2.13 a. We know that $P(S) = P(E_1 \cup E_2 \cup E_3 \cup E_4) = 1$ and, since the four events are pairwise mutually exclusive, $P(S) = P(E_1) + \ldots + P(E_4) = .01 + ? + .09 + .81$. Thus $? = P(E_2) = 1 - .91 = .09$.

b. $P(\text{at least one hit}) = P(E_1 \cup E_2 \cup E_3) = P(E_1) + P(E_2) + P(E_3) = .01 + .09 + .09 = .19$.

2.22 a. Let $w1$ denote the first wine, $w2$ the second, and $w3$ the third. Then one sample point would be an ordered triple indicating the rank of each wine. For example, $(w1, w2, w3)$ would indicate that $w1$ is superior to $w2$and $w3$ while $w2$ is superior to just $w3$.

b. The sample space is given by all of the possible ordered triples. That is,

$$(w1, w2, w3), (w1, w3, w2), (w2, w1, w3),$$
$$(w2, w3, w1), (w3, w1, w2), (w3, w2, w1)$$

c. Suppose $w1$ is superior to $w2$ and $w3$. Then the probability that the "expert" ranks $w1$ as first or second is

$$P[(w1, w2, w3) \text{ or } (w1, w3, w2) \text{ or } (w2, w1, w3) \text{ or } (w3, w1, w2)] = 4/6 = 2/3.$$

2.25 a. Define the events: E: family's income exceeds \$35,353
N: family's income does not exceed \$35,353

Then the sample points are

E_1: $(EEEE)$	E_2: $(EEEN)$	E_3: $(EENE)$	E_4: $(ENEE)$
E_5: $(NEEE)$	E_6: $(EENN)$	E_7: $(ENEN)$	E_8: $(NEEN)$
E_9 : $(ENNE)$	E_{10} : $(NENE)$	E_{11} : $(NNEE)$	E_{12} : $(ENNN)$
E_{13} : $(NENN)$	E_{14} : $(NNEN)$	E_{15} : $(NNNE)$	E_{16} : $(NNNN)$

b. $A = \{E_1, E_2, \ldots, E_{11}\}$
$B = \{E_6, E_7, \ldots, E_{11}\}$
$C = \{E_2, E_3, E_4, E_5\}$

c. By the definition of median $P(E) = P(N) = 0.5$. Therefore, each simple event is equally likely and $P(E_i) = \frac{1}{16}$. Then

$P(A) = \frac{11}{16}$ $\quad P(B) = \frac{3}{8}$ $\quad P(C) = \frac{1}{4}$

2.30 $(4)(3)(4)(5) = 240$ by an application of the mn rule.

2.35 $\binom{9}{3}\binom{6}{5} = \frac{9!}{3!5!1!} = 504$ ways

2.41 There are $\binom{50}{3} = 19{,}600$ ways to choose the three winners. Since the choice is random, each of the 19,600 sample points is equally likely.

a. There are $\binom{4}{3} = 4$ ways for the organizers to win all of the prizes. Hence, the desired probability is $\frac{4}{19{,}600}$.

b. The organizers can win exactly 2 of the prizes if 1 of the other 46 people wins 1 prize. Using the mn rule, there are $\binom{4}{2}\binom{46}{1} = 276$ ways for this to occur. Hence, the desired probability is $\frac{276}{19{,}600}$.

c. $\binom{4}{1}\binom{46}{2} = 4140$. The probability is $\frac{4140}{19{,}600}$.

d. $\binom{46}{3} = 15{,}180$. The desired probability is $\frac{15{,}180}{19{,}600}$.

2.44 The total number of ways to choose 4 students from 8 is $\binom{8}{4} = \frac{8!}{4!4!} = 70$. Since the choice is random, each of the 70 sample points is equally likely, and it remains only to determine how many sample points result in exactly 2 of the 3 undergraduates and 2 of the 5 graduates. Using the mn rule, this number is $(C_2^3)(C_2^5) = 3(10) = 30$ and the desired probability is $\frac{30}{70} = \frac{3}{7}$.

2.48 Refer to Theorem 2.3. The total number of ways to divide the 9 motors into 3 groups of size 3 is $\frac{9!}{3!3!3!}$. If both of the motors from a particular supplier are assigned to the first line, there are only 7 motors to be assigned, one to line 1 and 3 each to lines 2 and 3. This can be done in $\frac{7!}{1!3!3!}$ ways. Hence the probability of interest is

$$\frac{\left(\frac{7!}{1!3!3!}\right)}{\left(\frac{9!}{3!3!3!}\right)} = \frac{7!3!}{9!} = \frac{1}{12}.$$

2.50 $6!\left(\frac{1}{6}\right)^6 = \frac{5}{324}$