

Chapter 7

7.1 a The values in cents are 0, 1, 2, ...

b Yes, because we can identify the first, second, etc.

c Yes, it is finite because students cannot earn an infinite amount of money.

d Technically, the variable is discrete.

7.2 a 0, 1, 2, ..., 100

b Yes.

c Yes, there are 101 values.

d The variable is discrete because it is countable.

7.3 a 0, 1, 2, ...

b Yes, we can identify the first value (0), the second (1), and so on.

c It is finite, because the number of cars is finite.

d The variable is discrete because it is countable.

7.4 a any value between 0 and several hundred miles

b No, because we cannot identify the second value or any other value larger than 0.

c No, uncountable means infinite.

d The variable is continuous.

7.5 a No the sum of probabilities is not equal to 1.

b Yes, because the probabilities lie between 0 and 1 and sum to 1.

c No, because the probabilities do not sum to 1.

7.6 $P(x) = 1/6$ for $x = 1, 2, 3, 4, 5,$ and 6

7.7 a

<u>x</u>	<u>P(x)</u>
0	$24,750/165,000 = .15$
1	$37,950/165,000 = .23$
2	$59,400/165,000 = .36$
3	$29,700/165,000 = .18$
4	$9,900/165,000 = .06$
5	$3,300/165,000 = .02$

b (i) $P(X \leq 2) = P(0) + P(1) + P(2) = .15 + .23 + .36 = .74$

(ii) $P(X > 2) = P(3) + P(4) + P(5) = .18 + .06 + .02 = .26$

(iii) $P(X \geq 4) = P(4) + P(5) = .06 + .02 = .08$

7.8 a $P(2 \leq X \leq 5) = P(2) + P(3) + P(4) + P(5) = .310 + .340 + .220 + .080 = .950$

$$P(X > 5) = P(6) + P(7) = .019 + .001 = .020$$

$$P(X < 4) = P(0) + P(1) + P(2) + P(3) = .005 + .025 + .310 + .340 = .680$$

$$b. E(X) = \sum xP(x) = 0(.005) + 1(.025) + 2(.310) + 4(.340) + 5(.080) + 6(.019) + 7(.001) = 3.066$$

$$c. \sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (0 - 3.066)^2 (.005) + (1 - 3.066)^2 (.025) + (2 - 3.066)^2 (.310) \\ + (3 - 3.066)^2 (.340) + (4 - 3.066)^2 (.220) + (5 - 3.066)^2 (.080) + (6 - 3.066)^2 (.019) \\ + (7 - 3.066)^2 (.001) = 1.178$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{1.178} = 1.085$$

$$7.9 P(0) = P(1) = P(2) = \dots = P(10) = 1/11 = .091$$

$$7.10 a P(X > 0) = P(2) + P(6) + P(8) = .2 + .4 + .1 = .7$$

$$b P(X \geq 1) = P(2) + P(6) + P(8) = .2 + .4 + .1 = .7$$

$$c P(X \geq 2) = P(2) + P(6) + P(8) = .2 + .4 + .1 = .7$$

$$d P(2 \leq X \leq 5) = P(2) = .2$$

$$7.11a P(3 \leq X \leq 6) = P(3) + P(4) + P(5) + P(6) = .04 + .28 + .42 + .21 = .95$$

$$b. P(X > 6) = P(X \geq 7) = P(7) + P(8) = .02 + .02 = .04$$

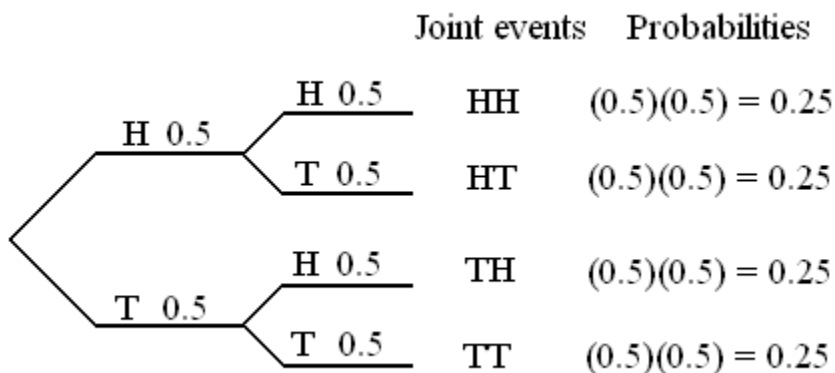
$$c. P(X < 3) = P(X \leq 2) = P(0) + P(1) + P(2) = 0 + 0 + .01 = .01$$

$$7.12 P(\text{Losing 6 in a row}) = .5^6 = .0156$$

$$7.13 a P(X < 2) = P(0) + P(1) = .10 + .43 = .53$$

$$b P(X > 1) = P(2) + P(3) = .26 + .21 = .47$$

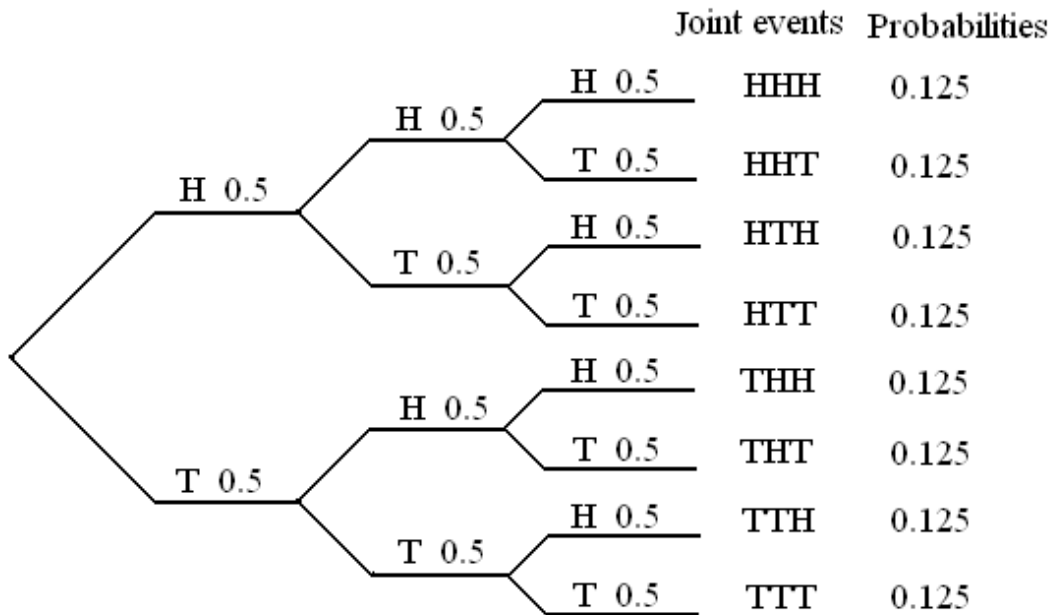
7.14



- a $P(HH) = .25$
- b $P(HT) = .25$
- c $P(TH) = .25$
- d $P(TT) = .25$

- 7.15 a $P(0 \text{ heads}) = P(TT) = .25$
- b $P(1 \text{ head}) = P(HT) + P(TH) = .25 + .25 = .50$
- c $P(2 \text{ heads}) = P(HH) = .25$
- d $P(\text{at least 1 head}) = P(1 \text{ head}) + P(2 \text{ heads}) = .50 + .25 = .75$

