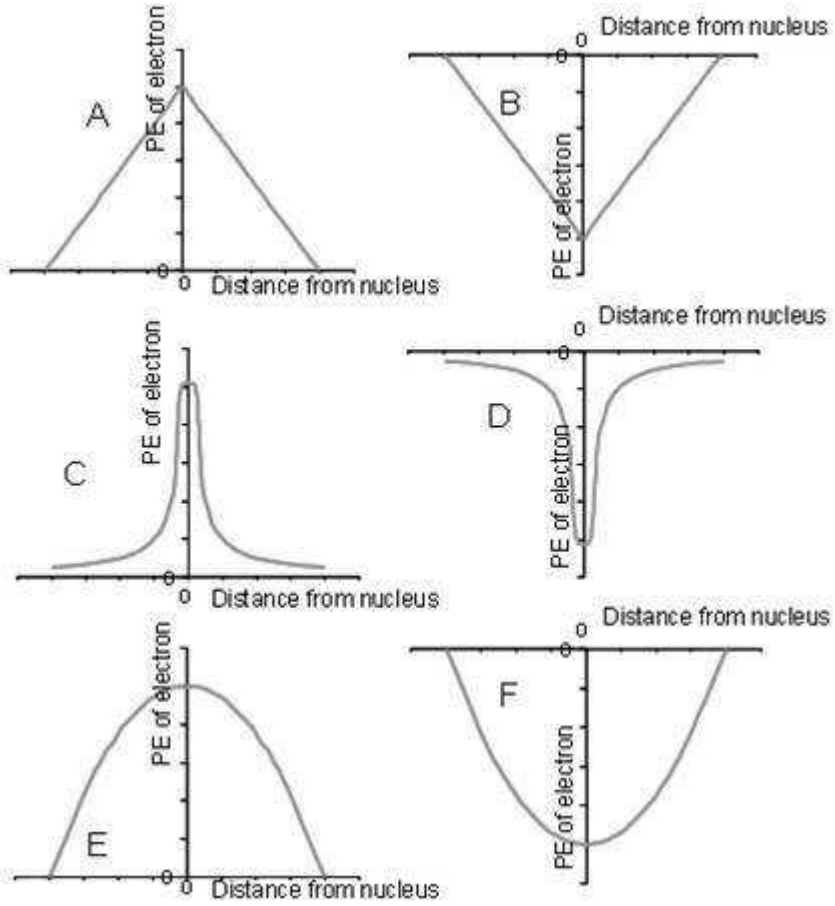
A 50nm (24eV) photon is going into a gas of hydrogen atoms all in the ground state. What of the following is a possible result?

1. The atom absorbs the photon, and the electron leaves with 10.4EV of kinetic energy
2. Only 13.6 eV of energy is absorbed. The electron is liberated from the atom, and the photon continues with 10.4eV of energy.
3. It is impossible for the atom to absorb the photon
4. The photon passes through the gas without being absorbed.
5. One hydrogen atom would absorb 13.6 eV of energy and another would absorb the rest of the photon energy.

Save Answer

23. HW5 (Q23) (Points: 1)

For the case of the hydrogen atom, we have an atom with 1 proton in the nucleus. Which curve best represents how the potential energy of an electron would vary as its distance from the nucleus increased?



- 1. A
- 2. B
- 3. C
- 4. D
- 5. E
- 6. F

Save Answer

24. HW5 (Q24) (Points: 1)

We can think more about the potential energy of an electron in the hydrogen atom by considering a negatively charged electron in the vicinity of a positively charged proton.

If we define the potential energy of the electron as 0 when it is infinitely far from the proton, what is its potential energy when D=0.075nm (in eV)? (give answer to three sig fig, such as 2.22E-2)

1.

Save Answer

25. HW5 (Q25) (Points: 1)

If we halve the distance, what happens to potential energy of the electron? (check all that apply)

- 1. it becomes more negative
- 2. it becomes less negative
- 3. it becomes more positive

- 4. it becomes less positive
- 5. by factor of 1/4
- 6. by factor of 1/2
- 7. by factor of 2
- 8. by factor of 4
- 9. PE does not change

Save Answer

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26. HW5 (Q26) (Points: 0)

READ CAREFULLY:

How long did you take to do this week's Vista HW (which includes the laser in class tutorial)?

- 1. <1hr
- 2. 1hr
- 3. 2 hr
- 4. 3 hr
- 5. 4 hr
- 6. 5 hr
- 7. 6 hr
- 8. >6 hr

Save Answer

Finish **Save All** **Help**