NOV 16 2018

KATHMANDU UNIVERSITY

End Semester Examination [C]
November, 2018

Marks scored:

Level : B.Sc.
Year : IV

Course : PHYS 412
Semester: II

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

Registration No.: Date :

SECTION "A"

[20 Q.×1=20 marks]

Choose and tick the most appropriate answer.

1. The energy transferred by elastic collisions between electrons and gas molecules is
   [a] half of initial kinetic energy of the electron
   [b] extremely large
   [c] extremely small
   [d] zero

2. If n is the number density of the target particles, u is the velocity of the incoming particle and σ be the collision cross section, then the mean free time τ is expressed as
   [a] $\tau = \frac{\sigma}{nu}$ [b] $\tau = \frac{1}{nu\sigma}$ [c] $\tau = nu\sigma$ [d] $\tau = \frac{nu}{\sigma}$

3. In the Maxwell-Boltzmann velocity distribution, the most probable speed is
   [a] greater than the average speed
   [b] equal to the square root of 3kT/m
   [c] less than the average speed
   [d] equal to root mean square (rms) speed

4. The equation $e^- + A^+ \rightarrow A + hv$ represents
   [a] electron attachment [b] radiative recombination
   [c] electron impact ionization [d] electron impact excitation

5. Photo-ionization cross section is
   [a] about an order of magnitude smaller than the ionization cross section caused by electron collisions
   [b] about an order of magnitude larger than the ionization cross section caused by electron collisions
   [c] several order of magnitude larger than the ionization cross section caused by electron collisions
   [d] equal to the ionization cross section caused by electron collisions

6. The energy of ground state, first excited state and the second excited state are respectively −13.6, −3.4 eV and −1.5 eV. The energy required to raise the electron from ground state to the second excited state is
   [a] 12.1 eV [b] 10.2 eV [c] 1.89 eV [d] 18. 5 eV

7. A radiation of frequency ν falls on a gas of ionization potential V_i. The condition for photo-ionization of the gas is

[a] $h\nu = \frac{eVi}{c}$ [b] $h\upsilon \geq eV_i$ [c] $h\upsilon \leq eV_i$ [d] $h\upsilon \geq \sqrt{eV_i}$

8. Consider the following statements
(A) DC sputter deposition is suitable for insulator deposition
(B) sputtering yield (S) values are typically in the range of 0.01 and 4.
[a] A is true but B is false
[b] A is false but B is true
[c] both A and B are true
[d] both A and B are false

9. DC sputter deposition requires an ion current of more than..... in order to achieve reasonable deposition rates.
[a] 1 A/cm^2 [b] 1 mA/m^2 [c] 1 μA/cm^2 [d] 1 mA/cm^2

10. Energy of sputtered atoms incident upon the substrate
[a] increases the adhesion of film
[b] decreases the adhesion
[c] has no effect on film adhesion
[d] may increase or decrease the film adhesion depending upon material of the substrate

11. Thin films of TiC are used
[a] for wear-resistant coatings
[b] as semiconducting materials
[c] in solar cells
[d] as phosphorescent materials

12. In an ion plating system with a resistance-heated evaporation source, evaporation materials are limited to those with melting points below about
[a] 2000 ° C [b] 1300° C. [c] 900° C [d] 3000° C

13. The maximum density of free electrons in the ionospheric layer at critical frequency of 1.3 MHz should be equal to
[a] 2.1×10^{10} m^{-3}
[b] 2.1×10^{12} m^{-3}
[c] 2.1×10^{11} m^{-3}
[d] 2.1×10^{10} cm^{-3}

14. 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

15. Low temperature plasma is typically suitable for surface modification of polymers
[a] because it has low electron density
[b] because of thermal non-equilibrium between electrons and neutrals
[c] because of thermal equilibrium between electrons and neutrals
[d] because of thermal equilibrium between electrons and ions

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16. In a MHD power generator, the power produced per unit volume of the fuel gas depends upon
[a] square of the conductivity [b] inverse square of the conductivity
[c] square of the gas velocity [d] cube of the gas velocity

17. In the case of deposition/etching process by chemical transport in plasma
[a] the deposition of the film takes place when $T_{subst} > T_{charge}$
[b] the deposition of the film takes place when $T_{subst} < T_{charge}$
[c] the deposition of the film takes place when $T_{subst} = T_{charge}$
[d] the etching takes place when $T_{subst} > T_{charge}$

18. In a spontaneous nuclear reaction
[a] the total mass of the products = total mass of the reactants
[b] total mass of the products > total mass of the reactants
[c] total mass of the products < total mass of the reactants
[d] nothing can be said for sure

19. Mass of neutron is m_n= 1.008665 a.m.u, mass of proton is m_p= 1.007825 a.m.u and mass of helium nucleus is M_{He}= 4.002870 a.m.u. The binding energy for an α-particle should be
[a] 14 MeV [b] 931 MeV [c] 28 MeV [d] 17.6 MeV

20. In thermonuclear fusion reaction, the Lawson criteria is expressed as
[a] $n\tau \geq 10^{14}$ for D-D reaction [b] $n\tau > 10^{14}$ for D-T reaction
[c] $n\tau \geq 10^{16}$ for D-T reaction [d] $n\tau \leq 10^{16}$ for D-T reaction

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SECTION "B"

[5 Q.×4=20 marks]

1. What is meant by photo ionization? Describe the terms photo ionization cross section and efficiency of photo ionization.

OR

Describe the main recombination processes in a plasma. Explain the process dielectronic recombination.

2. Write a short note on the characteristic features of non-thermal plasma. Explain why the thermal non-equilibrium becomes prominent in low pressure regime.

3. Describe chemical transport in plasma and also explain the relation among the system parameters.

4. Explain the terms mass defect and binding energy. Calculate the energy released in the following fusion reaction.

$${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$$

Given $${}^{2}_{1}H = 2.014102\,a.u.$$ $${}^{1}_{0}n = 1.008665 a.u.$$
$${}^{3}_{1}He = 3.016049\,a.u.$$ $${}^{4}_{2}He = 4.002604\,a.u.$$

5. Write a short note on formation of different layers of earth's ionosphere.

SECTION "C"

[5 Q.×7=35 marks]

6. Explain adsorption and trapping of gas molecules on a solid surface. What is meant by sticking probability? Describe the variation of sticking probability as a function of the energy of incoming particle to the surface of the solid.

7. Outline the main differences between chemical vapor deposition (CVD) and plasma enhanced chemical vapor deposition (PECVD). Describe a typical PECVD system used for the deposition of SiO_2 thin film.

OR

What is meant by sputtering of a material? Describe a magnetron sputtering system used for the deposition of thin films. Outline the basic differences between the magnetron sputtering and ordinary sputtering.

8. Describe the principle of MHD power generator. Deduce the expression for the maximum power output. Calculate the open circuit voltage and the maximum power output of MHD engine having the following specifications:
Plate area= 1 m^2, distance between plates = 0.5 m, flux density= 4 Wb/m^2, average gas velocity = 1km/s, conductivity of the gas = 10 mho/m

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 the ultimate energy source.

10. What do you mean by maximum useable frequency for the propagation of radio waves? Describe it assuming the curved surface of the earth.

OR

Write short notes on (i) Lawson criteria for fusion reaction
(ii) Plasma surface modification of polymers