AP PHYSICS C: MECHANICS • EXERCISE SHEET

3.3 Potential Energy

Name: _____ Class: _____ Date: _____ **Total: 16 marks**

Objective

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

You must be able to:

- use **gravitational potential energy** 重力势能: $U = mgh$
- use **elastic potential energy** 弹性势能: $U = \frac{1}{2}kx^2$
- explain that potential energy is stored energy of position or configuration
- find the change in potential energy between two positions

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

■ Gravitational potential energy

Near Earth's surface,

$$U = mgh,$$

measured from a chosen reference height. A 2 kg mass raised 3 m ($g = 10$ m s^{-2}) gains $U = 2(10)(3) = 60$ J.

■ Elastic potential energy

A stretched or compressed spring stores

$$U = \tfrac{1}{2}kx^2.$$

A spring with $k = 400$ N m^{-1} compressed 0.1 m stores $U = \frac{1}{2}(400)(0.1)^2 = 2$ J.

■ Change in potential energy

Only the *change* matters. Lifting from h_1 to h_2: $\Delta U = mg(h_2 - h_1)$.

2 Practice

Now apply the methods above.

2.1 A 5 kg mass is at height 4 m ($g = 10$ m s^{-2}). Find its gravitational PE. [2]

2.2 A spring ($k = 200$ N m^{-1}) is stretched 0.2 m. Find its elastic PE. [2]

2.3 State what kind of energy a raised object stores. [1]

2.4 A 3 kg box is lifted from 1 m to 4 m ($g = 10$ m s^{-2}). Find the change in PE. [2]

3 Exam-style questions

3.1 Gravitational potential energy near Earth's surface is [1]

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

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

- **A** 2
- **B** 4
- **C** 1/2
- **D** 1

3.3 A spring with $k = 500$ N m^{-1} is compressed 0.06 m.

(a) Find the elastic potential energy stored. [2]

(b) State what happens to this energy if the spring is released to push a block. [1]

3.4 A 10 kg crate is raised 2.5 m ($g = 9.8$ m s^{-2}).

(a) Find the gain in gravitational potential energy. [2]

(b) State the minimum work needed to lift it. [1]

4 Go further

You are ready for more on this subtopic:

- work through the interactive **3.3 Potential Energy** lesson on the **Learn** page;
- read the **Work, Energy, and Power** section of the AP Physics C: Mechanics handout on the **Know** page for the full explanation and worked diagrams.

Solutions

2.1 $U = mgh = 5(10)(4) = 200$ J.

2.2 $U = \frac{1}{2}kx^2 = \frac{1}{2}(200)(0.2)^2 = 4$ J.

2.3 Gravitational potential energy.

2.4 $\Delta U = mg(h_2 - h_1) = 3(10)(4 - 1) = 90$ J.

3.1 **B** —$U = mgh$.

3.2 **B** —$U \propto x^2$, so doubling gives $2^2 = 4$.

3.3 (a) $U = \frac{1}{2}(500)(0.06)^2 = 0.9$ J. (b) It converts into the block's kinetic energy.

3.4 (a) $\Delta U = 10(9.8)(2.5) = 245$ J. (b) 245 J.