

KATHMANDU UNIVERSITY
End Semester Examination
March/April, 2017

Marks Scored:

Level : B. Sc.
Year : IV

Course : PHYS 402
Semester : I

Exam Roll No. : _____ Time : 30 mins.

F. M. : 20

Registration No. : _____

Date : **MAR 27 2017**

SECTION "A"

[20 Q. × 1 = 20 marks]

Choose and tick the most appropriate answer.

1. For collision between electrons and gas molecules of Nitrogen, the energy transfer coefficient is nearly equal to
[a] 1% [b] 0.01% [c] 10% [d] 100%
2. The temperature at which the excitation of sodium atom emitting radiation of wavelength 589.3 nm is equal to
[a] 25000 K [b] 65000 K [c] 2500° K [d] 2500°C
3. The number of electrons produced by a single electron while traversing a distance 'd' between the electrodes is $e^{\alpha d}$. Then the number of positive ions produced will be equal to
[a] $e^{\alpha d}$ [b] $e^{\alpha d} - 1$ [c] $e^{\alpha d} + 1$ [d] $e^{(\alpha d + 1)}$
4. Debye length (λ_D) in a plasma is
[a] directly proportional to the square root of the temperature (T)
[b] directly proportional to the square root of the electron number density (n_e)
[c] directly proportional to the temperature (T)
[d] inversely proportional to the square root of the temperature (T)
5. In a gas discharge, where typical values for T and n_e are around 10^4 K and 10^{16} m^{-3} , respectively, Debye length (λ_D) will be
[a] 10^{-6} m [b] 10^{-3} m [c] 10^{-3} cm [d] 10^{-4} m
6. If D_+ , μ_+ and D_e , μ_e represent the diffusion coefficient and mobilities of positive ions and electrons respectively in a plasma, then the ambipolar diffusion coefficient D_a is given by
[a] $D_a = \frac{D_+\mu_+ + D_e\mu_e}{\mu_e + \mu_+}$ [b] $D_a = \frac{D_+\mu_e + D_e\mu_+}{\mu_e + \mu_+}$
[c] $D_a = \frac{D_+\mu_e - D_e\mu_+}{\mu_e + \mu_+}$ [d] $D_a = \frac{D_e\mu_+ + D_+\mu_e}{D_e + D_+}$
7. A doubly charged helium nucleus of energy 3.5 MeV moving in a magnetic field of 8 T has a maximum Larmor radius of
[a] 3.4 m [b] 20 cm [c] 3.4 cm [d] 2 mm
8. A charged particle of specific charge q/M is accelerated through a potential difference of V volts. Its speed will be equal to
[a] $\frac{q^2 M}{V}$ [b] $\sqrt{\frac{q^2 M}{V}}$ [c] $\sqrt{\frac{2 q V}{M}}$ [d] $\sqrt{\frac{q^2 V}{M}}$

