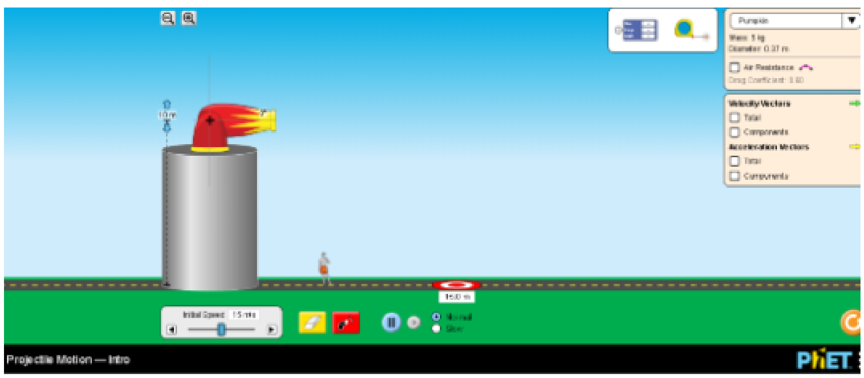
**Everyday Physics in your life:**

1. As you get ready for bed, you roll up one of your socks into a tight ball and toss it into the laundry basket across the room. Then, you try to toss the other sock without rolling it up.. What effects whether or not your socks land in the basket?

Several factors influence whether your socks land in the basket. Aerodynamics play a role, with a rolled sock being more stable in flight. Weight distribution is also important, as a tight ball is denser and less affected by air resistance. Consistency in the throwing force and angle is crucial for accuracy. The distance to the basket and your aim are key components as well. Additionally, environmental factors such as air currents and obstacles in the room can affect the sock's trajectory.

**Develop your understanding:**

2. Use [Intro] screen to test your ideas about the things that affect the landing location of a projectile.




a. Make a complete list of things that affect the landing site of a projectile including your ideas from question #1 and any discoveries you made using the simulation.
b. Next to each item, briefly explain why you think the landing location changes.

The landing site of a projectile is influenced by several factors. Aerodynamics affect flight stability and accuracy, while weight distribution ensures denser objects face less air resistance and travel in straighter paths. The throwing force determines the distance and speed, and the throwing angle sets the arc and range of the flight. Distance plays a role, with closer targets being easier to hit accurately. Precise aiming is essential for accuracy, and environmental factors like air currents and obstacles can alter the trajectory. From simulation discoveries, additional factors include initial velocity, where higher speed increases range, and projectile shape, with more aerodynamic shapes traveling further. Wind speed and direction can divert the course, gravity pulls the projectile downward affecting its arc, and surface interaction such as bounce and friction on impact can change the final position.

3. What is meant by the expression "flight path of a projectile"? Draw the flight path of your socks and describe the shape. Use the simulation to investigate how the items you listed in #2 affect the shape of the flight path. Summarize your discoveries including explanations for the different flight paths.

The trajectory of a projectile is profoundly influenced by a multitude of factors, each exerting its own unique impact on the path it follows through space. Among these variables, the initial velocity plays a pivotal role, with higher speeds resulting in elongated trajectories that maximize distance, while lower speeds produce narrower paths, limiting range. Similarly, the launch angle dictates the shape of the trajectory, with angles below 45 degrees yielding shorter, more direct paths, and angles above 45 degrees creating higher, albeit shorter trajectories. The height of launch extends or shortens the duration of flight, directly affecting the length of the trajectory. Additionally, air resistance alters the trajectory's curvature and length, with higher resistance resulting in shorter, flatter paths. The mass of the projectile influences its interaction with air, with heavier objects maintaining truer parabolic paths compared to lighter ones. Wind conditions, gravity, spin effects, and launch platform movement further contribute to the complexity of the trajectory, with each factor uniquely shaping the path and ultimately determining the projectile's landing location.

4. Suppose your friend asks you to tell them about projectiles. You start to explain, but she interrupts. "Wait," she says, "You're using a lot of words I don't understand. Can you explain in English?" Knowing that a picture is worth a thousand words, you draw a picture of a projectile



path and label all the terms that are on the simulation page. Draw a picture like you would for your friend and write what you would tell her about the terms. Insert an image of your drawing if you can.

Initial Velocity: This is how fast something is moving when it's first thrown, shot, or launched. It determines how far and how fast the object will travel.

Launch Angle: Imagine you're throwing a ball. The launch angle is the angle at which you throw it above the ground. If you throw it straight ahead, it's a low angle. If you throw it high up, it's a high angle.

