

PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

Lasers - CSIR NET Physics PYQs

Atomic and Molecular Physics . All PYQs (2015-2025) with answer key

14 questions . Answer key included

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Q1. [Dec 2015] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2015 Dec	5 M
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For a two level system, the population of atoms in the upper and lower levels are 3×10^{18} and , respectively. If the coefficient of stimulated emission is $3.0 \times 10^5 \text{ m}^3/\text{W} - \text{s}^3$ and the energy density is $9.0 \text{ J}/\text{m}^3 - \text{Hz}$, the rate of stimulated emission will be

1. $6.3 \times 10^{16} \text{ s}^{-1}$
2. $4.1 \times 10^{16} \text{ s}^{-1}$
3. $2.7 \times 10^{16} \text{ s}^{-1}$
4. $1.8 \times 10^{16} \text{ s}^{-1}$

Q2. [June 2015] . 3.5 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2015 June	3.5 M
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In a two-state system, the transition rate of a particle from state 1 to state 2 is t_{12} , and the transition rate from state 2 to state 1 is t_{21} . In the steady state, the probability of finding the particle in state 1 is

1. $\frac{t_{21}}{t_{12}+t_{21}}$
2. $\frac{t_{12}}{t_{12}+t_{21}}$
3. $\frac{t_{12}t_{21}}{t_{12}+t_{21}}$
4. $\frac{t_{12}-t_{21}}{t_{12}+t_{21}}$

Q3. [June 2015] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2015 June	5 M
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A He – Ne laser operates by using two energy levels of Ne separated by 2.26 eV . Under steady state conditions of optical pumping, the equivalent temperature of the system at which the ratio of the number of atoms in the upper state to that in the lower state will be 1/20, is approximately (the Boltzmann constant $k_B = 8.6 \times 10^{-5} \text{ eV/K}$)

1. 10^{10} K
2. 10^8 K
3. 10^6 K
4. 10^4 K

Q4. [Dec 2016] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2016 Dec	5M
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A two level system in a thermal (black body) environment can decay from the excited state by both spontaneous and thermally stimulated emission. At room temperature (300 K), the frequency below which thermal emission dominates over spontaneous emission is nearest to

1. 10^{13} Hz
2. 10^8 Hz
3. 10^5 Hz
4. 10^{11} Hz

Q5. [June 2016] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2016 June	5M
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The separation between the energy levels of a two-level atom is 2 eV . Suppose that 4×10^{20} atoms are in the ground state and 7×10^{20} atoms are pumped into the excited state just before lasing starts. How much energy will be released in a single laser pulse?

1. 24.6 J
2. 22.4 J
3. 98 J
4. 48 J

Q6. [Dec 2017] . 3.5 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2017 Dec	3.5M
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Consider a system of identical atoms in equilibrium with blackbody radiation in a cavity at temperature T . The equilibrium probabilities for each atom being in the ground state $|0\rangle$ and an excited state $|1\rangle$ are P_0 and P_1 respectively. Let n be the average number of photons in a mode in the cavity that causes transition between the two states. Let $W_{0\rightarrow 1}$ and $W_{1\rightarrow 0}$ denote, respectively, the squares of the matrix elements corresponding to the atomic transitions $|0\rangle \rightarrow |1\rangle$ and $|1\rangle \rightarrow |0\rangle$. Which of the following equations hold in equilibrium?

1. $P_0 n W_{0\rightarrow 1} = P_1 W_{1\rightarrow 0}$
2. $P_0 n W_{0\rightarrow 1} = P_1 n W_{1\rightarrow 0}$
3. $P_0 n W_{0\rightarrow 1} = P_1 W_{1\rightarrow 0} - P_1 n W_{1\rightarrow 0}$
4. $P_0 n W_{0\rightarrow 1} = P_1 W_{1\rightarrow 0} + P_1 n W_{1\rightarrow 0}$

Q7. [June 2017] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2017 June	5M
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If the coefficient of stimulated emission for a particular transition is $2.1 \times 10^{19} \text{ m}^3 \text{ W}^{-1} \text{ s}^{-3}$ and the emitted photon is at wavelength 3000 \AA , then the lifetime of the excited state is approximately

1. 20 ns
2. 40 ns
3. 80 ns
4. 100 ns

Q8. [Dec 2018] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2018 Dec	5M
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The volume of an optical cavity is 1 cm^3 . The number of modes it can support within a bandwidth of 0.1 nm , centered at $\lambda = 500 \text{ nm}$, is of the order of

