

HOMEWORK SET 4: DEGENERACY

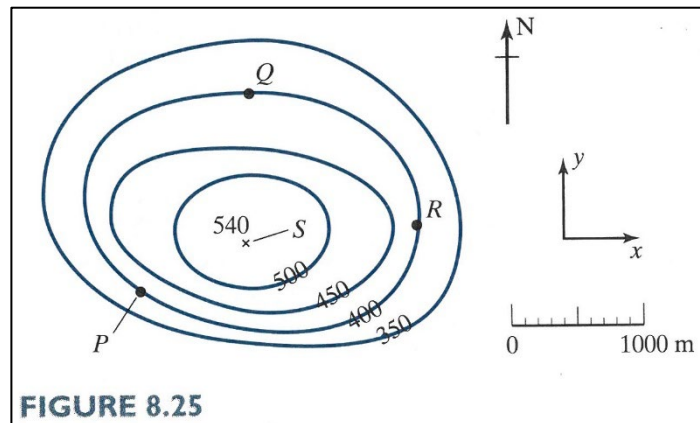
Due Monday, January 27, 2025

PROBLEMS FROM TZDII¹

8.5 A mountain can be described by the function $h(x, y)$ which gives the height above sea level of a point that is x east and y north of the origin O ,

- a) Describe in words the meaning of $\partial h/\partial x$ and $\partial h/\partial y$?
 - b) What does it mean to a hiker who is walking due north if $\partial h/\partial y$ is positive?
 - c) What if they are walking due north, but $\partial h/\partial y$ is zero and $\partial h/\partial x$ is positive?
- (USE WORDS SUCH AS EAST OR EASTWARD, NORTH OR NORTHWARD, UPHILL, DOWNHILL, OR FLAT, ETC.)

8.6 Let $h(x, y)$ describe a mountain as in Problem 8.5. If the same mountain is given by the contour map in Figure 8.25, give estimates for $\partial h/\partial x$ and $\partial h/\partial y$ at points P , Q , and R and the summit, S . The scale for x and y (shown by the ruled line) are given in meters.



8.13 The energy levels of a particle in a cubical box can be found from (8.103)

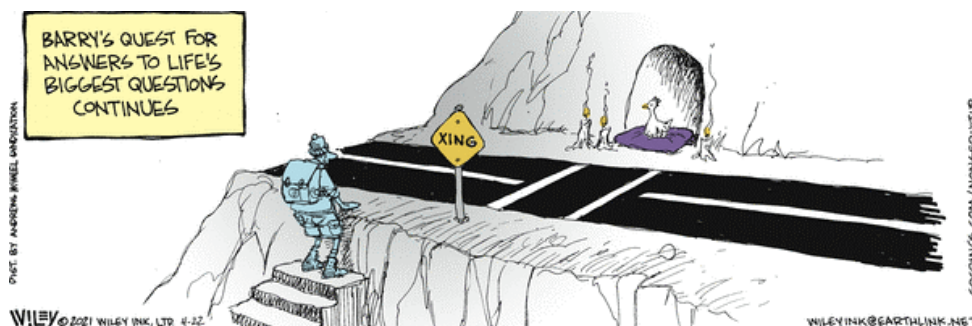
$$E = \frac{\hbar^2 \pi^2}{2M} \left(\frac{n_x^2}{a^2} + \frac{n_y^2}{b^2} + \frac{n_z^2}{c^2} \right)$$

(Problem 8.15) by setting $a = b = c$. Find the lowest eight energy levels for a particle in a three-dimensional, rigid cubical box. Draw an energy-level diagram for these levels, showing their quantum numbers, energies, and degeneracies. (SEE THE ENERGY-LEVEL DIAGRAM FOR THE SQUARE BOX, FIGURE 8.2, P. 256).

FIGURE 8.2

The energy levels of a particle in a two-dimensional, square rigid box. The lowest allowed energy is $2E_0$; the line at $E = 0$ is merely to show the zero of the energy scale. The degeneracies, listed on the right, refer to the number of independent wave functions with the same energy.

n_x	n_y	E_{n_x, n_y}	Degeneracy
1	3	$10E_0$	2
3	1		
2	2	$8E_0$	1
1	2	$5E_0$	2
2	1		
1	1	$2E_0$	1
		$E = 0$	



¹ Taylor, Zafiratos, & Dubson, *Modern Physics for Scientists and Engineers*, 2nd Edition, Pearson, Prentice Hall, 2004