Mark scored:

KATHMANDU UNIVERSITY
End Semester Examination
July, 2018

JUL 16 2018

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. In plasmas generated by discharge under a pressure of less than several tens of Torr, the electron temperature becomes high but the gas particles remain at relatively low temperature. This is because
[a] the collision frequency between electrons and gas particles is large
[b] the collision frequency between electrons and gas particles is small
[c] the degree of ionization becomes low in this pressure range
[d] the degree of ionization becomes significant at this pressure range

2. In classical kinetic theory, the cross section for a collision between hard elastic spherical particles with radius r_i is equal to
[a] πr_i^2 [b] $2\pi r_i^2$ [c] $4\pi r_i^2$ [d] $\sqrt{2}\,\pi r_i^2$

3. Which one of the following equation represents the Penning ionization?
[a] $A+B \rightarrow A^+ + e + B$ [b] $A+B \rightarrow A^+ + e + B^*$
[c] $A+B^* \rightarrow A^+ + e + B$ [d] $A^*+B \rightarrow A^+ + e + B$

4. Consider a three-body recombination process involving an electron. If the third body is an atom or molecule, the recombination coefficient is proportional to (the symbols have their usual meanings)
[a] $(kTe/e)^{-5/2}$ [b] $p(kTe/e)^{-3/2}$ [c] $p(kTe/e)^{5/2}$ [d] $p(kTe/e)^{-5/2}$

5. In a plasma, the collision of charged particles is
[a] governed by long range coulomb force
[b] governed by short range coulomb force
[c] governed by their random velocities
[d] exactly similar to the collision of neutral molecules in a gas

6. Let I_a be the intensity of light absorbed while passing through a given volume and I_p be the electric current between two electrodes carried by ions which are generated by the photo-ionization process, the photo-ionization efficiency f at a given wavelength of incident light is expressed as
[a] $f = \frac{I_p e}{I_a h\nu}$ [b] $f = \frac{I_p / e}{I_a / h\nu}$ [c] $f = \frac{I_a / e}{I_p / h\nu}$ [d] $f = \frac{I_a}{I_p}$

7. The number of gas molecules Z which impinge on a unit surface area of a solid at temperature T and gas pressure P is given by (m is the mass of the molecule)

[a] $Z = \frac{P}{\sqrt{2\pi mkT}}$ [b] $Z = \frac{P}{2\pi mkT}$

[c] $Z = 2\pi mkT$ [d] $Z = P(2\pi mkT)^{\frac{1}{2}}$

8. Which one of the following is true ?

[a] The implantation process becomes very efficient for energy > 10^6 eV

[b] The implantation process becomes very efficient for energy 1- 100 eV

[c] The sticking probability curve goes through a minimum in the intermediate region between 10^{-4} eV-0.1 eV

[d] The sticking probability curve goes through a maximum in the intermediate region between one and several hundred electron volts.

9. The sputtering yield (S) is defined as

[a] the number of atoms ejected from the target per unit volume of the target material

[b] mass of the material removed per unit time

[c] mass of the material removed per unit energy of the incident ion

[d] the number of atoms ejected from the target per incident ion.

10. In a plasma stream transport system, the relation among the system parameters is expressed as

[a] $n = n_0(1 - B^2 / kz)$ [b] $n_0 = n\ (1 - kz / B^2)$

[c] $n = n_0(1 - kzB^2)$ [d] $n = n_0(1 - kz / B^2)$

11. Which one of the following statement is correct?

[a] in thermal CVD, the reaction takes place at ground state of the atoms and molecules

[b] in PECVD the reaction takes place at ground state of the atoms and molecules

[c] in thermal CVD the reaction is caused by the excited species

[d] PECVD needs relatively higher substrate temperature than thermal CVD

12. The equation $(AB)_{(g)} + (CD)_{(g)} = (AC)_{(s)} + (BD)_{(g)}$ is used to represent

[a] physical vapor deposition [b] thermal pyrolysis

[c] chemical vapor deposition [d] sputter eposition

13. The critical frequency of EM wave for F-layer of the ionosphere is 18 MHz, the maximum electron density in this layer must be ,