1. 10^3
2. 10^5
3. 10^{10}
4. 10^7

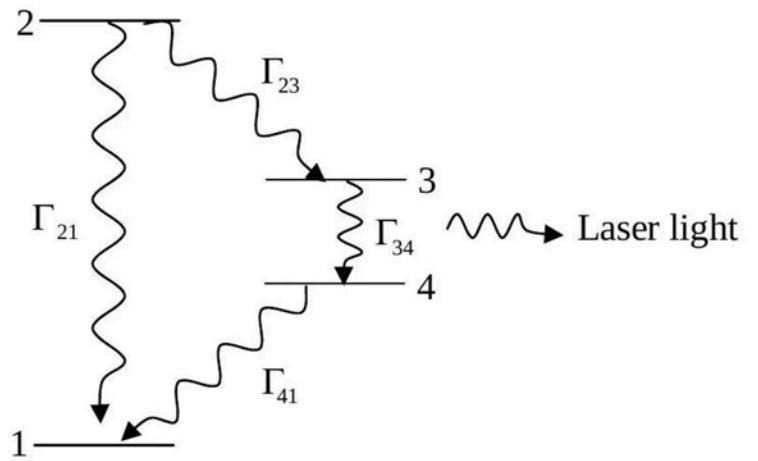
Q9. [June 2018] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2018 June	5M
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The electronic energy level diagram of a molecule is shown in the following figure, Let Γ_{ij} denote the decay rate for a transition from the level i to j . The molecules are optically pumped from level 1 to 2. For the transition from level 3 to level 4 to be a lasing transition, the decay rates have to satisfy

1. $\Gamma_{21} > \Gamma_{23} > \Gamma_{41} > \Gamma_{34}$
2. $\Gamma_{21} > \Gamma_{41} > \Gamma_{23} > \Gamma_{34}$
3. $\Gamma_{41} > \Gamma_{23} > \Gamma_{21} > \Gamma_{34}$
4. $\Gamma_{41} > \Gamma_{21} > \Gamma_{34} > \Gamma_{23}$



Q10. [June 2019] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2019 June	5M
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The cavity of a He-Ne laser emitting at 632.8 nm , consists of two mirrors separated by a distance of 35 cm . If the oscillations in the laser cavity occur at frequencies within the gain bandwidth of 1.3 GHz , the number of longitudinal modes allowed in the cavity is

1. 1
2. 2
3. 3
4. 4

Q11. [June 2020] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2020 June	5M
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The energies of the 3 lowest states of an atom are $E_0 = -14 \text{ eV}$, $E_1 = -9 \text{ eV}$ and $E_2 = -7 \text{ eV}$. The Einstein coefficients are $A_{10} = 3 \times 10^8 \text{ s}^{-1}$, $A_{20} = 1.2 \times 10^8 \text{ s}^{-1}$ and $A_{21} = 8 \times 10^7 \text{ s}^{-1}$. If a large number of atoms are in the energy level E_2 , the mean radiative lifetime of this excited state is

1. $8.3 \times 10^{-9} \text{ s}$
2. $1 \times 10^{-8} \text{ s}$
3. $0.5 \times 10^{-8} \text{ s}$
4. $1.2 \times 10^{-8} \text{ s}$

Q12. [Dec 2025] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2025 Dec	5M	AMP
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An optical cavity of a laser, formed by two plane mirrors, is filled up with an active medium. The medium emits radiation at wavelengths 450 nm , 600 nm , and 750 nm . If the medium is continuously pumped, at which cavity length among the following, will all three wavelengths be amplified?

1. $750\mu\text{ m}$
2. $1500\mu\text{ m}$
3. $600\mu\text{ m}$
4. $450\mu\text{ m}$

Q13. [June 2025] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2025 June	5M	AMP
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A highly collimated laser beam with a diameter of 1 cm and wavelength 500 nm is directed from the earth's surface towards the moon ($\sim 384,000$ km away from the earth). Assuming ideal diffraction limited propagation in vacuum, which of the following best estimates the diameter of the beam upon returning to the earth after reflection from an ideal reflector installed on the moon.

1. 200 m
2. 20 m
3. 20 km
4. 200 km

Q14. [June 2025] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2025 June	5M	AMP
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Consider a laser cooling experiment where atoms are slowed down by an inelastic process of absorption and subsequent emission of photons. If light of wavelength 776.5 nm is used to slow down potassium atoms (mass number 39) with initial speed 130 ms^{-1} , the number of such absorption and emission cycles needed to bring the atoms to rest is closest to

1. 10^3
2. 10^2
3. 10^5
4. 10^4

Answer Key

14 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	Atomic and Molecular Physics	Lasers	3
Q2	Atomic and Molecular Physics	Lasers	1
Q3	Atomic and Molecular Physics	Lasers	4
Q4	Atomic and Molecular Physics	Lasers	1
Q5	Atomic and Molecular Physics	Lasers	4
Q6	Atomic and Molecular Physics	Lasers	4
Q7	Atomic and Molecular Physics	Lasers	3
Q8	Atomic and Molecular Physics	Lasers	3
Q9	Atomic and Molecular Physics	Lasers	None
Q10	Atomic and Molecular Physics	Lasers	3
Q11	Atomic and Molecular Physics	Lasers	3
Q12	Atomic and Molecular Physics	Lasers	4
Q13	Atomic and Molecular Physics	Lasers	3
Q14	Atomic and Molecular Physics	Lasers	4

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