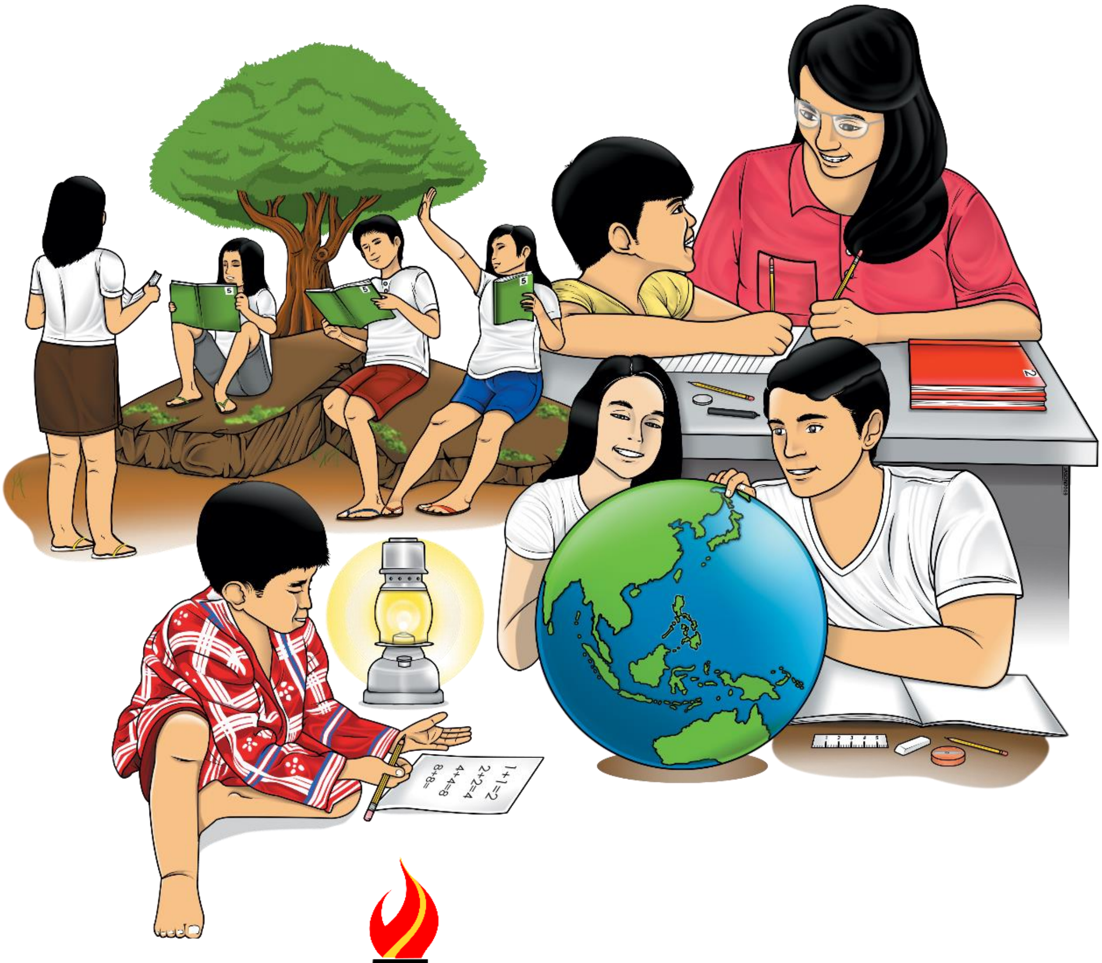
8

Science

Quarter 1 – Module 1:
Forces



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Science

Quarter 1 – Module 1:

Forces

Introductory Message

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 them.

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.

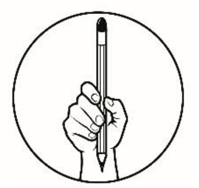
Thank you.

What I Need to Know

This module was designed and written with you in mind. It is here to help you master Forces. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

After going through this module, you are expected to:

1. Investigate the relationship between the amount of force applied and the mass of the object to the amount of change in the object's motion. (Week 1 S8FE-Ia-15)



What I Know

Choose the letter of the correct answer. Write your answers on a separate sheet of paper.