7.16



- 7.17 a $P(2 \text{ heads}) = P(HHT) + P(HTH) + P(THH) = .125 + .125 + .125 = .375$
- b $P(1 \text{ heads}) = P(HTT) + P(THT) = P(TTH) = .125 + .125 + .125 = .375$
- c $P(\text{at least 1 head}) = P(1 \text{ head}) + P(2 \text{ heads}) + P(3 \text{ heads}) = .375 + .375 + .125 = .875$
- d $P(\text{at least 2 heads}) = P(2 \text{ heads}) + P(3 \text{ heads}) = .375 + .125 = .500$

7.18a. $\mu = E(X) = \sum xP(x) = -4(.59) + 5(.15) + 7(.25) + 8(.01) = .22$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (-4 - .22)^2 (.59) + (5 - .22)^2 (.15) + (7 - .22)^2 (.25) + (8 - .22)^2 (.01)$$

$$= 26.03$$

b.	x	-4	5	7	8
	y	-20	25	35	40
	P(y)	.59	.15	.25	.01

$$c. E(Y) = \sum yP(y) = -20(.59) + 25(.15) + 35(.25) + 40(.01) = 1.10$$

$$V(Y) = \sum (y - \mu)^2 P(y) = (-20 - 1.10)^2 (.59) + (25 - 1.10)^2 (.15) + (35 - 1.10)^2 (.25) + (40 - 1.10)^2 (.01) = 650.8$$

$$d. E(Y) = E(5X) = 5E(X) = 5(.22) = 1.10$$

$$V(Y) = V(5X) = 5^2 V(X) = 25(26.03) = 650.8.$$

$$7.19a \mu = E(X) = \sum xP(x) = 0(.1) + 1(.3) + 2(.2) + 3(.4) = 1.9$$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (0 - 1.9)^2 (.1) + (1 - 1.9)^2 (.3) + (2 - 1.9)^2 (.2) + (3 - 1.9)^2 (.4) = 1.09$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{1.09} = 1.044$$

b.	x	0	1	2	3
	y	2	5	8	11
	P(y)	.1	.3	.2	.4

$$c. E(Y) = \sum yP(y) = 2(.1) + 5(.3) + 8(.2) + 11(.4) = 7.7$$

$$\sigma^2 = V(Y) = \sum (y - \mu)^2 P(y) = (2 - 7.7)^2 (.1) + (5 - 7.7)^2 (.3) + (8 - 7.7)^2 (.2) + (11 - 7.7)^2 (.4) = 9.81$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{9.81} = 3.12$$

$$d. E(Y) = E(3X + 2) = 3E(X) + 2 = 3(1.9) + 2 = 7.7$$

$$\sigma^2 = V(Y) = V(3X + 2) = V(3X) = 3^2 V(X) = 9(1.09) = 9.81$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{9.81} = 3.12$$

The parameters are identical.

$$7.20a. P(X \geq 2) = P(2) + P(3) = .4 + .1 = .5$$

$$b. \mu = E(X) = \sum xP(x) = 0(.2) + 1(.3) + 2(.4) + 3(.1) = 1.4$$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (0 - 1.4)^2 (.2) + (1 - 1.4)^2 (.3) + (2 - 1.4)^2 (.4) + (3 - 1.4)^2 (.1) = .84$$

$$7.21 E(\text{Profit}) = E(5X) = 5E(X) = 5(1.4) = 7.0$$

$$V(\text{Profit}) = V(5X) = 5^2 V(X) = 25(.84) = 21.0$$

$$7.22 a P(X > 4) = P(5) + P(6) + P(7) = .20 + .10 + .10 = .40$$

$$b P(X \geq 2) = 1 - P(X \leq 1) = 1 - P(1) = 1 - .05 = .95$$

$$7.23 \mu = E(X) = \sum xP(x) = 1(.05) + 2(.15) + 3(.15) + 4(.25) + 5(.20) + 6(.10) + 7(.10) = 4.1$$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (1 - 4.1)^2 (.05) + (2 - 4.1)^2 (.15) + (3 - 4.1)^2 (.15) + (4 - 4.1)^2 (.25) \\ + (5 - 4.1)^2 (.20) + (6 - 4.1)^2 (.10) + (7 - 4.1)^2 (.10) = 2.69$$

$$7.24 Y = .25X; E(Y) = .25E(X) = .25(4.1) = 1.025$$

$$V(Y) = V(.25X) = (.25)^2 (2.69) = .168$$

7.25 a.	x	1	2	3	4	5	6	7
	y	.25	.50	.75	1.00	1.25	1.50	1.75
	P(y)	.05	.15	.15	.25	.20	.10	.10

$$b. E(Y) = \sum yP(y) = .25(.05) + .50(.15) + .75(.15) + 1.00(.25) + 1.25(.20) + 1.50(.10) + 1.75(.10) \\ = 1.025$$

$$V(Y) = \sum (y - \mu)^2 P(y) = (.25 - 1.025)^2 (.05) + (.50 - 1.025)^2 (.15) + (.75 - 1.025)^2 (.15) \\ + (1.00 - 1.025)^2 (.25) + (1.25 - 1.025)^2 (.20) + (1.50 - 1.025)^2 (.10) + (1.75 - 1.025)^2 (.10) = .168$$

c. The answers are identical.

$$7.26 a P(4) = .06$$

$$b P(8) = 0$$

$$c P(0) = .35$$

$$d P(X \geq 1) = 1 - P(0) = 1 - .35 = .65$$

$$7.27 a P(X \geq 20) = P(20) + P(25) + P(30) + P(40) + P(50) + P(75) + P(100) \\ = .08 + .05 + .04 + .04 + .03 + .03 + .01 = .28$$

$$b P(X = 60) = 0$$

$$c P(X > 50) = P(75) + P(100) = .03 + .01 = .04$$

$$d P(X > 100) = 0$$

$$7.28 a P(X = 3) = P(3) = .21$$

$$b P(X \geq 5) = P(5) + P(6) + P(7) + P(8) = .12 + .08 + .06 + .05 = .31$$

$$c P(5 \leq X \leq 7) = P(5) + P(6) + P(7) = .12 + .08 + .06 = .26$$

$$7.29 a P(X > 1) = P(2) + P(3) + P(4) = .17 + .06 + .01 = .24$$

$$b P(X = 0) = .45$$

$$c P(1 \leq X \leq 3) = P(1) + P(2) + P(3) = .31 + .17 + .06 = .54$$

$$7.30 \mu = E(X) = \sum xP(x) = 0(.04) + 1(.19) + 2(.22) + 3(.28) + 4(.12) + 5(.09) + 6(.06) = 2.76$$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (1 - 2.76)^2 (.04) + (2 - 2.76)^2 (.19) + (3 - 2.76)^2 (.28) \\ + (4 - 2.76)^2 (.12) + (5 - 2.76)^2 (.09) + (6 - 2.76)^2 (.06) = 2.302$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{2.302} = 1.517$$

