strucked by the massive ions in the gas discharge. These positive ions carry a large kinetic energy that heats the cathode, while the anode is strucked by the electrons which carry much less kinetic energy than the ions.

b- To minimize sputtering of the cathode material when the discharge current is following in the tube. Excessive sputtering would contaminate the gas within the tube and reduce or eliminate laser operation.

c- The volume that encloses the cathode also serves as a gas reservoir to increase the volume of gas in the tube and thus, to extend tube life.

5. Draw and label the energy level diagram of a He:Ne lasers, and explain the energy transfer processes in the active medium.

6.What is the most common output wavelength (and color) of He:Ne lasers? What are the other important wavelengths they lase at? What was the wavelength of the first operating He:Ne laser?

Ans:

The most common output wavelength is 632.8 nm (red color). The other important wavelengths are the 1.15 μm (near IR), 3.39 μm (IR) and 543.3 nm (green). The wavelength of the first He:Ne laser was 1.152 μm.

7. What are the wavelengths of the commercially available He:Ne lasers? What are their relative gain compared to 632.8 nm output? What one can conclude from their low relative gain?

Ans:

He:Ne lasers normally operate with the familiar red (632.8 nm) beam, but multiple transitions are possible, allowing the laser to operate (with suitable optics) at wavelengths in the infrared, orange, yellow and green.

Commercially, four visible wavelengths of He:Ne laser are commonly available as outlined in the table below:

Commercially available He:Ne lasers

Wavelength(nm)	Relative gain (compared to 632.8 nm output)
543.5(green)	0.06
594.1(yellow)	0.07
611.9(orange)	0.2
632.8(red)	1

These low relative gains means that lasers which emit such wavelengths are not nearly as efficient as the common red type since the spectral lines that need to be amplified are much weaker at these wavelengths. Thus, other color He:Ne lasers must be much larger for the same output power and use higher quality mirrors. For example, a small red He:Ne tube might have an output of up to 20 mW, a comparable green tube would be limited to under 3 mW. Also, because of the low gain of the green He:Ne, special low-loss optics are required which are much more critical (and expensive) than red He:Ne optics (the reflectivity of a typical green He:Ne tube OC is 99.92 to 99.95%).

8.Explain how lasing on the 3.39 μm line and the 1.15 μm line competes with the 632.8 nm line.

Ans:

The 3.39 μm line and the 632.8 nm line share the same upper lasing level (starting level). When such a condition exists, the line having the greatest gain will lase, and the weaker line will not. With neon, the gain is so great for the 3.39 μm that lasing can be obtained at this wavelength without a pair of mirrors for feedback (super radiant lasing).

The 1.15 μm line and the 632.8 nm line share the same lower lasing level (terminating level). If the 1.15 μm line lases, atoms from 2s are transferred to level 2p, raising its population and reducing the population inversion for the 632.8 nm line.

9. Describe superradiant lasing. Give an example.

Ans:

Superradiant means that no mirrors are used. For example, pure neon can laser superradiantly in a narrow tube (e.g. 40 cm long x 1mm ID) in the orange (611.9 nm) and yellow. (1964)

10. the laser transitions in He:Ne laser are always competing with each other. What one can do to get the required red color?

Ans:

Two requirements are needed to get the wanted wavelengths (red). They are:

1- The mirrors that forming the laser cavity are highly reflective (often over 99%) at only the wanted color (red).

2- Extreme care to minimize losses at the wanted color.

11. What are the methods used in He:Ne lasers to suppress the unwanted laser lines (the IR lines)?

Ans:

There are three methods for the elimination of unwanted IR lines in He:Ne lasers:

a- The most common method is the use of mirrors that are highly reflective of 632.8 nm but highly transmitting (or absorbing) at other two lines to induce a large loss at these wavelengths and hence suppress the strong IR transition. This is done by the use of selective mirror coatings that have a reflective bandpass strongly peaked at 632.8nm.

b- The use of magnetic suppression (a row of magnets is placed beside the plasma tube) in larger plasma tubes (e.g., 1m) of higher power (2mW output or more) He:Ne lasers.

c- Intracavity tuning with a prism or placement of a 3.39 μm absorber, such as methane gas, in the cavity.

12. Discuss the decay of the electrons in the terminal level of He:Ne laser.

13. Why the discharge tube diameter of the He:Ne laser should be kept as narrow as possible?

14. What is the output of a typical He:Ne laser? Its typical physical size?

Ans:

Power output of commercially available He:Ne lasers ranges from under 1 mW (≈ 0.5 mW) for a small laser to just over 100mW for a large laser. Its typical physical size from 10 to 100 cm.

15. Why He:Ne lasers are of low power outputs?

OR : Why the He:Ne laser is destined to remain a relatively low power device?

16. State in brief how the lasing process occurs in He:Ne laser.

Ans:

The entire lasing process: excitation of the He atoms, transfer to the ULL in neon, lasing transitions, and decay from the LLL.

17. Why does the lasing action in He:Ne laser ceased at high tube currents?

18. Could we increase the output power of He:Ne laser by increasing the current indefinitely? Why?

19. How does the recommended operating current be chosen in He:Ne laser?

Ans:

First, there is a minimum current below which ionization cannot be sustained, and the laser drops out of operation. Above this, as current is increased, there is a range where the laser output increases with current (this increase is not proportional to current increase). Above certain level, output will decreased with increased current. Normally the recommended operating current is chosen to coincide with the maximum output power.

20. On what factors do the operating voltages depend?

Ans:

Operating voltages vary with several factors, among them the diameter of the capillary (plasma tube), the gas fill pressure and the length of the laser.

21. What are the virtues of He:Ne laser in spite of its low power output?

Ans:

a. It has an exceptionally narrow lasing line width.

b. Most He:Ne lasers operate in TEM_{00} mode and yield excellent beam quality.

c. It is small and light enough to be readily portable.

22. What are the two possible designs of He:Ne laser mirrors placement.

23. What are the technical features of the He:Ne laser mirrors?

24. What are the resonator configurations that employed in He:Ne lasers? Which configuration is usually used?

25. Why a current limiting resistor is used in He:Ne laser?

OR, What is the role of the ballast resistor in He:Ne lasers?

26. A small He:Ne tube is operated from a power supply which has an output of 1838 V. this particular tube has an operating current of 5 mA and a voltage of 1320 V is measured across the tube at that current. Find the required ballast resistance and the heat power dissipated through it.

Ans:

$$R_{ballast} = \frac{V_{supply} - V_{tube}}{I_{tube}}$$

$$= \frac{1838V - 1320V}{0.005\ A} = 104\ k\Omega$$

When operating, this resistance has 518 V across it, hence:

Heat power dissipated = I .V= 0.005 A x 518 V = 2.6 W.