1. Which of the following describes a force?
   A. a pull only
   B. a push only
   C. a push or pull or both
   D. neither a push nor a pull

2. What is the unit of force in metric system?
   A. Calorie
   B. Joules
   C. Newtons
   D. Pounds

3. How do forces occur?
   A. in pairs
   B. in triplets
   C. by themselves
   D. as single quantity

4. When you move a chair across the floor, what force must your push be stronger than?
   A. friction
   B. magnetic
   C. normal
   D. tension

5. A 500-N lady sits on the floor. How much force the floor exerts on her?
   A. 50 N
   B. 250 N
   C. 500 N
   D. 1000 N

6. Which force always pulls the objects to the ground?
   A. applied
   B. friction
   C. gravitational
   D. tension

7. A leaf falls from a tree. What force(s) are acting on it?
   A. Air resistance only
   B. Gravitational force only
   C. Applied force and air resistance
   D. Air resistance and gravitational forces

8. When a cabinet touches the floor, which type of forces exist?
   A. Contact forces
   B. Balanced forces
   C. Non-contact forces
   D. Unbalanced forces

9. The Earth has a bigger mass than the Moon. If you were able to travel to the Moon, what happens to your weight?
   A. increases
   B. decreases
   C. stays the same
   D. varies with day and night

10. What is the net force in the figure below?

Illustrated by: Rhenan O. Bacolod

A. 1 N, to the left
B. 1 N, to the right
C. 11 N, to the left
D. 11 N, to the right

Lesson 1 Forces

Force can be operationally defined based on observed effects. This means that a force can be described in terms of what it does. However, forces do not always cause motion. It does not necessarily follow that forces acting on an object will always cause it to move. Figures below are examples where forces have tendency of changing the motion of an object or not.

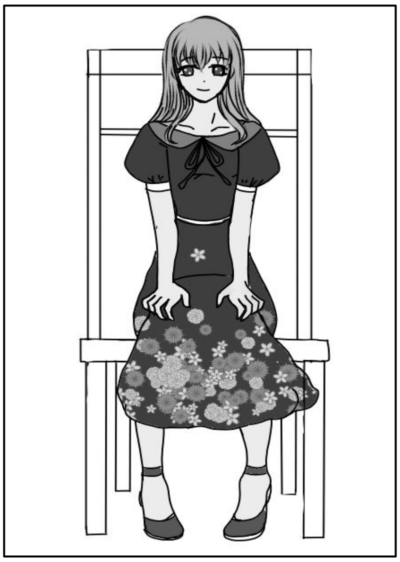


Figure 1. A girl sitting on a chair
Illustrated by: Rosa Mia L. Pontillo

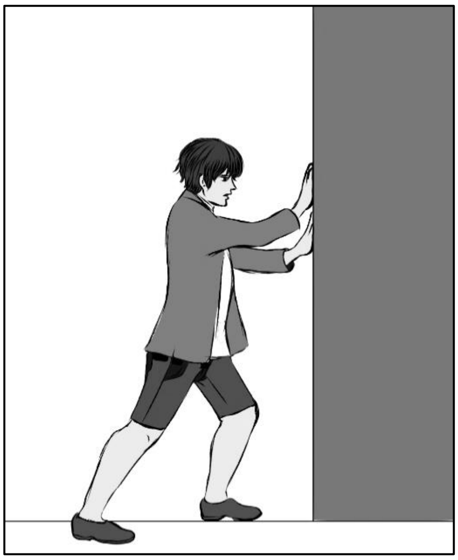


Figure 2. A boy pushing a wall
Illustrated by: Rosa Mia L. Pontillo

Figure 3. A woman throwing a ball

Illustrated by: Rosa Mia L. Pontillo

What can forces do? Forces can produce changes in motion. What are these changes in motion?

What's In

In Grade 7, you learned displacement, velocity, and acceleration. You conducted activities wherein you understood and made visual representations of the motion of objects such as motion graphs. The ideas were arrived at by studying examples of uniform motion or objects moving in straight line at constant speed. Then you were introduced to non-uniform motion where the object covers unequal displacements at equal intervals of time.

