AP PHYSICS 1 • EXERCISE SHEET

3.4 Conservation of Energy

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS thermal energy 热能 • conservative forces 保守力 • conserved 守恒 • nonconservative forces 非保守力 • energy 能量

Objective

Build the skills to answer exam questions on **conservation of energy**.

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

1 Worked examples

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

■ **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.

■ **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.

■ **Example**

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

2 Practice

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

2.2 State the main energy change when friction acts on a moving block. [1]

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

3 Exam-style questions

3.1 As a skier descends a frictionless slope, her gravitational potential energy is [1]

- **A** increased
- **B** converted to kinetic energy
- **C** unchanged
- **D** converted to thermal energy

3.2 When friction acts on a moving object, its mechanical energy is [1]

- **A** created
- **B** exactly conserved
- **C** partly converted to thermal energy
- **D** destroyed

3.3 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. [1]

(b) Find the kinetic energy on landing. [1]

(c) Find the energy converted to thermal and other forms. [1]

Solutions

2.1 $\frac{1}{2}mv^2 = mgh \Rightarrow v = \sqrt{2gh} = \sqrt{2(10)(3.0)} = 7.7$ m s^{-1}.

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

2.3 $v = \sqrt{2gh} = \sqrt{2(10)(0.20)} = 2.0$ m s^{-1}.

3.1 B.

3.2 C.

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