AP PHYSICS 1 • EXERCISE SHEET

2.4 Newton's First Law

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

Objective

Build the skills to answer exam questions on **Newton's first law** —inertia and equilibrium.

You must be able to:

- state **Newton's first law** 牛顿第一定律: an object's velocity stays constant unless a net external force acts
- define **inertia** 惯性 as the resistance to a change in motion, measured by **mass** 质量
- state the condition for **translational equilibrium** 平动平衡 (net force zero)
- apply the first law to objects at rest or moving at constant velocity

1 Worked examples

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

■ Equilibrium means balanced forces

An object is in **translational equilibrium** when $\sum \vec{F} = 0$. This includes both **at rest** and **constant velocity** —"no net force" does **not** mean "no motion".

■ Inertia and mass

More mass → more inertia → harder to speed up, slow down, or turn. A loaded truck is harder to stop than a bicycle at the same speed.

■ Balancing forces

A crate slides at constant velocity, so the forces balance: if friction is 30 N backward, the applied pull must be 30 N forward.

2 Practice

2.1 A car moves along a straight road at a **constant** 20 m s^{-1}. State the net force on it. [1]

2.2 A box sits still on a floor. Friction can act up to 12 N. A push of 7.0 N is applied.

State the friction force and whether the box moves. [2]

2.3 Explain, using inertia, why passengers lurch forward when a bus brakes suddenly. [2]

3 Exam-style questions

3.1 An object is in translational equilibrium. Its velocity must be [1]

- **A** zero
- **B** constant (possibly zero)
- **C** increasing
- **D** decreasing

3.2 Which object has the greatest inertia? [1]

- **A** a 0.5 kg ball
- **B** a 2 kg book
- **C** a 50 kg crate
- **D** a 1 kg brick

3.3 A 500 N lamp hangs at rest from a single cable.

(a) State the tension in the cable. [1]

(b) State the net force on the lamp, and justify with the first law. [2]

4 Go further

- work through the **2.4 Newton's First Law** lesson on the **Learn** page;

- read the **Force and Translational Dynamics** section of the AP Physics 1 handout on the **Know** page.

Solutions

2.1 zero —constant velocity means the forces are balanced.

2.2 friction = 7.0 N (it matches the push up to its maximum); the box does not move, since $7.0 < 12$ N.

2.3 The passengers have inertia, so they tend to keep moving forward at the original speed while the bus slows beneath them.

3.1 B.

3.2 C.

3.3 (a) 500 N. (b) zero —at rest is equilibrium, so the net force must be zero by the first law.