Problem Solutions

Chapter 1

1. - 2. a) 4/52 b) 7.7×10^{4} 3. The result of 20 flips is closer to 50-50 on average. The probability of exactly 10 heads is small (0.18) 4. They stick together and lose mobility. 5. - 6. 225 7. Foolish. The probability each time is 1/2, regardless of past history. 8. Molecule: 3.1×10^{-10} m. Atom: about 2×10^{-10} m. Nucleus: about 4×10^{-15} m 9. 12 10. 7.3×10^{-11} m, 4.0×10^{-14} m, 9.5×10^{-37} m
11. a) 0.2 nm b) 3.3×10^{-24} kg·m/s c) electron: 3.6×10^{6} m/s, proton: 2.0×10^{3} m/s d) electron: 38 eV, proton: 0.021 eV e) 6200 eV 12. a) 0.42 nm b) 1.5×10^{10} /m c) 6.3 (=2π) d) 130 m, 0.0483 /m, 6.3 (=2π) 13. $\Delta p_x = 6.6 \times 10^{-24}$ kg·m/s, $\Delta v_x = 7.3 \times 10^{6}$ m/s 14. a) 3.0×10^{5} b) 27 15. 13 16. 7.8×10^{80} 17. a) 1.6×10^{-14} m b) 3.2 MeV 18. a) 38 eV b) 7.3×10^{6} m/s (It could be going in either direction.) 19. a) x2 b) x2 c) x8 20. - 21. a) 7.6×10^{54} states/J = 1.2×10^{36} states/eV b) 8.4 states/eV 22. a) ±35º, ±66º, 90º b) ±45º, 90º c) ±55º 23. They are in a state with orbital angular momentum of l=1, and oriented opposite to the orientation of the two parallel spins. 24. $|\boldsymbol{\mu}| = 1.61 \times 10^{-23}$ J/T, $\mu_z = \pm 9.27 \times 10^{-24}$ J/T, $U = \pm 9.27 \times 10^{-24}$ J 25. $|\boldsymbol{\mu}| = 2.44 \times 10^{-26}$ J/T, $\mu_z = \pm 1.41 \times 10^{-26}$ J/T, $U = \pm 1.41 \times 10^{-26}$ J 26. about 10^{364}
27. $\pm 7.4 \times 10^{-24}$ J, $\pm 3.7 \times 10^{-24}$ J, 0 J 28. a) 9.2×10^{-8} N b) 1.8×10^{3} N/m c) 4.5×10^{16} /s d) 30 eV e) about 3 times greater 29. If the kinetic energy were zero, the momentum would be zero, the wavelength would be infinite, and so the particle would not be contained within the potential well 30. 4, 8, $2^{10^{24}} = 10^{3.0 \times 10^{23}}$ 31. 77 ($2^{77} \approx 10^{23}$)

Chapter 2

1. a) $\overline{f+g} = \sum P_s(f_s + g_s) = \sum P_s f_{ss} + \sum P_s g_s = \bar{f} + \bar{g}$ b) $\overline{cf} = \sum P_s c f_s = c \sum P_s f_s = c\bar{f}$ 2. 16 3. a) 33 1/6, b) 5 1/6 c) -4/3 d) 63 1/2 4. a) 4 1/2 b) 23 1/2 5. 7 7/8 6. -(1/2)μB 7. a) 3/8 b) 6 c) hhtt, htht, htth, thht, thth, tthh, yes 8. a) 0.59 b) 0.33 c) 0.073 9. 1/36 10. a) 0.48 b) 0.39 11. a) 0.0042, 56 b) 0.0046 12. 0.156, 5 13. a) 0.313 b) 10 14. 0.165 15. 1820 16. 10^{375} 17. 0.0252 18. 0.0224 19. a) 6.7×10^{-6} b) 4.5×10^{-2} c) 2.1×10^{-35} 20. a) 4.0% low b) 1.7% low c) 0.8% low d) 0.4% low 21. 1.0×10^{29} 22. a) 0.130 b) 0.072 c) 0.026 23. a) 0.062 b) 0.062 24. $P_N(n,m) = \frac{N!}{n!m!(N-n-m)!}\frac{(r-2)^{N-n-m}}{r^N}$ 25. - 26. a) no b) yes 27. 3/40 (There are 40 unseen cards and 3 of them are queens) 28. a) 1/13 b) 1/4 c) yes d) 1/52 29. 5.8 cents 30. a) 0.0467 b) 0.155 31. 12.25 32. a) 7 b) 7

Chapter 3

1. a) 16.7 b) 3.7 c) 0.22 2. a) 1.67×10^{7} b) 3.7×10^{3} c) 2.2×10^{-4} 3. (Justify each step in the Equation 3.3.) 4. a) 10^{18} b) 10^{9} c) 10^{-9} 5. a) 10 b) 2.6 c) 0.26 6. a) 10^{27} b) 2.6×10^{13} c) 2.6×10^{-14} 7. a) 50 b) 5 c) 0.080 d) 0.067 8. a) 10^{14} b) 10^{7}

9. a) (1) Definition of mean values with $n^2 = \sum n^2 P_N(n)$ (2) $n^2 p^n = \left(p\frac{\partial}{\partial p}\right)^2 p^n$ (3) binomial expansion, $\sum_n \frac{N!}{n!(N-n)!} p^n q^{N-n} = (p+q)^N$ b) $\bar{n} = \left(p\frac{\partial}{\partial p}\right)(p+q)^n$ c) Just do the derivatives and evaluate them at p+q=1 (q=1-p, etc.). 10. a) 100 b) 9.1 c) A=0.0437, B=0.00600 d) 0.0437 e) 0.0326
11. 10^{116}

12. a) $\ln P(n) = N\ln N + \frac{1}{2}\ln N - n\ln n - \frac{1}{2}\ln n - (N-n)\ln(N-n) - \frac{1}{2}\ln(N-n) - \frac{1}{2}\ln(2\pi) + n\ln p + (N-n)\ln q$

b) - c) - d) - e) - 13. We know with certainty (i.e., probability=1) that a system must be in one of its possible cofigurations. Therefore, the sum over all configurations must give a total probability of one. 14.