Height of Launch: This is how high above the ground you are when you throw or launch something. The higher you are, the longer the object stays in the air.

Air Resistance: When things move through the air, they encounter resistance, like when you stick your hand out of a moving car. Air resistance slows down objects in flight.

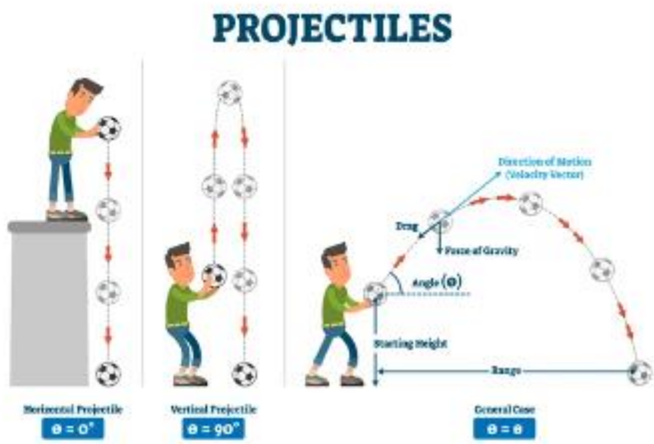
Mass of the Projectile: This is how heavy the object is that you're throwing or launching. Heavier objects are harder to stop or slow down, so they tend to keep moving further.

Wind Speed and Direction: If there's wind blowing, it affects the path of the object. A strong wind can push the object off course or make it go faster or slower.

Gravity: This is what pulls everything down toward the Earth. When you throw something, gravity pulls it back down. Its why things fall to the ground.

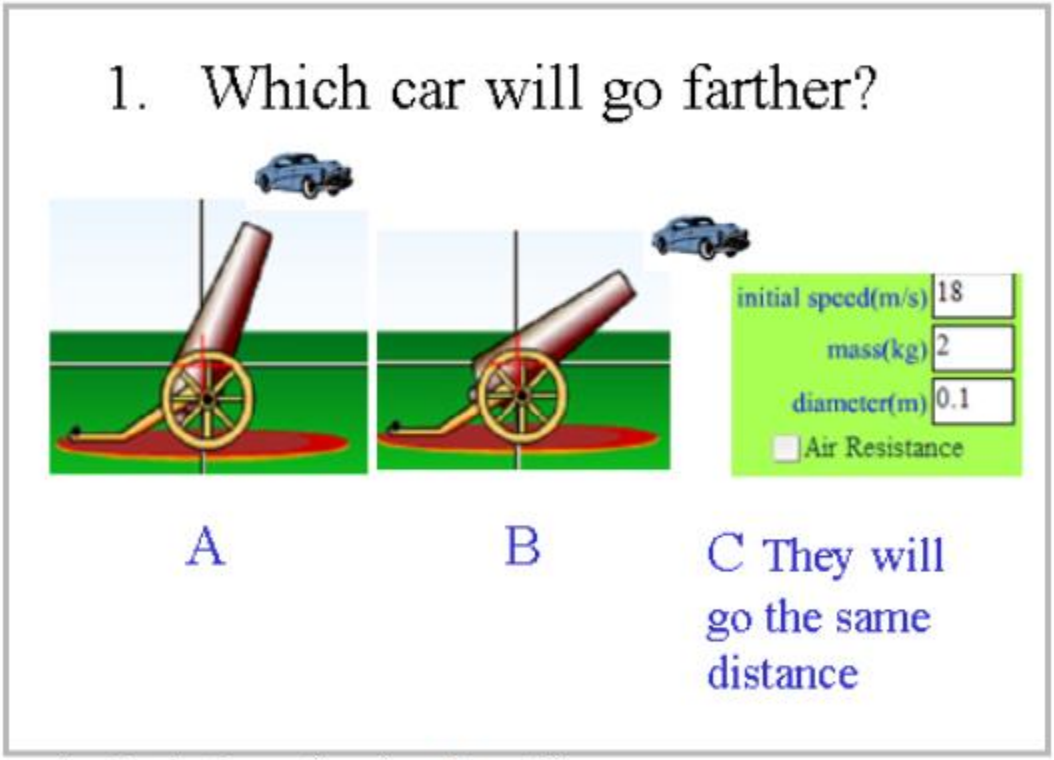
Spin: Imagine throwing a spinning ball. The way it spins can make it curve in the air, like how a curveball moves in baseball.

