AP PHYSICS C: MECHANICS • HOLIDAY HOMEWORK 假期作业

4 Conservation of momentum and collisions – Part 2

Name: ____________ Class: ________ Date: __________

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
conserved	守恒			
perfectly inelastic collision	非弹性碰撞			
elastic collision	弹性碰撞			
recoils	反冲			

Recall

In Part A you met momentum $p = mv$ and impulse. Now the big payoff:

- When two things push on each other, their pushes are equal and opposite (Newton's third law).
- So in a crash or an explosion, the **total** momentum does not change.
- This one idea solves collisions that would be hard to do with forces.

Each idea has a worked example before the Practice.

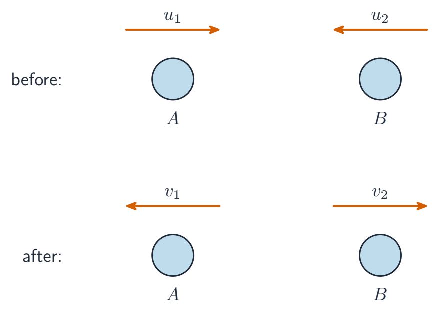
New ideas

1 Conservation of momentum

If no outside force acts on a system, its total momentum is **conserved** 守恒 – the total before equals the total after:

$$\sum p_{\text{before}} = \sum p_{\text{after}}.$$

The internal pushes come in equal-and-opposite pairs, so they cancel and cannot change the total.



2 Collisions that stick

In a **perfectly inelastic collision** 非弹性碰撞 the objects **stick together** and move off with one shared velocity.

Worked example. A 1000 kg car at 20 m/s hits a stationary 1500 kg car and they lock together. Momentum is conserved:

$$1000 \times 20 = (1000 + 1500)\,v \;\Rightarrow\; v = \frac{20000}{2500} = 8.0 \text{ m/s}.$$

3 Elastic and inelastic

Momentum is conserved in **every** collision, but kinetic energy is not:

- In an **elastic collision** 弹性碰撞, kinetic energy is also conserved (a clean bounce).
- In an **inelastic collision**, some kinetic energy becomes heat and deformation (a crash).

4 Recoil

When one part of a still system is pushed one way, the rest **recoils** 反冲 the other way so the total momentum stays zero.

Worked example. A 60 kg skater at rest throws a 2.0 kg ball at 8.0 m/s. Starting from zero total momentum: $0 = (60)v + (2.0)(8.0)$, so $v = -\frac{16}{60} = -0.27$ m/s – she slides back at 0.27 m/s. This is how rockets work.

Watch out: momentum is a **vector**. Give one direction a + sign and the opposite a − sign before you add – two equal speeds in opposite directions add to **zero** momentum, not double.

Practice

Try these in order. The methods are all above.

2.1 A 2.0 kg trolley at 3.0 m/s hits a stationary 1.0 kg trolley and they stick together. Find their common speed. [3]

2.2 State what is always conserved in a collision, and what is conserved only if the collision is elastic. [2]

2.3 A 50 kg student on frictionless ice throws a 1.0 kg ball at 6.0 m/s. Find the student's recoil speed. [3]

2.4 Two identical balls roll toward each other at the same speed and stick together. Explain why they stop. [2]

2.5 A 0.50 kg ball at 4.0 m/s collides head-on with a stationary 0.50 kg ball. After an **elastic** collision the first stops. State the second ball's speed and give your reason. [2]