$$7.31 Y = 10X; E(Y) = E(10X) = 10E(X) = 10(2.76) = 27.6$$

$$V(Y) = V(10X) = 10^2 V(X) = 100(2.302) = 230.2$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{230.2} = 15.17$$

$$7.32 \mu = E(X) = \sum xP(x) = 1(.24) + 2(.18) + 3(.13) + 4(.10) + 5(.07) + 6(.04) + 7(.04) + 8(.20) = 3.86$$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (1 - 3.86)^2 (.24) + (2 - 3.86)^2 (.18) + (3 - 3.86)^2 (.13) + (4 - 3.86)^2 (.10) \\ + (5 - 3.86)^2 (.07) + (6 - 3.86)^2 (.04) + (7 - 3.86)^2 (.04) + (8 - 3.86)^2 (.20) = 6.78$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{6.78} = 2.60$$

$$7.33 \text{ Revenue} = 2.50X; E(\text{Revenue}) = E(2.50X) = 2.50E(X) = 2.50(3.86) = 9.65$$

$$V(\text{Revenue}) = V(2.50X) = 2.50^2 V(X) = 6.25(6.78) = 42.38$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{42.38} = 6.51$$

$$7.34 E(\text{Value of coin}) = 400(.40) + 900(.30) + 100(.30) = 460. \text{ Take the } \$500.$$

$$7.35 \mu = E(X) = \sum xP(x) = 0(.10) + 1(.20) + 2(.25) + 3(.25) + 4(.20) = 2.25$$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (0 - 2.25)^2 (.10) + (1 - 2.25)^2 (.20) + (2 - 2.25)^2 (.25) + (3 - 2.25)^2 (.13) \\ + (4 - 2.25)^2 (.20) = 1.59$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{1.59} = 1.26$$

$$7.36 E(\text{damage costs}) = .01(400) + .02(200) + .10(100) + .87(0) = 18. \text{ The owner should pay up to } \$18 \text{ for the device.}$$

$$7.37 E(X) = \sum xP(x) = 1,000,000(1/10,000,000) + 200,000(1/1,000,000) + 50,000(1/500,000) \\ + 10,000(1/50,000) + 1,000(1/10,000) = .1 + .2 + .1 + .2 + .1 = .7$$

Expected payoff = 70 cents.

$$7.38 \mu = E(X) = \sum xP(x) = 1(.05) + 2(.12) + 3(.20) + 4(.30) + 5(.15) + 6(.10) + 7(.08) = 4.00 \\ \sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (1-4.0)^2 (.05) + (2-4.0)^2 (.12) + (3-4.0)^2 (.20) + (4-4.0)^2 (.30) \\ + (5-4.0)^2 (.15) + (6-4.0)^2 (.10) + (7-4.0)^2 (.08) = 2.40$$

$$7.39 Y = .25X; E(Y) = E(.25X) = .25E(X) = .25(4.0) = 1.0$$

$$V(Y) = V(.25X) = (.25)^2 V(X) = .0625(2.40) = .15$$

$$7.40 \mu = E(X) = \sum xP(x) = 0(.10) + 1(.25) + 2(.40) + 3(.20) + 4(.05) = 1.85$$

$$7.41 \text{ Profit} = 4X; \text{ Expected profit} = E(4X) = 4E(X) = 4(1.85) = \$7.40$$

$$7.42 \text{ Breakeven point} = 15,000 / (7.40 - 3.00) = 3,409$$

$$7.43 \text{ a } \begin{array}{r} \underline{x} \quad P(x) \\ 1 \quad .6 \\ 2 \quad .4 \end{array}$$

$$\text{b } \begin{array}{r} \underline{y} \quad P(y) \\ 1 \quad .6 \\ 2 \quad .4 \end{array}$$

$$\text{c } \mu = E(X) = \sum xP(x) = 1(.6) + 2(.4) = 1.4$$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (1-1.4)^2 (.6) + (2-1.4)^2 (.4) = .24$$

$$\text{d } \mu = 1.4, \sigma^2 = .24$$

$$7.44 \text{ a } \sum_{\text{all } x} \sum_{\text{all } y} xyP(x, y) = (1)(1)(.5) + (1)(2)(.1) + (2)(1)(.1) + (2)(2)(.3) = 2.1$$

$$\text{COV}(X, Y) = \sum_{\text{all } x} \sum_{\text{all } y} xyP(x, y) - \mu_x \mu_y = 2.1 - (1.4)(1.4) = .14$$

$$\sigma_x = \sqrt{\sigma_x^2} = \sqrt{.24} = .49, \sigma_y = \sqrt{\sigma_y^2} = \sqrt{.24} = .49$$

$$\rho = \frac{\text{COV}(X, Y)}{\sigma_x \sigma_y} = \frac{.14}{(.49)(.49)} = .58$$

$$7.45 \ E(X + Y) = E(X) + E(Y) = 1.4 + 1.4 = 2.8$$

$$V(X + Y) = V(X) + V(Y) + 2\text{COV}(X, Y) = .24 + .24 + 2(.14) = .76$$

$$7.46 \ a \quad \begin{array}{c} \underline{x+y} \quad \underline{P(x+y)} \\ 2 \quad .5 \\ 3 \quad .2 \\ 4 \quad .3 \end{array}$$

$$2 \quad .5$$

$$3 \quad .2$$

$$4 \quad .3$$

$$b \ \mu_{x+y} = E(X+Y) = \sum (x+y)P(x+y) = 2(.5) + 3(.2) + 4(.3) = 2.8$$

$$\sigma_{x+y}^2 = V(X+Y) = \sum [(x+y) - \mu_{x+y}]^2 P(x+y) = (2-2.8)^2 (.5) + (3-2.8)^2 (.2) + (4-2.8)^2 (.3) = .76$$

c Yes

$$7.47 \ a \quad \begin{array}{c} \underline{x} \quad \underline{P(x)} \\ 1 \quad .4 \\ 2 \quad .6 \end{array}$$

$$1 \quad .4$$

$$2 \quad .6$$

$$b \quad \begin{array}{c} \underline{y} \quad \underline{P(y)} \\ 1 \quad .7 \\ 2 \quad .3 \end{array}$$

$$1 \quad .7$$

$$2 \quad .3$$

$$c \ \mu = E(X) = \sum xP(x) = 1(.4) + 2(.6) = 1.6$$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (1-1.6)^2 (.4) + (2-1.6)^2 (.6) = .24$$

$$d \ \mu = E(Y) = \sum yP(y) = 1(.7) + 2(.3) = 1.3$$

$$\sigma^2 = V(Y) = \sum (y - \mu)^2 P(y) = (1-1.3)^2 (.7) + (2-1.3)^2 (.3) = .21$$

$$7.48 \ a \quad \sum_{\text{all } x} \sum_{\text{all } y} xyP(x, y) = (1)(1)(.28) + (1)(2)(.12) + (2)(1)(.42) + (2)(2)(.18) = 2.08$$

$$\text{COV}(X, Y) = \sum_{\text{all } x} \sum_{\text{all } y} xyP(x, y) - \mu_x \mu_y = 2.08 - (1.6)(1.3) = 0$$

$$\sigma_x = \sqrt{\sigma_x^2} = \sqrt{.24} = .49, \ \sigma_y = \sqrt{\sigma_y^2} = \sqrt{.21} = .46$$

