Assignment 11

The due date for submitting this assignment has passed.

Due on 2021-04-07, 23:59 IST.

As per our records you have not submitted this assignment.

1. Consider a cavity of volume \( V \) filled with electromagnetic radiation, which follows the Planck distribution. Initially, the frequency of the maximum \( f_0 \) of the cavity is very small, the frequency is expanded to \( 2f_0 \). Find the total absorbed energy density per unit frequency range of Planck distribution.

   [Hint: Assume the expansion to be adiabatic.]
   \[
   \frac{d\omega}{\omega^4} \to \frac{d\omega}{(2\omega)^4} = \frac{1}{2^4} \frac{d\omega}{\omega^4}
   \]

   No, the answer is incorrect.
   Accepted Answers:
   \[
   2^4
   \]

   2. The Universe is known to be permeated with a background radiation, which is called the relic of early universe following the Big Bang. This 1-point photon density is roughly, to within about one order of magnitude, for \( T = 3K \) is

   \[
   3000 \text{ cm}^3
   \]

   No, the answer is incorrect.
   Accepted Answers:
   \[
   100 \text{ cm}^3
   1000 \text{ cm}^3
   500 \text{ cm}^3
   \]

   3. The average number of photons in an enclosure of 22.4 litre at 273 K is

   \[
   \text{9.91} 	imes 10^3
   \]

   No, the answer is incorrect.
   Accepted Answers:
   \[
   6.93 	imes 10^3
   \]

4. Consider a gas of \( N \) spinless bosons in a d-dimensional box of volume \( V \), with a dispersion relation

   \[
   \epsilon = \sqrt{p^2 + m^2}
   \]

   where \( p \) and \( m \) are both arbitrary positive constants.

   a) The condition for \( n \) and \( m \) for Bose-Einstein condensation is

   No, the answer is incorrect.
   Accepted Answers:
   \[
   d < 1
   \]

5. The equation of state for this gas below the critical temperature \( T_c \) is

   No, the answer is incorrect.
   Accepted Answers:
   \[
   P = \frac{3}{4} \epsilon T_c / \xi(3/2)
   \]

6. The value of the degeneracy, \( j \) where the Bose-Einstein condensation takes place is

   No, the answer is incorrect.
   Accepted Answers:
   \[
   j = \frac{1}{2}
   \]

7. Considering \( \frac{k_B T}{\hbar} = 1 \), where \( T \) is the temperature, for \( \Delta = 0 \), the shift in the transition temperature \( T_c - T \) is

   No, the answer is incorrect.
   Accepted Answers:
   \[
   0.01
   0.05
   0.1
   0.2
   \]

8. Consider a gas of \( N \) spinless fermions in a d-dimensional box of volume \( V \), with a dispersion relation

   \[
   \epsilon = \sqrt{p^2 + m^2}
   \]

   where \( p \) and \( m \) are both arbitrary positive constants.

   a) The condition for \( n \) and \( m \) for Bose-Einstein condensation is

   No, the answer is incorrect.
   Accepted Answers:
   \[
   d > 1
   \]

b) The equation of state for this gas below the critical temperature \( T_c \) is

   No, the answer is incorrect.
   Accepted Answers:
   \[
   P = \frac{1}{2} \epsilon T_c / \xi(1)
   \]

The single-particle energy of an ideal boson gas has an energy gap \( \Delta > 0 \):

\[
\epsilon(x) = \left\{ \begin{array}{ll}
-\Delta & (x = 0), \\
\frac{1}{2} \epsilon(x) & (x > 0)
\end{array} \right.
\]

\[
\epsilon(x) = \left\{ \begin{array}{ll}
\frac{1}{2} \epsilon(x) & (x = 0), \\
\frac{1}{2} \epsilon(x) & (x > 0)
\end{array} \right.
\]

9. The degeneracy \( j \) where the Bose-Einstein condensation takes place is

   No, the answer is incorrect.
   Accepted Answers:
   \[
   j = \frac{1}{2}
   \]

10. The temperature \( T \) of a blackbody is

   No, the answer is incorrect.
   Accepted Answers:
   \[
   100 \text{ K}
   \]

11. Consider a gas of \( N \) spinless fermions in a d-dimensional box of volume \( V \), with a dispersion relation

   \[
   \epsilon = \sqrt{p^2 + m^2}
   \]

   where \( p \) and \( m \) are both arbitrary positive constants.

   a) The condition for \( n \) and \( m \) for Bose-Einstein condensation is

   No, the answer is incorrect.
   Accepted Answers:
   \[
   d > 1
   \]

b) The equation of state for this gas below the critical temperature \( T_c \) is

   No, the answer is incorrect.
   Accepted Answers:
   \[
   P = \frac{1}{2} \epsilon T_c / \xi(1)
   \]