AP PHYSICS 1 • EXERCISE SHEET

1.3 Representing Motion

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS slope 斜率 • area 面积 • free fall 自由落体 • kinematic equations 运动学方程 • velocity 速度

Objective

Build the skills to answer exam questions on **representing motion** — motion graphs and the equations for constant acceleration.

You must be able to:

- read **position-time**, **velocity-time**, and **acceleration-time** graphs
- use the **slope** 斜率: slope of an x-t graph = velocity; slope of a v-t graph = acceleration
- use the **area** 面积: area under a v-t graph = displacement; area under an a-t graph = change in velocity
- apply the **kinematic equations** 运动学方程 for constant acceleration
- analyse **free fall** 自由落体 with $g = 9.8$ m s^{-2}

1 Worked examples

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

■ **The kinematic equations (constant a)**

$$v = v_0 + at, \qquad \Delta x = v_0 t + \tfrac{1}{2}at^2,$$

$$v^2 = v_0^2 + 2a\,\Delta x, \qquad \Delta x = \tfrac{1}{2}(v_0 + v)\,t.$$

Choose the one that is **missing the quantity you don't know**.

■ **Slopes and areas**

On a v-t graph the **slope** is the acceleration and the **area** under the line is the displacement. A line rising from 0 to 12 m s^{-1} over 4.0 s: slope = 3.0 m s^{-2}; area = $\frac{1}{2}(4.0)(12) = 24$ m.

■ **Free fall**

Take down as positive, so $a = g = 9.8$ m s^{-2}. A ball dropped from rest for 2.0 s: $\Delta x = \frac{1}{2}(9.8)(2.0)^2 = 19.6$ m and $v = 9.8 \times 2.0 = 19.6$ m s^{-1}.

2 Practice

2.1 A car accelerates from rest at 2.0 m s^{-2} for 6.0 s. Find its final velocity. [1]

2.2 For the same car, find the distance it travels in that time. [2]

2.3 On a velocity-time graph, state what (a) the slope and (b) the area under the line represent. [2]

2.4 A stone is dropped from rest. Find its speed after 3.0 s (take $g = 9.8$ m s^{-2}). [1]

3 Exam-style questions

3.1 The area under a velocity-time graph gives the [1]

- **A** acceleration
- **B** displacement
- **C** speed
- **D** jerk

3.2 A ball is thrown straight up. At its highest point, its [1]

- **A** velocity and acceleration are both zero
- **B** velocity is zero and acceleration is 9.8 m s^{-2} downward
- **C** velocity is maximum and acceleration is zero
- **D** velocity and acceleration both point up

3.3 A car travelling at 25 m s^{-1} brakes to rest in a distance of 50 m.

(a) Find its acceleration. [2]

(b) Find the time it takes to stop. [1]

3.4 A ball is thrown vertically upward at 20 m s^{-1} (take $g = 10$ m s^{-2}).

(a) Find the time to reach the top. [1]

(b) Find the maximum height reached. [2]

Solutions

2.1 $v = 0 + 2.0(6.0) = 12$ m s^{-1}.

2.2 $\Delta x = \frac{1}{2}(2.0)(6.0)^2 = 36$ m.

2.3 (a) acceleration; (b) displacement.

2.4 $v = 9.8(3.0) = 29.4$ m s^{-1}.

3.1 B.

3.2 B — the speed is zero at the top but gravity still acts downward.

3.3 (a) $v^2 = v_0^2 + 2a\,\Delta x \Rightarrow 0 = 25^2 + 2a(50)$, so $a = -6.25$ m s^{-2}. (b) $t = \dfrac{0 - 25}{-6.25} = 4.0$ s.

3.4 (a) $t = \dfrac{20}{10} = 2.0$ s. (b) $h = \dfrac{v_0^2}{2g} = \dfrac{20^2}{20} = 20$ m.