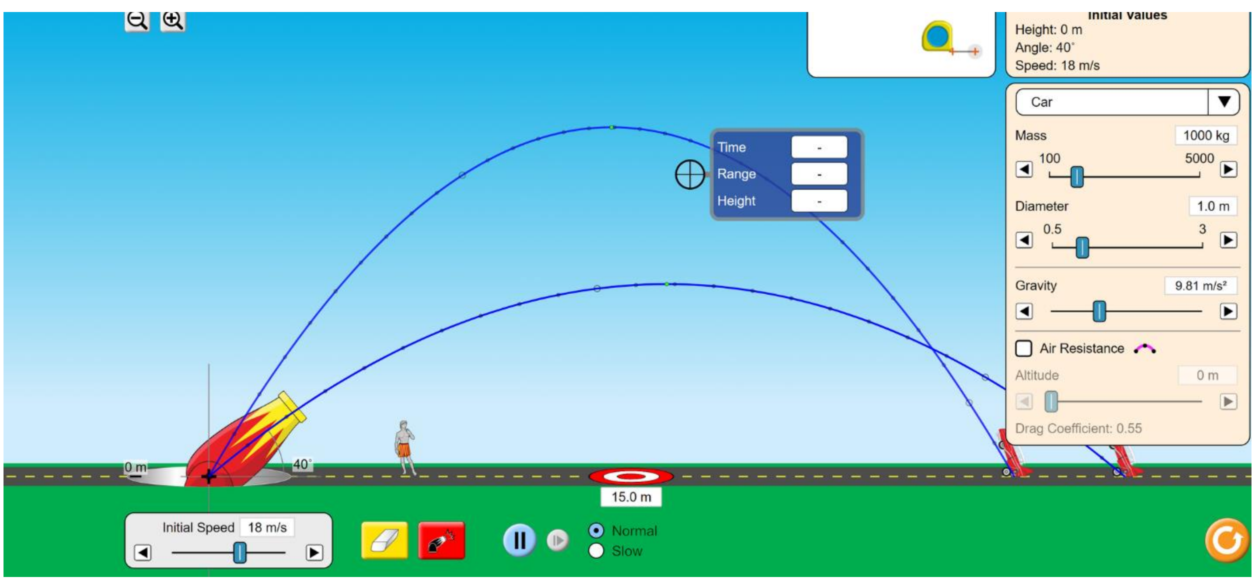
Launch Platform Movement: If you're standing on a moving platform when you throw something, the platform's movement adds to the object's speed or direction.




5. Describe in your own words why using the simulation is a good method for studying projectiles. Include the error sources the simulation eliminates (or minimizes) and what representations the simulation provides that are helpful.

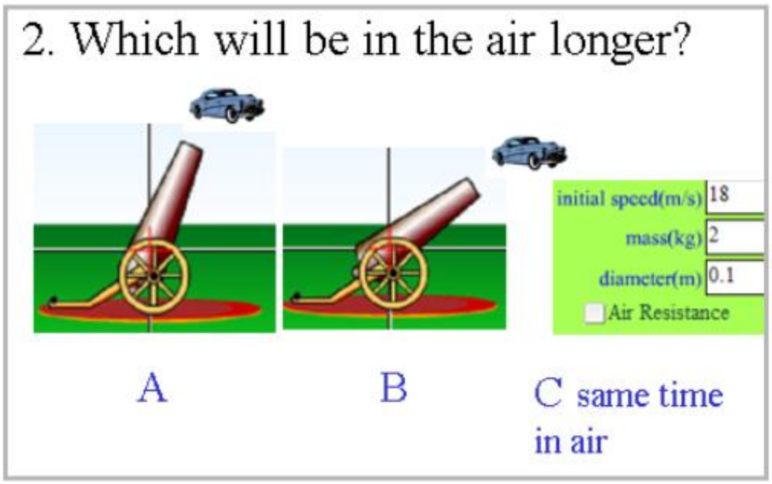
Simulation used to study projectiles is like having a virtual lab where we can experiment with different situations. It's handy because we can explore how changing things like speed, angle, and air resistance affects the path of objects we throw. Unlike real-life experiments, the simulation helps us by removing errors that could happen, like inconsistencies in how hard we throw or changes in wind. This way, we get accurate results every time. Plus, the simulation gives us visual representations, like graphs and animations, which make it easier to understand what's going on. So, it's like having a reliable and fun tool for learning about projectiles without needing real-world setups.


