AP PHYSICS 1 • EXERCISE SHEET

2.5 Newton's Second Law

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

Objective

Build the skills to answer exam questions on **Newton's second law** —relating force, mass, and acceleration.

You must be able to:

- state **Newton's second law** 牛顿第二定律, $\vec{a} = \dfrac{\sum \vec{F}}{m}$
- explain that acceleration is **proportional** to net force and **inversely proportional** to mass
- resolve forces into perpendicular **components** 分量 on an inclined surface
- apply the second law to connected objects joined by a string

1 Worked examples

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

■ Applying $F = ma$

A net force of 12 N on a 3.0 kg block gives $a = \dfrac{12}{3.0} = 4.0$ m s^{-2} in the direction of the net force.

■ On an incline

Resolve weight along and perpendicular to the slope. On a frictionless incline of angle θ, the acceleration down the slope is $a = g \sin\theta$.

■ Connected masses

For masses joined by a string, apply $F = ma$ to the **whole system** to find a, then to **one mass** to find the tension. A 2.0 kg and a 3.0 kg block pulled by 10 N: $a = \dfrac{10}{5.0} = 2.0$ m s^{-2}.

2 Practice

2.1 A net force of 20 N acts on a 4.0 kg trolley. Find its acceleration. [1]

2.2 A 1500 kg car accelerates at 2.0 m s^{-2}. Find the net force on it. [1]

2.3 A block slides down a frictionless ramp at 30° (take $g = 10$ m s^{-2}). Find its acceleration along the ramp. [2]

2.4 State how the acceleration changes if the net force doubles while the mass stays the same. [1]

3 Exam-style questions

3.1 If the net force on an object doubles and its mass halves, the acceleration becomes [1]

- **A** unchanged
- **B** twice as large
- **C** four times as large
- **D** half as large

3.2 A 2.0 kg object accelerates at 5.0 m s^{-2}. The net force on it is [1]

- **A** 0.4 N
- **B** 2.5 N
- **C** 7.0 N
- **D** 10 N

3.3 Two blocks, 2.0 kg and 3.0 kg, sit in contact on a frictionless floor. A 15 N force pushes on the 2.0 kg block.

(a) Find the acceleration of the pair. [2]

(b) Find the contact force between the blocks. [2]

4 Go further

- work through the **2.5 Newton's Second 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 $a = \dfrac{20}{4.0} = 5.0$ m s^{-2}.

2.2 $F = ma = 1500 \times 2.0 = 3000$ N.

2.3 $a = g \sin 30° = 10 \times 0.5 = 5.0$ m s^{-2}.

2.4 it also doubles (acceleration is proportional to net force).

3.1 C.

3.2 D —$F = 2.0 \times 5.0 = 10$ N.

3.3 (a) $a = \dfrac{15}{2.0 + 3.0} = 3.0$ m s^{-2}. (b) On the 3.0 kg block, $F = ma = 3.0 \times 3.0 = 9.0$ N.