Chapter 5: Conservation of Momentum

To our knowledge, we rarely hear anyone say that the law of conservation of momentum is wrong. However, there must be many physicists who secretly harbor doubts about this law. This is evident from the textbooks written by physicists. Their logic is terribly confused. And, without exception, this law, unfortunately, is also wrong.

To begin with, in order to highlight what is wrong, let's start with the physicist's interpretation of a seemingly simple problem, such as the collision of two spheres.

5.1 Physicists' interpretation of the elastic collision of two spheres

A certain mechanics textbook provides the following example problem. While the interpretation of such an example problem may not necessarily represent the consensus of all physicists, textbooks generally do not include anything that is not accepted within the world of physics. What is written in this textbook is wrong, but this is wrong in all mechanics textbooks, so I have no intention of criticizing only this textbook. I will refrain from mentioning the title of this book. This type of example problem is extremely basic, and it is likely that this example problem itself is not original to this textbook.

Furthermore, the examples given here are fundamental, and therefore worth considering. Examples that are not worth considering are the kind that are often found in physics textbooks, overusing sin, cos, etc., and are essentially riddles. Physics textbooks are not mathematics exercises; they should be helpful in understanding physical phenomena. However, because they only give students riddles, students are unable to understand physical phenomena and develop the mistaken belief that physics is about solving riddles detached from physical phenomena. Since those who receive this kind of skills training will become future physicists, it is not surprising that physicists sometimes cannot understand physical phenomena.

[Example 1] There are two spheres A and B moving along a straight line. Their masses are m and M, respectively. Initially, B is at rest, and A collides with it at velocity u. Assuming the collision is perfectly elastic, find the energy transferred from A to B.

[Solution] Let U be the velocity of A after the collision, and V be the velocity of B. According to the law of conservation of momentum,

$$mU + MV = mu \qquad (5.1)$$

Being perfectly elastic means there is no loss of kinetic energy, so the condition in this case is:

$$\frac{1}{2}mU^2 + \frac{1}{2}MV^2 + \frac{1}{2}mu^2 \qquad (5.2)$$

In other words,

$$mU^2 + MV^2 = mu^2$$

This is the result. Equation (5.1) and this equation

$$m(u - U) = MV, m(u^2 - U^2) = MV^2$$

Transforming it as, and then performing division,

$$\frac{m(u-U)(u+U)}{m(u-U)} = \frac{MV^2}{MV}$$

$$V - U = u \qquad (5.3)$$

Therefore, solving for U and V from equations (5.1) and (5.3)

$$U = \frac{m-M}{m+M}u \qquad (5.4)$$

$$V = \frac{2m}{m+M}u \qquad (5.5)$$

Therefore, the energy transferred from A to B is

$$\frac{1}{2}MV^2 = \frac{2Mm^2}{(m+M))^2}u^2 = 2M\frac{1}{(1+\frac{M}{m})^2}u^2$$

That is the case.

5.2 What is wrong with the physicists' interpretation of the elastic collision of two spheres?

The answer given in 5.1 is correct if we consider physics to be the study of solving riddles detached from the real world, but it is wrong if we consider physics to be a science that should reflect the real world. We believe that such an answer is wrong because we consider physics to be a science that should reflect the real world. In other words, such an answer does not reflect the real world.

Where exactly is the mistake?

Equation (5.3) means that the relative velocity of A and B before the collision is equal to the relative velocity of A and B after the collision. And that relative velocity does not depend on the masses of A and B. If this were true, it would constitute a valid law in itself.

Physicists prefer to use variables, in this case the masses of A and B, represented by letters such as m and M, when performing calculations. This method is certainly convenient in that it provides a general description of cases where the values of m and M vary. However, one should not be satisfied with obtaining such results. The actual phenomenon cannot be known without substituting specific values for m and M. If it is possible to substitute appropriate values for the variables, one should actually substitute them and perform calculations. If physicists had done this, errors like the one in this example would have been easily discovered.