1. Which car will go farther?
initial speed(m/s) 18
mass(kg) 2
diameter(m) 0.1
Air Resistance
A
B
C They will go the same distance


Initial Values
Height: 0 m
Angle: 40°
Speed: 18 m/s
Car
Mass 1000 kg
100
5000
Diameter 1.0 m
0.5
3
Gravity 9.81 m/s²
Air Resistance
Altitude 0 m
Drag Coefficient: 0.55
Time
Range
Height
0 m
40°
15.0 m
Initial Speed 18 m/s
Normal
Slow

B will go farther. B is thrown at an angle of 40 degrees while A is thrown at an angle of 40 degrees.

When a projectile is launched at a lower angle, like 40 degrees compared to 60 degrees, more of its initial velocity is directed horizontally. This horizontal component of velocity helps it cover more ground before gravity pulls it down. Additionally, lower launch angles experience less air resistance due to their flatter trajectory, allowing them to maintain their velocity over a longer distance. As a result, even though both projectiles have the same initial speed, mass, and diameter, the one with the lower launch angle will typically travel farther.



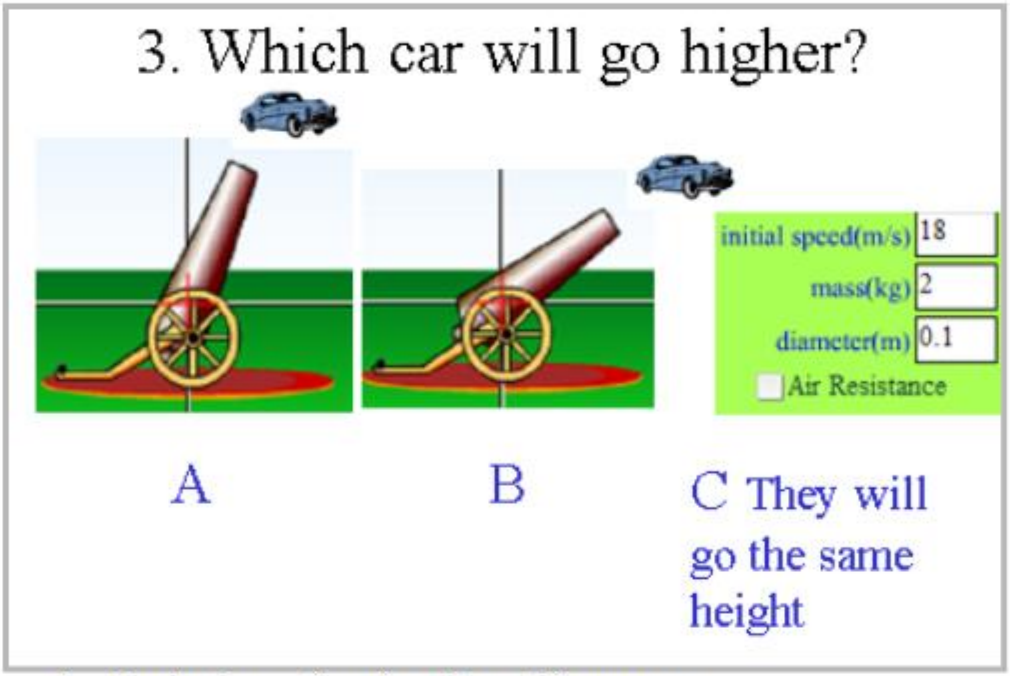

The projectile launched at a higher angle here which is A in this case(60 degrees)will stay in the air longer(3.2 sec) compared to the one launched at a lower angle which is B (40 degrees), which stays for 2.3sec. This is because a higher launch angle results in a steeper trajectory, causing the projectile to reach a greater maximum height. As a result, it spends more time ascending and descending, leading to a longer flight time.

It is because:

