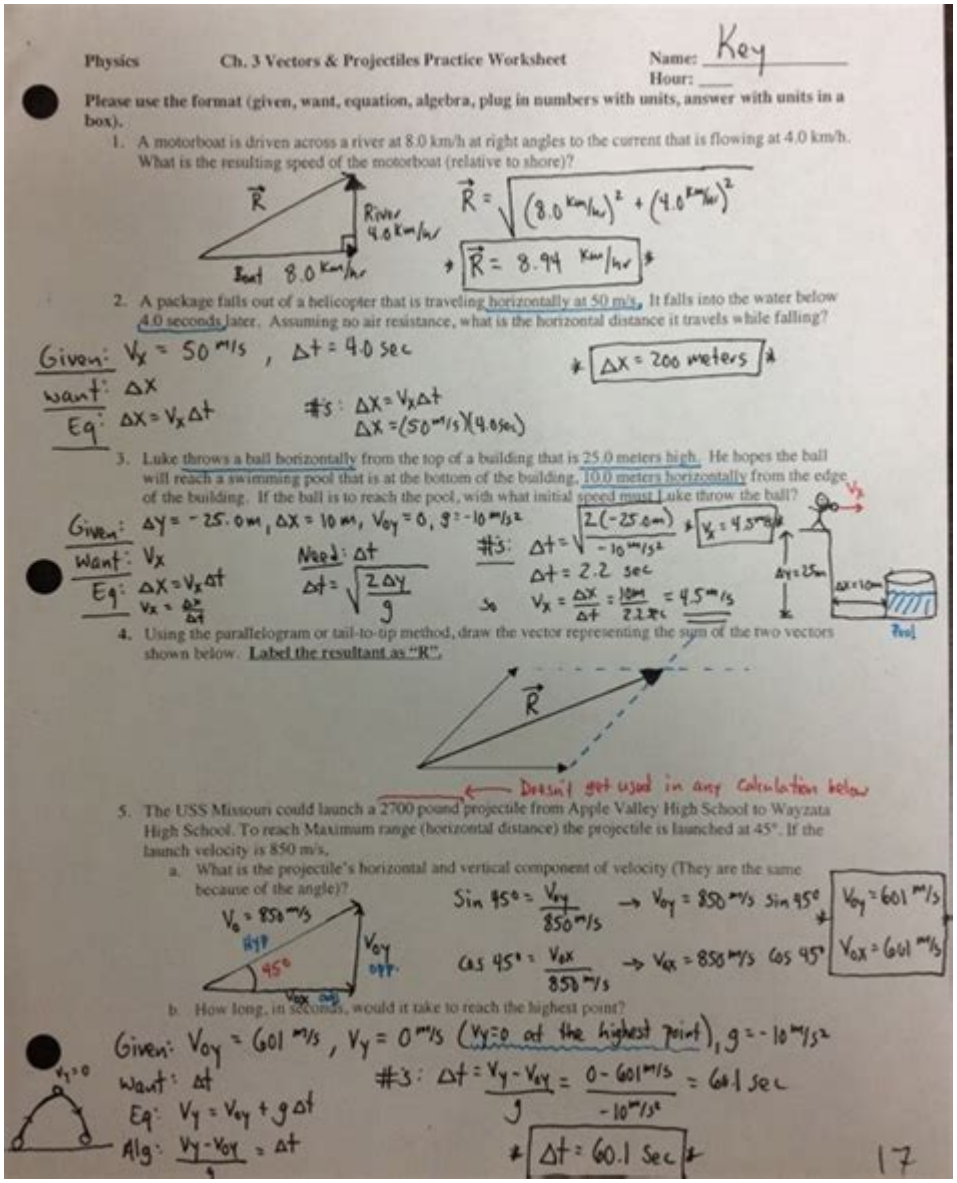
Vectors And Projectiles Worksheet Answers



Physics Ch. 3 Vectors & Projectiles Practice Worksheet Name: Key Hour: ___

Please use the format (given, want, equation, algebra, plug in numbers with units, answer with units in a box).

1. A motorboat is driven across a river at 8.0 km/h at right angles to the current that is flowing at 4.0 km/h. What is the resulting speed of the motorboat (relative to shore)?

$\vec{R} = \sqrt{(8.0\ km/hr)^2 + (4.0\ km/hr)^2}$

$\vec{R} = 8.94\ km/hr$

2. A package falls out of a helicopter that is traveling horizontally at 50 m/s. It falls into the water below 4.0 seconds later. Assuming no air resistance, what is the horizontal distance it travels while falling?

