1. Calculate the plasma pressure, root mean square velocity, most probable velocity, Debye length, number of particles in the Debye sphere and the plasma frequency of the following plasmas \( (n \text{ cm}^{-3}, kT \text{ eV}) \):

(a) Fusion Plasma : \( n = 10^{15}, kT = 10,000 \)
(b) Glow discharge : \( n = 10^9, kT = 2 \)
(c) Flame : \( n = 10^8, kT = 0.1 \)
(d) Interplanetary space : \( n = 1, kT = 0.01 \)

2. In a certain Townsend discharge the primary cathode emission is 20 pA and the first Townsend coefficient has the value of 1.5 cm\(^{-1}\). If the electrodes are 4 cm apart and secondary effect is negligible, find the discharge current.

3. The following measurements were obtained from a Townsend discharge with constant electric field:

<table>
<thead>
<tr>
<th>Electrode spacing, (d) (mm)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge current (I) (10^{-12}) A</td>
<td>6.4</td>
<td>8.2</td>
<td>10.5</td>
<td>13.5</td>
<td>22.5</td>
<td>38.5</td>
<td>68.7</td>
<td>134</td>
</tr>
</tbody>
</table>

Estimate the First Townsend Coefficient \(\alpha\) and then the Second Coefficient \(\gamma\).

4. With reference to the Paschen curve below,

![Paschen curve](image)

if a discharge at \(p = 0.1\) torr, \(d = 20\) cm is to be initiated, what is the voltage required to caused a breakdown?

What will be the breakdown voltage if \(p = 0.025\) torr, \(d = 20\) cm?
5. Plot the graphs of $\frac{\alpha}{p}$ against $\sqrt{\frac{p}{E} \times 1000}$ for argon and helium at pressure of $p = 1$ torr.