Exercise walk-through

Potential Energy ▪ 3.3

eXercise

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

Method — 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.

Method — Elastic potential energy

A stretched or compressed spring stores

$$U = \tfrac{1}{2} k x^2.$$

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

Method — Change in potential energy

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

Practice 2.1 ▪ 2 marks

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

Solution 2.1

Method: Gravitational potential energy

Worked steps

$U = mgh = 5(10)(4) = 200$ J M1 A1.

Practice 2.2 ▪ 2 marks

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

Solution 2.2

Method: Elastic potential energy

Worked steps

$U = \frac{1}{2}kx^2 = \frac{1}{2}(200)(0.2)^2 = 4$ J M1 A1.

Practice 2.3 ▪ 1 mark

State what kind of energy a raised object stores.

Solution 2.3

Worked steps

Gravitational potential energy B1.

Practice 2.4 ▪ 2 marks

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

Solution 2.4

Worked steps

$\Delta U = mg(h_2 - h_1) = 3(10)(4-1) = 90$ J M1 A1.

Exam-style 3.1 ▪ 1 mark

Gravitational potential energy near Earth's surface is

A $\frac{1}{2}mv^2$

B mgh

C $\frac{1}{2}kx^2$

D Fd

Solution 3.1

Method: Gravitational potential energy

A $\frac{1}{2}mv^2$

B mgh ✓

C $\frac{1}{2}kx^2$

D Fd

Worked steps

B — $U = mgh$.

Exam-style 3.2 ▪ 1 mark

Doubling the compression of a spring changes its stored energy by a factor of

A 2

B 4

C $1/2$

D 1

Solution 3.2

Method: Elastic potential energy

A 2

B 4 ✓

C $1/2$

D 1

Worked steps

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

Exam-style 3.3 ▪ 2 marks

A spring with $k = 500$ N m^{-1} is compressed 0.06 m.
(a) Find the elastic potential energy stored.
(b) State what happens to this energy if the spring is released to push a block.

Solution 3.3

Method: Elastic potential energy

Worked steps

(a) $U = \frac{1}{2}(500)(0.06)^2 = 0.9$ J M1 A1. (b) It converts into the block's kinetic energy B1.

Exam-style 3.4 ▪ 2 marks

A 10 kg crate is raised 2.5 m ($g = 9.8$ m s^{-2}).
(a) Find the gain in gravitational potential energy.
(b) State the minimum work needed to lift it.

Solution 3.4

Method: Gravitational potential energy

Worked steps

(a) $\Delta U = 10(9.8)(2.5) = 245$ J M1 A1. (b) 245 J B1.