AP PHYSICS C: MECHANICS • EXERCISE SHEET

3.4 Conservation of Energy

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

Objective

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

You must be able to:

- apply **conservation of mechanical energy** 机械能守恒 when no friction acts
- convert between kinetic and potential energy
- use $K_i + U_i = K_f + U_f$
- account for energy lost to friction as thermal energy

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.

Mechanical energy is conserved

With no friction, the total of kinetic plus potential energy stays constant:

$$K_i + U_i = K_f + U_f.$$

A falling object

Drop a 2 kg mass from 5 m ($g = 10$ m s^{-2}). All the PE becomes KE:

$$mgh = \tfrac{1}{2}mv^2 \Rightarrow v = \sqrt{2gh} = \sqrt{2(10)(5)} = 10 \text{ m s}^{-1}.$$

When friction acts

Friction removes mechanical energy as heat:

$$K_i + U_i = K_f + U_f + (\text{energy lost to friction}).$$

2 Practice

Now apply the methods above.

2.1 State the condition under which mechanical energy is conserved. [1]

2.2 A ball is dropped from 2 m ($g = 10$ m s^{-2}). Find its speed just before landing. [2]

2.3 At the top of a swing, a pendulum has 6 J of PE and no KE. State its KE at the bottom (no friction). [1]

2.4 Where does mechanical energy go when friction acts? [1]

3 Exam-style questions

3.1 In the absence of friction, as an object falls its [1]

- **A** total mechanical energy increases
- **B** total mechanical energy stays constant
- **C** kinetic energy decreases
- **D** potential energy increases

3.2 A cart at the top of a frictionless track has PE = 40 J and KE = 0. At the bottom its KE is [1]

- **A** 0
- **B** 20 J
- **C** 40 J
- **D** 80 J

3.3 A 0.5 kg ball is released from rest at height 1.8 m on a frictionless ramp ($g = 10$ m s^{-2}).

(a) Find its speed at the bottom. [2]

(b) State the assumption you made. [1]

3.4 A 1 kg block slides down a ramp, starting with 20 J of PE, and reaches the bottom with 14 J of KE.

(a) State how much energy was lost to friction. [1]

(b) Explain where that energy went. [1]

4 Go further

You are ready for more on this subtopic:

- work through the interactive **3.4 Conservation of 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 When no friction (or other non-conservative force) acts.

2.2 $v = \sqrt{2gh} = \sqrt{2(10)(2)} = 6.3$ m s^{-1}.

2.3 6 J (all PE becomes KE).

2.4 It becomes thermal energy (heat).

3.1 B —with no friction, total mechanical energy is constant.

3.2 C —all 40 J of PE becomes KE.

3.3 (a) $v = \sqrt{2gh} = \sqrt{2(10)(1.8)} = 6$ m s^{-1}. (b) No friction / energy is conserved.

3.4 (a) $20 - 14 = 6$ J. (b) It was converted to thermal energy by friction.