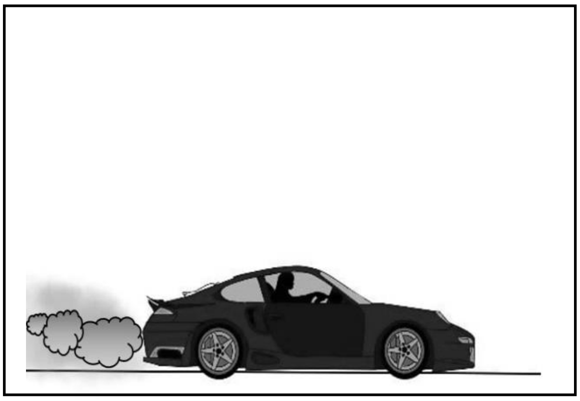


Figure 4. A moving car

Illustrated by: Rosa Mia L. Pontillo

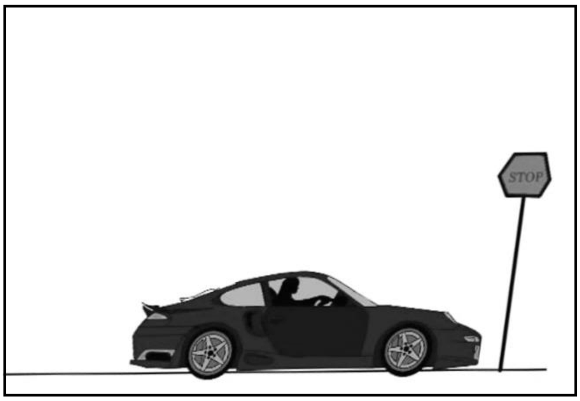


Figure 5. A car slowing down

Illustrated by: Rosa Mia L. Pontillo

When a car starts moving, it speeds up. When a car nears a stop sign, it slows down. The car is covering different displacements at equal time intervals, hence is not moving in constant velocity. This means the car is accelerating.

What's New

Most of the motions we come across in our daily life are caused primarily by FORCE.

To better understand the topic, perform the simple activities that follow.

Activity 1. Effect of force on a ball

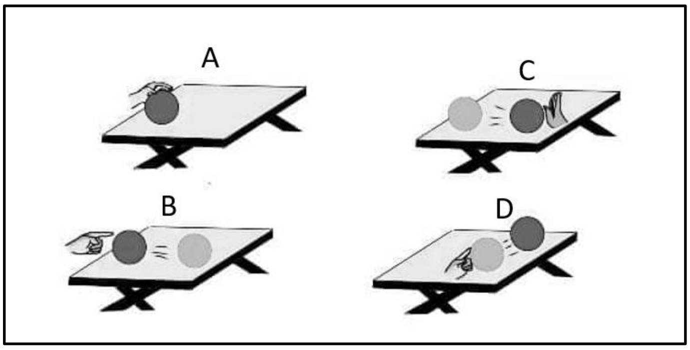
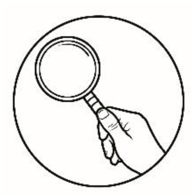


Figure 6. Effect of force on a ball

Illustrated by: Rosa Mia L. Pontillo

Examine the ball on top of the table in Figure 6. Choose the letter of your answer to the given conditions below:

Condition	**Answer**	
1. In letter A, is the ball at rest?	A. Yes	B. No
2. How can you make the ball move?	A. The ball has to be pushed or pulled.	B. The ball has to be pulled only.
3. In letter B, what happens to the ball when you push it with enough force?	A. The ball moves in the same direction as the force.	B. The ball does not move.
4. In letter C, while it is moving, how can you make the ball stop?	A. Exert a force opposite the motion of the ball.	B. The ball has to be pushed in the same direction of its motion.
5. In letter D, how can we make the ball change its direction?	A. The ball has to be pushed sideways.	B. The ball has to be pushed in the same direction of its motion.



