9

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DEPARTMENT OF EDUCATION

Science

Quarter 4 – Module 4: Conservation of Linear Momentum

ALTERNATIVE DELIVERY MODE
ADM

Science – Grade 9
Alternative Delivery Mode
Quarter 4 – Module 4: Conservation of Linear Momentum
First Edition, 2020

Published by the Department of Education
Secretary: Leonor Magtolis Briones
Undersecretary: Diosdado M. San Antonio

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Printed in the Philippines

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9

Science

Quarter 4 – Module 4: Conservation of Linear Momentum

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

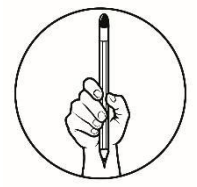
Thank you.

What I Need to Know

At the end of the lesson, you will be able to infer that the total momentum before and after collision is equal.

Specifically, after going through this module, you will be able to:

a. Describe the total momentum before and after collision in an isolated system.
b. Compare the total momentum before and after collision.



What I Know

Multiple-Choice: Read the statements carefully. Choose the **BEST** answer. Write the letter of your answers on your answer sheet.

_____1.) Which of the following statements describes momentum?
A. It is the product of body's mass and velocity.
B. It is the product of body's mass and acceleration.
C. It is the sum of body's mass and velocity.
D. It is the sum of body's mass and acceleration

_____2.) What is the momentum of the two cars after collision if its momentum before collision is 50 kgm/s?
A. 5 kgm/s
B. 15 kgm/s
C. 30 kgm/s
D. 50 kgm/s

_____ 3.) What type of quantity are momentum and velocity?
A. director
B. reactor
C. scalar
D. vector

_____4.) What is the unit for momentum?
A. kg●m/s
B. N●kg
C. kg●m/s2
D. N●m/s

_____ 5.) What word can best describe the total momentum in an isolated system?
A. conserved
B. large
C. lost
D. low

_____ 6.) What is the unit of velocity?
A. kg
B. kg•m/s
C. m/s
D. all of these

_____ 7.) Calculate the momentum of a car, which has a mass of 1000 kg and moves with a velocity of 20 m/s.
A. 500 kgm/s
B. 10, 020 kgm/s
C. 20000 kgm/s
D. 99 980 kgm/s

_____ 8.) The total momentum of two objects before collision is 50 kg. m/s. What will be their total momentum after collision?
A. 50 kg•m/s
B. 175 kg•m/s
C. 350 kg•m/s
D. not enough information

For nos. 9&10. Two 0.5 kg balls approach each other with the same speed of 1.0 m/s.

_____9.) What is the total momentum of the system before collision?
A. 0
B.0.50 kg•m/s
C. 1.0 kg•m/s
D.-1.0 kg•m/s

_____10.) If there is no external force acting on the system, what is the total momentum of the system after collision?
A. 0
B.0.50 kg•m/s
C. 1.0 kg•m/s
D.-1.0 kg•m/s

Lesson 1 Conservation of Linear Momentum

What's In

What's the Word?

Objectives

Arrange the following jumbled words to form terms related to conservation of momentum. Write your answers on your answer sheets.

1. **OILLICSON** - an instance of one moving object or person striking violently against another.
2. **DVSCEONER** - refers to something which doesn't change.
3. **MUTNEMMO** - product of the mass of a particle and its velocity
4. **LEUQA** - the same.
5. **TEMSYS** - an organized collection of parts that are highly integrated to accomplish an overall goal.

These are the physics terms that you will need to know as you will learn this lesson.

What's New

Situation 1

Imagine a 10-wheelers truck collided with a small car which is not moving. After they collide, the two vehicles are now stuck together as they move forward. Will their combined speed be greater than, equal to, or less than the speed of the truck before the collision? Defend your answer.

