AP PHYSICS 1 • EXERCISE SHEET

1.5 Vectors and Motion in Two Dimensions

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

Objective

Build the skills to answer exam questions on **vectors and motion in two dimensions** —components and projectile motion.

You must be able to:

- resolve a 2-D vector into perpendicular **components** 分量 with $A_x = A\cos\theta$, $A_y = A\sin\theta$
- add vectors by combining components to find the **resultant** 合矢量 (magnitude and direction)
- explain that a **projectile's** 抛体 horizontal and vertical motions are **independent** 相互独立
- analyse projectile motion by applying the kinematic equations separately to x and y
- find the **range** 射程, maximum height, and time of flight

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ Resolving a vector

A force $A = 50$ N at 30° above the horizontal:

$$A_x = 50\cos 30^\circ = 43 \text{ N}, \qquad A_y = 50\sin 30^\circ = 25 \text{ N}.$$

■ Independence of projectile motion

Horizontal motion is constant velocity, $v_x = v_0\cos\theta$; vertical motion is free fall, $a_y = -g$. The two directions share only the **time**.

■ A projectile launched horizontally

A ball leaves a 20 m high table at 5.0 m s^{-1} (take $g = 10$ m s^{-2}). Time to fall: $20 = \frac{1}{2}(10)t^2 \Rightarrow t = 2.0$ s. Horizontal range $= 5.0 \times 2.0 = 10$ m.

2 Practice

2.1 A force of 80 N acts at 60° above the horizontal. Find its horizontal and vertical components. [2]

2.2 A ball rolls off a bench 1.25 m high at 3.0 m s^{-1} (take $g = 10$ m s^{-2}). Find the time to land. [2]

2.3 Hence find how far from the base of the bench the ball lands. [1]

2.4 State what the horizontal and vertical motions of a projectile have in common. [1]

3 Exam-style questions

3.1 For a projectile (ignore air resistance), the horizontal component of velocity [1]

- **A** increases
- **B** decreases
- **C** stays constant
- **D** is zero

3.2 At the top of its path, a projectile's vertical velocity is [1]

- **A** maximum
- **B** zero
- **C** equal to its horizontal velocity
- **D** equal to g

3.3 A stone is thrown at 20 m s^{-1} at 30° above the horizontal (take $g = 10$ m s^{-2}).

(a) Find the initial vertical velocity component. [1]

(b) Find the time to reach the top of the path. [1]

(c) Find the maximum height. [2]

4 Go further

- work through the **1.5 Vectors and Motion in Two Dimensions** lesson on the **Learn** page;
- read the **Kinematics** section of the AP Physics 1 handout on the **Know** page.

Solutions

2.1 $A_x = 80\cos 60° = 40$ N; $A_y = 80\sin 60° = 69$ N.

2.2 $1.25 = \frac{1}{2}(10)t^2 \Rightarrow t^2 = 0.25$, $t = 0.50$ s.

2.3 $x = 3.0 \times 0.50 = 1.5$ m.

2.4 the time of flight (both motions last the same time).

3.1 **C**.

3.2 **B**.

3.3 (a) $v_{0y} = 20\sin 30° = 10$ m s^{-1}. (b) $t = 10/10 = 1.0$ s. (c) $h = \dfrac{v_{0y}^2}{2g} = \dfrac{10^2}{20} = 5.0$ m.