Possible Test Question

NOTE: I might add one more question to this list. Further, I might adjust, slightly, the wording on some questions to clear up any ambiguities.

==========

Derive Boltzman's Relation ($n=n_o exp[eV/kT]$) from the fluid equation of motion.

==========

Choose the BEST answer(only one) for the following questions from the options given (2.5 points each)

1. What is a plasma ?

a) Mixture of atoms and molecules in gaseous state.
b) Soup of electrons and ions.
c) Ionized gaseous state.
d) Soup of interacting charged particles with no neutrals.
e) other name for Colloids.
f) A gas with equal number of electrons and ions with no uncharged particles.

2. What is the frequency usually used for plasma applications and why?

a) 2.54 GHz , Cheap source.
b) 13.56 GHz , We get good property plasmas at this frequency.
c) 13.56 MHz , Federal government mandated frequency.
d) 13.56 GHz , Federal government mandated frequency.
e) 2.54 MHz , We get good property plasmas at this frequency.
f) Any frequency is fine and it all depends on the application.

3. Is plasma frequency a good parameter for measurement (Yes/No), Why?

a) Yes, We can measure it easily.
b) No, It's hard to measure the plasma frequency.
c) Yes, Plasma frequency is constant and its an attribute of plasma.
d) No, Other waves too can exist in the same frequency.
e) Yes, Plasma frequency is same as the electron frequency in plasma.
f) No, Plasma frequency changes with density.

4. What is a Debye length ?

a) It is the 1/e distance for reducing the momentum.
b) An effective length over which a plasma will shield a magnetic field.
c) It is the length an electron can travel without collision.
d) Length over which sheath exist in a plasma.
e) It is the 1/e distance for reducing a potential.
f) Debye length is E-15 meters.

5. What is the significance of Electric field in Ambipolar Diffusion ?

a) Pushes the electrons out and serves to retain the ions.
b) retains the electrons and ions in the plasma.
c) stabilizes the plasma by attracting ions and electrons.
d) pushes the uncharged particles towards the chamber walls.
e) pushes the ions and electrons out and maintains quasineutrality in the plasma.
f) pushes the ions out and serves to retain the electrons.

6. What happens to sheath potential as we go into the sheath (from plasma) ?

a) Potential decreases.
b) Potential increases.
c) Potential remains a constant.
d) Potential changes as a sinusoidal function.
e) Potential increases exponentially.
f) Potential increases linearly.

7. Pick the odd one out

a) Capacitively coupled plasmas.
b) Transformer coupled plasmas.
c) Resistively coupled plasmas.
d) Inductively coupled plasmas.

==========

a. Describe how a Diffusion Pump works.
b. Why would you not want to use a diffusion pump at atmospheric

pressure?

c. Why is it a good practice to use multistages of vacuum pumps (Mechanical Pump to Blower to Diffusion Pump) in series to achieve the desired pressure?

==========

What is the significance of the presheath region?
Assuming that the electron and ion densities are equal throughout the presheath and that the electron densities follow Boltzmann's equation, compare the electron and ion densities at the plasma – presheath interface and the presheath – sheath interface. What is the ion velocity at the plasma – presheath interface and the presheath – sheath interface?

==========

* Derive (a) Boltzmann's relation, $n = n_o \exp\left(\frac{e\phi}{kT_e}\right)$, (b) expression for the Debye length, $\lambda_{Debye} = \left(\frac{\varepsilon_0 kT_e}{e^2 n_o}\right)^{1/2}$, and (c) explain the physical meaning of the Debye length.

==========

Plot both the potential and the electric field of a plasma. Label the sheath and main plasma and explain why the potential and e field act the way they do.

==========

A distant galaxy contains a cloud of protons and antiprotons, each with a density of $n = 10^6 m^{-3}$ and temperature 100K. What is the Debye length? Compare this to the characteristic conditions in an MHD generator where T=2500K and $n = 10^{20} m^{-3}$.
==========

1: A high pressure, steady state argon plasma discharge confined between two parallel plates located at x=±L/2, is created in argon gas density n_g by uniformly illuminating the region within the plates with UV radiation. This radiation creates a uniform number of electron-ion pairs per unit volume per unit time (m-3.s-1) everywhere within the plates. Electrons and ions are lost to the walls by ambipolar diffusion. Assuming the electron and ion temperatures are uniform and constant with time, with Te>>Ti, and choosing

boundary conditions such that n(x)□0 at the walls, find the plasma density n(x)and peak density n_0 within the plates.

==========

Exam questions

Derive the Boltzmann's relation $n_e = n_0 \exp(\frac{e\square}{kT_e})$ from simplified momentum conservation equation $0 = \square\square \bullet P + qnE$

==========

Explain why in DC capacitive discharges the breakdown voltage is higher than the voltage which can sustain the plasma.

==========