AP PHYSICS 1 • EXERCISE SHEET

3.3 Potential Energy

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

Objective

Build the skills to answer exam questions on **potential energy**.

You must be able to:

- define **potential energy** 势能 as energy stored in the configuration of a system
- calculate **gravitational potential energy** 重力势能 with $\Delta U_g = mg\,\Delta h$
- calculate **elastic potential energy** 弹性势能 with $U_s = \frac{1}{2}kx^2$
- relate a **conservative force** 保守力 to the change in potential energy
- interpret a **potential energy versus position** graph

1 Worked examples

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

■ Gravitational potential energy

$\Delta U_g = mg\,\Delta h$. Lifting a 2.0 kg book 3.0 m (take $g = 10$ m s^{-2}): $\Delta U_g = 2.0 \times 10 \times 3.0 = 60$ J.

■ Elastic potential energy

$U_s = \frac{1}{2}kx^2$. A spring with $k = 200$ N m^{-1} compressed 0.10 m: $U_s = \frac{1}{2}(200)(0.10)^2 = 1.0$ J.

■ Reading a potential-energy graph

A **minimum** of U is a point of **stable equilibrium**; the object oscillates about it. The steeper the curve, the larger the force ($F = -$ slope).

2 Practice

2.1 Find the gravitational potential energy gained by lifting a 5.0 kg box 2.0 m (take $g = 10$ m s^{-2}). [2]

2.2 A spring of constant 300 N m^{-1} is compressed 0.20 m. Find the elastic potential

energy stored. [2]

2.3 State what a minimum on a potential-energy versus position graph tells you about the object there. [1]

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3 Exam-style questions

3.1 The elastic potential energy stored in a spring is [1]

- **A** kx
- **B** $\frac{1}{2}kx$
- **C** $\frac{1}{2}kx^2$
- **D** kx^2

3.2 Doubling the compression of a spring changes its stored potential energy by a factor of [1]

- **A** 2
- **B** 4
- **C** $\frac{1}{2}$
- **D** no change

3.3 A 0.30 kg ball is raised 1.5 m and then released from rest (take $g = 10\ \text{m s}^{-2}$).

(a) Find the gravitational potential energy at the top. [2]

(b) Using energy conservation, find its speed just before it lands. [2]

4 Go further

- work through the **3.3 Potential Energy** lesson on the **Learn** page;
- read the **Work, Energy, and Power** section of the AP Physics 1 handout on the **Know** page.

Solutions

2.1 $\Delta U_g = mg\,\Delta h = 5.0 \times 10 \times 2.0 = 100$ J.

2.2 $U_s = \frac{1}{2}(300)(0.20)^2 = 6.0$ J.

2.3 it is a point of stable equilibrium (the object tends to stay or oscillate about it).

3.1 C.

3.2 B —$U_s \propto x^2$.

3.3 (a) $U_g = 0.30 \times 10 \times 1.5 = 4.5$ J. (b) $\frac{1}{2}mv^2 = U_g \Rightarrow v = \sqrt{2g\,\Delta h} = \sqrt{30} = 5.5$ m s^{-1}.