1. A beam of ions is injected into a gas. The beam has an initial density n_o ions/cm^3. **Find** the density of the remaining ions at a distance equal to (a) the mean free path, (b) five times the mean free path.

2. In an experiment to measure α for a certain gas, it was found that the steady state current is 5.5×10^{-8} A at 8 kV at a distance of 0.4 cm between the plane electrodes. Keeping the field constant and reducing the distance to 0.1 cm results in a current of 5.5×10^{-9} A. **Calculate**:
   a) Townsend's primary ionization coefficient α.
   b) The number of electrons emitted from the cathode per second.
   c) The electrode spacing that would result an electron avalanche of 10^2.

3. In an experiment in a certain gas it was found that the current between two Parallel plates were 1.22, 1.82 and 2.22 of the initiating photocurrent at distances 0.005, 0.01504 and 0.019 m respectively. E/P and P were maintained constant at 160 V/cm.torr, 0.1 torr respectively**. Calculate:**
   a) Townsend's primary ionization coefficient α.
   b) The secondary ionization coefficient γ.
   c) The ionization efficiency.
   d) The distance and the voltage at which transition to self sustained (breakdown) take place.

4. The following table gives two sets of experimental results for studying Townsend's mechanism. E is kept constant in each set. **Determine** the values of Townsend's first and second ionization coefficients for each set.

I set 30 kV/cm *Gap distance (mm)*	*II set kV/cm* *Observed current A*	
	I set	*II set*
0.5	1.5×10^{-13}	6.5×10^{-14}
1.0	5×10^{-13}	2.0×10^{-13}
1.5	8.5×10^{-13}	4×10^{-13}
2.0	1.5×10^{-12}	8×10^{-13}
2.5	5.6×10^{-12}	1.2×10^{-12}
3.0	1.4×10^{-10}	6.5×10^{-12}
3.5	1.4×10^{-10}	6.5×10^{-11}
4.0	1.5×10^{-9}	4.0×10^{-10}
5.0	7.0×10^{-7}	1.2×10^{-8}

The minimum current observed is 6×10^{-14} A

5. The following table gives two sets of experimental results for studying Townsend's mechanism. E is kept constant in each set. **Determine** the values of Townsend's first and second ionization coefficients for each set.

Set 1:

Gap distance (mm)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0
Applied voltage V (volts)	1000	2000	3000	4000	5000	6000	7000	8000	10000
Observed current I (A)	10^{-13}	3×10^{-13}	6×10^{-13}	10^{-12}	4×10^{-12}	10^{-11}	10^{-10}	10^{-9}	5×10^{-7}

Set 2:

V (volts)	500	1000	1500	2000	2500	3000	3500	4000	4500
I (A)	5×10^{-14}	1.5×10^{-13}	3×10^{-13}	6×10^{-13}	10^{-12}	5×10^{-12}	5×10^{-11}	3×10^{-10}	10^{-8}

The minimum current observed when 150 V was applied was 5×10^{-14} A.

6. If an electron starts at a distance of 0.5 mm in a field where α = b-ax cm-1, where X is measured from the cathode surface in cm, **Specify** the type of this field and give the reason, **Also Find** the distance it must travel to produce an avalanche of 10^2 electrons where $a=10*10^3$ and $b=3.5*10^3$.

7. **Repeat** the above problem if an electron starts at x=5mm.

8. For the field given in problem No.6, **Determine** the minimum distance from the anode, from which an electron start an avalanche having a total no of electrons of 10^2.

9. For the field given in problem No.6, If $\alpha-\eta=a-b\sqrt{X}$ cm^{-1}, **Determine** the thickness of ionization zone.