4.19 What's wrong? In each of the following scenarios, there is something wrong. Describe what is wrong and give a reason for your answer.

(a) If two events are disjoint, we can multiply their probabilities to determine the probability that they will both occur.

(b) If the probability of A is 0.6 and the probability of B is 0.5, the probability of both A and B happening is 1.1.

(c) If the probability of A is 0.35, then the probability of the complement of A is -0.35.

4.20 What's wrong? In each of the following scenarios, there is something wrong. Describe what is wrong and give a reason for your answer.

(a) If the sample space consists of two outcomes, then each outcome has probability 0.5.

4.23 Ringtones. What are the popular ringtones? The web site funtonia.com updates its list of top ringtones frequently. Here are probabilities for the top 10 ringtones listed by the site recently:[7]

Ringtone	Probability	Ringtone	Probability
Empire State of Mind	0.180	Bad Romance	0.081
Baby By Me	0.136	I Can Transform Ya	0.075
Forever	0.114	Down	0.070
Party in the USA	0.107	I Gotta Feeling	0.068
Fireflies	0.103	Money To Blow	0.066

(a) What is the probability that a randomly selected ringtone from this list is either Empire State of Mind or I Gotta Feeling?

(b) What is the probability that a randomly selected ringtone from this list is not Empire State of Mind and not I Gotta Feeling? Be sure to show how you computed this answer.

4.25 Distribution of blood types. All human blood can be "ABO-typed" as one of O, A, B, or AB, but the distribution of the types varies a bit among groups of people. Here is the distribution of blood types for a randomly chosen person in the United States:[8]

Blood type	A	B	AB	O
U.S. probability	0.42	0.11	?	0.44

(a) What is the probability of type AB blood in the United States?

(b) Maria has type B blood. She can safely receive blood transfusions from people with blood types O and B. What is the probability that a randomly chosen person from the United States can donate blood to Maria?

4.26 Blood types in Ireland. The distribution of blood types in Ireland differs from the U.S. distribution given in the previous exercise:

Blood type	A	B	AB	O
Ireland probability	0.35	0.10	0.03	0.52

Choose a person from the United States and a person from Ireland at random, independently of each other. What is the probability that both have type O blood? What is the probability that both have the same blood type?

4.27 Are the probabilities legitimate? In each of the following situations, state whether or not the given assignment of probabilities to individual outcomes is legitimate, that is, satisfies the rules of probability. If not, give specific reasons for your answer.

(a) Choose a college student at random and record gender and enrollment status: $P(\text{female full-time}) = 0.44$, $P(\text{female part-time}) = 0.56$, $P(\text{male full-time}) = 0.46$, $P(\text{male part-time}) = 0.54$.

(b) Deal a card from a shuffled deck: $P(\text{clubs}) = 16/52$, $P(\text{diamonds}) = 12/52$, $P(\text{hearts}) = 12/52$, $P(\text{spades}) = 12/52$.

(c) Roll a die and record the count of spots on the up-face: $P(1) = 1/3$, $P(2) = 0$, $P(3) = 1/6$, $P(4) = 1/3$, $P(5) = 1/6$, $P(6) = 0$.

4.32 Roulette. A roulette wheel has 38 slots, numbered 0, 00, and 1 to 36. The slots 0 and 00 are colored green, 18 of the others are red, and 18 are black. The dealer spins the wheel and at the same time rolls a small ball along the wheel in the opposite direction. The wheel is carefully balanced so that the ball is equally likely to land in any slot when the wheel slows. Gamblers can bet on various combinations of numbers and colors.

(a) What is the probability that the ball will land in any one slot?

(b) If you bet on "red," you win if the ball lands in a red slot. What is the probability of winning?

(c) The slot numbers are laid out on a board on which gamblers place their bets. One column of numbers on the board contains all multiples of 3, that is, 3, 6, 9, ..., 36. You place a "column bet" that wins if any of these numbers comes up. What is your probability of winning?

4.19. (a) The probability that both of two disjoint events occur is 0. (Multiplication is appropriate for *independent* events.) (b) Probabilities must be no more than 1; $P(A \text{ and } B)$ will be no more than 0.5. (We cannot determine this probability exactly from the given information.) (c) $P(A^c) = 1 - 0.35 = 0.65$.

4.20. (a) The two outcomes (say, A and B) in the sample space need not be equally likely. The only requirements are that $P(A) \geq 0$, $P(B) \geq 0$, and $P(A) + P(B) = 1$. (b) In a table of random digits, each digit has probability 0.1. (c) If A and B were independent, then $P(A \text{ and } B)$ would equal $P(A)P(B) = 0.06$. (That is, probabilities are multiplied, not added.) In fact, the given probabilities are impossible, because $P(A \text{ and } B)$ must be less than the smaller of $P(A)$ and $P(B)$.

4.23. (a) $P(\text{“Empire State of Mind” or “I Gotta Feeling”}) = 0.180 + 0.068 = 0.248$.
   (b) $P(\text{neither “Empire State of Mind” nor “I Gotta Feeling”}) = 1 - 0.248 = 0.752$.

4.25. (a) The given probabilities have sum 0.97, so $P(\text{type AB}) = 0.03$.
   (b) $P(\text{type O or B}) = 0.44 + 0.11 = 0.55$.

4.26. $P(\text{both are type O}) = (0.44)(0.52) = 0.2288$; $P(\text{both are the same type}) = (0.42)(0.35) + (0.11)(0.10) + (0.03)(0.03) + (0.44)(0.52) = 0.3877$.

4.27. (a) Not legitimate because the probabilities sum to 2. (b) Legitimate (for a nonstandard deck). (c) Legitimate (for a nonstandard die).

4.32. (a) All are equally likely; the probability is 1/38. (b) Because 18 slots are red, the probability of a red is $P(\text{red}) = \frac{18}{38} \doteq 0.474$. (c) There are 12 winning slots, so $P(\text{win a column bet}) = \frac{12}{38} \doteq 0.316$.