Marks Scored:

KATHMANDU UNIVERSITY
End Semester Examination [C]
June, 2018

Level : B. Sc.
Year : IV

Course : PHYS 402
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date : JUN 17 2018

SECTION "A"
[20 Q. × 1 = 20 marks]

Choose and ***tick*** the most appropriate answer.

1. Resonance potential means
   a) energy required to raise an atom to its highest excited state
   b) energy required to raise an atom to its first excited state
   c) energy required to ionize the atom
   d) sum of excitation potential and ionization potential

2. In a gas discharge with $n_e = 10^{12}\ m^{-3}$ and KTe= 0.1, the Debye length (λ_D) will be
   a) 2.3×10^{-3} m b) 2×10^{-5} m c) 2.3×10^{-3} mm d) 10^{-4} m

3. Consider a gas in which only 25% of the atoms are ionized. If P be the pressure of the gas before ionization, the total pressure P_i of the partially ionized gas is expressed as
   a) $P_i = 1.25\ P$ b) $P_i = 1.5\ P$ c) $P_i = 0.25\ P$ d) $P_i = P$

4. Consider a spherical plasma with radius 1cm and electron density $n_e=10^{11}cm^{-3}$. The electric field that would be generated if n_i exceeds n_e by 1% is
   a) 6 000 V/m b) 3000 V/m c) 60,000 V/m d) 3 kV/cm

5. A light of wavelength 500 Å falls on an atomic hydrogen (with ionization potential of 13.58 eV) resulting photo ionization. The maximum velocity of the ejected electron will be
   a) 3×10^6 cm/s b) 2×10^6 m/s c) 2×10^5 m/s d) 10^7 m/s

6. The breakdown voltage of a gas in a DC discharge depends
   a) only on pressure *(p)* of the gas
   b) depends only on the inter-electrode distance *(d)*
   c) depends on the ratio of *p* and *d*
   d) depends on the product of *p* and *d*

7. The electron density in a plasma is $10^{18}\ m^{-3}$. The associated plasma frequency must be
   a) 90 MHz b) 9GHz c) 0.9 GHz d) 9kHz

8. The degree of ionization α is defined using densities n_A and n_{A+} for A and A+ as
   a) $\alpha = \frac{n_{A+}}{n_A + n_{A+}}$ b) $\alpha = \frac{n_{A+}}{n_A}$ c) $\alpha = \frac{n_A}{n_A + n_{A+}}$ d) $\alpha = \frac{n_A + n_{A+}}{n_A}$

9. Which one of the following statement is true?
   a) The energy transferred by elastic collisions between electrons and gas molecules is extremely small
   b) The energy transferred by elastic collisions between electrons and gas molecules is extremely large
   c) The energy transferred by elastic collisions between heavy ions and gas molecules is extremely small
   d) The energy transferred by elastic collisions between electrons and gas molecules is independent of their masses

10. The condition of electrical breakdown of a gas is expressed as
   a) $\alpha(e^{\gamma d}-1)=1$ b) $\gamma=\frac{1}{e^{\alpha d}}$ c) $\gamma(e^{\alpha d}-1)=1$ d) $\gamma=e^{\alpha d}-1$

11. Which one of the following equation does NOT represent the criterion for plasma?
   a) $\omega\tau>1$ b) $\lambda_D<<L$ c) $\omega\tau<1$ d) $N_D>>>1$

12. In a plasma, if $B \simeq 0.32\ T$ and $B \simeq 10^{18}\ m^{-3}$ the cyclotron frequency is
   [a] much smaller than the electron plasma frequency
   [b] much larger than the electron plasma frequency
   [c] double the value of electron plasma frequency
   [d] approximately equal to the electron plasma frequency

13. A solar wind proton having a velocity of 300 km/s enters normally to earth's magnetic field of 5×10^{-9} T. The Larmor's radius for the proton is equal to
   a) 7.5 km b) 626 km c) 750m d) 300 km

14. Which one of the following statement is true regarding the group velocity (v_g), phase velocity (v_p) and velocity of light (c) ?
   a) v_g is always less than c
   b) v_p is always less than c
   c) v_g can be more than c in some cases
   d) v_p is always equal to v_g

15. The number of quanta required for the ionization of a gas having ionization potential V_i by "multiphoton absorption" process is equal to
   a) $V_i/h\nu$ b) $V_i\, h\nu$ c) $h\nu/ V_i$ d) $3\ V_i$

