AP PHYSICS 1 • EXERCISE SHEET

2.6 Gravitational Force

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

Objective

Build the skills to answer exam questions on **gravitational force**.

You must be able to:

- state **Newton's law of universal gravitation** 万有引力定律, $F_g = \dfrac{Gm_1m_2}{r^2}$
- distinguish **mass** 质量 (an intrinsic property) from **weight** 重量 (a gravitational force)
- calculate the **gravitational field strength** 引力场强度 $g = \dfrac{GM}{r^2}$ and use $F_g = mg$
- explain how the force changes with **separation** and with the **masses**

1 Worked examples

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

■ **The inverse-square law**

$F_g = \dfrac{Gm_1m_2}{r^2}$ with $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}. **Double the separation → force falls to one quarter** $(1/2^2)$.

■ **Mass versus weight**

Mass (in kg) never changes; weight $F_g = mg$ (in N) depends on the local field g. A 60 kg student weighs ≈ 590 N on Earth ($g = 9.8$) but ≈ 100 N on the Moon ($g = 1.6$).

■ **Field of a planet**

$g = \dfrac{GM}{r^2}$ points toward the planet's centre. It is the force per unit mass, so weight $= mg$.

2 Practice

2.1 State the difference between the mass and the weight of an object. [2]

2.2 Find the weight of a 50 kg crate on Earth (take $g = 9.8$ m s^{-2}). [1]

2.3 The distance between two masses is tripled. State the factor by which the gravitational force changes. [1]

2.4 A rock has mass 2.0 kg. State its mass and find its weight on the Moon ($g = 1.6$ m s^{-2}). [2]

3 Exam-style questions

3.1 If the separation between two masses is halved, the gravitational force between them [1]

- **A** halves
- **B** doubles
- **C** is one quarter as large
- **D** is four times as large

3.2 The weight of an object depends on [1]

- **A** its mass only
- **B** the local gravitational field only
- **C** both its mass and the local gravitational field
- **D** neither

3.3 A planet has twice Earth's mass and the same radius.

(a) State how its surface gravitational field compares with Earth's. [1]

(b) A 10 kg object is taken there. State its mass and find its weight (Earth $g =$

9.8 m s^{-2}). [2]

4 Go further

- work through the **2.6 Gravitational Force** 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 Mass is the amount of matter (kg), the same everywhere; weight is the gravitational force on it (N) and depends on the local field.

2.2 $F_g = mg = 50 \times 9.8 = 490$ N.

2.3 it becomes $\dfrac{1}{9}$ as large ($1/3^2$).

2.4 mass = 2.0 kg (unchanged); weight = $2.0 \times 1.6 = 3.2$ N.

3.1 D.

3.2 C.

3.3 (a) twice as strong ($g \propto M$ at fixed r). (b) mass = 10 kg; weight = $10 \times (2 \times 9.8) = 196$ N.