Let's try calculating by plugging in some specific numbers. To show that the solution to this example is wrong, it is sufficient to provide one specific counterexample. If the mass M of B is twice the mass m of A, then M = 2m. Let's find the specific velocities U and V after the collision in this case. From equations (5.4) and (5.5),

$$U = \frac{m-2m}{m+2m}u = -\frac{1}{3}u$$
$$V = \frac{2m}{m+2m}u = \frac{2}{3}u$$

This is the result. Substituting this into equation (5.1),

$$-\frac{1}{3}\mathrm{mu} + \frac{2}{3}\cdot 2\mathrm{mu} = \mathrm{mu}$$

Thus, this identity appears correct at first glance. However, please consider this carefully. The momentum of A obtained by substituting the velocity U after the collision is $-\frac{1}{3}mu$, but here the negative sign that appears simply indicates that the direction from A to B is the positive direction, and that the direction is the opposite; it does not mean that momentum itself is negative.

For example, if a wall is placed at the end of the direction of motion of A, and A elastically collides with it and bounces back,The momentum of A is the same in both directions.

In other words, the momentum of A at that time is $\frac{1}{3}mu$. The relationship between this momentum and the momentum of B since the sum is the total momentum after the collision, that quantity is,

$$\frac{1}{3}mu + \frac{4}{3}mu = \frac{5}{3}mu$$

This means that this amount is greater than the momentum mu before the collision, and the total momentum after the collision will be greater than the total momentum before the collision. If this were true, no one would burn oil or anything to generate electricity. Energy would simply increase if objects were colliding.

Such a thing is, of course, not real. Physicists confidently assert that the manufacture of perpetual motion machines is impossible, yet their theories suggest that perpetual motion machines *must* be manufactured. On what basis did they claim that the manufacture of perpetual motion machines was impossible? If their basis was physical theory, then they should rather argue that perpetual motion machines *can* be manufactured.

The phenomenon described in this example cannot be reproduced in an experiment involving the collision of two spheres. This must not have been verified at all. If it had been verified, such an example would not exist.

5.3 Law of Conservation of Momentum

(1) Where is the law of conservation of momentum wrong?

As stated in 5.2, we know that the solution to this example problem is incorrect, but we still don't know the fundamental reason why it's wrong. The so-called law used in the solution to this example problem is:

Law of conservation of momentum $mU + MV = mu$

Law of Conservation of Kinetic Energy $\frac{1}{2}mU^2 + \frac{1}{2}MV^2 = \frac{1}{2}mu^2$

These were the two. Since arithmetic calculations are basically not wrong, if there is a mistake, it must be due to either both of these laws or one of them.

Let's start by considering the law of conservation of momentum. Physicists fundamentally misuse this law, so using their conclusions will only lead to further errors. We must return to the basics of examining phenomena. Let's consider the following example.

[Example 2] There are two spheres A and B moving along a straight line, with masses m and nm respectively. Initially, B is at rest, and A collides with it at a velocity u. Assuming the collision is perfectly elastic and A remains at rest after the collision, what will be the velocity of B?

However, these velocities are relative to a coordinate system that can be considered an inertial frame of reference fixed on Earth.

This example problem seems very simple at first glance. However, even physicists don't know the correct answer to this problem. Let's start by stating what seems to be the correct answer, and then discuss the confused thinking of the physicists.

[Answer, Correct] If we let V be the velocity of B after the collision, then by the law of conservation of momentum,

$$mu + nm0 = m0 + nmV$$

It can be written as. Therefore, V is

$$V = \frac{u}{n}$$

For example, if the mass of B is three times the mass of A, then n=3, so $V = \frac{1}{3}u$, and B will move with a probability of the 1/3 velocity of u.

This idea seems perfectly correct, but another way of thinking can lead to yet another answer. The physicists' thinking is as follows. Unfortunately, this kind of confusing thinking is mainstream among physicists.

[Answer, Incorrect] Since A is moving in a straight line at a constant velocity, a Galilean transformation is possible between A and B, and there is no point in having to use a coordinate system fixed to the Earth. The result will be the same even if we measure from a coordinate system fixed to A. Therefore, let's measure from this coordinate system.

