

DIRECT FORMULA FOR \bar{E} in H.O.

$\bar{E} = \frac{1}{2} kT$ for each term (K & D P.E)

c.g. In 3-D, 3 K.E & 3 P.E terms

$\bar{E} = kT + kT + kT = 3kT$

$\bar{E} = 3kT$

but if particles are non interacting

$\Rightarrow \bar{E} = \frac{1}{2} kT + \frac{1}{2} kT + \frac{1}{2} kT$

$\Rightarrow \bar{E} = \frac{3}{2} kT$

For H.O.

$Z = \sum_{n=0}^{\infty} e^{-\beta (n + \frac{1}{2}) h\nu}$

$Z = e^{-h\nu\beta/2} + e^{-3h\nu\beta/2} + \dots$

GP series

$a = e^{-h\nu\beta/2} \quad r = e^{-\beta h\nu}$

$\therefore Z = \frac{e^{-\beta h\nu/2}}{1 - e^{-\beta h\nu}}$

For 3D HO, $Z_N = \left(\frac{1}{1 - e^{-\beta h\nu}}\right)^3 N$

Average value of $n = \frac{1}{2}$

Partition fn for particles in magnetic field

$Z = e^{-\beta E} = e^{-\beta(\vec{\mu} \cdot \vec{H})} = e^{-\beta(\vec{\mu} \cdot \vec{B})}$

up $\rightarrow \mu B$, down $\rightarrow -\mu B$

$Z = e^{-\mu\beta B} + e^{\mu\beta B}$

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EXAMPLE \rightarrow If $F = NkT \ln\left(\frac{2\omega V}{N} (kT)^{5/2}\right)$

Find U.

Soln. As $F = -NkT \ln Z$

$\Rightarrow Z = \frac{2\omega V (kT)^{5/2}}{N}$

$U = -\frac{\partial}{\partial \beta} (\ln Z) = -\frac{\partial}{\partial \beta} \left(\ln\left(\frac{2\omega V}{N} (kT)^{5/2}\right) \right)$

$= \frac{5N}{2\beta} = \frac{5}{2} NkT$

$U = \frac{5}{2} NkT$

Ensemble \rightarrow system of collection of similar systems having some const parameters

Microcanonical Walls are rigid impermeable well insulated
Canonical Walls are rigid conducting impenetrable
Grand canonical Walls are impenetrable rigid conducting

N, V, E

V, N, T

P, V, T

These quantities remain same in a particle ensemble i.e. in microcanonical, canonical & Grand canonical resp. $\frac{1}{kT} \leftarrow$ Energy fluctuation $\rightarrow \frac{1}{N}$

Maxwell Boltzmann distⁿ law of velocities

No. of particles in velocity range v to $v+dv$ is $N(v_x) dv_x = N \left(\frac{m}{2\pi kT}\right)^{1/2} e^{-\frac{mv_x^2}{2kT}} dv_x$

$P = \frac{n}{N} = \left(\frac{m}{2\pi kT}\right)^{1/2} e^{-\frac{mv_x^2}{2kT}}$

$P_{max} = \left(\frac{m}{2\pi kT}\right)^{1/2} \left(\frac{kT}{m}\right)^{1/2}$

$\bar{v}_x = \int_{-\infty}^{\infty} v_x P dv_x = 0$

$\bar{v}_x = \bar{v}_y = \bar{v}_z = 0$

$\langle v_x v_y \rangle = \langle v_y v_x \rangle = \langle v_z v_x \rangle = 0$

In 1-D $\langle v_x^2 \rangle = \langle v_y^2 \rangle = \langle v_z^2 \rangle = kT/m$

In 2-D $\langle v_x^2 \rangle = \langle v_y^2 \rangle = \langle v_z^2 \rangle = 2kT/m$

In 3-D $\langle v_x^2 \rangle = \langle v_y^2 \rangle = \langle v_z^2 \rangle = 3kT/m$

Statistical Physics

Rachel S Tattersall



Statistical Physics:

The book delves into Statistical Physics. Statistical Physics is an essential topic that must be grasped by everyone, from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into Statistical Physics, encompassing both the fundamentals and more intricate discussions.

1. This book is structured into several chapters, namely:

- Chapter 1: Introduction to Statistical Physics
- Chapter 2: Essential Elements of Statistical Physics
- Chapter 3: Statistical Physics in Everyday Life
- Chapter 4: Statistical Physics in Specific Contexts
- Chapter 5: Conclusion

2. In chapter 1, the author will provide an overview of Statistical Physics. This chapter will explore what Statistical Physics is, why Statistical Physics is vital, and how to effectively learn about Statistical Physics.

3. In chapter 2, the author will delve into the foundational concepts of Statistical Physics. This chapter will elucidate the essential principles that must be understood to grasp Statistical Physics in its entirety.

4. In chapter 3, this book will examine the practical applications of Statistical Physics in daily life. The third chapter will showcase real-world examples of how Statistical Physics can be effectively utilized in everyday scenarios.

5. In chapter 4, the author will scrutinize the relevance of Statistical Physics in specific contexts. The fourth chapter will explore how Statistical Physics is applied in specialized fields, such as education, business, and technology.

6. In chapter 5, the author will draw a conclusion about Statistical Physics. The final chapter will summarize the key points that have been discussed throughout the book.

The book is crafted in an easy-to-understand language and is complemented by engaging illustrations. This book is highly recommended for anyone seeking to gain a comprehensive understanding of Statistical Physics.

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