Marks Scored:

KATHMANDU UNIVERSITY
End Semester Examination
July/August, 2017

Level : B.Sc.(AP)
Year : IV
Course : PHYS 412
Semester : II
Exam Roll No. :
Time : 30 mins.
F. M. : 20
Registration No. :
Date AUG 15 2017

SECTION "A"

[20 Q. × 1=20 marks]

Choose and tick the most appropriate answer.

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

2. The temperature of ions in a gas discharge tube is about 500K. The corresponding energy of the ion is
   [a] 5 eV [b] 0.05 eV [c] 500 eV [d] 1 eV

3. The molecular density in gas is *n* and the diameter of its molecule is *d*, then the mean free path of the molecule λ is equal to
   [a] $\frac{\pi}{nd^2}$ [b] $\frac{1}{\pi nd}$ [c] $\frac{1}{\sqrt{2}\,\pi nd^2}$ [d] $\frac{1}{3\sqrt{2}\,\pi nd^2}$

4. Experimental study in plasmas have shown that the cross-section of the collision of electrons with atoms and molecules is of the order of
   [a] 10^{-16} cm^2 [b] 10^{-16} m^2 [c] 10^{16} cm^2 [d] 10^{-12} cm^2

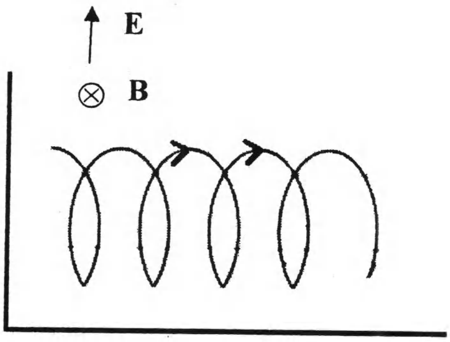
5. Collision of charged particles in a plasma is
   [a] governed by short range coulomb force
   [b] governed by long range coulomb force
   [c] governed by their random velocities
   [c] exactly similar to the collision of neutral molecules in a gas

6. If λ is the wavelength of radiation that falls on a gas of ionization potential V_i. The value of λ required for photo-ionization of the gas to occur can be expressed as
   [a] $\lambda = \frac{12345}{V_i} \mathring{A}$ [b] $\lambda = \frac{1235}{V_i} \mu m$ [c] $\lambda = \frac{V_i}{1235} \mathring{A}$ [d] $\lambda = 1235 V_i nm$

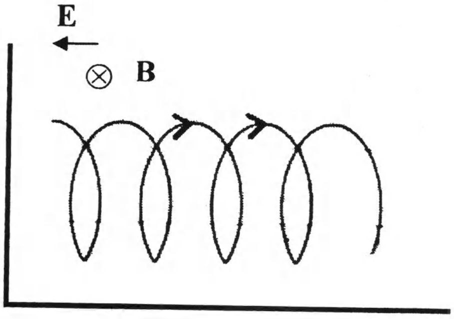
7. The increase in plasma density in magnetically confined region of a magnetron sputtering system
   [a] causes a decrease in discharge impedance
   [b] causes an increase in discharge impedance
   [c] has no influence on the impedance
   [d] may cause an increase or decrease of the impedance depending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

8. Which one of the following figures correctly represents the trace of electron motion in space close to magnetron electrode.

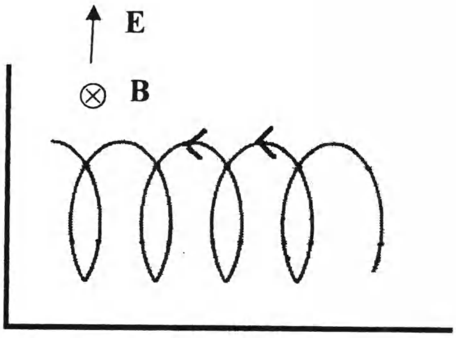
[a]



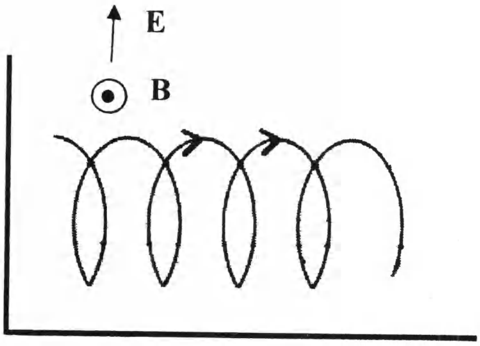
[b]



[c]



[d]



9. Which one of the following statement is true?
[a] sticking probability of gas molecule is low in a clean surface
[b] sticking probability of gas molecule is independent of the nature of the surface
[c] the implantation process of particle on a solid becomes very efficient for energy $>10^6$ eV
[d] the implantation process of particle on a solid becomes very efficient for energy $<10^6$ eV

