LASER

Challenging **MCQ** questions by The Physics Cafe

Compiled and selected by The Physics Cafe

1 A laser point creates a spot on a screen as it reflects 70% of the light striking it. This light exerts radiation pressure on the screen.

The laser point is now moved twice as far away from the screen.

i. The radiation pressure remains the same because the intensity of the laser light remains constant.

ii. The radiation pressure decreases because the beam diverges and area of illumination increases.

iii. The radiation pressure decreases because energy of the light is lost due to scattering from air molecules and dust particles light travels a longer distance to the screen.

Which of the statements above is/are correct?

A i only

B ii only

C iii only

D ii and iii only

2 Which one of the following statements best describes stimulated emission in a laser?

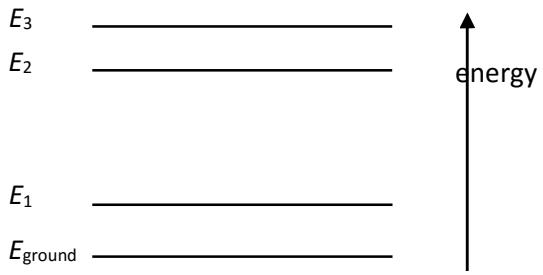
A Electrons collide with atoms in a metastable state and cause photons to be emitted.

B Atoms in a metastable state de-excite and cause electrons to be emitted.

C Photons interact with atoms in a metastable state and cause photons to be emitted.

D Photons interact with atoms in a metastable state and cause electrons to be emitted.

3 The diagram below shows the energy levels for the atoms of a 4-level laser system.



Which set of life-times for electrons residing in that energy state is possible if E_2 is the metastable state for this laser system?

	E_1	E_2	E_3
A	10^{-3} s	10^{-8} s	10^{-7} s
B	10^{-7} s	10^{-9} s	10^{-3} s
C	10^{-7} s	10^{-3} s	10^{-9} s
D	10^{-8} s	10^{-3} s	10^{-2} s

4 Why is laser light monochromatic?

A The excited electrons are in a metastable state.

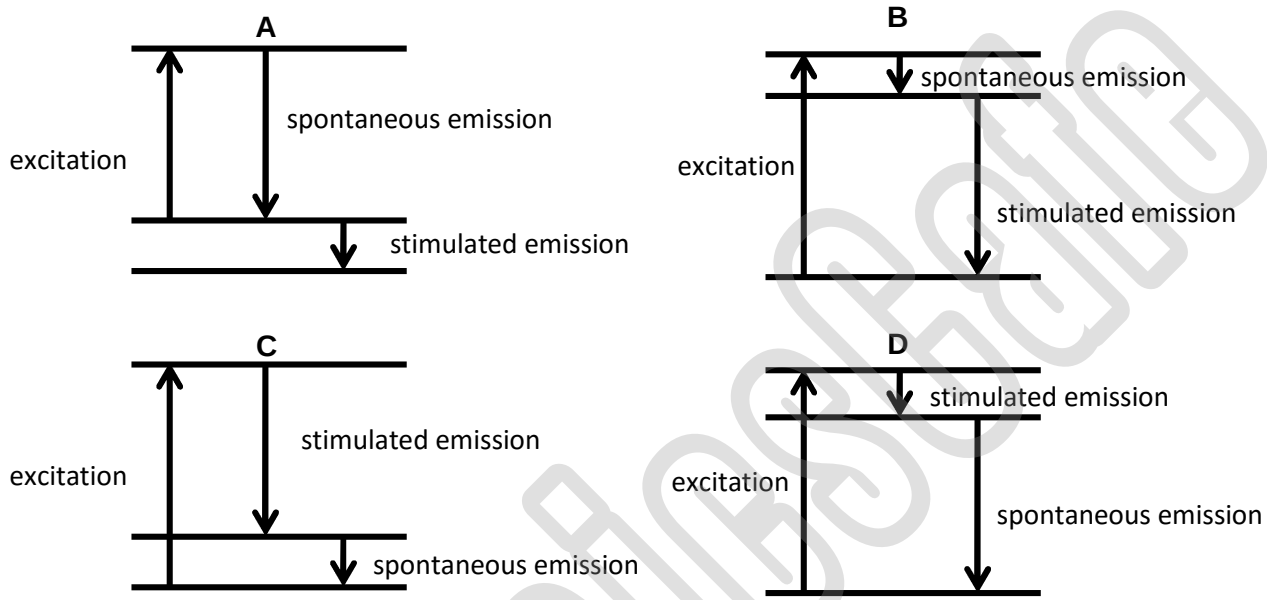
B The system is in a state of population inversion.