BEFORE COLLISION:

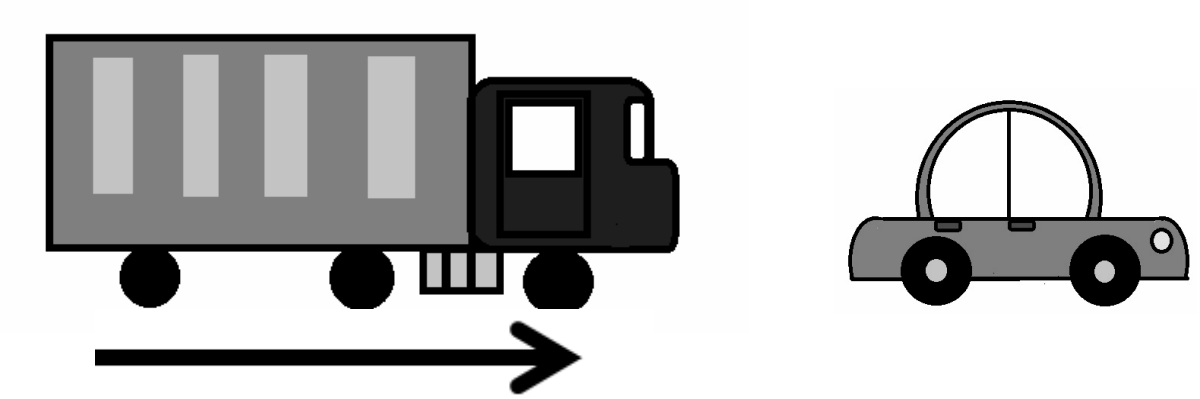
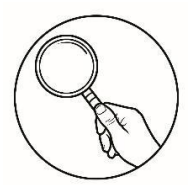


Fig 1.1 (a) *A fast moving 10-wheeler truck*; (b) *a stationary car*

AFTER COLLISION:

Fig 1.2 (a) *A slowing down 10-wheeler truck*; (b) *a fast moving car*

(Illustrated by: Mary Joy B. Obregon)



What is It

MOMENTUM BEFORE AND AFTER COLLISION

Newton's Third law of motion states that if an object exerts a force on the other, the other object also exerts force towards it with equal magnitude. Suppose two cars with different masses collide with each other. During collision, the two cars gained the same momentum but moved in opposite direction. Since the cars have different masses, they will accelerate differently as stated in Newton's second law of motion. There are 3 different types of Potential energy.

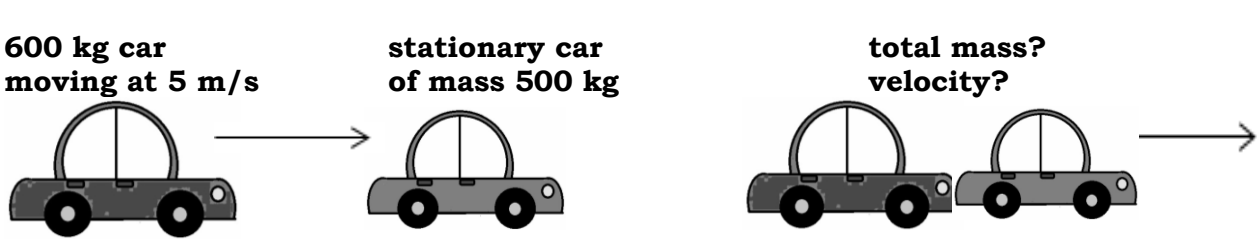


Fig. 2(a) A moving car bumped into a stationary car (b) After collision, the two cars sticked and moved together with the same speed

(Illustrated by: Mary Joy B. Obregon)

Note: In studying momentum of the two or more colliding objects, we will consider a closed system or isolated system. It is considered a closed system if no external force is exerted on the system like air resistance, friction and the like hence the same objects were present or used before and after (or no one enters or leaves in it) an event.

In all collisions, momentum is conserved. This is because of the law of conservation of momentum.