$$\rho = \frac{\text{COV}(X, Y)}{\sigma_x \sigma_y} = \frac{0}{(.49)(.46)} = 0$$

$$7.49 \ E(X + Y) = E(X) + E(Y) = 1.6 + 1.3 = 2.9$$

$$V(X + Y) = V(X) + V(Y) + 2\text{COV}(X, Y) = .24 + .21 + 2(0) = .45$$

7.50 a

$x + y$	$P(x + y)$
2	.28
3	.54
4	.18

b $\mu_{x+y} = E(X+Y) = \sum (x+y)P(x+y) = 2(.28) + 3(.54) + 4(.18) = 2.9$

$$\sigma_{x+y}^2 = V(X+Y) = \sum [(x+y) - \mu_{x+y}]^2 P(x+y) = (2-2.9)^2 (.28) + (3-2.9)^2 (.54) + (4-2.9)^2 (.18) = .45$$

c Yes

7.51 a

x	$P(x)$	y	$P(y)$
1	.7	1	.6
2	.2	2	.4
3	.1		

b $\mu_x = E(X) = \sum xP(x) = 1(.7) + 2(.2) + 3(.1) = 1.4$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (1-1.4)^2 (.7) + (2-1.4)^2 (.2) + (3-1.4)^2 (.1) = .44$$

$$\mu_y = E(Y) = \sum yP(y) = 1(.6) + 2(.4) = 1.4$$

$$\sigma^2 = V(Y) = \sum (y - \mu)^2 P(y) = (1-1.4)^2 (.6) + (2-1.4)^2 (.4) = .24$$

$$\sum_{\text{all } x} \sum_{\text{all } y} xyP(x, y) = (1)(1)(.42) + (1)(2)(.28) + (2)(1)(.12) + (2)(2)(.08) + (3)(1)(.06) + (3)(2)(.04) = 1.96$$

$$\text{COV}(X, Y) = \sum_{\text{all } x} \sum_{\text{all } y} xyP(x, y) - \mu_x \mu_y = 1.96 - (1.4)(1.4) = 0$$

$$\sigma_x = \sqrt{\sigma_x^2} = \sqrt{.44} = .66, \quad \sigma_y = \sqrt{\sigma_y^2} = \sqrt{.24} = .49$$

$$\rho = \frac{\text{COV}(X, Y)}{\sigma_x \sigma_y} = \frac{0}{(.66)(.49)} = 0$$

c

$x + y$	$P(x + y)$
2	.42
3	.40
4	.14
5	.04

7.52

	x		
y	0	1	2
1	.42	.21	.07
2	.18	.09	.03

7.53

	x	
y	0	1
1	.04	.16
2	.08	.32
3	.08	.32

7.54 a

Refrigerators, x	P(x)
0	.22
1	.49
2	.29

b

Stoves, y	P(y)
0	.34
1	.39
2	.27

c $\mu_x = E(X) = \sum xP(x) = 0(.22) + 1(.49) + 2(.29) = 1.07$

$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (0 - 1.07)^2 (.22) + (1 - 1.07)^2 (.49) + (2 - 1.07)^2 (.29) = .505$

d $\mu_y = E(Y) = \sum yP(y) = 0(.34) + 1(.39) + 2(.27) = .93$

$\sigma^2 = V(Y) = \sum (y - \mu)^2 P(y) = (0 - .93)^2 (.34) + (1 - .93)^2 (.39) + (2 - .93)^2 (.27) = .605$

e $\sum_{\text{all } x} \sum_{\text{all } y} xyP(x, y) = (0)(1)(.08) + (0)(1)(.09) + (0)(2)(.05) + (1)(0)(.14) + (1)(1)(.17)$

$+ (1)(2)(.18) + (2)(0)(.12) + (2)(1)(.13) + (2)(2)(.04) = .95$

$\text{COV}(X, Y) = \sum_{\text{all } x} \sum_{\text{all } y} xyP(x, y) - \mu_x \mu_y = .95 - (1.07)(.93) = -.045$

$\sigma_x = \sqrt{\sigma_x^2} = \sqrt{.505} = .711, \sigma_y = \sqrt{\sigma_y^2} = \sqrt{.605} = .778$

$\rho = \frac{\text{COV}(X, Y)}{\sigma_x \sigma_y} = \frac{-.045}{(.711)(.778)} = -.081$

7.55 a

Bottles, x	P(x)
0	.72
1	.28

b	<u>Cartons, y</u>	<u>P(y)</u>
	0	.81
	1	.19

$$c \mu_x = E(X) = \sum xP(x) = 0(.72) + 1(.28) = .28$$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (0 - .28)^2 (.72) + (1 - .28)^2 (.28) = .202$$

$$d \mu_y = E(Y) = \sum yP(y) = 0(.81) + 1(.19) = .19$$

$$\sigma^2 = V(Y) = \sum (y - \mu)^2 P(y) = (0 - .19)^2 (.81) + (1 - .19)^2 (.19) = .154$$

$$e \sum_{\text{all } x} \sum_{\text{all } y} xyP(x, y) = (0)(0)(.63) + (0)(1)(.09) + (1)(0)(.18) + (1)(1)(.10) = .100$$

$$\text{COV}(X, Y) = \sum_{\text{all } x} \sum_{\text{all } y} xyP(x, y) - \mu_x \mu_y = .100 - (.28)(.19) = .0468$$

$$\sigma_x = \sqrt{\sigma_x^2} = \sqrt{.202} = .449, \sigma_y = \sqrt{\sigma_y^2} = \sqrt{.154} = .392$$

$$\rho = \frac{\text{COV}(X, Y)}{\sigma_x \sigma_y} = \frac{.100}{(.449)(.392)} = .568$$

$$7.56 \text{ a } P(X = 1 | Y = 0) = P(X=1 \text{ and } Y = 0)/P(Y = 0) = .14/.34 = .412$$

$$\text{b } P(Y = 0 | X = 1) = P(X=1 \text{ and } Y = 0)/P(X = 1) = .14/.49 = .286$$

$$\text{c } P(X = 2 | Y = 2) = P(X=2 \text{ and } Y = 2)/P(Y = 2) = .04/.27 = .148$$

$$7.57 E\left(\sum X_i\right) = \sum E(X_i) = 18 + 12 + 27 + 8 = 65$$

$$V\left(\sum X_i\right) = \sum V(X_i) = 8 + 5 + 6 + 2 = 21$$

$$7.58 E\left(\sum X_i\right) = \sum E(X_i) = 35 + 20 + 20 + 50 + 20 = 145$$

$$V\left(\sum X_i\right) = \sum V(X_i) = 8 + 5 + 4 + 12 + 2 = 31$$

$$\sigma = \sqrt{31} = 5.57$$

$$7.59 E\left(\sum X_i\right) = \sum E(X_i) = 8 + 14 + 5 + 3 + 30 + 30 + 10 = 100$$