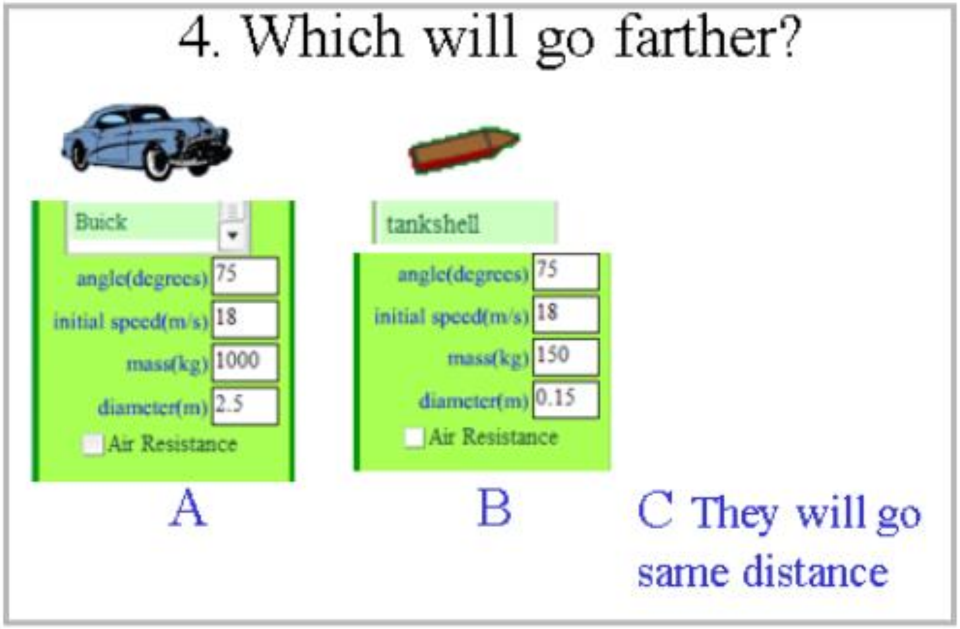
Time Spent Ascending: A projectile launched at a higher angle takes longer to reach its maximum height since it's traveling more vertically. This means it spends more time in the ascending phase of its trajectory.

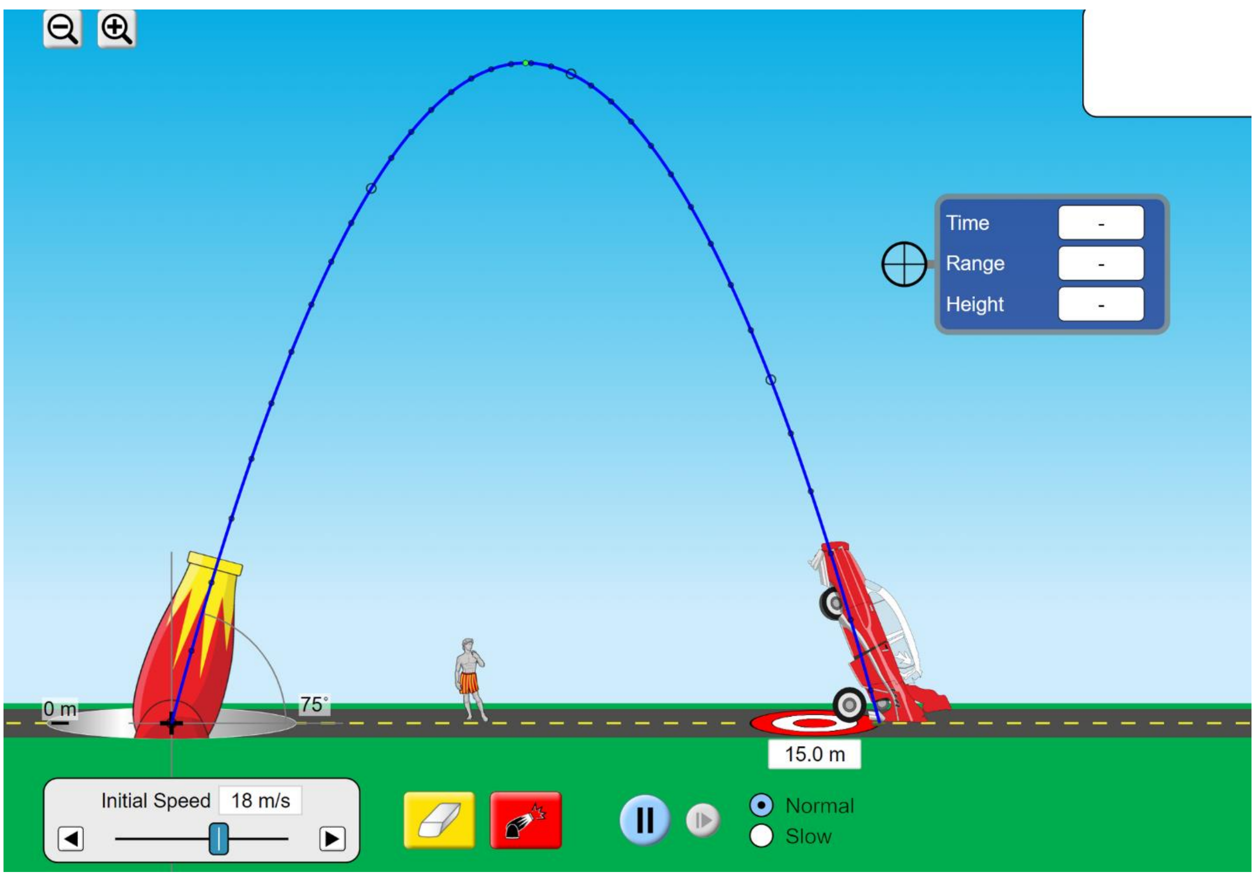
Time Spent Descending: Similarly, once the projectile reaches its peak height, it then descends back to the ground. A higher launch angle results in a longer descent phase due to the greater height achieved.