What is It

You have observed that the ball moves once you push or pull it. This is called force. Consider a ball on top of a table as shown in Figure 6. The ball will not move when there is no force applied to it (Figure 6A). If you push the ball, it will move or roll across the surface of the table (Figure 6B). And when it is again pushed in the direction of its motion, it moves faster and even farther (Figure 6B). But when you push it on the other side instead, opposite to the direction of its motion, the ball may slow down and eventually stop (Figure 6C). Lastly, when you push it in a direction different from its original direction of motion, the ball also changes its direction (Figure 6D). In conclusion, force can make the ball, or any object move, move faster, stop, or change its direction of motion. But, does this occur always? Can force always effect change in the state of motion of an object?

To accurately describe the forces acting on an object, let us examine the figure below:

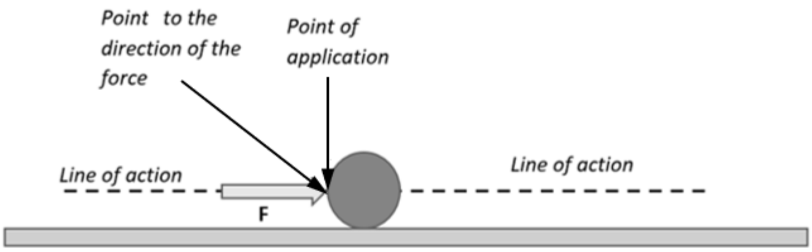


Figure 7. Physical concepts illustrated on a ball
Illustrated by: Rhenan O. Bacolod

Figure 7 shows how force acts on a ball, but you need to be familiar with the following terms:

- **magnitude** – refers to the size or strength of the force. It is commonly expressed in Newton (N) for Meter-Kilogram-Second (MKS) system, Dyne (dyn) for Centimeter–Gram–Second (CGS) system and pounds (lbs) for Foot–Pound–Second (FPS) system. In the International System of Units (SI), Newton is commonly used which is named after Sir Isaac Newton, an English physicist and mathematician.
- **direction** – points to where the object goes. The direction of the arrowhead indicates the direction of the force. The length of the arrow represents the amount of force (relative magnitude).
- **point of application** – the location of where the force is applied.
- **line of action** – is the straight line passing through the point of application and is parallel to the direction of force.

There are two types of force, namely:

Contact forces – forces where objects touch or contact with each other.

Examples of contact forces:

1. **Applied** – a force given to a person or object by another person or object. Its symbol is **F** depending on who or what applies force to the object. If a boy applies a force to a wall, we denote it with $\mathbf{F_{BOY}}$. Refer to the figure below.

Figure 8. Applied force of a boy ($\mathbf{F_{\mathit{BOY}}}$) towards the wall

Illustrated by: Rosa Mia L. Pontillo

2. **Friction** – is the force acting against or opposite an object in contact with which makes the movement of the object slow down. Friction always opposes the motion of an object. Its symbol is written as $\mathbf{F_{\mathit{f}}}$. ***Air resistance*** denoted by $\mathbf{F_{\mathit{AIR}}}$ is an example of frictional force of the air against a flying kite, airplanes, parachutes or those in skydiving sports. For free-falling objects, this force is always considered negligible, meaning the magnitude is unnoticeable.

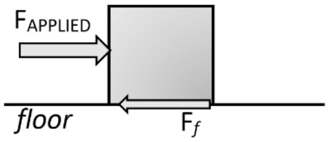


Figure 9. Frictional force ($\mathbf{F_{\mathit{f}}}$) acts opposite to the force applied

Illustrated by: Rhenan O. Bacolod

3. **Normal** – is the force that acts perpendicular to the surface of the object in contact with. Its symbol is $\mathbf{F_N}$.