The law of conservation of momentum states that:

when two objects in an isolated system collide, the total momentum of the objects before the collision is equal to the total momentum of the objects after the collision.

Mathematically;

Eq. 1: $m_1v_1+m_2v_2=(m_1+m_2)\ v'$

Where:

m_1 = mass of the first object in kilogram (kg);

v_1 = velocity of the first object before collision in meter per second (m/s);

m_2 = mass of the second object in kilogram (kg);

v_2 = velocity of the second object before collision in meter per sec (m/s); and

v' = velocity of the combined object after collision in meter per sec (m/s)

Sample Problem # 1

A 0.2-kg billiard ball traveling at 1.5 m/s on a table undergoes a collision with another 0.15-kg billiard ball travelling at 2.0 m/s. The two cue balls stick together after collision. What is the velocity of the combined balls after the collision?

Step 1: Identify what is asked in the problem.

You are asked to determine the velocity of the combined (v') balls after the collision:

v' = ? (velocity of the combined balls)

Step 2: Identify the given in the problem

m_1=0.2 kg (mass of the first billiard ball)

m_2=0.10 kg (mass of the second billiard ball)

v_1=1.5 m/s (velocity of the first billiard ball)

v_2=3.0 m/s (velocity of the second billiard ball)

Step 3: What is asked in the problem?

v' = ? (solve for the combined velocity of the two cue balls after collision)

Step 4: Use the equation to solve for the unknown.

p(before)=p(after)

(total momentum before collision = total momentum after collision

$m_1v_1+m_2v_2=(m_1+m_2)v'$ ⟶ v' is the combined velocity of the two cue balls

(0.20 kg)(1.5m/s)+(0.10kg)(3.0m/s)=(0.20 kg + 0.10kg)v'

0.30 kg•m/s + 0.3 kg•m/s = (0.30 kg) v'

$\frac{0.60\ \text{kg•m/s}}{0.30\ \text{kg}} = \frac{(0.30\ \text{kg})\ v'}{0.30\ \text{kg}}$

Step 5: Thus by simplifying the equations above, the velocity of the combined cue balls after the collision is:

v'=2.0 m/s

Therefore: the two billiard balls moved together 2.0 m/s towards the direction of motion of the first ball.

Sample Problem # 2

A 1.5 kg bowling ball moves in an alley at 2 m/s. It collides with and sticks to a bowling pin of mass 0.2 kg, which is stationary before collision. What is the velocity of the combined ball and pin after collision?

Step 1: Identify what is asked in the problem.

You are asked to determine the velocity of the combined (v') objects after the collision:

v' = ? (velocity of the combined objects)

Step 2: Identify the given in the problem

m_1=1.5 kg (mass of the bowling ball)

m_2=0.20 kg (mass of the bowling pin)

v_1=1.2 m/s (velocity of the bowling ball)

v_2=0 m/s (velocity of the bowling pin since it is stationary)

} before collision

Step 3: What is asked in the problem?

v' = ? (solve for the combine velocity of the two objects after collision)

Step 4: Use the equation to solve for the unknown.

p(before)=p(after)

(total momentum before collision = total momentum after collision)

$m_1v_1+m_2v_2=(m_1+m_2)\ v'$ v' → is the combined velocity of the two objects

(1.5 kg)(2 m/s)+(0.50 kg)(0 m/s)=(1.5 kg + 0.5 kg)v'

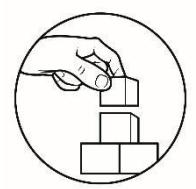
3.0 kg•m/s + 0 kg•m/s = (2.0 kg) v'

$\frac{3.0\ kg•m/s}{2.0\ kg} = \frac{(2.0\ kg)\ v'}{2.0\ kg}$

Step 5: Thus by simplifying the equations above, the velocity of the combined carts after the collision is:

v'= 1.5 m/s

Therefore the bowling ball and pin moved together at 1.5 m/s towards the direction of the bowling ball.