Total Flight Time: Combining the longer ascending and descending phases, the projectile launched at a higher angle has a longer total flight time compared to the one launched at a lower angle.




In comparing the two cars launched with identical speeds but different launch angles (60 degrees and 40 degrees) off the same ramp, the car launched at 60 degrees , here which is Car A will generally ascend to a greater height. This is because the higher launch angle directs more of the car's initial velocity vertically, maximizing its upward velocity component. As a result, the car can better overcome the force of gravity and reach a higher elevation on the ramp before its velocity is fully converted into potential energy, allowing it to achieve a greater height than the car launched at the shallower 40-degree angle.


4. Which will go farther?
Buick
angle(degrees) 75
initial speed(m/s) 18
mass(kg) 1000
diameter(m) 2.5
Air Resistance
A
tankshell
angle(degrees) 75
initial speed(m/s) 18
mass(kg) 150
diameter(m) 0.15
Air Resistance
B
C They will go same distance


Time -
Range -
Height -
0 m
75°
15.0 m
Initial Speed 18 m/s
Normal
Slow

While using the formula for Range, we get;

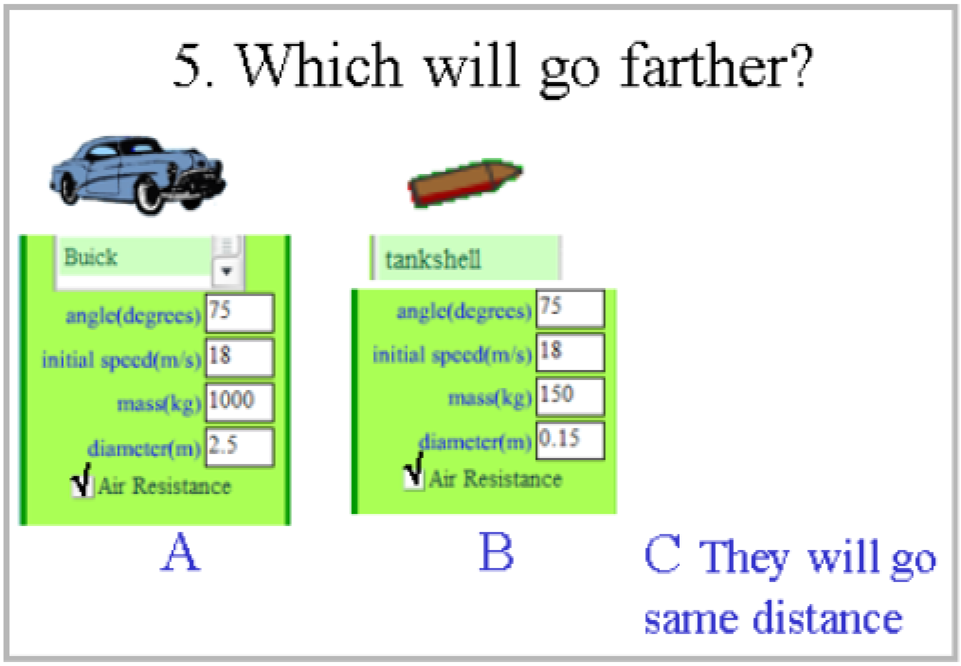
R= $u^2$Sin2theta/g,

R= $(18)^2$ Sin2*75/ 9.8

= 16.5m for both approx

The range of a projectile is determined by its initial velocity and launch angle, regardless of its mass or diameter. This is because the horizontal motion of a projectile is solely influenced by its initial velocity and the angle at which it is launched. It doesn't matter if one object is heavier or bigger than the other; if they are thrown with the same initial speed and angle, they will cover the same horizontal distance before hitting the ground.