16. In a gas, the most probable velocity (v_m), linearly averaged velocity (v_{av}) and root mean square velocity (v_{rms}) are related as
   a) $v_m : v_{av} : v_{rms} = 1:2:3$
   b) $v_m : v_{av} : v_{rms} = 1:1.128:1.224$
   c) $v_m : v_{av} : v_{rms} = 1:\sqrt{2}:1$
   d) $v_m : v_{av} : v_{rms} = 1:1.224:1.128$

17. The diffusion of electrons in a plasma is
a) directly proportional to collision frequency in absence of magnetic field
b) inversely proportional to collision frequency in absence of magnetic field
c) inversely proportional to collision frequency in presence of magnetic field
d) always directly proportional to collision frequency

18. Ionization of a gas becomes more efficient if the frequency of applied power supply is increased because
a) it enhances the diffusion of charged particles to chamber walls
b) increases the process of secondary electron emission
c) decreases the ionization potential of the gas
d) loss of charged particles is reduced due to trapping effect

19. Which one of the following equation represents the dispersion relation for ion acoustic wave in plasma?

a) $\frac{\omega}{k}=\left(\frac{KT_e+\gamma_i KT_i}{M}\right)^{\frac{1}{2}}$

b) $\frac{\omega}{k}=\left(\frac{\gamma_i KT_i}{M}\right)^{\frac{1}{2}}$

c) $\frac{\omega}{k}=\left(\frac{KT_e+KT_i}{M}\right)^{\frac{1}{2}}$

d) $\frac{\omega}{k}=\left(\frac{\gamma_e KT_e+KT_i}{M}\right)^{\frac{1}{2}}$

20. At the floating potential in the single Langmuir probe diagnostics of plasma, the ion current to the probe is
a) greater than the electron current
b) smaller than the electron current
c) equal to the electron current
d) greater than or equal to the electron current

KATHMANDU UNIVERSITY
End Semester Examination [C]
June, 2018

JUN 17 2018

Level : B. Sc.
Year : IV
Time : 2 hrs.30 mins.

Course : PHYS 402
Semester : I
F.M. : 55

SECTION "B"
[5 Q. × 4 = 20 marks]

1. Calculate the Debye length (λ_D) and the number of charged particles in the Debye sphere (N_D) for the following plasmas
   a) a typical fusion reactor with $n_e = 10^{21}\ m^{-3}$, $KT_e = 10$ KeV
   b) Earth's ionosphere with $n_e = 10^{12}\ m^{-3}$, $KT_e = 0.1$ eV

2. Give a qualitative explanation of the minimum in Paschen curve with necessary theory.

3. What is meant by mobility of charged particle in a plasma? Deduce the expression for the mobility of electron in the presence of uniform electric field E.

   OR

   What is meant by Larmor frequency and Larmor's radius? Compute Larmor's radius r_L for a 10 KeV electron in the earth's magnetic field of 5×10^{-5}T when $V_{\parallel}$ is negligible.

4. Outline the basic differences between hot plasma and low temperature plasma with suitable examples. Explain why low temperature non-thermal plasmas are typically suitable for material processing.

   OR

   Write a short note on thermal excitation and ionization of a gas.

5. Describe the method of diagnostics of plasma by microwave signal.

SECTION "C"
[5 Q × 7 = 35 Marks]

6. What is the maximum energy transfer in an elastic collision between an electron and atom? Deduce the expression for the ratio of energy transfer E_t to initial kinetic energy E_i of the electron.

7. With necessary theory, derive the expression for the coefficient of diffusion of electrons in a plasma in presence of a magnetic field B. Also explain the term ambipolar diffusion in plasma.

8. Deduce the dispersion relation for ion-acoustic wave in plasma and discuss the validity of plasma approximation using the relation.

OR

Describe the mechanism of plasma oscillation. Show that plasma frequency is given by

$$\omega_p = \left(\frac{n_0 e^2}{\varepsilon_0 m} \right)^{\frac{1}{2}}$$

9. Describe the mechanism of energy loss from a plasma in the form of Bremsstrahlung radiation. Explain how it differs from the cyclotron radiation.

OR

Describe the method of plasma diagnostics using single Langmuir probe. Describe the theory used to determine electron temperature (T_e) and electron density (n_e) by this method

10. Briefly describe the Townsend theory of ionization of a gas. A gap of 0.005m between parallel electrodes in a gas breaks down at an applied potential of 150 volts. The electron multiplication coefficient (α) is 460 m^{-1}. How many secondary electrons are produced by each positive ion impinging on the cathode?