CAREER ENDEAVOUR
Best Institute for IIT-JAM, NET & GATE

IIT-JAM PHYSICS-PH
TEST : THERMODYNAMICS

Time: 00:45 Hour

Date : 03-09-2017
M.M. : 28

Instructions:

- **Part-A** contains **10** Multiple Choice Questions (MCQ). Each question has 4 choices (a), (b), (c) and (d), for its answer, out of which **ONLY ONE** is correct. For each correct answer you will be awarded **2 marks**. For each incorrect answered **0.5 mark** will be deducted.

- **Part-B** contains **2** Multiple Select Questions (MSQ). Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which **ONE or MORE than ONE** is/are correct. For each correct answer you will be awarded **2 marks**, there is no negative marking in this section.

- **Part-C** contains **2** Numerical Answer Type (NAT) questions which contain **2 Marks** for each, and there is no negative marking.
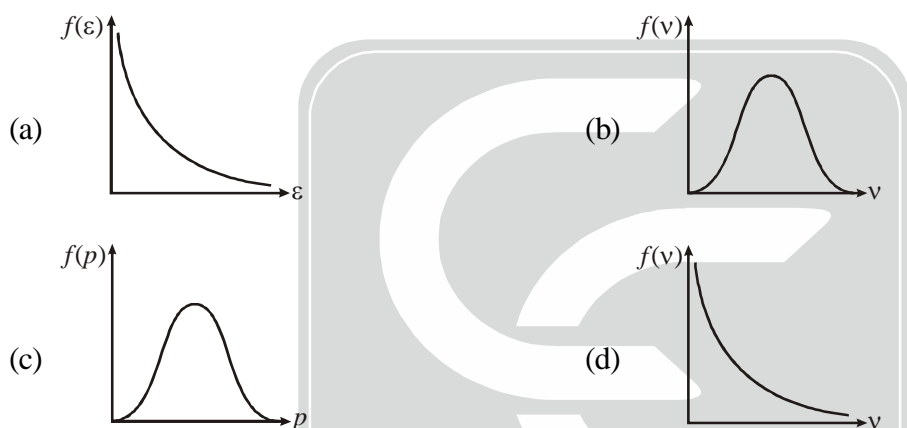
PART-A [MULTIPLE CHOICE QUESTIONS (MCQ)]

1. The mean free path of nitrogen at some temperature and pressue is 0.8×10^{-5} cm. At this temperature and pressure, there are 2.7×10^{18} molecules/cm³. What is the order of molecular diameter ?
   (a) 10^{-7} cm
   (b) 10^{-7} m
   (c) 10^{-6} cm
   (d) 10^{-6} m

2. What is the root mean square speed of a gas whose density is 1.4 gm/litre at a pressure of 105 N/m² ?
   (a) 1.5 cm/s
   (b) 15 cm/s
   (c) 1.5 m/s
   (d) 15 m/s

3. At room temperature, the r.m.s. speed of the molecules of a certain diatomic gas is found to be 1930 m/s. The gas is
   (a) H_2
   (b) F_2
   (c) O_2
   (d) Cl_2

4. One gram mole of oxygen at 27 ℃ and one atmospheric pressure is enclosed in a vessel. Assuming the molecules to be moving with $v_{r.m.s.}$, what is the number of collisions per second, which the molecules make with one square metre area of the wall.
   (a) 1.96×10^{27} per sec.
   (b) 0.98×10^{27} per sec.
   (c) 0.98×10^{28} per sec.
   (d) 1.96×10^{28} per sec.

5. Consider a Maxwellian distribution of the velocity of the molecules of an ideal gas. Let v_p and $v_{r.m.s.}$ denote the most probable velocity and r.m.s. velocity, respectively. The magnitude of the ratio $v_p/v_{r.m.s.}$ is :
   (a) 1
   (b) 2/3
   (c) $\sqrt{2/3}$
   (d) $\sqrt{3/2}$

6. Let v_x and v_y denote the components of the velocity along x-and y-directions, respectively of an ideal gas particle of mass m. At the absolute temperature T, the average value of $v_x^2 v_y^2$ is proportional to
   (a) m^2
   (b) m^{-2}
   (c) m^{-1}
   (d) m^1

7. The average translational kinetic energy of O_2 (molar mass 32) molecules at a particular temperature is 0.048 eV. The translational kinetic energy of N_2 (molar mass 28) molecules in eV at the same temperature is
   (a) 0.0015
   (b) 0.0030
   (c) 0.0480
   (d) 0.7600

8. Consider oxygen gas at room temperature and pressure and assume that only translational and rotational motions of the molecules contribute to the specific heat. If C_p and C_v denote respectively, specific heats at constant pressure and volume, then the ratio C_p/C_v is
   (a) 3/5   (b) 5/3   (c) 5/7   (d) 7/5

9. Maxwell's law of distribution of speed show that the number of molecules with average speed is
   (a) Very small   (b) Large   (c) Zero   (d) Exactly equal to one

10. A brass measuring tape measures 2.10 m at a temperature of 15 °C. What is the percentage error in the measurement of length by the tape at 40 °C ?
    (The coefficient of linear expansion for brass is 19×10^{-6} per °C)
    (a) 0.0047 %   (b) 0.47 %   (c) 4.7 %   (d) 0.047 %

PART-B [MULTIPLE SELECTIVE QUESTIONS (MSQ)]

11. Which of the following graphs represent the Maxwellian distribution in 2-dimension ?

12. The speed of 10 molecules of a gas are 1 m/s, 3 m/s, 7 m/s, 5 m/s, 3 m/s, 9 m/s, 3 m/s, 8 m/s, 9 m/s, 2 m/s. Which of the following is correct ?
    (a) The most probable speed is 3 m/s   (b) The most probable speed is 4 m/s
    (c) The r.m.s. speed is 4.76 m/s   (d) The r.m.s. speed is 5.76 m/s

PART-C [NUMERICAL ANSWER TYPE QUESTIONS (NAT)]

13. The ratio of one-dimensional velocities $\langle v_x \rangle_{avg.}$ to $\langle v_x \rangle_{r.m.s.}$ is ....

14. A diatomic molecule has all degrees of freedom(translation, vibrational and rotational). Its energy would be .... (in terms of $k_B T$).

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****** ANSWER KEY ******

PART - A

1. (a)   2. (d)   3. (a)   4. (a)   5. (c)

6. (b)   7. (c)   8. (d)   9. (b)   10. (d)

PART - B

11. (b) & (c)   12. (a) & (d)

PART - C

13. (0)   14. (3.5)