$$V\left(\sum X_i\right) = \sum V(X_i) = 2 + 5 + 1 + 1 + 8 + 10 + 3 = 30$$

$$7.60 E\left(\sum X_i\right) = \sum E(X_i) = 10 + 3 + 30 + 5 + 100 + 20 = 168$$

$$V\left(\sum X_i\right) = \sum V(X_i) = 9 + 0 + 100 + 1 + 400 + 64 = 574$$

$$\sigma = \sqrt{574} = 24.0$$

$$7.61 E(R_p) = w_1 E(R_1) + w_2 E(R_2) = (.30)(.12) + (.70)(.25) = .211$$

$$\begin{aligned} V(R_p) &= w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho \sigma_1 \sigma_2 \\ &= (.30)^2 (.02)^2 + (.70)^2 (.15^2) + 2(.30)(.70)(.5)(.02)(.15) = .0117 \end{aligned}$$

$$\sigma_{R_p} = \sqrt{.0117} = .1081$$

$$7.62 E(R_p) = .211$$

$$\begin{aligned} V(R_p) &= w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho \sigma_1 \sigma_2 \\ &= (.30)^2 (.02)^2 + (.70)^2 (.15^2) + 2(.30)(.70)(.25)(.02)(.15) = .0114 \end{aligned}$$

$$\sigma_{R_p} = \sqrt{.0114} = .1067$$

$$7.63 E(R_p) = .211$$

$$\begin{aligned} V(R_p) &= w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho \sigma_1 \sigma_2 \\ &= (.30)^2 (.02)^2 + (.70)^2 (.15^2) + 2(.30)(.70)(0)(.02)(.15) \\ &= .0111 \end{aligned}$$

$$\sigma_{R_p} = \sqrt{.0111} = .1054$$

7.64 The expected value does not change. The standard deviation decreases.

7.65 a She should choose stock 2 because its expected value is higher.

b. She should choose stock 1 because its standard deviation is smaller.

$$7.66 E(R_p) = w_1 E(R_1) + w_2 E(R_2) = (.60)(.09) + (.40)(.13) = .1060$$

$$\begin{aligned} V(R_p) &= w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho \sigma_1 \sigma_2 \\ &= (.60)^2 (.15)^2 + (.40)^2 (.21^2) + 2(.60)(.40)(.4)(.15)(.21) = .0212 \end{aligned}$$

$$7.67 E(R_p) = w_1 E(R_1) + w_2 E(R_2) = (.30)(.09) + (.70)(.13) = .1180$$

$$\begin{aligned} V(R_p) &= w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho \sigma_1 \sigma_2 \\ &= (.30)^2 (.15)^2 + (.70)^2 (.21^2) + 2(.30)(.70)(.4)(.15)(.21) = .0289 \end{aligned}$$

The statistics used in Exercises 7.68 to 7.80 were computed by Excel. The variances were taken from the variance-covariance matrix. As a result they are the population parameters. To convert to statistics multiply the variance of the portfolio returns by $n/(n-1)$.

7.68 a

Stock	1	2	3
Means	.0463	.1293	-.0016
Variances	.0148	.0100	.0039

b Invest all your money in stock 2; it has the largest mean return.

c Invest all your money in stock 3; it has the smallest variance.

7.69 a

	A	B	C	D	E
1	Portfolio of 3 Stocks				
2			Stock 1	Stock 2	Stock 3
3	Variance-Covariance Matrix	Stock 1	0.0148		
4		Stock 2	0.0037	0.0100	
5		Stock 3	0.0015	-0.0012	0.0039
6					
7	Expected Returns		0.0463	0.1293	-0.0016
8					
9	Weights		0.3333	0.3333	0.3333
10					
11	Portfolio Return				
12	Expected Value	0.0580			
13	Variance	0.0041			
14	Standard Deviation	0.0640			

b The mean return on the portfolio is greater than the mean returns on stocks 1 and 3, but smaller than that of stock 2. The variance of the returns on the portfolio is smaller than that for stocks 1 and 2 and slightly larger than that of stock 3.

7.70 a

	A	B	C	D	E
1	Portfolio of 3 Stocks				
2			Stock 1	Stock 2	Stock 3
3	Variance-Covariance Matrix	Stock 1	0.0148		
4		Stock 2	0.0037	0.0100	
5		Stock 3	0.0015	-0.0012	0.0039
6					
7	Expected Returns		0.0463	0.1293	-0.0016
8					
9	Weights		0.5	0.3	0.2
10					
11	Portfolio Return				
12	Expected Value	0.0616			
13	Variance	0.0060			
14	Standard Deviation	0.0777			

b The mean return on this portfolio is greater than the mean returns on stocks 1 and 3 and the portfolio in Exercise 7.69, but smaller than that of stock 2. The variance of the returns on this portfolio is smaller than that for stocks 1 and 2 and larger than that of stock 3 and the portfolio in Exercise 7.69.

7.71 a

Stock	1	2	3
Means	.0232	.0601	.0136
Variances	.0957	.2345	.0515

b Invest all your money in stock 2; it has the largest mean return.

c Invest all your money in stock 3; it has the smallest variance.

7.72 a

	A	B	C	D	E
1	Portfolio of 3 Stocks				
2			Stock 1	Stock 2	Stock 3
3	Variance-Covariance Matrix	Stock 1	0.0957		
4		Stock 2	-0.0288	0.2345	
5		Stock 3	0.0004	0.0243	0.0515
6					
7	Expected Returns		0.0232	0.0601	0.0136
8					
9	Weights		0.3	0.4	0.3
10					
11	Portfolio Return				
12	Expected Value	0.0351			
13	Variance	0.0498			
14	Standard Deviation	0.2231			

b The mean return on the portfolio is greater than the mean returns on stocks 1 and 3, but smaller than that of stock 2. The variance of the returns on the portfolio is smaller than that for the three stocks.

7.73 a

	A	B	C	D	E
1	Portfolio of 3 Stocks				
2			Stock 1	Stock 2	Stock 3
3	Variance-Covariance Matrix	Stock 1	0.0957		
4		Stock 2	-0.0288	0.2345	
5		Stock 3	0.0004	0.0243	0.0515
6					
7	Expected Returns		0.0232	0.0601	0.0136
8					
9	Weights		0.1	0.1	0.8
10					
11	Portfolio Return				
12	Expected Value	0.0192			
13	Variance	0.0397			
14	Standard Deviation	0.1991			

b The mean return on this portfolio is greater than the mean return on stock 3, but smaller than that of stocks 1 and 2 and the portfolio in Exercise 7.72. The variance of the returns on this portfolio is smaller than that for all three stocks and the portfolio in Exercise 7.72.

7.74 a

Stock	1	2	3	4
Means	.0187	-.0176	.0153	.0495
Variances	.0615	.0232	.0228	.0517

b Invest all your money in stock 4; it has the largest mean return.

c Invest all your money in stock 3; it has the smallest variance.

7.75 a

	A	B	C	D	E	F
1	Portfolio of 4 Stocks					
2			Stock 1	Stock 2	Stock 3	Stock 4
3	Variance-Covariance Matrix	Stock 1	0.0615			
4		Stock 2	-0.0012	0.0232		
5		Stock 3	0.0168	-0.0022	0.0228	
6		Stock 4	0.0129	0.0179	-0.0005	0.0517
7						
8	Expected Returns		0.0187	-0.0176	0.0153	0.0495
9						
10	Weights		0.25	0.25	0.25	0.25
11						
12	Portfolio Return					
13	Expected Value	0.0165				
14	Variance	0.0154				
15	Standard Deviation	0.1241				

b The mean return on the portfolio is greater than the mean returns on stocks 2 and 3, but smaller than that of stocks 1 and 4. The variance of the returns on the portfolio is smaller than that for the four stocks.

