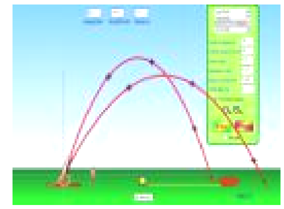
Name: ______________________

Projectile Motion (Intro) PhET Simulations Lab


Projectile Motion

Introduction:
Projectiles travel with two components of motion, X any Y. The acceleration and velocity in the Y direction is independent of the acceleration (if any) and velocity in the X direction. In this module, you will investigate the motion of a simple projectile. Realize that while gravity (acceleration) acts on the projectile in the ____________ direction, it does not affect the velocity of the projectile in the ____________ direction.

Procedure: *(we will be ignoring air resistance during this lab)*

- Run the PhET Simulations → Play → Motion → Projectile Motion Run Now!
- The cannon can be moved to add or remove initial Y position and X position.
- The cannon can be pivoted to change the firing angle, θ.
- The tape measure can be moved and dragged to measure range to target.
- To fire the cannon, Fire.
- To erase the projectile's path, Erase.

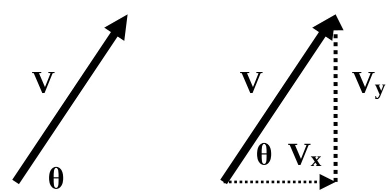
Be sure **air resistance is off** and spend some time firing various projectiles.

- Set the initial speed to a value between 10-15m/s. Choose your favorite projectile.
- Find the range of the projectile at various angles.

θ = _30__	Range (dx) = ________ m	θ = _70__	Range (dx) = ________ m
θ = _40__	Range (dx) = ________ m	θ = _80__	Range (dx) = ________ m
θ = _50__	Range (dx) = ________ m	Add two more → θ = _____	Range (dx) = ________ m
θ = _60__	Range (dx) = ________ m	θ = _____	Range (dx) = ________ m

- Measure the distance from the cannon to the target using the tape measure.
- Move the target to 21.0 m from the cannon. Attempt to hit the target with three different angles by changing the firing angle and initial velocity.

Range (d_x) = 21.0m	θ = __________	Vi = ___________
Range (d_x) = 21.0m	θ = __________	Vi = ___________
Range (d_x) = 21.0m	θ = __________	Vi = ___________



VERY IMPORTANT

- ❖ A projectile's velocity (v) has an X component (v_x) and a Y component (v_y). The X component (v_x) is found by multiplying the magnitude of the velocity by the ***cosine*** of the angle, θ.
- ❖ Similarity, the Y component of velocity is found by multiplying the magnitude of the velocity by the ***sine*** of the angle, θ.

$$v_x = v\cos\theta$$

$$v_y = v\sin\theta$$

So, a projectile fired at **20 m/s** at **65º** has an X-velocity of $v_x = 20\cos 65$ or **8.5** m/s.

The projectile would have a Y-velocity of $v_y = 20\sin 65$ or **18** m/s.

So, the projectile would fire as far as one fired horizontally at 8.5 m/s and as high as one fired straight up at 18 m/s.

A projectile fired at 30 degrees with a velocity of 15 m/s would have an x-velocity component of ________ m/s and a y-velocity component of ________ m/s.

Calculate the components of the following projectile's velocities:

1. $v = 35$ m/s $\theta = 15^o$ v_x =____ v_y = ____
2. $v = 35$ m/s $\theta = 30^o$ v_x =____ v_y = ____
3. $v = 35$ m/s $\theta = 45^o$ v_x =____ v_y = ____
4. $v = 35$ m/s $\theta = 60^o$ v_x =_____ v_y = ____
5. $v = 35$ m/s $\theta = 75^o$ v_x =_____ v_y = ____
6. $v = 35$ m/s $\theta = 90^o$ v_x =_____ v_y = ____

- We can reverse the process and combine the two components of velocity back into one velocity fired at an angle.
- The magnitude of velocity is found using the Pythagorean Theorem with v_x and v_y as the legs of a right triangle. For instance, the velocity of a projectile with an x-component of 7.2 and a y-component of 4.8 is $\sqrt{7.2^2 + 4.8^2} = 8.7$ m/s.
- The angle above the horizontal is found using the inverse tangent ($\tan^{-1}$) of the legs v_y/v_x. For instance, the angle of the projectile described above would be $\tan^{-1}(\frac{4.8}{7.2}) = 34^o$.

Calculate the velocity magnitude and angle of the projectiles listed below:

7. $v_x = 5.6$ $v_y = 6.4$ v =_____ θ = ______
8. $v_x = 2.8$ $v_y = 4.9$ v =_____ θ = ______
9. $v_x = 8.1$ $v_y = -7.2$ v =_____ θ = _____
10. $v_x = -1.3$ $v_y = -5.2$ v = ____ θ = _____

Conclusion Questions:

1. Without air resistance, the piano travels *further / the same distance* as the football. (circle)
2. This is due to the fact that velocity in the X-direction *increases / is constant / decreases* as projectiles travel.
3. The Y-component of velocity *increases / is constant / decreases* as projectiles travel.
4. The answers to #2 and #3 are due to the fact that gravity acts *only in the Y / both the X any Y* direction.
5. The path of a projectile is a *linear curve / round curve / parabolic curve*.
6. This is due to the fact that the time component in the free fall equation (dy) is ______________.
7. Without air resistance, maximum range of a projectile is obtained with an angle of_________ .
8. The same range can be obtained with angles of ________ and ________.
9. Firing a projectile at 25 m/s at an angle of 35^o is similar to firing a projectile with a speed of ___________________ straight up and ___________________ horizontally.
10. A projectile with a horizontal component of 13 m/s and a vertical component of 18 m/s would have an overall velocity of _________________ m/s at an angle of ________________ above the horizontal.