Before the collision, from A's perspective, B is observed approaching A at a relative velocity u. Also, before and after the collision, A's velocity is always zero. This is natural because we are observing from a coordinate system fixed to A. Using this coordinate system, after the collision, B will be observed moving away from this coordinate system. If we denote this velocity as -V, then according to the law of conservation of momentum,

$$m0 + nmu = m0 - nmV$$

Therefore,

$$V = -u$$

From A's perspective, B appears to be moving away at the same relative velocity as it was before the collision. This velocity does not depend on the mass of the colliding objects. Also, under the conditions of the example, A is at rest relative to the Earth, so B is moving at a velocity u relative to the Earth.

This type of thinking error is similar to that in Example 1, and can be easily pointed out. As the conclusion of this solution shows, if B moves relative to the Earth at a velocity u after the collision, then when n>1, This is because it would imply that the momentum has increased from the initial state. Furthermore, the study of collisions actually deals with accelerated motion, and therefore Galilean transformations would not be applicable.

The reason such incorrect conclusions can be reached is that there is a flawed understanding of the concept of velocity. For example, from the perspective of a train traveling at a constant speed, the station (or space?) appears to be moving in the opposite direction. However, this does not mean that the train has any way of extracting the station's kinetic energy; the train's kinetic energy depends not on the station's mass, but on the train's own mass.

The concept of relative velocity is fundamentally incompatible with concepts like momentum and kinetic energy. While velocity is one of the most basic concepts in physics, a misunderstanding of this concept leads to widespread inaccuracies in physical knowledge. When discussing velocity in relation to momentum, one should use inertial velocity or inertial coordinate velocity; relative velocity yields incorrect results.

(2) Recognition of the direction of momentum

Momentum is defined as mass × velocity. Velocity has direction, and depending on the direction, momentum can be negative or positive. Of course, it's impossible for kinetic energy to be positive when the direction of motion is east and negative when it's west. However, if we use the law of conservation of momentum as is, we get this conclusion. The law of conservation of momentum must be modified.

Physicists describe the law of conservation of momentum as follows:

$$m_1v_1 + m_2v_2 + \ldots + m_nv_n = m_1v_1 + m_2v_2 + \ldots + m_nv_n' \qquad (5.6)$$

If two objects of the same mass are moving in opposite directions, their total momentum P is:

$$P = mv + m(-v) = 0$$

This would mean that the momentum is zero. This is obviously wrong and must be corrected. In the case of one-dimensional motion,

$$|m_1v_1| + |m_2v_2| + \ldots + |m_nv_n| = |m_1v_1|' + |m_2v_2|' + \ldots + |m_nv_n|' \qquad (5.7)$$

This can be solved by writing it this way. || represents the absolute value. In general cases such as three dimensions, this absolute value symbol is agreed upon as its magnitude. This is a fairly common convention for vectors. That is,

$$v = v_x\boldsymbol{i} + v_y\boldsymbol{j} + v_z\boldsymbol{k}$$
$$|v| = \sqrt{v_x^2 + v_y^2 + v_z^2} \qquad (5.8)$$

That's all you need to write.

Of course, there is also the concept of a difference in momentum. In that case, for example,

$$P = |m_1 v_1| - |m_2 v_2| \qquad (5.9)$$

This is how it should be written. With the conventional way of writing it, it was not possible to distinguish between the opposite direction of momentum motion and the difference in momentum, but this way of writing it avoids such confusion.

5.4 Law of Conservation of Kinetic Energy

Next, let's consider the law of conservation of kinetic energy. I don't know who first coined this term, but according to physicists, the law of conservation of kinetic energy can be expressed as follows.

$$\begin{aligned} &\tfrac{1}{2} m_1 v_1^2 + \tfrac{1}{2} m_2 v_2^2 + \ldots + \tfrac{1}{2} m_n v_n^2 \\ &= \tfrac{1}{2} m_1 (v'_1)^2 + \tfrac{1}{2} m_2 (v'_2)^2 + \ldots + \tfrac{1}{2} m_n (v'_n)^2 \end{aligned} \qquad (5.10)$$

For example, according to the solution to Example 1, the following two equations are compatible.

