Mark scored:

KATHMANDU UNIVERSITY
End Semester Examination
July, 2019

Level : B.Sc.
Year : IV
Course : PHYS 412
Semester : II

Exam Roll No. :
Time: 30 mins.
F. M. : 20

Registration No.:
Date :

SECTION "A"
[20Q. × 1 = 20 marks]

Choose and tick the most appropriate answer.

1. Dissociative ionization process is represented by
   [a] $A + B^* \rightarrow AB^+ + e$
   [b] $A^* + B \rightarrow A + B^+ + e$
   [c] $AB + e \rightarrow A + B^+ + 2e$
   [d] $AB + e \rightarrow A + B + e$

2. The wavelength of radiation required for the ionization of O_2 having ionization potential of 12.2 V is equal to
   [a] 910 Å
   [b] 1015 Å
   [c] 1015 nm
   [d] 850 Å

3. The degree of ionization α is defined as (n_A and n_{A+} are the densities of particles A and A+ respectively)
   [a] $\alpha = \frac{n_{A+}}{n_{A+} + n_A}$
   [b] $\alpha = \frac{n_A}{n_{A+} + n_A}$
   [c] $\alpha = \frac{n_{A+}}{n_A}$
   [d] $\alpha = \frac{n_{A+}}{n_A - n_{A+}}$

4. An ionization process caused by the collision between metastable particles at excited states and neutral particles which have a lower ionization energy than the excitation energy of the metastable particles is known as
   [a] Thomson ionization
   [b] Penning ionization
   [c] Townsend ionization
   [d] radiative ionization

5. The mean free path of a gas molecule is inversely proportional to
   [a] square of the diameter of the molecule
   [b] square root of the diameter of the molecule
   [c] molecular diameter
   [d] fourth power of the molecular diameter

6. In the earth's atmosphere the ionization of the air is due to solar radiation of wavelength in the range of
   [a] 350Å-1350 Å
   [b] 100Å-350 Å
   [c] 1000Å-1350 Å
   [d] 350 nm-1350 nm

7. The increase in plasma density in magnetically confined region of a magnetron sputtering system
[a] causes a decrease in discharge impedance
[b] causes an increase in discharge impedance
[c] has no influence on the impedance
[d] may cause an increase or decrease of the impedance depending upon the target material

8. The sputtering yield
[a] increases with the decrease in mass of the bombarding ion
[b] decreases with the decrease in mass of the bombarding ion
[c] decreases with the increase in energy of the bombarding ion
[d] does not depend on the mass of the bombarding ion

9. Metals are normally deposited using .....process.
[a] Spin-on [b] Thermal oxidation
[c] Physical vapor deposition [d] Chemical vapor deposition

10. The relation between the etching rate E of a target material (having atomic weight M and density ρ) and the ion current density J_+ at its surface is given by
[a] $E = 62.3 J_+ \rho / M$ [b] $E = 62.3 J_+ M \rho$
[c] $E = 62.3 J_+ M / \rho$ [d] $E = 62.3 J_+ M^2 / \rho$

11. In the case of the resistance-heated evaporation source, evaporation materials are limited to those with melting points below about
[a] 1300° C. [b] 700° C. [c] 1900° C. [d] 3000° C.

12. Which of the following statements is NOT CORRECT?
[a] Infrared photons are required to photodissociate an oxygen (O_2) molecule.
[b] Photoionization of common atmospheric gases requires ultraviolet light
[c] Photodissociation of oxygen molecules occur naturally in the upper atmosphere
[d] Most of the high energy photons from the sun are filtered by upper atmosphere and do not reach the surface of the earth

13. If the maximum electron density for F-layer in ionosphere is 4 x 10^6 electrons/cm^3, then the critical frequency of EM wave for F-layer will be
[a] 4 MHz [b] 9 MHz [c] 25 MHz [d] 18 MHz

14. The plasma used for deposition of thin films via PECVD usually have electron energy and plasma density in the range of .....respectively.
[a] 0.5-10 eV and 10^9-10^{12} cm^3. [b] 10-100 eV and 10^9-10^{12} cm^3.
[c] 10-100 eV and 10^9-10^{12} m^3. [d] 0.5-10 eV and 10^{12}-10^{15} cm^3.

