microstates than Fermions because any number of Bosons can occupy an energy state.[21] This concludes our discussion of macrostate probability determination. Since the concept of a macrostate, microstate, and microstate probability are important to our next topic, the determination of thermodynamic properties, a summary of terms is appropriate.

TABLE IIIA-3: MICROSTATES AND PROBABILITIES OF MACROSTATES FOR SYSTEMS OF FOUR BOLTZONS, BOSONS, AND FERMIONS

Macrostate	W_i^{M-B}	p_i^{MB}	W_i^{B-E}	p_i^{BE}	W_i^{F-D}	p_i^{FD}
I	324	0.537	18	0.346	9	0.9
II	108	0.178	10	0.192	1	0.1
III	81	0.134	15	0.289	0	0
IV	54	0.090	6	0.115	0	0
V	36	0.060	3	0.058	0	0
Total	603	1.000	52	1.000	10	1.0

Macrostate. When a system of N particles has a total energy U and occupies an array of energy levels $\varepsilon_j (j = 1,2,3,\ldots,J)$, its particles can be distributed over this array in any manner that satisfies

$$U = \sum_{j=1}^{J} n_{j,i}\varepsilon_j \qquad \text{and} \qquad N = \sum_{j=1}^{J} n_{j,i}$$

The solutions of these equations are the particle distributions over the levels, $n_{j,i}$. Each of these $i = 1,2,3,\ldots,I^*$ solutions is a macrostate.

Microstates. A microstate is a more detailed description of the particle distribution than a macrostate. It specifies not only how many particles are in each level, but also in which energy states they reside. In the case of distinguishable particles, a microstate also specifies which particle is in which state. A microstate distribution completely specifies every distinct characteristic of the particles among the accessible energy states.

Macrostate Probabilities. It is not important that microstate particle distributions be specified, only that the number of microstates in each macrostate, W_i, be determined. Eqn. IIIA-7a,b, or c permits this determination for Boltzons, Bosons, and Fermions, respectively. This determination allows the macrostate probabilities to be determined.

$$p_i = \frac{W_i}{\sum_{i=1}^{I^*} W_i} \qquad \text{(IIIA-9)}$$

[21] For macrostates in which no level holds more than a single particle, $W_i^{BE} = W_i^{FD}$.

Ans. 8. (a) All diatomic molecules necessarily are even; Boson. (b) One electron, one proton, also even; Boson. (c) One proton, odd; Fermion. (e) A single electron is odd; Fermion. This recognition may help put the Bohr electron shell model in better prespective. As you recall, the first shell can contain at most 2 electrons, the second 8, the third 18, and so on. It is now recognizable that the shells correspond to levels with the first shell having 2 states. It will hold no more than 2 electrons since both states would then hold a particle. And the Pauli exclusion principle will permit no more than one electron to occupy a state. (e) and (f) Waves are massless. They have no electrons, protons, or neutrons. Zero is an even number; Bosons.