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KATHMANDU UNIVERSITY
End Semester Examination [C]
December, 2018

Marks Scored:

Level : B.Sc.
Year : II

Course : PHYS 212
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. The symbols have their usual meanings.

1. A Carnot's engine takes 300cal. of heat at 500K and rejects 150 cal. of heat to the sink. The temperature of sink is:
   [a] 125 K [b] 250 K [c] 750 K [d] 1000 K

2. The ratio of specific heat of a gas at constant pressure to at constant volume is 'γ', the change in internal energy of one mole of a gas when the volume changes from V to 2V at constant pressure P is:
   [a] $\frac{R}{\gamma - 1}$ [b] PV [c] $\frac{PV}{\gamma - 1}$ [d] $\frac{\gamma PV}{\gamma - 1}$

3. The slope of isothermal to adiabatic curves are related as :
   [a] Isothermal curve slope = adiabatic curve slope
   [b] Isothermal curve slope = $\gamma \times$ adiabatic curve slope
   [c] Adiabatic curve slope = $\gamma \times$ Isothermal curve slope
   [d] Adiabatic curve slope = $\frac{1}{2} \times$ Isothermal curve slope

4. Which of the following relations holds for all three expansions i.e. Joule expansion, Joule-Thomson expansion and Adiabatic expansion?
   [a] $dW = 0$ [b] $dQ = 0$ [c] $dU = 0$ [d] $dQ > 0$

5. If T_i is the temperature of inversion, T_B is the Boyle's temperature and T_c is critical temperature, then
   [a] $T_i < T_B < T_c$ [b] $T_c > T_B < T_i$
   [c] $T_B > T_i > T_c$ [d] $T_i = 2\ T_B = 6.75\ T_c$

6. Which of the following statement is wrong?
   [a] Specific heat of saturated water vapour at 100°C is negative.
   [b] There is only one triple point of the substance.
   [c] Boiling point of every liquid rises with increases in pressure.
   [d] Latent heat can not become zero.

7. The second virial coefficient B
   [a] is zero at Boyle temperature
   [b] is positive at low temperatures
   [c] is higher than first virial coefficient
   [d] varies in a different manner for different gases

8. Which of the following gas shows heating effect during throttling process?
   [a] Oxygen [b] Carbon dioxide [c] Helium [d] Nitrogen

9. Three similar coins are tossed for a large number of times. The probability of getting two heads and one tail uppermost is:
[a] $\frac{2}{8}$ [b] $\frac{3}{8}$ [c] $\frac{2}{64}$ [d] $\frac{1}{64}$

10. The diameter of a molecule of benzene, if $n = 2.79 \times 10^9$ molecule per c.c. and mean free path $\lambda = 2.2 \times 10^{-6} cm$, is
[a] $60.2 \times 10^{-8} cm$ [b] $6.02 \times 10^{-8}\, m$ [c] $6.02 \times 10^{-8} cm$ [d] $60.2 \times 10^{-8}\, m$

11. Electromagnetic radiation is emitted by:
[a] all bodies at all temperature [b] all bodies at 100°C
[c] all bodies at absolute zero [d] only a few bodies at all temperature

12. In the phenomenon of diffusion, the diffusion coefficient 'D' is equal to
[a] $\frac{1}{3}\rho\bar{v}\lambda$ [b] $\rho\bar{v}\lambda$ [c] $\frac{\bar{v}\lambda}{3\rho}$ [d] $\frac{1}{3}\bar{v}\lambda$

13. According to Boltzmann canonical distribution law:
[a] low energy cells contain more particles.
[b] high energy cells contain more particles.
[c] number of molecules having zero energy is greater than any other energy.
[d] zero energy molecules are zero.

14. Which of the following statements is NOT true?
[a] Joule expansion is a free expansion.
[b] In Joule expansion gas expands in a vacuum.
[c] No external work is done in Joule expansion.
[d] No internal work is done in Joule expansion.

15. The phase diagram of harmonic oscillator of mass m and spring constant k, having energy E is:
[a] the circle of radius $\sqrt{2mE}$
[b] the circle of radius $\sqrt{\frac{2E}{k}}$
[c] ellipse of semi-minor axis $\sqrt{2mE}$ and semi-major axix $\sqrt{\frac{2E}{k}}$
[d] ellipse of semi-minor axis $\sqrt{\frac{2E}{k}}$ and semi-major axis $\sqrt{2mE}$

Fill in the blanks.

16. In a thermodynamic system, the process in which the pressure remains constant is called.....

17. The number of possible arrangements of distributing 3 classical particles in 4 energy levels is equal to.....

18. Bose-Einstein (BE) and Fermi-Dirac (FD) statistic approaches to Maxwell-Boltzmann (MB) statistics for.....

19. During emission and absorption process of photons in black body chamber, the constraint that no more valid is.....

20. Einstein theory of specific heat agrees with the Dulong and Petit's law at .....

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SECTION "B"
[5Q.×4=20 marks]

1. Describe the physical concept of entropy. Derive an expression for entropy of a perfect gas in terms of temperature and pressure.

2. Show that the coefficient of diffusion of a gas is proportional to $T^{3/2}$.

3. What do you mean by thermodynamical probability? Deduce Boltzmann's entropy-probability relation $S = K \log_e \Omega$.

OR

State and explain law of equipartition of energy.

4. Define Boyle point. Show that for all gases obeying Vander Waal's equation, the Boyle temperature is $T_B = \frac{a}{Rb}$.

5. Show that average energy at 0°K will be 3/5 times of Fermi energy.

OR

The collision diameters of hydrogen, nitrogen and chlorine gases are 2.5 Å, 3.5 Å and 4.0Å respectively. Compare their thermal conductivities.

SECTION "C"
[5Q ×7=35 marks]

6. Distinguish between Joule-Thomson's expansion and adiabatic expansion. Obtain an expression for the change in temperature for a Vander Waal gas in Joule Thomson's expansion.

7. What is meant by black body radiation? Using Bose-Einstein statistics, show that total energy density within the frequency range ν to $\nu+d\nu$ is given by

$$U_\nu d\nu = \left(\frac{8\pi\nu^2 d\nu}{c^3}\right)\left(\frac{h\nu}{e^{\frac{h\nu}{kT}} - 1}\right)$$

Obtain the Stefan's constant (σ) and Wien's constant (b)

8. Calculate the increase in entropy when 20 gm of water at 20°C is converted into vapour at 100°C. (Given specific heat of water = 4.2 Joule $gm^{-1}deg^{-1}$, Latent heat of water = 2.27×10^3 Joule gm^{-1}).

OR

Calculate the fraction of oxygen molecules within 1% of the most probable velocity at NTP. What is the effect of changing (i) the gas to hydrogen? (ii) the temperature to 500 °C?

9. Compare the basic postulates of the Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Deduce the law of distribution of energy of particles according to Fermi-Dirac statistics.

10. Write down the assumptions of Debye's theory of specific heat capacity of solid. Derive an expression for lattice heat capacity for this model.