9. An electron with velocity 'v' enters a region of uniform magnetic field which is perpendicular to v. The path followed by the electron will be
 [a] helical [b] parabolic [c] circular [d] elliptical
10. Cyclotron radiation in plasma usually falls in the
 [a] visible region [b] UV-region [c] X-ray region [d] RF region
11. Which one of the following statement is true regarding the radiation from plasma
 [a] loss of energy by cyclotron radiation is proportional to T_e^2
 [b] loss of energy by cyclotron radiation is proportional to T_e
 [c] loss of energy by cyclotron radiation is proportional to $\sqrt{T_e}$
 [d] loss of energy by Bremsstrahlung radiation is proportional to T_e
12. Radiation produced due to the deceleration of a charged particle refers to
 [a] Recombination radiation [b] Bremsstrahlung
 [c] Blackbody radiation [d] betatron radiation
13. Ion acoustic waves are basically
 [a] constant frequency waves but turn into constant velocity wave at short wavelength.
 [b] constant frequency waves but turn into constant velocity wave at long wavelength.
 [c] constant velocity waves but turn into constant frequency wave at short wavelength.
 [d] constant velocity waves but turn into constant frequency wave at long wavelength.
14. The frequency of electron plasma oscillation in a plasma is found to be 90 GHz measured by microwave diagnostic method. The density of electron in the plasma must be
 [a] 10^{18} m^{-3} [b] 10^{18} cm^{-3} [c] 10^{20} m^{-3} [d] 10^9 m^{-3}
15. A radiation of tunable frequency ω is incident on a plasma of electron plasma frequency ω_p . Which one of the following statements is true?
 [a] If $\omega_p < \omega$ then the radiation will pass through the plasma
 [b] If $\omega_p > \omega$ then the radiation will pass through the plasma
 [c] If $\omega_p < \omega$ then the refractive index of the medium becomes imaginary
 [d] If $\omega_p = \omega$ then the refractive index of the medium becomes imaginary
16. A hydrogen atom is excited from the ground state ($n=1$) where its energy level is $-21.8 \times 10^{-19} \text{ J}$ to the higher level ($n=2$) of energy $-5.4 \times 10^{-19} \text{ J}$. When the atom falls back to ground state, the wavelength of the emitted radiation will be
 [a] 1.2 \AA [b] $1.2 \times 10^{-7} \text{ m}$ [c] $2.4 \times 10^{-7} \text{ cm}$ [d] $2.4 \times 10^{-6} \text{ cm}$
17. Which one of the following is NOT the source of error in the plasma diagnostics by electrical probe method?
 [a] photo emission may occur from the surface of the probe
 [b] secondary electron may be emitted from the probe surface due to impact of incident electrons
 [c] if the electron velocity distribution is non-Maxwellian the theory of probe becomes invalid
 [d] if the pressure is low the probe theory may not be valid

18. At the floating potential in the single Langmuir probe measurement of plasma 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
19. Which one of the following represents the criterion for a plasma?
[a] $\lambda_D \ll L$ [b] $\lambda_D \gg L$ [c] $\omega\tau < 1$ [d] $N_D \ll 1$
20. If we regard the molecules as the rigid sphere of radius "r", the effective collision cross section will be equal to
[a] $2r$ [b] $2r^2$ [c] πr^2 [d] $4\pi r^2$

KATHMANDU UNIVERSITY
End Semester Examination
March/April, 2017

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. Explain the physical meaning of Debye length (λ_D) in a plasma. Calculate λ_D for the following plasmas and verify that these plasmas satisfy the condition $N_D \gg 1$.

Plasma	n_e (m^{-3})	T_e (K)
Interstellar gas	10^3	10^2
Gas discharge	10^{20}	10^4

2. Write a short note on ionization of a gas by the method of exploding wire.
3. An electron with a velocity v enters a region of uniform magnetic field which is perpendicular to v . Describe the motion of the electron in this case. How will the motion be modified if the field is not perpendicular to v ?

OR

Describe the motion of charged particles in the presence of electric and magnetic field in a plasma and also draw the trajectories of the motion of electrons and ions.

4. Write a short note on the use of optical emission spectroscopy for the diagnostics of plasma.

OR

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

5. What is meant by quasi-neutrality in plasma? Consider a spherical plasma with radius 1cm and electron density $n_e = 10^{11} \text{ cm}^{-3}$. Calculate the electric field that would be generated if n_i exceeds n_e by 1%.

SECTION "C"

[5 Q × 7 = 35 marks]

6. Explain the Townsend theory of ionization by collision and deduce the condition of gaseous breakdown. Describe the physical meaning of Paschen minimum.

OR

What is the maximum energy transfer in an elastic collision between an electron and atom (ion)? 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 . Outline the important difference in the diffusion process in absence and presence of magnetic field.
8. Derive dispersion relation for electron plasma waves (Bohm-Gross waves) and ion-acoustic wave in plasma. Describe the important differences between these two types of waves.

OR

Describe the mechanism of oscillation in a plasma and hence deduce the expression for plasma frequency. Compute the plasma frequency in the case of following plasmas

- (a) controlled thermonuclear plasma with a density of about $10^{22} \text{ (m}^{-3}\text{)}$
- (b) laboratory plasma with density of about $10^{18} \text{ (m}^{-3}\text{)}$

9. Describe the theory of Langmuir single probe and explain the current-voltage characteristics obtained by using the probe in a typical plasma. Explain how it is used to determine the electron temperature (T_e) and density (n_e) in a plasma.
10. Describe the mechanism of energy loss from a plasma in the form of cyclotron radiation. Explain how it differs from the Bremsstrahlung radiation.