C The emitted photon and incident photon are of the same phase.

D Photons of the same energy as that of the incident photons are emitted when the electrons transit down from a higher energy level.

5 In a helium-neon laser, helium atoms collide with neon atoms and excite them. This produces a population inversion which allows stimulated emission.

Which neon energy level diagram correctly shows the excitation of the neon atoms by the helium atoms, the spontaneous blue-green light from the neon, and the stimulated emission of red light?



6 When light of frequency less than threshold is shone onto a metal, no electron is emitted regardless how long is the light radiated on the metal. However, it was found that when laser light of frequency lower than the threshold is used, electrons could be emitted. Which of the following is the correct explanation?

A The photon theory does not apply to laser light.

B Each laser photon has a higher momentum that can knock out the electrons.

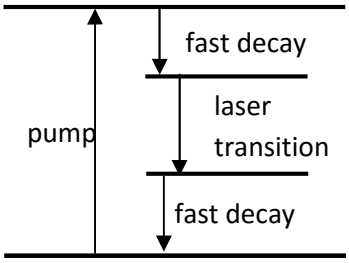
C Laser light has very high intensity and is highly coherent so the electrons have a chance to absorb more than a photon at the same time.

D Laser light exhibits wave behaviour rather than particulate behaviour so that the electron can absorb the wave energy continuously for a longer time interval.

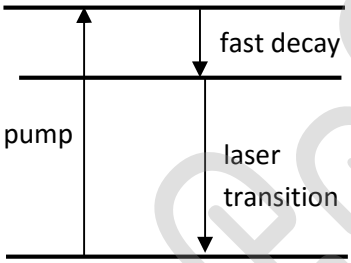
7 Below are energy level schemes of possible laser materials. The "pump" is where excitation takes place. The "laser transition" indicates the transition where lasing should occur. The transition "fast decay" is fast compared to the pumping or excitation process as well as the lasing transition.

Which of these level schemes is best for facilitating population inversion?

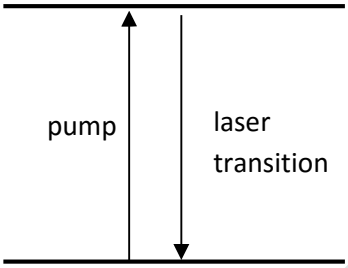
A



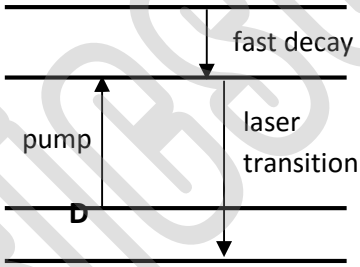
B



C

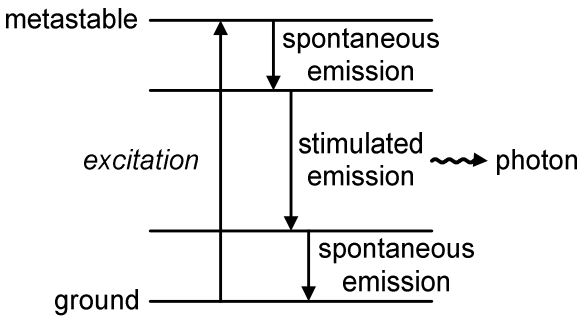


D

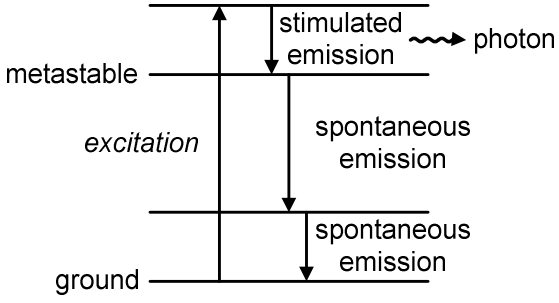


8 Which diagram correctly shows the three possible processes: excitation, stimulated emission and spontaneous emission between the energy levels in a 3-level laser system?