Law of conservation of momentum	$mU + MV = mu$
Law of Conservation of Kinetic Energy	$\tfrac{1}{2} mU^2 + \tfrac{1}{2} MV^2 = \tfrac{1}{2} mu^2$

Considering the simple case where masses m and M are the same, the relationship between these two equations in terms of speed can be graphically represented as shown in Figure 5.1.

(1) Law of Conservation of Momentum (2) Law of conservation of kinetic energy

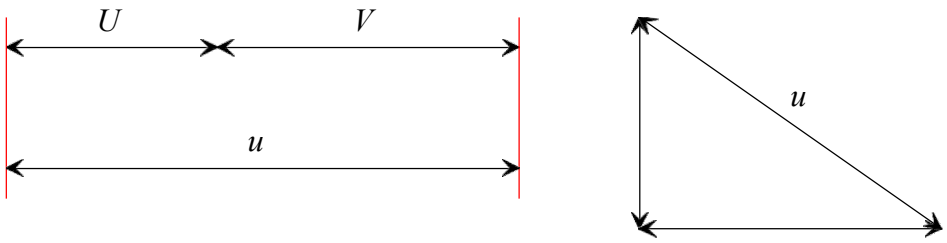


Figure 5.1 Relationship between the law of conservation of momentum and the law of conservation of kinetic energy

At this time, the conditions for the values of U and V for these two equations to hold are:

- $U=0$
- $V=0$
- $U=0 \; and \; V=0$

These are the only three conditions, and they cannot be reconciled under ordinary conditions (U+0 and V+0). If these two equations were generally reconciled, they would have to be reconciled under all conditions, but even under the simple condition of having the same masses for A and B, reconciliation is extremely rare. In conclusion, these two equations are not reconciled.

This is evident even when substituting specific numerical values. Such calculations are at the elementary school level. The fact that physicists believe these two equations are compatible indicates that their level of knowledge is below that of an elementary school student.

What is the basis for what is called the law of conservation of kinetic energy? We will discuss this strange thing in Chapter 12, but for now, let me just say that this so-called law is not a law at all.

5.5 Correct Application of the Law of Conservation of Momentum

In section 5.3, we gained a correct understanding of the law of conservation of momentum. Let us further develop this idea and state the correct solution to the first example problem. That example problem is:

[Example 1] There are two spheres A and B moving along a straight line. Their masses are m and M, respectively. Initially, B is at rest, and A collides with it at velocity u. Assuming the collision is perfectly elastic, find the energy transferred from A to B.

That was the case. If the problem remains as it is, the correct answer would be as follows.

[Solution] The velocity u given in this example is not clearly defined as a reference velocity. If we interpret this velocity as the relative velocity between A and B, then the momentum of A and B after the collision cannot be determined using the relative velocity. Therefore, the energy transferred to B cannot be determined.

This is the result. Since this conclusion is not very meaningful, let's rewrite the example problem as follows. Also, since the mass M of B can be expressed in the form of how many times the mass of A it is, let's use nm, and since the expression energy is inappropriate, let's use the term momentum.

[Example 3] There are two spheres A and B moving along a straight line. Their masses are m and nm, respectively. Initially, B is at rest, and A is about to collide with it at velocity u.

Assume a collision occurs. Assuming the collision is perfectly elastic, find the momentum transferred from A to B.

However, these velocities are relative to a coordinate system that can be considered an inertial frame of reference fixed on Earth.

[Answer] The momentum before the collision is as follows:

before the collision $A;\ |mu|$

$B;\ |nm0| = 0$

Therefore, A collides with B with a momentum of |mu|, and the force applied to B at this time is the force due to the momentum corresponding to |mu|. At this time, the momentum transmitted to B is considered to be |mu|. Conversely, A receives a force in the opposite direction to the force due to the momentum corresponding to |mu| due to a reactive force. Since the amount of momentum lost by A can be considered to be |mu|, the amount of momentum added to A is -|mu|. From this consideration, the amount of momentum after the collision is calculated for A and B respectively.

after the collision $A;\ |mu| - |mu| = 0$

$B;\ |nm0| + |mu| = |mu|$

Therefore, the momentum of B after the collision is mu.