Given: $V_x = 50\ m/s$, $\Delta t = 4.0\ sec$

Want: Δx

Eq: $\Delta x = V_x \Delta t$

#s: $\Delta x = V_x \Delta t$

$\Delta x = (50\ m/s)(4.0\ sec)$

$\Delta x = 200\ meters$

3. Luke throws a ball horizontally from the top of a building that is 25.0 meters high. He hopes the ball will reach a swimming pool that is at the bottom of the building, 10.0 meters horizontally from the edge of the building. If the ball is to reach the pool, with what initial speed must Luke throw the ball?

Given: $\Delta y = -25.0\ m$, $\Delta x = 10\ m$, $V_{oy} = 0$, $g = -10\ m/s^2$

Want: V_x

Eq: $\Delta x = V_x \Delta t$, $V_x = \frac{\Delta x}{\Delta t}$

Need: Δt, $\Delta t = \sqrt{\frac{2\Delta y}{g}}$

#s: $\Delta t = \sqrt{\frac{2(-25.0\ m)}{-10\ m/s^2}}$

$\Delta t = 2.2\ sec$

So $V_x = \frac{\Delta x}{\Delta t} = \frac{10\ m}{2.2\ sec} = 4.5\ m/s$

$V_x = 4.5\ m/s$

4. Using the parallelogram or tail-to-tip method, draw the vector representing the sum of the two vectors shown below. Label the resultant as "R".

$\vec{R}$

← Doesn't get used in any calculation below

5. The USS Missouri could launch a 2700 pound projectile from Apple Valley High School to Wayzata High School. To reach Maximum range (horizontal distance) the projectile is launched at 45°. If the launch velocity is 850 m/s,

a. What is the projectile's horizontal and vertical component of velocity (They are the same because of the angle)?

$V_0 = 850\ m/s$, 45°

$\sin 45° = \frac{V_{oy}}{850\ m/s} \rightarrow V_{oy} = 850\ m/s \sin 45°$

$\cos 45° = \frac{V_{ox}}{850\ m/s} \rightarrow V_{ox} = 850\ m/s \cos 45°$

$V_{oy} = 601\ m/s$

$V_{ox} = 601\ m/s$

b. How long, in seconds, would it take to reach the highest point?

Given: $V_{oy} = 601\ m/s$, $V_y = 0\ m/s$ ($V_y = 0$ at the highest point), $g = -10\ m/s^2$

Want: Δt

Eq: $V_y = V_{oy} + g\Delta t$

Alg: $\frac{V_y - V_{oy}}{g} = \Delta t$

#3: $\Delta t = \frac{V_y - V_{oy}}{g} = \frac{0 - 601\ m/s}{-10\ m/s^2} = 60.1\ sec$

$\Delta t = 60.1\ sec$

17

Vectors and projectiles worksheet answers are essential for students studying physics, particularly in the context of motion and dynamics. This article will explore key concepts related to vectors and projectiles, including definitions, formulas, and sample problems with solutions. Understanding these principles is crucial for solving questions related to motion in two dimensions, particularly those involving the trajectory of projectiles.

Understanding Vectors

Vectors are quantities that have both magnitude and direction. They are fundamental in physics, especially when analyzing forces, velocities, and accelerations. Here are some key characteristics of vectors:

Key Characteristics of Vectors

1. Magnitude: This is the size or length of the vector, often represented as a numerical value.
2. Direction: This indicates where the vector is pointing, which can be represented in terms of angles or coordinate axes.
3. Components: Vectors can be broken down into their components, typically along the x and y axes. For example, a vector A can be expressed as:
- A = A_x i + A_y j
where A_x and A_y are the vector's components along the x and y axes, respectively, and i and j are the unit vectors in the corresponding directions.

Types of Vectors

1. Position Vector: Represents the position of a point in space relative to a reference point.
2. Displacement Vector: The difference between the final and initial position vectors.
3. Velocity Vector: Represents the rate of change of position with respect to time, including both speed and direction.
4. Acceleration Vector: Indicates the rate of change of velocity, also with both magnitude and direction.

Projectile Motion

Projectile motion refers to the motion of an object that is launched into the air and is subject to the force of gravity. The object follows a curved path called a trajectory, which can be analyzed using vector principles.

Characteristics of Projectile Motion

1. Horizontal Motion:
- The horizontal component of motion is uniform, meaning that the horizontal velocity remains constant (ignoring air resistance).
- The distance traveled horizontally can be calculated using the formula:
$$
d_x = v_{x} \cdot t
$$
where v_{x} is the horizontal velocity and t is time.

2. Vertical Motion:
- The vertical component is affected by gravity, resulting in uniform acceleration.
- The vertical distance can be calculated using the following equation of motion:
$$
d_y = v_{y} \cdot t - \frac{1}{2} g t^2
$$

where g is the acceleration due to gravity (approximately $9.81 \, \text{m/s}^2$ downward).

3. Trajectory:
- The path followed by a projectile is parabolic.
- The maximum height and range of the projectile can be calculated using specific formulas, which will be addressed later.