7.76 a

	A	B	C	D	E	F
1	Portfolio of 4 Stocks					
2			Stock 1	Stock 2	Stock 3	Stock 4
3	Variance-Covariance Matrix	Stock 1	0.0615			
4		Stock 2	-0.0012	0.0232		
5		Stock 3	0.0168	-0.0022	0.0228	
6		Stock 4	0.0129	0.0179	-0.0005	0.0517
7						
8	Expected Returns		0.0187	-0.0176	0.0153	0.0495
9						
10	Weights		0.20	0.20	0.10	0.50
11						
12	Portfolio Return					
13	Expected Value	0.0265				
14	Variance	0.0231				
15	Standard Deviation	0.1521				

b The mean return on this portfolio is greater than the mean return on stocks 1, 2, and 3, and the mean return on the portfolio in Exercise 7.75. It is smaller than the mean return on stock 4. The variance of the returns on this portfolio is smaller than that for stocks 1, 2, and 4, but larger than the variance on the returns of stock 3 and the variance of the returns on the portfolio in Exercise 7.75.

7.77 a

Stock	GE	Seagram	Coca-Cola	McDonald's
Means	.0231	.0148	.0213	.0156
Variances	.0019	.0043	.0017	.0025

b Invest all your money in General Electric; it has the largest mean return.

c Invest all your money in Coca-Cola; it has the smallest variance.

7.78 a

	GE	SEAGRAM	COKE	MCDONALDS
GE	0.0019			
SEAGRAM	0.0004	0.0043		
COKE	0.0004	-0.0005	0.0017	
MCDONALDS	0.0004	0.0011	0.0002	0.0025

b Invest in General Electric and Coca-Cola.

7.79

	A	B	C	D	E	F
1	Portfolio of 4 Stocks					
2			GE	SEAGRAM	COKE	MCDONALDS
3	Variance-Covariance Matrix	GE	0.0019			
4		SEAGRAM	0.0004	0.0043		
5		COKE	0.0004	-0.0005	0.0017	
6		MCDONALDS	0.0004	0.0011	0.0002	0.0025
7						
8	Expected Returns		0.0231	0.0148	0.0213	0.0156
9						
10	Weights		0.40	0.25	0.20	0.15
11						
12	Portfolio Return					
13	Expected Value	0.0195				
14	Variance	0.0009				
15	Standard Deviation	0.0305				

7.80 We created a portfolio with the following weights

General Electric	40%
Seagram	10%
Coca-Cola	40%
McDonald's	10%

	A	B	C	D	E	F
1	Portfolio of 4 Stocks					
2			GE	SEAGRAM	COKE	MCDONALDS
3	Variance-Covariance Matrix	GE	0.0019			
4		SEAGRAM	0.0004	0.0043		
5		COKE	0.0004	-0.0005	0.0017	
6		MCDONALDS	0.0004	0.0011	0.0002	0.0025
7						
8	Expected Returns		0.0231	0.0148	0.0213	0.0156
9						
10	Weights		0.40	0.10	0.40	0.10
11						
12	Portfolio Return					
13	Expected Value	0.0208				
14	Variance	0.0008				
15	Standard Deviation	0.0289				

$$7.81 P(X = x) = \frac{n!}{x!(n-x)!} p^x (1-p)^{n-x}$$

$$a P(X = 3) = \frac{10!}{3!(10-3)!} (.3)^3 (1-.3)^{10-3} = .2668$$

$$b P(X = 5) = \frac{10!}{5!(10-5)!} (.3)^5 (1-.3)^{10-5} = .1029$$

$$c P(X = 8) = \frac{10!}{8!(10-8)!} (.3)^8 (1-.3)^{10-8} = .0014$$

$$7.82 \text{ a } P(X = 3) = P(X \leq 3) - P(X \leq 2) = .650 - .383 = .267$$

$$\text{b } P(X = 5) = P(X \leq 5) - P(X \leq 4) = .953 - .850 = .103$$

$$\text{c } P(X = 8) = P(X \leq 8) - P(X \leq 7) = 1.000 - .998 = .002$$

$$7.83 \text{ a } .26683$$

$$\text{b } .10292$$

$$\text{c } .00145$$

$$7.84 \text{ } P(X = x) = \frac{n!}{x!(n-x)!} p^x (1-p)^{n-x}$$

$$\text{a } P(X = 0) = \frac{5!}{0!(5-0)!} (.4)^0 (1-.4)^{5-0} = .0778$$

$$\text{b a } P(X = 2) = \frac{5!}{2!(5-2)!} (.4)^2 (1-.4)^{5-2} = .3456$$

$$\text{c } P(X \leq 3) = P(0) + P(1) + P(2) + P(3) = .0778 + .2592 + .3456 + .2304 = .9130$$

$$\text{d } P(X \geq 2) = P(2) + P(3) + P(4) + P(5) = .3456 + .2304 + .0768 + .0102 = .6630$$

$$7.85 \text{ a } P(X = 0) = P(X \leq 0) = .078$$

$$\text{b } P(X = 2) = P(X \leq 2) - P(X \leq 1) = .683 - .337 = .346$$

$$\text{c } P(X \leq 3) = .913$$

$$\text{d } P(X \geq 2) = 1 - P(X \leq 1) = 1 - .337 = .663$$

$$7.86 \text{ a } .07776$$

$$\text{b } .34560$$

$$\text{c } .91296$$

$$\text{d } .66304$$

$$7.87 \text{ a } P(X = 18) = P(X \leq 18) - P(X \leq 17) = .659 - .488 = .171$$

$$\text{b } P(X = 15) = P(X \leq 15) - P(X \leq 14) = .189 - .098 = .091$$

$$\text{c } P(X \leq 20) = .910$$

$$\text{d } P(X \geq 16) = 1 - P(X \leq 15) = 1 - .189 = .811$$

$$7.88 \text{ a } .17119$$

$$\text{b } .09164$$

$$\text{c } .90953$$

$$\text{d } .81056$$

7.89 a .09306

b .64385

c .85468

7.90 Binomial distribution with $p = .25$

$$a P(X = 1) = \frac{4!}{1!(4-1)!} (.20)^1 (1-.20)^{4-1} = .4096$$

b Table 1 with $n = 8$: $p(2) = P(X \leq 2) - P(X \leq 1) = .797 - .503 = .294$

c Excel: $P(10) = .10745$

7.91a Excel with $n = 10$ and $p = 244/495$: $P(X \geq 5) = 1 - P(X \leq 4) = 1 - .39447 = .60553$

b $E(X) = np = 100(244/495) = 49.29$

$$7.92 a P(X = 2) = \frac{5!}{2!(5-2)!} (.45)^2 (1-.45)^{5-2} = .3369$$

b Excel with $n = 25$ and $p = .45$: $P(X \geq 10) = 1 - P(X \leq 9) = 1 - .2424 = .7576$

