Exercise walk-through

Conservation of Energy ▪ 3.4

eXercise

You must be able to

- state the **law of conservation of energy** 能量守恒定律 for an isolated system
- distinguish **conservative forces** 保守力 from **nonconservative forces** 非保守力 such as friction
- apply **conservation of mechanical energy** when no nonconservative force does work
- account for energy transferred to **thermal energy** 热能 when friction acts

Method — Mechanical energy is conserved without friction

With only conservative forces, $KE_i + PE_i = KE_f + PE_f$. A pendulum trades potential for kinetic energy and back.

Method — With friction, track the heat

$KE_i + PE_i = KE_f + PE_f + E_{thermal}$. Friction converts mechanical energy into thermal energy — the total is still conserved.

Method — Example

A 1.0 kg ball is dropped 5.0 m (take $g = 10$ m s^{-2}). All the PE becomes KE: $v = \sqrt{2gh} = \sqrt{2(10)(5.0)} = 10$ m s^{-1}.

Practice 2.1 ▪ 2 marks

A 2.0 kg cart starts from rest at the top of a 3.0 m high frictionless ramp (take $g = 10$ m s^{-2}). Find its speed at the bottom.

Solution 2.1

Method: Example

Worked steps

$\frac{1}{2}mv^2 = mgh \Rightarrow v = \sqrt{2gh} = \sqrt{2(10)(3.0)} = 7.7$ m s^{-1} M1 A1.

Practice 2.2 ▪ 1 mark

State the main energy change when friction acts on a moving block.

Solution 2.2

Worked steps

mechanical energy is converted to thermal energy (heat) B1.

Practice 2.3 ▪ 2 marks

A pendulum bob swings down through a height of 0.20 m. Find its speed at the lowest point (take $g = 10$ m s^{-2}).

Solution 2.3

Method: Example

Worked steps

$v = \sqrt{2gh} = \sqrt{2(10)(0.20)} = 2.0 \text{ m s}^{-1}$ M1 A1.

Exam-style 3.1 ▪ 1 mark

As a skier descends a frictionless slope, her gravitational potential energy is

A increased

B converted to kinetic energy

C unchanged

D converted to thermal energy

Solution 3.1

Method: Mechanical energy is conserved without friction

A increased

B converted to kinetic energy ✓

C unchanged

D converted to thermal energy

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

When friction acts on a moving object, its mechanical energy is

A created

B exactly conserved

C partly converted to thermal energy

D destroyed

Solution 3.2

A created

B exactly conserved

C partly converted to thermal energy ✓

D destroyed

Worked steps

C.

Exam-style 3.3 ▪ 1 mark

A 0.50 kg ball is dropped from 8.0 m and hits the ground at 10 m s^{-1} (take $g = 10$ m s^{-2}).

(a) Find the initial gravitational potential energy.

(b) Find the kinetic energy on landing.

(c) Find the energy converted to thermal and other forms.

Solution 3.3

Method: Example

Worked steps

(a) $U_g = mgh = 0.50 \times 10 \times 8.0 = 40$ J **B1**. (b) $KE = \frac{1}{2}(0.50)(10)^2 = 25$ J **B1**.
(c) $40 - 25 = 15$ J lost to thermal/other forms **B1**.