Sections 7.5 and 7.6

- If A and B are events in an experiment and \( P(A) \neq 0 \), then the **conditional probability** that the event B will occur given that the event A has already occurred is 
  \[
  P(B|A) = \frac{P(A \cap B)}{P(A)}
  \]

- **Product Rule**: 
  \[
  P(A \cap B) = P(A) \cdot P(B | A)
  \]

- **Tree Diagrams**

- If A and B are independent events then 
  \[
  P(A \cap B) = P(A) \quad \text{and} \quad P(B|A) = P(B).
  \]
  Furthermore, two events are independent if and only if 
  \[
  P(A \cap B) = P(A) \cdot P(B).
  \]
  This can be extended to more than two events.

- **Bayes’ Theorem**

1. A survey was done of students in which both their age and the number of pieces of candy they ate on Halloween was observed. The following results were obtained:

<table>
<thead>
<tr>
<th>Age</th>
<th>0</th>
<th>10–10</th>
<th>&gt;10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 18</td>
<td>5</td>
<td>30</td>
<td>45</td>
<td>80</td>
</tr>
<tr>
<td>18–20</td>
<td>20</td>
<td>50</td>
<td>40</td>
<td>110</td>
</tr>
<tr>
<td>Over 20</td>
<td>25</td>
<td>75</td>
<td>60</td>
<td>160</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>155</td>
<td>145</td>
<td>350</td>
</tr>
</tbody>
</table>

(a) What is the probability that a student who ate 10 or fewer pieces of candy was over 20?

(b) What is the probability that a student who was under 18 ate more than 10 pieces of candy?

(c) What is the probability that a student was over 20 and ate zero pieces of candy?

(d) What is the probability that a student ate 10 pieces of candy or less given they were in the age group 18 – 20?

2. If two fair four-sided dice are rolled, what is the probability that the sum is 7 given that the sum is greater than 5?

3. In one area, 4% of the population drive luxury cars. However, 17% of the CPAs drive luxury cars. Are the events “person drives a luxury car” and “person is a CPA” independent?

4. In a home theater system, the probability that the video component needs repair within 1 year is 0.02, the probability that the electronic component needs repair within 1 year is 0.03, and the probability that the audio component needs repair within 1 year is 0.01. Assuming the probabilities are independent, what is the probability that exactly two components will need repair within 1 year?

5. Unfortunately, two lights have been added to Mrs. Kilmer’s commute to work. After a few weeks of collecting data, she has determined that the probability that she will be stopped by the light at 2818 and Holleman is 0.2857 whereas the probability that she will be stopped by the light at 2818 and Luther is 0.0476. Assuming these events are independent, what is the probability that she will be stopped by at least one of the two lights on her drive to work tomorrow morning?

6. Two fair six-sided dice are rolled and the numbers landing uppermost are observed. Let \( A \) be the event that exactly one five is rolled and let \( B \) be the event that the sum of the dice is at least 10. Are the events \( A \) and \( B \) independent?

7. A survey has shown that 95% of the women in a certain community work outside the home. Of these women, 56% are married, while 85% of the women who do not work outside the home are married. Find the probabilities that a woman in the community can be categorized as follows:

   (a) A single woman working outside the home.
   (b) Married.

8. A bicycle factory runs two assembly lines, A and B. If 95% of line A’s products pass inspection, while only 90% of line B’s products pass inspection, and 60% of the factory’s bikes come off assembly line B (the rest off A), find the probability of a bike not passing inspection.

9. Given the following tree diagram, answer the following questions:

10. Box A contains 8 basketballs and 5 footballs. Box B contains 6 basketballs and 9 footballs. Box C contains 3 basketballs and 4 soccer balls. An experiment consists of selecting a ball at random from Box A and placing it in Box B. A ball is then randomly selected from Box B and placed into Box C. A ball is then randomly selected from Box C. If a football is selected from Box C, what is the probability that a football was drawn out of Box A?

11. The probability that a person with certain symptoms has a disease is 0.8. The blood test used to confirm this diagnosis gives positive results for 90% of people with the disease and 5% of those without the disease. What is the probability that an individual who has the symptoms and who reacts positively to the test actually has the disease?

12. A building contractor buys 70% of his cement from supplier A, and 30% from supplier B. A total of 90% of the bags from A arrive undamaged, while 95% of the bags from B arrive undamaged. Find the probability that a damaged bag came from supplier B.

13. The following table shows the proportion of people over 18 who are in various age categories, along with the probabilities that a person in a given age category will vote in a general election.

<table>
<thead>
<tr>
<th>Age</th>
<th>Percent of Voting Age</th>
<th>Probability of a Person of this Age Voting</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 – 21</td>
<td>11.0</td>
<td>0.48</td>
</tr>
<tr>
<td>22 – 24</td>
<td>7.6</td>
<td>0.53</td>
</tr>
<tr>
<td>25 – 44</td>
<td>37.6</td>
<td>0.68</td>
</tr>
<tr>
<td>45 – 64</td>
<td>28.3</td>
<td>0.64</td>
</tr>
<tr>
<td>65 or over</td>
<td>15.5</td>
<td>0.74</td>
</tr>
</tbody>
</table>

(a) Find the probability that a voter is in the age category 18–21.

(b) Find the probability that a person who did not vote was in the age category 45 – 64.