Task 1: Ion Identification

A) For **Feature A** the atom responsible is **oxygen(833.33 Å)** .
its ionic state is (+1) [O II spectrum]

For **Feature B** the atom responsible is **Carbon(903.62 Å)** .
its ionic state is (+1) [C II spectrum]

For **Feature C** the atoms responsible are **Nitrogen(915-916Å)**
its ionic state is (+1) [N II spectrum],
Hydrogen (930-972 Å) its ionic state is (+0) [H I spectrum],
Oxygen (988 , 1025Å) its ionic state is (+0) [O I spectrum]

For **Feature D** the atom responsible is **Carbon(1036-1037Å)**
its ionic state is (+1) [C II spectrum],
oxygen atom is also in this region**(1039.230 Å)**
its ionic state is (+0) [O I spectrum],

For **Feature E** the atom responsible is **Nitrogen(1084.580Å)**
its ionic state is (+1) [N II spectrum],

For **Feature F** the atom responsible is **Hydrogen(1215Å)**
its ionic state is (+0) [H I spectrum],

For **Feature G** the atom responsible is **Oxygen(1304Å)**
its ionic state is (+0) [O I spectrum],

For **Feature H** the atom responsible is **Carbon(1329Å)**
its ionic state is (+0) [C I spectrum],
[C II spectrum] is also present in this region **(1334-1335Å) ,**
its ionic state is (+1)

B) **Lyman Series:**

$$1/\lambda = R_H(1 - 1/n^2)$$

Where n is a natural number greater than or equal to 2 (i.e., n = 2, 3, 4, …). λ=wavelength, $R_{H} = 1.0968\times 10^{-3}$ Å^{-1} (Rydberg constant)

Therefore, the lines seen in the image above are the wavelengths corresponding to n = 2 on the right, to n = ∞ on the left.

The wavelengths in the Lyman series are all ultraviolet:

n	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**∞, the Lyman limit**
Wavelength (Å)	**1215.6701**	**1025.7220**	**972.53650**	**949.74287**	**937.80331**	**930.748142**	**926.225605**	**923.150275**	**920.963006**	**919.351334**	**911.753**

In **Feature C** from right side in plot of light intensity vs wavelength in Angstrom line started from 1025.7220 **Å** where n=3 & continued till 911.753 **Å** where n = ∞ There are infinitely many spectral lines, but they become very dense as they approach n = ∞ (the Lyman Limit), so only some of the first lines and the last one appear.

The photon is emitted with the electron moving from a **higher energy level** to a **lower energy level**. Here at near 911 **Å** lines become very dense & emitted photon energy of certain wavelength is absorbed by certain gaseous atom. As large no of atoms are absorbing photon energy the intensity of light decreases abruptly & reaches to near about 0.1

So the Plunge is created near 911 Å.

Task 2: Astrophysical Absorption Line Exercise

1) The intensity (I) of a given wavelength (λ) is given by the equation

$I(\lambda)=\exp[-\alpha(\upsilon)\times d]$ [here d=thickness of slab, $\alpha(\upsilon)$=absorption co-efficient]

$n_{H=}\ 0.1, x=0.1, \upsilon_0=2.46607\times10^{15}$,
$\Gamma=6.265\times10^{8}$, $f=0.4164$, $g_0=2$, $Z=2.00$

A) $\upsilon=c/\lambda$ here $\upsilon_0=2.46607\times10^{15}$

$\lambda=1/\upsilon_0=1/2.46607\times10^{15}=0.4\times10^{-15}$

$\upsilon=(3\times10^{10})/0.4\times10^{-15}=7.5\times10^{25}$

$\alpha(\upsilon)=(e^2\times f\times n_H\times(1-x)\times g_0\times\Gamma)/((4\times\pi\times m_e\times c\times z)((\upsilon-\upsilon_0)^2+(\Gamma/4\pi)^2))$

After putting all values we get $\alpha(\upsilon)=0.028\times10^{-46}$

Now spectrum

$I(\lambda)=\exp[-0.028\times10^{-46}\times10^{14}]=\exp[-0.028\times10^{-32}]$
[here $d=10^{14}$]

B) For $d=10^{18}$ similarly

$I(\lambda)=\exp[-0.028\times10^{-46}\times10^{18}]=\exp[-0.028\times10^{-28}]$

C) For $d=10^{21}$ similarly

$I(\lambda)=\exp[-0.028\times10^{-46}\times10^{21}]=\exp[-0.028\times10^{-25}]$

2)

A) The intensity (I) of a given wavelength (λ) is given by the equation

$I(\lambda)=\exp[-\alpha(\upsilon)\times d]$ [here d=thickness of slab, $\alpha(\upsilon)$=absorption co-efficient]

$n_{H=}$ 0.1, x=0.1, $\upsilon_0=2.46632\times10^{15}$,
$\Gamma=6.265\times10^8$, f=0.4164, $g_0=2$, Z=2.00

$\upsilon=c/\lambda$ here $\upsilon_0=2.46632\times10^{15}$

$\lambda=1/\upsilon_0=1/2.46632\times10^{15}=0.405\times10^{-15}$

$\upsilon=(3\times10^{10})/0.405\times10^{-15}=7.40\times10^{25}$

$$\alpha(\upsilon)=(e^2\times f\times n_H\times(1-x)\times g_0\times\Gamma)/((4\times\pi\times m_e\times c\times z)((\upsilon-\upsilon_0)^2+(\Gamma/4\pi)^2))$$

After putting all values we get $\alpha(\upsilon)=0.0288\times10^{-46}$

Now spectrum

$I(\lambda)=\exp[-0.0288\times10^{-46}\times10^{14}]=\exp[-0.0288\times10^{-32}]$
[here d= 10^{14}]

B) For d=10^{18} similarly

$I(\lambda)=\exp[-0.0288\times10^{-46}\times10^{18}]=\exp[-0.0288\times10^{-28}]$

C) For d=10^{21} similarly

$I(\lambda)=\exp[-0.0288\times10^{-46}\times10^{21}]=\exp[-0.0288\times10^{-25}]$

3)

Let's say 6 spectras

A=exp[- 0.028×10^{-32}]
B=exp[- 0.028×10^{-28}]
C=exp[- 0.028×10^{-25}]

D=exp[- 0.0288×10^{-32}]
E=exp[- 0.0288×10^{-28}]
F=exp[- 0.0288×10^{-25}]

INTENSITY:

Intensity of A will be slightly greater than D,Intensity of B will be slightly greater than E,Intensity of C will be slightly greater than F

Overall order **A>D>B>E>C>F**

Frequency:

Frequency of A will be slightly greater than D, Frequency of B will be slightly greater than E,Frequency of C will be slightly greater than F

Overall order **A>D>B>E>C>F**

Wavelength :

Wavelength of D will be slightly greater than A, Wavelength of E will be slightly greater than B,Wavelength of F will be slightly greater than C

Overall order **F>C>E>B>D>A**