What's More

ACTIVITY 1

CONSERVATION OF MOMENTUM

I. OBJECTIVE:

1. Describe how a marble works and how conservation of momentum explains the motion of marbles.

II. MATERIALS NEEDED:

- marbles (at least 15 pieces)
- meter sticks (2)

III. PROCEDURE:

1. Setup the experiment as shown in Figure 1 below. You can use more than 8 marbles on your setup.

Figure 3. Marbles of the same size and mass arranged in an improvised plane

(Illustrated by: Mary Joy B. Obregon)

2. Arrange the marbles close to each other so as no space should be between them.

3. Get another piece of marble and strike it at one end of the arranged marbles. Observe what will happen.

Q1. What have you observed?

4. Do step 3 using additional 2 marbles.

Q2. What happen to the setup?

Q3. If you are going to use 5 marbles, what do you think will happen?

Q4. How are you going to explain the law of conservation of momentum based from the experiment you just performed?

ACTIVITY 2

WORD HUNT

Look for words related to conservation of linear momentum. You can find them diagonally, horizontally and vertically. Write your answers on your answer sheet.

O	**M**	**E**	**N**	**T**	**O**	**D**	**E**	**C**	**O**	**S**
C	**O**	**N**	**S**	**E**	**R**	**V**	**E**	**D**	**A**	**C**
O	**M**	**K**	**T**	**H**	**J**	**E**	**T**	**U**	**I**	**V**
N	**E**	**B**	**A**	**J**	**H**	**L**	**U**	**T**	**R**	**E**
S	**N**	**O**	**T**	**I**	**Y**	**O**	**R**	**T**	**E**	**R**
E	**T**	**E**	**I**	**T**	**E**	**C**	**D**	**G**	**A**	**T**
R	**U**	**C**	**O**	**L**	**L**	**I**	**S**	**I**	**O**	**N**
V	**M**	**U**	**N**	**T**	**I**	**T**	**D**	**S**	**R**	**H**
A	**R**	**E**	**A**	**N**	**N**	**Y**	**H**	**O**	**K**	**Y**
T	**E**	**E**	**R**	**F**	**E**	**H**	**A**	**L**	**I**	**K**
I	**J**	**Q**	**Y**	**E**	**A**	**C**	**M**	**A**	**S**	**S**
O	**H**	**J**	**U**	**K**	**R**	**W**	**E**	**T**	**G**	**M**
N	**O**	**I**	**A**	**A**	**E**	**R**	**R**	**E**	**A**	**N**
D	**E**	**G**	**H**	**J**	**L**	**E**	**A**	**D**	**O**	**G**

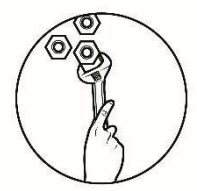
What I Have Learned

Group Activity: Song Composition

In a small group (3-4 members), compose a song about conservation of momentum with at least one stanza or four lines but not exceed six stanzas. Write your song in a clean sheet of paper.

Rubrics

Criteria	5	4	3	2
Teamwork	The group worked very well with each other and the tasked was shared equally among the group members.	The group worked well with each other and some members participated slightly more than others.	Group communicated relatively with a few lapses in the lines. Some students dominated and others did not participate.	Group did not work together. There were many obvious miscommunication and lapses in the presentation.
Content	Addressed all the required facts or information; and uses easily understandable terms.	Most important points were covered but with few gaps.	More points covered adequately, but with some errors in information.	Few information were mentioned and with many errors.
Delivery	Eye contact is effectively established with proper gestures, and well-modulated voice.	Eye contact is somewhat established and with few improper gestures and modulated voice.	Eye contact is hardly established to the viewers and with many improper gestures. The voice is sometimes low.	No eye contact is made to the viewers, too many improper gestures and a soft low voice.



What I Can Do

Think Physics!!!

Suppose two cars collide with each other. How can you minimize the danger to the passengers of the colliding cars? State your reason by using what you have learned in the conservation of momentum.