7.93 a Table 1 with $n = 5$ and $p = .5$: $P(X = 2) = P(X \leq 2) - P(X \leq 1) = .5 - .187 = .313$

b: Table 1 with $n = 25$ and $p = .5$: $P(X \geq 10) = 1 - P(X \leq 9) = 1 - .115 = .885$

$$7.94 a P(X = 2) = \frac{5!}{2!(5-2)!} (.52)^2 (1-.52)^{5-2} = .2990$$

b Excel with $n = 25$ and $p = .52$: $P(X \geq 10) = 1 - P(X \leq 9) = 1 - .08033 = .91967$

7.95 a Excel with $n = 25$ and $p = 2/38$: $P(X \geq 2) = 1 - P(X \leq 1) = 1 - .61826 = .38174$

b Excel with $n = 25$ and $p = 2/38$: $P(X = 0) = .25880$

c Excel with $n = 25$ and $p = 18/38$: $P(X \geq 15) = 1 - P(X \leq 14) = 1 - .85645 = .14355$

d Excel with $n = 25$ and $p = 18/38$: $P(X \leq 10) = .29680$

7.96 Table 1 with $n = 25$ and $p = .3$: $P(X \leq 10) = .902$

7.97 Table 1 with $n = 25$ and $p = .90$

a $P(X = 20) = P(X \leq 20) - P(X \leq 19) = .098 - .033 = .065$

b $P(X \geq 20) = 1 - P(X \leq 19) = 1 - .033 = .967$

c $P(X \leq 24) = .928$

d $E(X) = np = 25(.90) = 22.5$

$$7.98 P(X = 0) = \frac{4!}{0!(4-0)!} (.8)^0 (1-.8)^{4-0} = .0016$$

$$7.99 \text{ Excel with } n = 20 \text{ and } p = .48: P(X \geq 10) = 1 - P(X \leq 9) = 1 - .48344 = .51656$$

$$7.100 \text{ Table 1 with } n = 25 \text{ and } p = .60: P(X \geq 15) = 1 - P(X \leq 14) = 1 - .414 = .586$$

$$7.101 \text{ a Excel with } n = 100 \text{ and } p = .52: P(X \geq 50) = 1 - P(X \leq 49) = 1 - .30815 = .69185$$

$$\text{b Excel with } n = 100 \text{ and } p = .36: P(X \leq 30) = .12519$$

$$\text{c Excel with } n = 100 \text{ and } p = .06: P(X \leq 5) = .44069$$

$$7.102 \text{ Table 1 with } n = 25 \text{ and } p = .10$$

$$\text{a } P(X = 0) = P(X \leq 0) = .072$$

$$\text{b } P(X < 5) = P(X \leq 4) = .902$$

$$\text{c } P(X > 2) = P(X \geq 3) = 1 - P(X \leq 2) = 1 - .537 = .463$$

$$7.103 \text{ a Excel with } n = 200 \text{ and } p = .45: P(X \geq 100) = 1 - P(X \leq 99) = 1 - .91130 = .08870$$

$$\text{b Excel with } n = 200 \text{ and } p = .25: P(X \leq 55) = .81618$$

$$\text{c Excel with } n = 200 \text{ and } p = .30: P(50 \leq X \leq 75) = P(X \leq 75) - P(X \leq 49) = .99062 - .05059 = .94003$$

$$7.104 P(X = 20) = \frac{20!}{20!(20-20)!} (.75)^{20} (1-.75)^{20-20} = .00317$$

$$7.105 P(X = 0) = \frac{25!}{0!(25-0)!} (.07)^0 (1-.07)^{25-0} = .1630$$

$$7.106 \text{ Excel with } n = 100 \text{ and } p = .25: P(X > 25) = P(X \geq 26) = 1 - P(X \leq 25) = 1 - .55347 = .44653$$

$$7.107\text{a. Excel with } n = 10 \text{ and } p = .23: P(X \geq 5) = 1 - P(X \leq 4) = 1 - .94308 = .05692$$

$$\text{b. Excel with } n = 25 \text{ and } p = .23: P(X \leq 5) = .47015$$

$$7.108 \text{ Excel with } n = 50 \text{ and } p = .45: P(X \geq 19) = 1 - P(X \leq 18) = 1 - .12735 = .87265$$

$$7.109 \text{ Excel with } n = 25 \text{ and } p = 120/220 = .5455: P(X \geq 15) = 1 - P(X \leq 14) = 1 - .63320 = .36680$$

$$7.110 \text{ a } P(X = 0) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-2} 2^0}{0!} = .1353$$

$$b P(X = 3) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-2} 2^3}{3!} = .1804$$

$$c P(X = 5) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-2} 2^5}{5!} = .0361$$

$$7.111a P(X = 0) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-.5} .5^0}{0!} = .6065$$

$$b P(X = 1) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-.5} .5^1}{1!} = .3033$$

$$c P(X = 2) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-.5} .5^2}{2!} = .0758$$

$$7.112 a \text{ Table 2 with } \mu = 3.5: P(X = 0) = P(X \leq 0) = .030$$

$$b \text{ Table 2 with } \mu = 3.5: P(X \geq 5) = 1 - P(X \leq 4) = 1 - .725 = .275$$

$$c \text{ Table 2 with } \mu = 3.5/7: P(X = 1) = P(X \leq 1) - P(X \leq 0) = .910 - .607 = .303$$

$$7.113 a P(X = 5 \text{ with } \mu = 14/3) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-14/3} (14/3)^5}{5!} = .1734$$

$$b P(X = 1 \text{ with } \mu = 1/3) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-1/3} (1/3)^1}{1!} = .2388$$

$$7.114 P(X = 0 \text{ with } \mu = 2) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-2} (2)^0}{0!} = .1353$$

$$7.115 a \text{ Excel with } \mu = 2.2: P(X \geq 3) = 1 - P(X \leq 2) = 1 - .62271 = .37729$$

$$b \text{ Table 2 with } \mu = 11: P(10 \leq X \leq 15) = P(X \leq 15) - P(X \leq 9) = .907 - .341 = .566$$

$$7.116 a P(X = 0 \text{ with } \mu = 3) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-3} (3)^0}{0!} = .0498$$

$$b P(X = 10 \text{ with } \mu = 21) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-21} (21)^{10}}{10!} = .0035$$

$$7.117 a \text{ Table 2 with } \mu = 4: P(X \geq 10) = 1 - P(X \leq 9) = 1 - .992 = .008$$

$$b \text{ Table 2 with } \mu = 8: P(X \geq 20) = 1 - P(X \leq 19) = 1 - 1 = 0$$

$$7.118 P(X = 0 \text{ with } \mu = 80/200) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-.4} (.4)^0}{0!} = .6703$$

$$7.119 \text{ a Table 2 with } \mu = 5: P(X \geq 10) = 1 - P(X \leq 9) = 1 - .968 = .032$$

$$\text{b Excel with } \mu = 25: P(X \geq 25) = 1 - P(X \leq 24) = 1 - .47340 = .52660$$

$$7.120 \text{ a Table 2 with } \mu = 1.5: P(X \geq 2) = 1 - P(X \leq 1) = 1 - .558 = .442$$

