AP PHYSICS C: MECHANICS • EXERCISE SHEET

2.9 Resistive Forces

Name: _____ Class: _____ Date: _____ **Total: 13 marks**

Objective

Build the skills to answer exam questions on **resistive forces**.

You must be able to:

- describe a **drag force** 阻力 that opposes motion and grows with speed
- explain **terminal velocity** 终极速度: reached when drag balances weight
- describe the acceleration as it falls from g to zero at terminal velocity
- reason about a velocity-time graph that levels off

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

■ Drag opposes motion and grows with speed

A resistive (drag) force points opposite to the velocity and increases as the object speeds up. At low speed it is small; at high speed it can become large.

■ Terminal velocity

A falling object speeds up, so drag grows, until drag equals weight. Then the net force is zero and the velocity stops changing:

$$\text{drag} = mg \quad \Rightarrow \quad \text{terminal velocity.}$$

■ The acceleration fades

Just after release, drag is tiny, so $a \approx g$. As speed rises, drag grows and a falls, reaching zero at terminal velocity. The v-t graph curves and levels off.

2 Practice

Now apply the methods above.

2.1 State the direction of a drag force relative to the motion. [1]

2.2 What condition is met at terminal velocity? [1]

2.3 State the acceleration of an object at its terminal velocity. [1]

2.4 Just after a skydiver jumps, what is their approximate acceleration, and why? [2]

3 Exam-style questions

3.1 As a falling object speeds up, the drag force on it [1]

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

3.2 At terminal velocity, the net force on the object is [1]

- **A** equal to its weight
- **B** zero
- **C** upward
- **D** increasing

3.3 A raindrop falls and reaches terminal velocity.

(a) Explain, in terms of forces, why the velocity stops increasing. [2]

(b) Sketch in words the shape of its velocity-time graph. [1]

3.4 A 70 kg skydiver reaches terminal velocity ($g = 10$ m s^{-2}).

(a) State the size of the drag force. [2]

(b) State the acceleration at that instant. [1]

4 Go further

You are ready for more on this subtopic:

- work through the interactive **2.9 Resistive Forces** lesson on the **Learn** page;
- read the **Force and Translational Dynamics** section of the AP Physics C: Mechanics handout on the **Know** page for the full explanation and worked diagrams.

Solutions

2.1 Opposite to the motion.

2.2 Drag equals weight (net force zero).

2.3 Zero.

2.4 About g (≈ 9.8 m s^{-2}) —the speed is still low, so drag is negligible.

3.1 B —drag increases with speed.

3.2 B —at terminal velocity the forces balance, so the net force is zero.

3.3 (a) Drag grows with speed until it equals the weight; the net force becomes zero, so the velocity stops changing. (b) It rises steeply, curves over, and levels off at a constant value.

3.4 (a) drag $= mg = 70 \times 10 = 700$ N. (b) Zero.