Solving Projectile Motion Problems

When solving problems related to projectile motion, it's important to approach them systematically. Here are the steps:

1. Identify the Given Variables: Recognize what information is provided (initial velocity, angle of projection, etc.).
2. Resolve the Initial Velocity into Components:
- Use trigonometric functions:
- $v_{x} = v \cdot \cos(\theta)$
- $v_{y} = v \cdot \sin(\theta)$
where v is the initial velocity and θ is the angle of projection.

3. Apply Equations of Motion: Use the equations for horizontal and vertical motion to find the unknowns.

4. Combine Results: If necessary, combine the results from the horizontal and vertical analyses to find the total displacement or trajectory.

Sample Problem 1: Horizontal Range Calculation

Problem: A ball is thrown horizontally from a height of 20 meters. Calculate the horizontal distance it travels before hitting the ground. Assume no air resistance.

Solution:
1. Identify Variables:
- Height (h) = 20 m
- Initial vertical velocity (v_{y}) = 0 m/s

2. Calculate Time of Flight:
Using the vertical motion equation:
$$
h = \frac{1}{2} g t^2 \implies 20 = \frac{1}{2} \cdot 9.81 \cdot t^2
$$
$$
t^2 = \frac{20 \cdot 2}{9.81} \implies t = \sqrt{\frac{40}{9.81}} \approx 2.02 \, \text{s}
$$

3. Determine Horizontal Distance:

If the horizontal velocity (v_{x}) is known, the horizontal distance (d_x) can be calculated:
$$
d_x = v_{x} \cdot t
$$
For example, if $v_{x} = 5 \, \text{m/s}$:
$$
d_x = 5 \cdot 2.02 \approx 10.1 \, \text{m}
$$

Sample Problem 2: Maximum Height and Range

Problem: A projectile is launched at an angle of 30 degrees with an initial speed of 40 m/s. Calculate the maximum height and the range of the projectile.

Solution:
1. Resolve Components:
- $v_{x} = 40 \cdot \cos(30) \approx 34.64 \, \text{m/s}$
- $v_{y} = 40 \cdot \sin(30) = 20 \, \text{m/s}$

2. Calculate Maximum Height:
Using the formula for maximum height:
$$
H = \frac{v_{y}^2}{2g} = \frac{20^2}{2 \cdot 9.81} \approx 20.4 \, \text{m}
$$

3. Calculate Time of Flight:
Time to reach maximum height:
$$
t_{up} = \frac{v_{y}}{g} = \frac{20}{9.81} \approx 2.04 \, \text{s}
$$
Total time of flight $t = 2 \cdot t_{up} \approx 4.08 \, \text{s}$

4. Calculate Range:
$$
R = v_{x} \cdot t \approx 34.64 \cdot 4.08 \approx 141.5 \, \text{m}
$$

Common Mistakes in Projectile Motion Problems

1. Neglecting Air Resistance: Most basic physics problems assume no air resistance, which can significantly alter the results in real-life scenarios.
2. Incorrectly Resolving Components: Failing to use trigonometric functions correctly to resolve the initial velocity into horizontal and vertical components can lead to incorrect answers.
3. Mixing Units: Always ensure that units are consistent throughout calculations (e.g., using meters for distance and seconds for time).

4. Ignoring the Effects of Gravity: Remember that gravity only affects vertical motion; horizontal motion remains constant.

Conclusion

Understanding vectors and projectiles worksheet answers is vital for mastering concepts related to motion in physics. By grasping the principles of vector resolution, projectile motion, and the application of relevant formulas, students can effectively solve real-world problems. With practice, they will develop the skills needed to analyze and interpret various scenarios involving motion, leading to a deeper understanding of the physical world. Whether in a classroom setting or during self-study, these concepts form the foundation for more advanced topics in physics.

Frequently Asked Questions

What are the key components of a vector in projectile motion?

The key components of a vector in projectile motion are the horizontal and vertical components, which can be analyzed separately to understand the overall motion of the projectile.

How do you calculate the range of a projectile using vectors?

The range of a projectile can be calculated using the formula R = (v^2 sin(2θ)) / g, where v is the initial velocity, θ is the launch angle, and g is the acceleration due to gravity.

What role does gravity play in the motion of a projectile?

Gravity affects the vertical component of a projectile's motion, causing it to accelerate downwards at a rate of 9.81 m/s², while the horizontal motion remains constant in the absence of air resistance.

How can vector components be used to solve projectile motion problems?

Vector components can be used to break down the initial velocity into horizontal and vertical parts, allowing for separate analysis of the motion in each direction, which simplifies calculations of time, range, and height.

What is the significance of the launch angle in projectile

motion?

The launch angle determines the trajectory of the projectile, affecting both the maximum height and the range. An angle of 45 degrees typically yields the maximum range for a given initial velocity.

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