10. Sputtering yield of a material
[a] increases with the increase in mass of the bombarding ion
[b] decreases with the increase in mass of the bombarding ion
[c] is independent of the mass of the bombarding ion
[d] is independent of the energy of the bombarding ion

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

12. If f_c be the critical frequency for an ionospheric layer to reflect an electromagnetic wave at vertical incidence and $f_{\max}$ be the maximum frequency, then the refractive index μ of the medium is given by

[a] $\mu^2 = 1 - f_c^2 f_{\max}^2$ [b] $\mu^2 = 1 - \frac{f_{\max}^2}{f_c^2}$ [c] $\mu^2 = 1 - \frac{f_c^2}{f_{\max}^2}$ [d] $\mu^2 = 1 - f_c\, f_{\max}$

13. The ionization layer which exists during day time & usually vanishes at night due to highest recombination rate is
[a] D-region [b] normal E-region
[c] sporadic E-region [d] Appleton region

14. The maximum power P_{max} generated per unit volume in a MHD generator is given by

[a] $P_{max} = \frac{\sigma v B^2}{4}$ [b] $P_{max} = \frac{\sigma v^2 B^2}{4}$ [c] $P_{max} = \frac{4\sigma}{vB^2}$ [d] $P_{max} = vB^2$

15. The fusion process is possible at high temperature because at high temperatures
[a] the nuclei disintegrate
[b] the atoms disintegrate
[c] the nuclei get sufficient energy to overcome the nuclear force
[d] the nuclei get sufficient energy to overcome the coulomb repulsive force

16. Consider the following two statements
A. Lawson criteria for D-T reaction $n\tau \geq 10^{14} cm^{-3}s$
B. Lawson criteria for D-D reaction $n\tau \geq 10^{16} m^{-3}s$
Then,
[a] A is correct but B is incorrect [b] A is incorrect but B is correct
[c] both and B are correct [d] both A and B are incorrect

17. The energy radiated from the sun is due to
[a] chemical reaction [b] nuclear fusion
[b] nuclear fission [d] gravitational energy

18. A thermonuclear fusion plasma has $T_e = T_i = 2\times10^8$ K and $n = 10^{21} m^{-3}$. The pressure exerted by plasma on its container is equal to
[a] 5.52×10^6 N/m^2 [b] 5.52×10^5 N/m^2
[c] 5.52×10^6 dynes/cm^2 [d] 5.52 atm

19. When a polymer is subjected to a low temperature plasma treatment
[a] its surface energy will decrease changing the hydrophobic surface to hydrophilic
[b] its surface energy will increase changing the hydrophobic surface to hydrophilic
[c] its surface energy will decrease changing the hydrophilic surface to hydrophobic
[d] the polymer will melt after few seconds of exposure to plasma

20. In a thermal non-equilibrium plasma
[a] $T_e >> T_i$ [b] $T_e \geq T_i$ [c] $T_e = T_i < T_g$ [d] $T_e < T_i$

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SECTION "B"

[5 Q × 4 = 20 marks]

1. Outline the main differences between a hot plasma and a cold plasma. Explain why cold plasmas are typically suitable for processing of thermally sensitive materials.

2. Write down the most important reactions for excitation and ionization of atoms and molecules by electron impact in a plasma.

   OR

   Describe the process of photo-excitation and photo-ionization of a gas. What is meant by efficiency of photo-ionization? How is it measured?

3. What is meant by sputtering? Explain how magnetron sputtering is more efficient for deposition of thin films compared to ordinary sputtering method.

   OR

   Explain the important reaction processes associated to plasma enhanced CVD with the help of a well labeled schematic diagram.

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

5. Explain the term mass defect. Calculate the mass defect and energy released in the following nuclear fusion reaction.

$${}_1^2H + {}_1^2H \rightarrow {}_2^3He + {}_0^1n$$

Given $[{}_1^2H = 2.014102\,a.u.\quad {}_0^1n = 1.008665 a.u.\quad {}_2^3He = (3.016030\ )a.u.]$

SECTION "C"

[5 Q × 7 = 35 marks]

6. 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 = 1 km/s, conductivity of the gas = 10 mho/m.

7. Explain the principle of sputtering of a material by plasma. Des cribe a magnetron sputtering system used for the deposition of thin films. Outline the basic differences between the magnetron sputtering and conventional sputtering.

8. What do you mean by maximum useable frequency for the propagation of radio waves? Describe it assuming (i) flat surface and (ii) the curved surface of the earth.

9. Explain nuclear fusion reaction with a suitable example. What factor's make a fusion reaction difficult to achieve? Describe magnetic confinement fusion (MCF) and explain why nuclear fusion is supposed to solve the energy crisis of the world in future.

OR

Write a short note on surface modification of polymer by plasma treatment. Explain why a DC plasma cannot be used for the treatment of insulating materials.

10. Write short notes on:
(a) penning ionization (b) plasma nitriding