Range of a Projectile

A projectile is an airborne object that is under the sole influence of gravity. As it rises and falls, air resistance has a negligible effect. The launch angle of a projectile is the angle between the horizontal direction and the launch direction. The trajectory plot in Figure 1 shows the path of a projectile launched with a launch speed of 25.0 m/s at a launch angle of 45°.

The trajectory plot of a projectile looks the same regardless of the launch angle. The shape of the trajectory is mathematically described as being a parabola. Figure 2 represents the trajectory plot for three different launch angles for a projectile launched at 25.0 m/s.

The distance traveled horizontally from the launch position to the landing position is known as the range. The range of an angled-launch projectile depends upon the launch speed and the launch angle. Figure 3 illustrates the effect of launch angle on the range of a projectile for three different launch speeds.
Questions:
1. Based on Figure 1, what is the highest height obtained by a projectile launched with a speed of 25.0 m/s at a launch angle of 45°?
   a. Approximately 16 meters  
   b. Approximately 32 meters  
   c. Approximately 45 meters  
   d. Approximately 63 meters
2. A projectile is launched with a speed of 25 m/s and a launch angle of 60°. What will be the range of the projectile?
   a. 11 meters  
   b. 24 meters  
   c. 36 meters  
   d. 55 meters
3. For any given launch speed, what launch angle will result in the greatest range for a projectile?
   a. 40 degrees  
   b. 45 degrees  
   c. 60 degrees  
   d. 90 degrees  
   e. It depends on the actual launch speed that is used.
4. For a launch speed of 25 m/s, what launch angle will result in the same range as a projectile launched at an angle of 30°?
   a. 0 degrees  
   b. 25 degrees  
   c. 45 degrees  
   d. 60 degrees  
   e. Nonsense! Every angle will result in the same range as long as the launch speed is 25 m/s.
5. What effect does increasing launch angle have upon the range of a projectile?
   a. Increasing the launch angle always increases the range.  
   b. Increasing the launch angle always decreases the range.  
   c. Increasing the launch angle has no predictable effect upon the range.  
   d. For angles less than 45°: increasing the launch angle increases the range; the opposite is true for angles over 45°.
6. Which of the following projectiles will travel the highest?
   a. A projectile launched with a speed of 25 m/s and a launch angle of 30°.  
   b. A projectile launched with a speed of 25 m/s and a launch angle of 45°.  
   c. A projectile launched with a speed of 25 m/s and a launch angle of 60°.  
   d. Nonsense! Each of these projectiles will travel to the same height.
7. Consider the following two projectiles:

<table>
<thead>
<tr>
<th>Projectile</th>
<th>Launch Speed</th>
<th>Launch Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>40 m/s</td>
<td>30°</td>
</tr>
<tr>
<td>B</td>
<td>40 m/s</td>
<td>45°</td>
</tr>
</tbody>
</table>

Which projectile has the greatest range and how much further does it travel than the other projectile?

a. Projectile A travels further by approximately 141 meters.
b. Projectile B travels further by approximately 22 meters.
c. Projectile B travels further by approximately 82 meters.
d. Projectile B travels further by approximately 163 meters.
e. The two projectiles travel the same distance.

8. Consider the following two projectiles:

<table>
<thead>
<tr>
<th>Projectile</th>
<th>Launch Speed</th>
<th>Launch Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>15 m/s</td>
<td>25°</td>
</tr>
<tr>
<td>B</td>
<td>40 m/s</td>
<td>65°</td>
</tr>
</tbody>
</table>

Which projectile has the greatest range and how much further does it travel than the other projectile?

a. Projectile A travels further by approximately 62 meters.
b. Projectile B travels further by approximately 62 meters.
c. Projectile B travels further by approximately 108 meters.
d. Projectile B travels further by approximately 116 meters.
e. The two projectiles travel the same distance.

9. Consider a projectile launched with a speed of 25 m/s at an angle of 45°. How much higher is it after traveling a horizontal distance of 45 meters than it was after traveling a horizontal distance of 10 meters?

a. Approximately 5 meters.
b. Approximately 8 meters.
c. Approximately 13 meters.
d. Approximately 35 meters.
e. Nonsense! The projectile is actually lower after a horizontal distance of 45 meters.

10. Suppose that the football kicked by a place-kicker travels as a projectile (i.e., without air resistance). It is kicked with a speed of 25.0 m/s at a 30° angle. It must pass over field goal posts that are approximately 3 meters high. What would be the maximum field goal distance that could be kicked?

a. 6 meters  
b. 11 meters  
c. 49 meters  
d. 55 meters