AP PHYSICS 1 • EXERCISE SHEET

7.1 Defining Simple Harmonic Motion (SHM)

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

Objective

Build the skills to answer exam questions on **defining simple harmonic motion (SHM)**.

You must be able to:

- define **simple harmonic motion** 简谐运动 as motion where the restoring force is proportional to the displacement
- identify the condition $F = -kx$ that produces SHM
- give examples of SHM, such as a mass on a spring and a small-angle pendulum

1 Worked examples

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

The condition for SHM

The **restoring force** 回复力 is proportional to the displacement and points back toward equilibrium: $F = -kx$. The negative sign is what makes the motion oscillate.

Examples

A mass on a spring, and a pendulum swinging through a **small** angle, both obey $F = -kx$ (approximately, for the pendulum).

Not SHM

A ball bouncing off the floor is periodic but **not** SHM —its force is not proportional to displacement.

2 Practice

2.1 State the condition on the restoring force for simple harmonic motion. [1]

2.2 Give two examples of systems that perform SHM. [2]

2.3 A spring obeys $F = -kx$. State the direction of the force when the mass is displaced to the right of equilibrium. [1]

3 Exam-style questions

3.1 In simple harmonic motion, the restoring force is [1]

- **A** constant
- **B** proportional to the displacement
- **C** proportional to the speed
- **D** always zero

3.2 Which of these is an example of SHM? [1]

- **A** a ball rolling down a hill
- **B** a mass oscillating on a spring
- **C** a car braking to a stop
- **D** a satellite in a circular orbit

3.3 A 0.50 kg mass on a spring of constant $k = 200$ N m^{-1} is pulled 0.10 m from equilibrium.

(a) Find the size of the restoring force. [2]

(b) State the direction of this force. [1]

4 Go further

- work through the **7.1 Defining Simple Harmonic Motion** lesson on the **Learn** page;
- read the **Oscillations** section of the AP Physics 1 handout on the **Know** page.

Solutions

2.1 it must be proportional to the displacement and directed back toward equilibrium ($F = -kx$).

2.2 a mass on a spring; a small-angle pendulum.

2.3 to the left, back toward equilibrium.

3.1 B.

3.2 B.

3.3 (a) $F = kx = 200 \times 0.10 = 20$ N. (b) toward equilibrium (to the left).