Next, let's consider an example that is slightly more complex than the previous one.

[Example 4] There are two spheres A and B moving along a straight line. Their masses are m and nm, respectively. Initially, A is moving with velocity u and B is moving with velocity -ku.

Assume that two spheres, A and B, collide head-on. Assuming the collision is perfectly elastic, find the momentum of spheres A and B after the collision.

However, these velocities are relative to a coordinate system that can be considered an inertial frame of reference fixed on Earth.

[Solution] Let U be the velocity of A and V be the velocity of B after the collision. A collides with B with a momentum of |mu|, and a momentum of |mu| is added to B. Conversely, A is subjected to a reaction force of -|mu|. Also, B collides with A with a momentum of |nm(-ku)|, so the momentum added to A is |nm(-ku)|. Conversely, B has a momentum of -|nm(-ku)| added to it by a reactive force. Let's consider that the principle of superposition can be applied in this case. The law of momentum preservation is,

$$|mu| + |nm(-ku)| = |mu| + |nmV|$$

This can be written as. The left side of this equation represents the momentum before the collision, and the right side represents the momentum after the collision.

If we write the momentum before and after the collision separately, then for A and B respectively,

before the collision

$$A;|mu|$$

$$B;|nm(-ku)|$$

after the collision

$$A;|mu| = |mu| - |mu| + |nm(-ku)|$$

$$B;|nmV| = |nm(-ku)| - |nm(-ku)| + |mu|$$

Therefore, the momentum after the collision is

$$A;|\mathrm{mu}| = |\mathrm{nm}(-\mathrm{ku})|$$
$$B;|nmV| = |mu|$$

Therefore, the velocities U and V after the collision are,

$$A;U = -nku$$

$$B;V = \frac{u}{n}$$

This is the result.

As a result, A and B simply exchange their momentum. The momentum are clearly the same before and after the collision, and are thus preserved. Regarding velocity, if we set the values u=5, k=4, n=3 and compare the velocities of A and B before and after the collision,

	Velocity of A	Velocity of B
before the collision	$u = 5$	$-ku = -20$
after the collision	$U = -nku = -60$	$V = \frac{u}{n} = \frac{5}{3}$

This is the result.

These results can be said to have been experimentally confirmed when A and B have the same mass. While elastic collisions in the strict sense are not possible in reality, they have been confirmed approximately. When spheres of the same mass move in a straight line and collide head-on, they simply exchange momentum.

The reason why this kind of experimental verification hasn't been done, or isn't publicly known, when masses are different is likely because acknowledging such a thing would vehemently contradict existing physical knowledge about relative velocity. If A and B have equal masses, the relative velocities of A and B before the collision are equal to the relative velocities after the collision. However, if A and B have different masses, the relative velocities of A and B before the collision are no longer equal to the relative velocities after the collision. If we were to acknowledge this, we would no longer be able to claim that velocity is a relative concept. This is something that is obvious to us, but something that physicists do not understand. Their method is to cover up what they don't understand, so such things are not found in physics textbooks.

Next, let's consider a problem where a car rear-ends another car while it's moving.

[Example 5] There are two spheres A and B moving along a straight line. Their masses are m and nm, respectively. First, A is moving at velocity u and B is moving at velocity v, and when u > v, A collides with B. Assuming the collision is perfectly elastic, find the momentum of A and B after the collision.

However, these velocities are relative to a coordinate frame that can be considered an inertial frame fixed on the Earth.