$$\text{b Table 2 } \mu = 6: P(X < 4) = P(X \leq 3) = .151$$

$$7.121 \text{ a } P(X = 1 \text{ with } \mu = 5) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-5} (5)^1}{1!} = .0337$$

$$\text{b Table 2 with } \mu = 15: P(X > 20) = P(X \geq 21) = 1 - P(X \leq 20) = 1 - .917 = .083$$

$$7.122 \text{ a } P(X = 0 \text{ with } \mu = 1.5) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-1.5} (1.5)^0}{0!} = .2231$$

$$\text{b Table 2 with } \mu = 4.5: P(X \leq 5) = .703$$

$$\text{c Table 2 with } \mu = 3.0: P(X \geq 3) = 1 - P(X \leq 2) = 1 - .423 = .577$$

$$7.123 P(X = 5) = \frac{5!}{5!(5-5)!} (.774)^5 (1-.774)^{5-5} = .2778$$

$$7.124 \text{ a } E(X) = np = 40(.02) = .8$$

$$\text{b } P(X = 0) = \frac{40!}{0!(40-0)!} (.02)^0 (1-.02)^{40-0} = .4457$$

$$7.125 \text{ a } \mu = E(X) = \sum xP(x) = 0(.48) + 1(.35) + 2(.08) + 3(.05) + 4(.04) = .82$$

$$\begin{aligned} \sigma^2 = V(X) &= \sum (x - \mu)^2 P(x) = (0-.82)^2 (.48) + (1-.82)^2 (.35) + (2-.82)^2 (.08) \\ &\quad + (3-.82)^2 (.05) + (4-.82)^2 (.04) = 1.0876 \end{aligned}$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{1.0876} = 1.0429$$

$$7.126 \text{ a } P(X = 10 \text{ with } \mu = 8) = \frac{e^{-\mu} \mu^x}{x!} = \frac{e^{-8} (8)^{10}}{10!} = .0993$$

$$\text{b Table 2 with } \mu = 8: P(X > 5) = P(X \geq 6) = 1 - P(X \leq 5) = 1 - .191 = .809$$

$$\text{c Table 2 with } \mu = 8: P(X < 12) = P(X \leq 11) = .888$$

7.127 a $E(X) = np = 100(.15) = 15$

b $\sigma = \sqrt{np(1-p)} = \sqrt{100(.15)(1-.15)} = 3.57$

c Excel with $n = 100$ and $p = .15$: $P(X \geq 20) = 1 - P(X \leq 19) = 1 - .89346 = .10654$

7.128 Table 1 with $n = 10$ and $p = .3$: $P(X > 5) = P(X \geq 6) = 1 - P(X \leq 5) = 1 - .953 = .047$

7.129 a $\mu = E(X) = \sum xP(x) = 5(.05) + 6(.16) + 7(.41) + 8(.27) + 9(.07) + 10(.04) = 7.27$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (5-7.27)^2 (.05) + (6-7.27)^2 (.16) + (7-7.27)^2 (.41) \\ + (8-7.27)^2 (.27) + (9-7.27)^2 (.07) + (10-7.27)^2 (.04) = 1.1971$$

$\sigma = \sqrt{\sigma^2} = \sqrt{1.1971} = 1.0941$

7.130 Table 1 with $n = 10$ and $p = .20$: $P(X \geq 6) = 1 - P(X \leq 5) = 1 - .994 = .006$

7.131 a $P(X = 2) = \frac{10!}{2!(10-2)!} (.05)^2 (1-.05)^{10-2} = .0746$

b Excel with $n = 400$ and $p = .05$: $P(X = 25) = .0446$

c .05

7.132 a Excel with $n = 80$ and $p = .70$: $P(X > 65) = P(X \geq 66) = 1 - P(X \leq 65) = 1 - .99207 = .00793$

b $E(X) = np = 80(.70) = 56$

c $\sigma = \sqrt{np(1-p)} = \sqrt{80(.70)(1-.70)} = 4.10$

7.133 $\mu = E(X) = \sum xP(x) = 0(.35) + 1(.25) + 2(.18) + 3(.13) + 4(.09) = 1.36$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (0-1.36)^2 (.35) + (1-1.36)^2 (.25) + (2-1.36)^2 (.18) \\ + (3-1.36)^2 (.13) + (4-1.36)^2 (.09) = 1.73$$

$\sigma = \sqrt{\sigma^2} = \sqrt{1.73} = 1.32$

7.134 Table 1 with $n = 25$ and $p = .40$:

a $P(X = 10) = P(X \leq 10) - P(X \leq 9) = .586 - .425 = .161$

b $P(X < 5) = P(X \leq 4) = .009$

c $P(X > 15) = P(X \geq 16) = 1 - P(X \leq 15) = 1 - .987 = .013$

7.135 Excel with $n = 100$ and $p = .45$:

a $P(X > 50) = P(X \geq 49) = 1 - P(X \leq 50) = 1 - .86542 = .13458$

b $P(X < 44) = P(X \leq 43) = .38277$

c $P(X = 45) = .07999$

7.136 a $\mu = E(X) = \sum xP(x) = 0(.36) + 1(.22) + 2(.20) + 3(.09) + 4(.08) + 5(.05) = 1.46$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (0 - 1.46)^2 (.36) + (1 - 1.46)^2 (.22) + (2 - 1.46)^2 (.20) \\ + (3 - 1.46)^2 (.09) + (4 - 1.46)^2 (.08) + (5 - 1.46)^2 (.05) = 2.23$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{2.23} = 1.49$$

b $\mu = E(X) = \sum xP(x) = 0(.15) + 1(.18) + 2(.23) + 3(.26) + 4(.10) + 5(.08) = 2.22$

$$\sigma^2 = V(X) = \sum (x - \mu)^2 P(x) = (0 - 2.22)^2 (.15) + (1 - 2.22)^2 (.18) + (2 - 2.22)^2 (.23) \\ + (3 - 2.22)^2 (.26) + (4 - 2.22)^2 (.10) + (5 - 2.22)^2 (.08) = 2.11$$

$$\sigma = \sqrt{\sigma^2} = \sqrt{2.11} = 1.45$$

c Viewers of nonviolent shows remember more about the product that was advertised.

7.137 Excel with $n = 25$ and $p = 1/3$: $P(X \geq 10) = 1 - P(X \leq 9) = 1 - .69560 = .30440$

7.138 $p = .08755$ because $P(X \geq 1) = 1 - P(X = 0)$ with $n = 10$ and $p = .08755) = 1 - .40 = .60$

7.139 Excel with $n = 100$ and $p = .60$: $P(X > 50) = P(X \geq 51) = 1 - P(X \leq 50) = 1 - .02710 = .97290$

7.140 Binomial with $n = 5$ and $p = .01$.

<u>x</u>	<u>p(x)</u>
0	.95099
1	.04803
2	.00097
3	.00001
4	0
5	0

Case 7.1

Expected number of runs without bunting = .85.

If batter bunts:

Outcome	Probability	Bases		Expected Number	
		Occupied	Outs	of Runs	
1	.75	2nd	1	.69	.5175
2	.10	1st	1	.52	.0520
3	.10	none	2	.10	.0100
4	.05	1st and 2nd	0	1.46	.0730

Expected number of runs = .6255

Decision: Don't bunt.