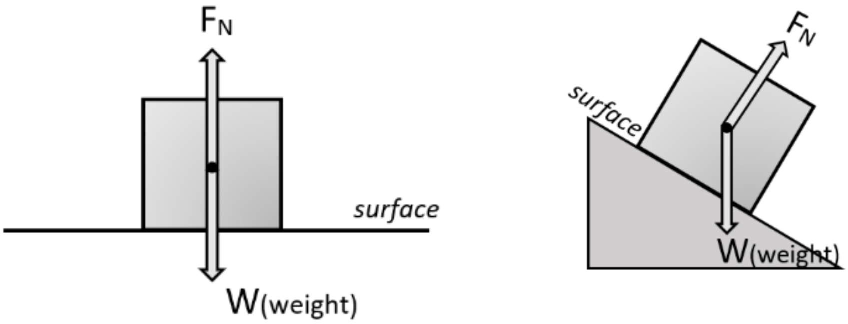


Figure 10. Normal force ($\mathbf{F_N}$) acts perpendicular to the surface

Illustrated by: Rhenan O. Bacolod

4. **Tension** – is the force applied to string, rope, chain or cable. Its symbol is **T**.

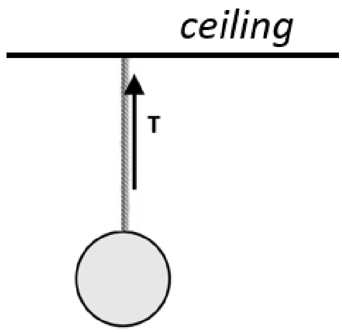


Figure 11. Tensional force or simply tension (**T**) that acts on the rope of a hanging ball.

Illustrated by: Rhenan O. Bacolod

Non-contact forces – forces where objects do not touch or contact with each other. These forces act over a zone or area called field.

Examples of non-contact forces:

1. **Gravitational (F_g)** – is the force of attraction between two objects. In the case of the Earth, this gravitational force causes objects to fall down to the ground. It makes satellites and smaller objects stay in orbit near the more massive planets. Mass and distance of the two objects affect the gravitational force that holds them. The bigger the masses of the objects are, the bigger is the gravitational force between them. The closer the objects are, the greater is the gravitational force between them. The figure below illustrates gravitational force between the Earth and the Moon. Earth has bigger gravitational force over the Moon.

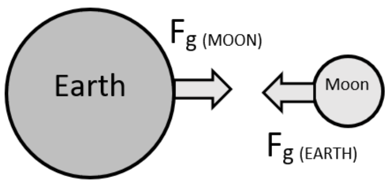


Figure 12. Gravitational force between the Earth and the Moon.

Illustrated by: Rhenan O. Bacolod

The weight of an object, denoted by **W**, is an example of the gravitational force of the Earth towards the object. In figure 13, the weight of a book **(W_{BOOK})** is illustrated.

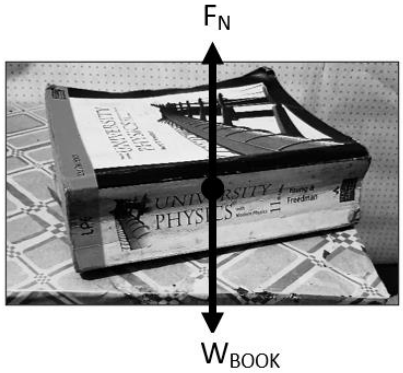


Figure 13. Illustration of the weight of a book **(W_{BOOK})** on the table with normal force (F_N)

Photo credit: Rhenan O. Bacolod

However, the weight of an object depends on the mass of the celestial body where the object is attracted to. Meaning, we seem to be lighter when we are on the moon than on the Earth.

2. **Magnetic–** are forces exerted on a field of attraction or repulsion as in the case of magnets and other magnetic materials. Magnets and magnetic materials have two poles – the north and south poles. Attraction may occur when two poles are not the same, a positive and a negative while repulsion takes place with the same poles, positive-positive and negative-negative.

Figure 14. Opposite poles attract Like poles repel

Illustrated by: Rhenan O. Bacolod

Balanced Forces

To describe a force, you must know two things. You must know the magnitude and the direction of the force. Suppose two teams are playing tug-of-war as shown in figure 15. Each team is pulling with equal magnitude of force, F_A and F_B , on the rope but in opposite directions. Neither team can make the other team move. Forces that are equal in magnitude but opposite in direction are called ***balanced forces***. Balanced forces do not cause a change in motion. When balanced forces act on an object at rest, the object will not move.