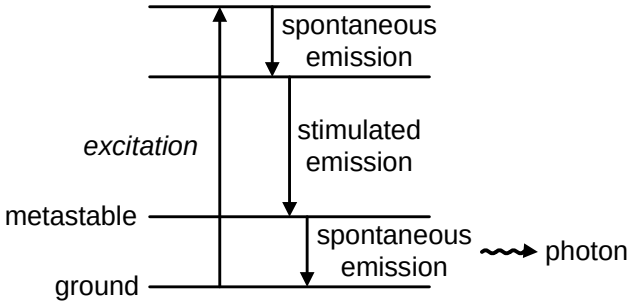
A



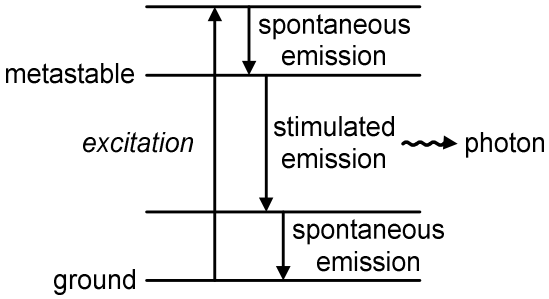
B



C



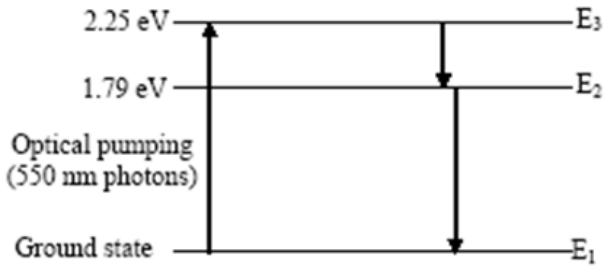
D



9 In a ruby laser, light of wavelength 550 nm from a xenon flash lamp is used to excite atoms from the ground state E_1 to energy state E_3.

Energy state E_2 is a long-lived state which allows the atom to "wait" for an incoming photon while building up a large population of atoms in that state.

The lasing transition is between energy states E_2 and E_1.



Which of the following statements regarding this laser is incorrect?

A The wavelength of the laser light is greater than 550 nm.

B Atoms can decay spontaneously from energy state E_3 to energy state E_2.

C Spontaneous emission does not occur between energy states E_2 and E_1 as lasing photons are produced by stimulated emission.

D During optical pumping, atoms in the ground state are excited to energy state E_3 by stimulated absorption of 550 nm photons.

10 Which of the following statements concerning a laser system is **incorrect**?

A Spontaneous emission occurs in the laser system.

B The intensity of the laser beam can be varied by changing the reflective coefficient of the partially reflecting mirror.

C The laser system does not require an external energy source.

D The laser medium consists of a metastable state.

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WORKED SOLUTIONS

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1 Ans: **D**

2 Ans: **C**
A – Photons interact with electrons/atoms in metastable state, resulting in stimulated emission of photons.
B- Electrons in a metastable state de-excited releasing photons.
D- Photons and not electrons are emitted.

3 Ans: **C**

4 Ans: **D**

When the incident photon and the emitted photons have the same energy, they will have the same wavelength and frequency. This results in a monochromatic laser light.

5 Ans: **D**

6 Ans: **C**

7 Ans: **A**

8 Ans: **D**
Stimulated emission occurs at metastable level.

9 Ans: **C**

10 Ans: **C**