AP PHYSICS 1 • EXERCISE SHEET

1.2 Displacement, Velocity, and Acceleration

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

Objective

Build the skills to answer exam questions on **displacement, velocity, and acceleration**—the language of motion along a line.

You must be able to:

- define **position** 位置 and **displacement** 位移 $\Delta x = x_f - x_i$ (a vector)
- find **average velocity** 平均速度 $v_{avg} = \dfrac{\Delta x}{\Delta t}$ and describe **instantaneous velocity** 瞬时速度
- tell **speed** 速率 (scalar) from **velocity** 速度 (vector), and see when their sizes differ
- find **average acceleration** 加速度 $a_{avg} = \dfrac{\Delta v}{\Delta t}$
- decide if an object is **speeding up** or **slowing down** from the signs of v and a

1 Worked examples

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

■ Displacement vs distance

Displacement is the change in position (a vector); **distance** 距离 is the path length (a scalar). A runner goes +100 m east then −40 m west:

- displacement = $(+100) + (-40) = +60$ m (60 m east)
- distance = $100 + 40 = 140$ m

■ Average velocity and acceleration

Use the change over the interval:

$$v_{avg} = \frac{\Delta x}{\Delta t}, \qquad a_{avg} = \frac{\Delta v}{\Delta t}.$$

A car speeds from 8 m s^{-1} to 20 m s^{-1} in 4 s: $a = \dfrac{20 - 8}{4} = +3$ m s^{-2}.

■ Speeding up or slowing down

Compare the **signs** of v and a:

- same sign → speeding up
- opposite signs → slowing down

A ball moving in the + direction with $a = -2$ m s^{-2} is slowing down.

2 Practice

2.1 A cyclist rides +300 m then returns −120 m. State (a) the displacement and (b) the distance travelled. [2]

2.2 A car's velocity changes from +30 m s^{-1} to +12 m s^{-1} in 6.0 s. Find its average acceleration. [2]

2.3 An object moves in the + direction while its acceleration is −4 m s^{-2}. State whether it is speeding up or slowing down, and why. [2]

2.4 In 5.0 s a train's displacement is +250 m. Find its average velocity. [1]

3 Exam-style questions

3.1 Which pair are **both** vectors? [1]

- **A** speed and distance
- **B** velocity and displacement
- **C** speed and velocity
- **D** distance and displacement

3.2 An object has velocity −6 m s^{-1} and acceleration −2 m s^{-2}. The object is [1]

- **A** speeding up
- **B** slowing down

- **C** at rest
- **D** moving at constant velocity

3.3 A jogger runs one full lap of a 400 m track, returning to the start, in 100 s.

(a) State the total distance run. [1]

(b) State the magnitude of the displacement. [1]

(c) Hence find the average velocity for the lap. [1]

3.4 A stone's velocity changes from $+5$ m s^{-1} to -5 m s^{-1} in 2.0 s.

(a) Find the average acceleration. [1]

(b) Explain why the answer is negative even though the final speed equals the initial speed. [1]

4 Go further

- work through the **1.2 Displacement, Velocity, and Acceleration** lesson on the **Learn** page;
- read the **Kinematics** section of the AP Physics 1 handout on the **Know** page.

Solutions

2.1 (a) $(+300) + (-120) = +180$ m. (b) $300 + 120 = 420$ m.

2.2 $a = \dfrac{12 - 30}{6.0} = -3.0$ m s^{-2}.

2.3 Slowing down — v and a have opposite signs, so the acceleration opposes the motion.

2.4 $v = \dfrac{250}{5.0} = +50$ m s^{-1}.

3.1 **B**.

3.2 **A** — v and a have the same sign, so the object speeds up.

3.3 (a) 400 m. (b) 0 m — start and end are the same point. (c) $v_{avg} = 0/100 = 0$ m s^{-1}.

3.4 (a) $a = \dfrac{-5 - (+5)}{2.0} = -5.0$ m s^{-2}. (b) Velocity is a vector; its direction reversed, so $\Delta v \neq 0$ even though the speed is unchanged.