[Solution] Let U be the velocity of A after the collision, and V be the velocity of B. If $u \leq v$, then A does not collide with B. If u - v is small and close to zero, the impact on B will be small, and if u - v is large, the impact on B will be large. From such experiential inferences, it can be considered that the amount of momentum due to the force A exerts on B is proportional to the relative speed of the inertial velocity u of A and the inertial velocity v of B. Here, the relative speed is not the ordinary relative speed, but the relative speed between inertial velocities, which is the relative speed between inertial velocities. The law of conservation of momentum is,

$$|mu| + |nmv| = |mu| + |nmV|$$

Therefore, the momentum corresponding to the force A exerts on B is, by assumption, |m(u-v)| Therefore, this momentum is added to B, and A loses this momentum. Thus, the momentum of A and B after the collision is

$A;|mu| = |mu| - |m(u-v)|$

$B;|nmV| = |nmv| + |m(u-v)|$

Therefore, the momentum before the collision and the momentum after the collision are:

before the collision; $|mu| + |nmv|$

after the collision; $|mu| + |nmV| = |mu| - |\mathrm{m(u-v)}| +$

$|\mathrm{nmv}| + |\mathrm{m(u-v)}| = |mu| + |nmv|$

This shows that momentum is conserved.

The solutions to examples 3-5 presented here have not been verified by experiment, but it would be easy to verify them experimentally. Such experiments can be easily conducted if they do not require excessive rigor.

As an example of an experiment that has already demonstrated this phenomenon, consider the following: Suppose there are two spheres, A and B, with B being twice as heavy as A. When measured on a balance scale, the two A's and B's balance is achieved. When the same force is applied to A and B, which are at rest on a plane, A will roll at twice the speed of B.

The same result would likely occur if, instead of the impulsive force applied to A and B in this experiment, another sphere C were struck at A and B at the same velocity. Such experiments preserve momentum. This is precisely what is stated in the law of existence.

5.6 Momentum and Relative Velocity

Originally, the purpose of writing this chapter was to use the concept of conservation of momentum to concretely demonstrate the shortcomings of the concept of relative velocity. However, because the law of conservation of momentum itself was incorrect, I ended up having to revise the law itself. Up until now, I have stated that the concept of momentum cannot be expressed by relative velocity, but because the concept of the law of conservation of momentum was not clearly defined, I did not explain it concretely. Here, I will explain it concretely based on the conclusion obtained in Example 4 of 5.5.

According to the results obtained in Example 4, the two spheres colliding head-on only exchanged momentum with each other. In the case of Example 4, the relationship between the velocities of spheres A and B before and after the collision is:

Velocity before collision	$A;u$
	$B;-ku$
Velocity after collision	$A;U=-nku$
	$B;V=\frac{u}{n}$

This was the case. Let's use this relationship, fix n=3, and compare specific examples of cases where the relative velocities of A and B before collision are the same, while varying the velocities of u and -ku.

		Velocity of A	Velocity of B	Relative velocity of A and B
(1)	before collision	$u = 5$	$-ku = -4$	9
	after collision	$U = -12$	$V = \frac{5}{3}$	$13\frac{2}{3}$ $[= 13 + \frac{2}{3}]$
(2)	before collision	$u = 4$	$-ku = -5$	9
	after collision	$U = -15$	$V = \frac{4}{3}$	$16\frac{1}{3}$ $[= 16 + \frac{1}{3}]$

In (1) case, from A's perspective, B appears to be approaching A at a speed of 9, and from B's perspective, A appears to be approaching B at a speed of 9.

As same, In (2) case, from A's perspective, B appears to be approaching A at a speed of 9, and from B's perspective, A appears to be approaching B at a speed of 9.

When relating the two cases in terms of relative velocity, they are exactly the same and indistinguishable. Physicists believe that relative velocity is the only form of velocity, and therefore, this relative velocity is the only thing that can be considered. In this case, the velocity of B as seen from A and the velocity of A as seen from B are exactly the same, so physicists believe that it is impossible to distinguish how fast A is moving and how fast B is moving, and that there is no way to do so.

Therefore, they believe that what happens after a collision must also be determined by this relative velocity. In other words, if two objects with the same relative velocity collide, there should be no difference after the collision, and they conclude that such a difference is impossible.

In both cases, the relative velocity before the collision is the same 9, but the relative velocity after the collision is different. Therefore, relative velocity cannot be used to consider momentum.

In this case, the velocity used must be the velocity of inertia. The motion of an object is not a relative concept, but an absolute one.