Similarly, in this scenario, both the car (projectile) and the tank shell are launched with the same initial velocity of 18 m/s and at the same launch angle of 75 degrees. Therefore, despite differences in their mass and diameter, they will both travel the same horizontal distance, resulting in the same range.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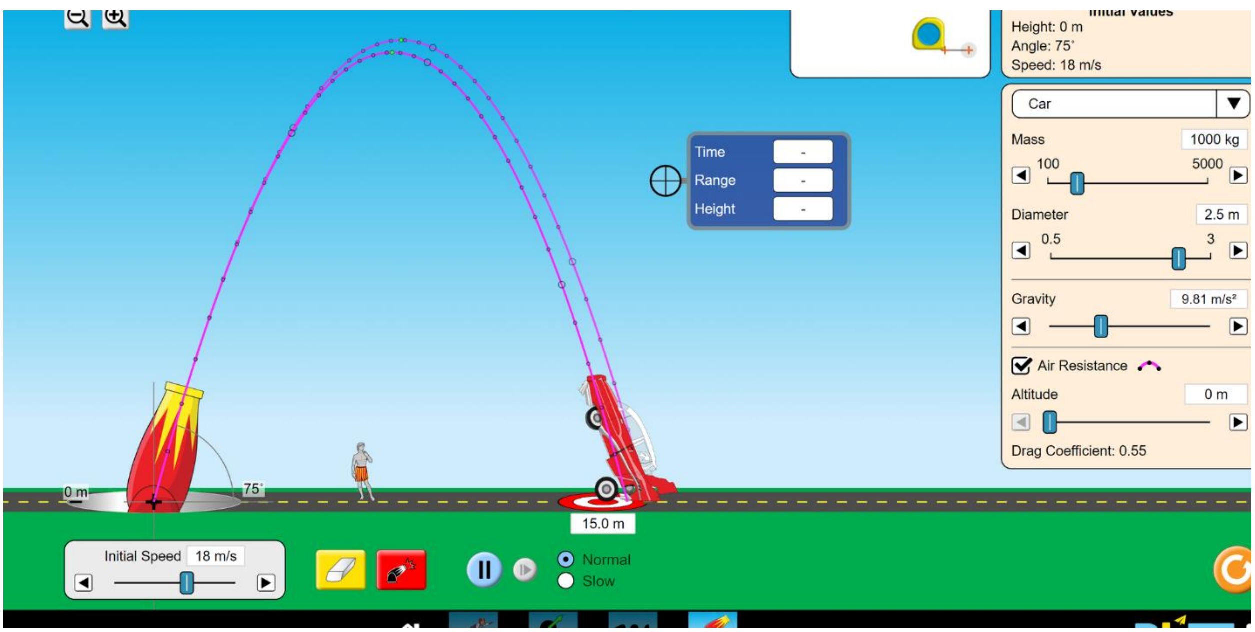
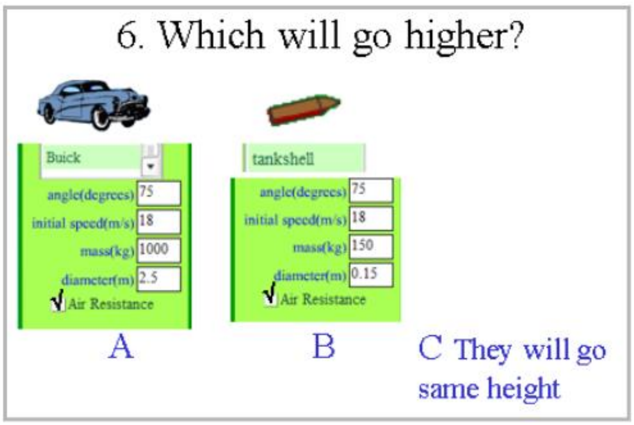
diameter(m) 2.5
Air Resistance
tankshell
angle(degrees) 75
initial speed(m/s) 18
mass(kg) 150
diameter(m) 0.15
Air Resistance
A
B
C They will go same distance


Height: 0 m
Angle: 75°
Speed: 18 m/s
Time
Range
Height
Car
Mass 1000 kg
100 5000
Diameter 2.5 m
0.5 3
Gravity 9.81 m/s²
Air Resistance
Altitude 0 m
Drag Coefficient: 0.55
0 m
75°
15.0 m
Initial Speed 18 m/s
Normal
Slow