15. In a MHD generator, helium gas is seeded with Cesium and then passed into duct in order to
[a] induce ionization
[b] increase electrical conductivity of gas at high temperature
[c] to lower the operating temperature of MHD
[d] to increase the magnetic field effect

16. Thermal non-equilibrium between electrons and ions in low temperature plasma used in surface treatment of materials
[a] arises due to low degree of ionization
[b] is due to low frequency of collision at reduced pressure
[c] becomes prominent at high pressure
[d] arises due to shielding of ions in the plasma

17. The potential energy associated with two charges separated by a distance *of* 1.0×10^{-14} m for two deuterons is equal to
[a] 0.28 MeV [b] 1.4 MeV [c] 0.7 KeV [d] 0.14 MeV

18. Lawson's criterion states that a net energy output is possible for values of $n\tau$ that meet the following conditions:
[a] $n\tau \geq 10^{14}$ s/cm^3 (D–T) and $n\tau \geq 10^{16}$ s/cm^3 (D–D)
[b] $n\tau \geq 10^{14}$ s/cm^3 (D–D) and $n\tau \geq 10^{16}$ s/cm^3 (D–T)
[c] $n\tau \geq 10^{14}$ s/cm^3 for both (D–T) and (D–D)
[d] $n\tau \geq 10^{16}$ s/cm^3 for both (D–T) and (D–D)

19. In nuclear fusion, it is necessary to accelerate positively charged nuclei to high kinetic energies to
[a] overcome electrical repulsive forces
[b] result in high amount of energy in short period of time
[c] get the isobars and isotopes
[d] get a sustainable reaction

20. The protons are kept at a separation of 10nm. Let Fn and Fe the nuclear force and the electromagnetic force between them, then
[a] $F_e = F_n$ [b] $F_e >> F_n$
[c] $F_e << F_n$ [d] F_e and F_n differ only slightly

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SECTION "B"
[5Q. × 4 = 20 marks]

1. Describe the main differences between a hot plasma and a cold plasma. Explain why cold plasmas are typically suitable for material processing.

2. Define the terms mean free path, collision frequency and collision cross-section. What is effective cross-section of collision between particles in plasma? How does the collision in plasma differ from the collision between molecules in a neutral gas?

3. Describe the principle mechanism of excitation and ionization of a gas. Explain the Penning ionization process.

OR

Describe the process of photo-excitation and photo-ionization of a gas. Explain the term photo-ionization efficiency.

4. Describe ion plating method for the deposition of thin films with the help of a well labeled diagram.

5. What is the principle of a MHD power generator? Calculate the open circuit voltage and the maximum power output of MHD engine having the following specifications: Plate area= 0.5 m^2, distance between plates = 0.5 m, flux density= 2Wb/m^2, average gas velocity = 1000 m/s, conductivity of the gas = 10 mho/m

SECTION "C"
[5Q. × 7 = 35 marks]

6. Explain the condition for the reflection of electromagnetic waves by ionospheric plasma. What do you mean by maximum useable frequency for the propagation of radio waves? Describe it assuming the curved surface of the earth.

7. What is meant by sputtering of a material? Explain the factors on which the sputtering yield depends? Briefly describe RF sputtering system used for the deposition of thin films.

8. PECVD system with well labeled diagram and explain the merits of this technique over the conventional methods of film deposition.

OR

Write short notes on (i) Plasma stream transport
(ii) Plasma surface modification of polymers

9. Explain nuclear fusion reaction with a suitable example. What factor's make a fusion reaction difficult to achieve? Name the two approaches currently being used to create fusion energy. Explain why fusion is considered as the ultimate solution for future energy crisis of the world?

10. Explain the terms mass defect and binding energy. The fusion reaction is proposed to be

$$2_1H^2 \rightarrow {}_2He^4 + Q$$

used for the production of industrial power. Assuming the efficiency of the process to be 30%, find how many kg of deuterium will be consumed in a year for an output of 50 MW. (Given Mass of ${}_1H^2$ = 2.014102 a.m.u. and Mass of ${}_2He^4$= 4.002604 a.m.u.)