g. Thus, the second level has a degeneracy of three, $g_2 = 3$. The first level has only one state, $g_1 = 1$. This level is said to be *non-degenerate*. This is typical, higher energy levels often have larger degeneracies.

Table IIIA-1 presents the states, levels, and degeneracies for the first several levels of a particle in a cubical box. The quantum numbers corresponding to the states in each successive level are listed. The degeneracy of a level is the number of possible permutations of those quantum numbers as shown. The first energy level where more than one non-permuted set has the same energy is level number 14. The two sets of quantum numbers are (1,1,5) and (3,3,3). The level number is designated as j. Thus for this level j = 14 and the energy, ε_{14}, equals 27 B_o. The following exercise will aid in seeing the relationships of the table.

TABLE IIIA-1: ENERGY STATES, ENERGY MAGNITUDES, AND LEVELS, AND ENERGY LEVEL DEGENERACIES FOR A PARTICLE WITHIN A FIELD-FREE CUBE

Quantum Numbers	Energy, ε_j	Degeneracy, g_j
(1,7,12), (3,4,13), (3,8,11), (5,5,12), (7,8,9), ... and all permutations	$\varepsilon_{140} = 194\ B_0$	$g_{140} = ?$
⋮	⋮	⋮
(1,1,5), (1,5,1), (5,1,1) (3,3,3)	$\varepsilon_{14} = 27\ B_0$	$g_{14} = 4$
(1,3,4), (3,1,4), (1,4,3) (3,4,1), (4,1,3), (4,3,1)	$\varepsilon_{13} = 26\ B_0$	$g_{13} = 6$
(2,2,4), (2,4,2), (4,2,2)	$\varepsilon_{12} = 24\ B_0$	$g_{12} = 3$
(2,3,3), (3,2,3), (3,3,2)	$\varepsilon_{11} = 22\ B_0$	$g_{11} = 3$
(1,2,4), ... , ...	$\varepsilon_{10} = 21\ B_0$	$g_{10} = ?$
(1,3,3), (3,1,3), (3,3,1)	$\varepsilon_9 = 19\ B_0$	$g_9 = 3$
(1,1,4), (1,4,1), (4,1,1)	$\varepsilon_8 = (?)B_0$	$g_8 = 3$
(?), ...	$\varepsilon_7 = 17\ B_0$	$g_7 = ?$
(1,2,3), (1,3,2), (2,1,3) (2,3,1), (3,1,2), (3,2,1)	$\varepsilon_6 = 14\ B_0$	$g_6 = 6$
(2,2,2)	$\varepsilon_5 = 12\ B_0$	$g_5 = 1$
(1,1,3), (1,3,1), (3,1,1)	$\varepsilon_4 = 11\ B_0$	$g_4 = 3$
(1,2,2), (2,1,2), (2,2,1)	$\varepsilon_3 = 9\ B_0$	$g_3 = 3$
(1,1,2), (1,2,1), (2,1,1)	$\varepsilon_2 = 6\ B_0$	$g_2 = 3$
(1,1,1)	$\varepsilon_1 = 3\ B_0$	$g_1 = 1$

Exercise 4. Several blanks have been left in Table IIIA-1. To assure your understanding of the relationship between the quantum numbers, energy states, energy levels, and degeneracy, determine the missing quantities: the quantum numbers for level seven and its degeneracy, $g_7 = ?$; the energy of level eight, $\varepsilon_8 = ?$; the degeneracy of level ten, $g_{10} = ?$ All distinct sets of quantum numbers for level 140 are listed. Find its degeneracy, $g_{140} = ?$

We summarize the definitions presented above.

STATE - (Energy State): A distinct condition of the system specified by the quantum numbers. Each state has an energy magnitude associated with it, $\varepsilon_{\ell,m,n}$ (often abbreviated ε_i).

Ans. 3. The minimum energy is

$$\varepsilon_{min} = \frac{(6.625 \cdot 10^{-34}\ \text{J s})^2}{8 \cdot 0.250\ \text{kg}} \cdot \left[\frac{1}{(1.2\ \text{m})^2} + \frac{1}{(2.7\ \text{m})^2}\right] = 1.83 \cdot 10^{-69}\text{J}$$

From which

$$\hat{V}_{min} = \frac{2\varepsilon_{min}}{m^*} = 4.0 \cdot 10^{-37}\ \text{m/s}.$$

At this rate, it would take approximately 10^{24} years before our displacement measuring device could detect its motion.