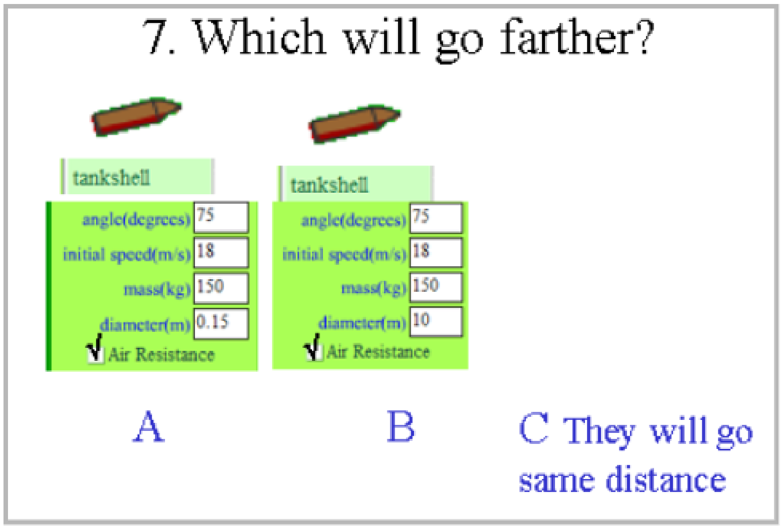
When air resistance is present, the projectile's range is affected because it experiences a decelerating force in the direction opposite to its motion. In this scenario, the projectile with less air resistance will likely travel farther.

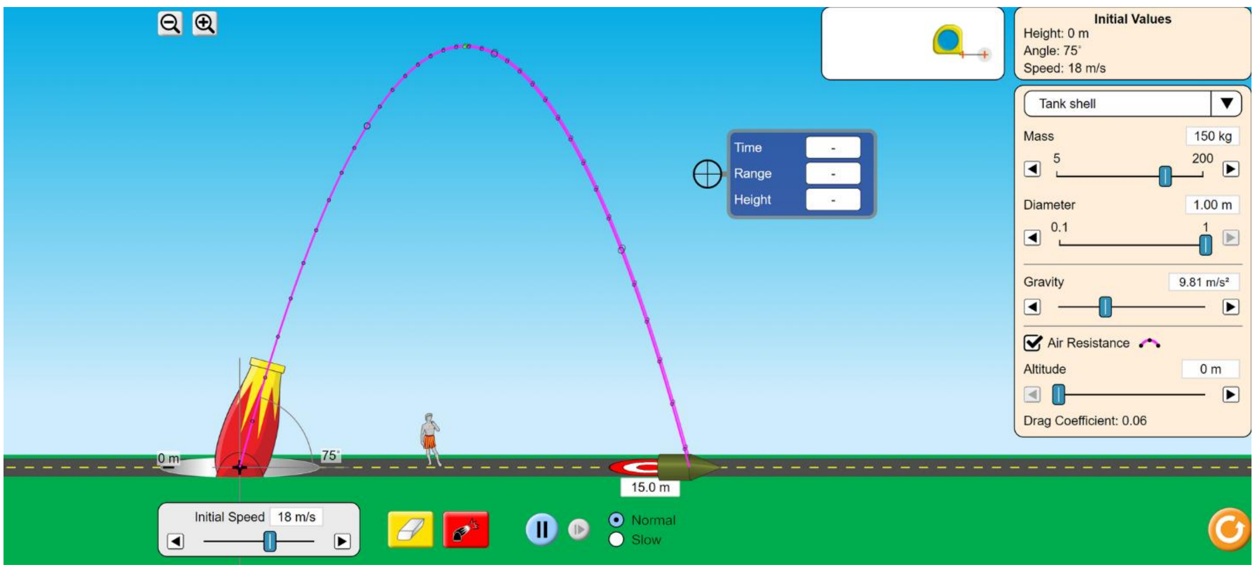
The impact of air resistance depends on several factors including the shape and surface area of the object. Generally, smaller and more aerodynamic objects experience less air resistance compared to larger and less streamlined ones.

So, the tank shell (object B) is smaller and likely more aerodynamic compared to the car (object A). Therefore, the tank shell (object B) would likely travel farther in this scenario where air resistance is a factor.




Given that both objects have the same initial velocity and launch angle but differing masses and shapes, the one with less mass and a more streamlined shape is likely to reach a higher altitude. Therefore, in this scenario, the tank shell (object B) would likely go higher than the car (object A).




Here, the difference in diameter will significantly affect air resistance. Tank shell B will experience much more air resistance due to its larger diameter, which means it will slow down more quickly compared to tank shell A.

Thus, Given the same initial velocity and angle of projection, tank shell A will likely travel farther than tank shell B due to experiencing less air resistance.