[a] 4×10^6 electrons/cm^3 [b] 4×10^6 electrons/m^3

[c] 4×10^{12} electrons/cm^3 [d] 2×10^9 electrons/cm^3

14. If H be the height of ionospheric layer, f_{max} and f_c be the maximum and critical frequency respectively, the maximum distance (D_{skip}) up to which a particular frequency can be used is expressed as,

[a] $D_{skip} = 2\sqrt{\frac{f_{max}^2}{f_c^2} - 1}$ [b] $D_{skip} = 2h\sqrt{\frac{f_{max}}{f_c} - 1}$

[c] $D_{skip} = 2h\sqrt{\frac{f_{max}^2}{f_c^2} - 1}$ [d] $D_{skip} = 2h\left(\frac{f_c}{f_{max}} - 1\right)$

15. Ionosphere is a low density plasma in which the density of free electrons is of the order of

[a] $10^6\ cm^{-3}$ [b] $10^6\ m^{-3}$ [c] $10^{18}\ cm^{-3}$ [d] $10^2\ cm^{-3}$

16. When the number of nucleons in the nucleus is increased, the binding energy per nucleon
[a] deceases continuously with mass number
[b] increases continuously with mass number
[c] first deceases and increases with mass number
[d] first increases and deceases with mass number

17. If the binding energy per nucleon of ${}_1H^1$ and ${}_2He^4$ are 1.123 MeV and 7.2 MeV respectively, then the energy released in the reaction ${}_1H^1 + {}_1H^1 = {}_2He^4$ is equal to

[a] 12.2 MeV [b] 24.3 MeV [c] 36.5 MeV [d] 72.2 MeV

18. A nuclear reaction is known as endoergic reaction, when its Q-value is

[a] positive [b] negative [c] zero [d] zero or negative

19. Power output per unit volume of a MHD generator is proportional to
[a] specific electrical conductivity of the gas
[b] square of the magnetic field strength
[c] square of the fluid velocity
[d] all of these

20. When a polymer sample is treated in oxygen or air plasma, its

[a] surface energy increases [b] surface energy decreases
[c] surface energy will not change [d] surface roughness will decrease

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SECTION "B"
[5 Q × 4 = 20 marks]

1. 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?

2. Describe the process of photo-excitation and photo-ionization of a gas. What is meant by efficiency of photo-ionization ? The ionization potential of oxygen and nitrogen are 12.2 eV and 15.51 eV respectively. Calculate the wavelength of solar radiation that can ionize these gases in the atmosphere.

3. Explain adsorption and trapping of gas molecules on a solid surface. What is meant by sticking probability? How does it depend on the nature of the surface? Write down the expression for sticking probability of a surface having fractional coverage θ.

OR

Write a short note on surface modification of polymers by low temperature plasma. Explain the main advantages of plasma treatment compared to conventional methods.

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

5. Explain the terms; mass defect and binding energy. Explain how the binding energy per nucleon varies with the mass number. Outline the main differences between chemical reaction and a nuclear reaction.

SECTION "C"
[5 Q × 7 = 35 Marks]

6. 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.

7. Describe the condition for reflection of electromagnetic waves from earth's ionosphere. The refractive index of an ionospheric layer is 0.95 and the maximum useable frequency is 12 MHz. If the height of the ionospheric layer is 300 km above the earth's surface then find out the distance between transmitter and receiver assuming earths' surface is flat.

8. Explain chemical vapor deposition (CVD) and plasma enhanced chemical vapor deposition (PECVD). Describe a PECVD system with well labeled diagram and explain the advantages of PECVD over thermal CVD process.

9. Consider a low pressure RF plasma with parallel plate electrode system and describe the processes involving plasma-solid interaction. Describe how SiO_2 thin films can be deposited using this system.

10. Distinguish between nuclear fission and fusion reaction. Outline the major challenges associated to generation of useful power from thermonuclear fusion reaction. Describe the principle of Magnetic Confinement Fusion (MCF) and also explain Lawson criteria.

OR

Describe the principle of MHD power generator with a well labeled diagram. What are the advantages of this type of generator? Calculate the open circuit voltage and the maximum power output of MHD engine having the following specifications:
Plate area= 0.6 m^2, distance between plates = 0.5 m, flux density= 2 Wb/m^2, average gas velocity = 1km/s, conductivity of the gas = 10 mho/m