Criteria	4	3	2	1
Content & Development (70%)	-Content is comprehensive and accurate. -Major points are stated clearly and are well supported - Responses are excellent, timely and address topic. - Content is clear -Specific examples are used.	-Content is accurate. -Major points are stated. -Responses are adequate and address topic. -Content is clear -Specific examples are used	-Content is not comprehensive. -Major points are addressed but not well supported. -Responses are inadequate or do not address topic. -Specific examples do not support topic.	-Content is incomplete. -Major points are not clear. -Specific examples are not used.
Grammar & Punctuation (30%)	-Rules of grammar, usage and punctuation are followed; spelling is correct.	-Rules of grammar, usage, and punctuation are followed with minor errors; spelling is correct.	-Paper contains few grammatical, punctuation and spelling errors.	-Paper contains numerous grammatical, punctuation and spelling errors.

Assessment

Multiple Choice: Read the statements carefully. Choose the BEST answer. Write the letter of your answers on the space provided before each number.

_____1.) Which of the following statements describes momentum?
A. It is the product of body's mass and velocity.
B. It is the product of body's mass and acceleration.
C. It is the sum of body's mass and velocity.
D. It is the sum of body's mass and acceleration

_____2.) Two billiard balls approach each other at equal speed. If they collide in a perfectly elastic collision, what would be their velocities after collision?
A. zero
B. same in magnitude and direction
C. same in magnitude but opposite in direction
D. different in magnitude and opposite in direction

_____3.) Two marbles with a total mass of 20 kg has an initial momentum of 100 kg m/s. If the marbles stick together after the collision, what is the final velocity of the marbles?
A. 5 m/s
B. 80 m/s
C. 120 m/s
D. 2, 000 m/s

_____4.) What is the unit for momentum?
A. kgm/s
B. Nkg
C. kgm/s2
D. Nm/s

_____ 5.) What word can best describe the total momentum in an isolated system?
A. conserved
B. large
C. lost
D. low

_____ 6.) What is the unit of velocity?
A. kg
B. kg m/s
C. m/s
D. all of these

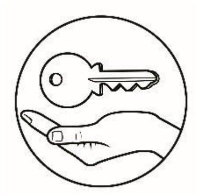
For nos. 7 & 8. Two 0.5 kg balls approach each other with the same speed of 2.0 m/s.

_____7.) What is the total momentum of the system before collision?
A. 0
B.0.50 kgm/s
C. 1.0 kgm/s
D.-1.0 kg m/s

_____8.) If there is no external force acting on the system, what is the total momentum of the system after collision?
A. 0
B.0.50 kgm/s
C. 1.0 kgm/s
D.-1.0 kg m/s

_____ 9.) Calculate the momentum of a car, which has a mass of 1000 kg and moves with a velocity of 2 m/s.
A. 500
B. 1, 002
C. 2000
D. 9 980

_____ 10.) The total momentum of two objects before collision is 175 kg. m/s. What will be their total momentum after collision?
A.50 kg m/s
B. 350 kg m/s
C. 175 kg m/s
D. not enough information



Answer Key

What I Know

1. A
2. D
3. D
4. A
5. A
6. C
7. C
8. A
9. B
10. B

What's the Word

COLLISION
CONSERVED
MOMENTUM
EQUAL
SYSTEM

WORD HUNT

Horizontal:
CONSERVED
COLLISION
MASS

Diagonal:
EQUAL

Vertical:
CONSERVATION
MOMENTUM
STATIONARY
LINEAR
VELOCITY
ISOLATED

Post Test

1. A
2. C
3. A
4. A
5. A
6. C
7. C
8. C
9. C
10. C

References

Alvarez, Liza A., et.al. 2014. *Science - Grade 9 Learner's Module.* 5th Floor, Mabini Building, DepEd Complex, Meralco Avenue, Pasig City, Philippines, 1600. Department of Education

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