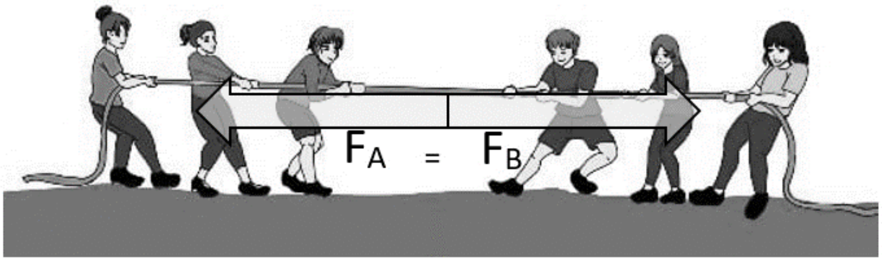


Figure 15. A representation of balanced forces in a tug-of-war game

Illustrated by: Rosa Mia L. Pontillo

Unbalanced Forces

When you push a table and then it moves, unbalanced forces are present. Forces that cause a change in the motion of an object are ***unbalanced forces***. Unbalanced forces are not equal and in opposite direction. Suppose that one of the teams in tug-of-war, as shown in figure 16, exerts greater magnitude of force, F_B, on the ground than the other team, the forces applied on the ground would no longer be equal. One team would be able to pull the other team in the direction of the larger force.

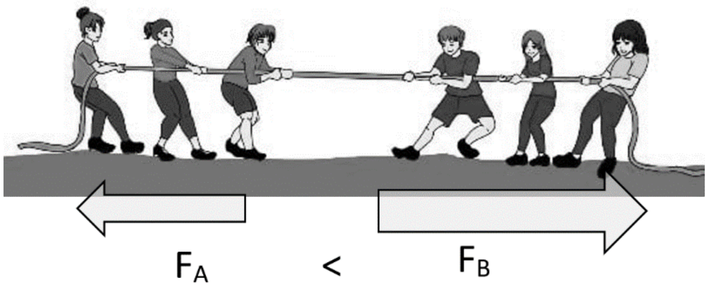


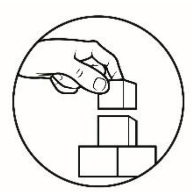
Figure 16. A representation of unbalanced force in a tug-of-war game
Illustrated by: Rosa Mia L. Pontillo

Net or Resultant Force

In an object, there may be several forces acting on it. ***Net force*** or ***resultant force*** is the sum of all forces acting on an object. Two or more forces in the same line of action exerted on an object are balanced if their effects cancel each other.

When an object is at rest, a zero net force would make the object remains at rest. Moreover, when the object is moving, a zero net force would make the object maintain its velocity at a given time interval.

On the other hand, when the net force is not zero, the object's velocity will change. A net force exerted to an object at rest may cause the object to move. In a moving object, a net force will increase its velocity when the force is in the same direction of its motion. If the net force is in the opposite direction of the object's motion, the force will reduce the object's velocity. When the net force acts sideways on a moving object, the direction of the object's velocity changes.



What's More

Forces can be applied to objects in different directions at the same time. It is important to identify all the forces acting on the object which cause change in the motion. In the succeeding activities, you are going to identify forces present in objects at rest.

Activity 2. Forces on objects at rest

Objective:

After accomplishing this activity, you should be able to identify what forces are acting on an object at rest.

Material:

picture

Directions:

A. Look and study the picture below.

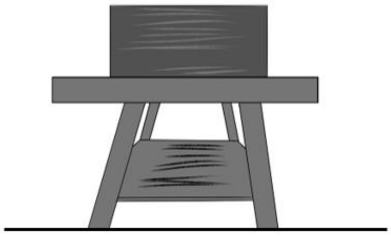
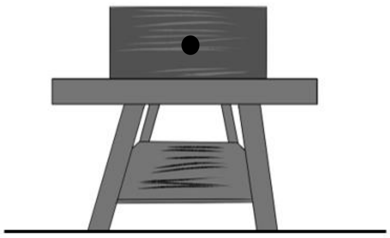


Figure 17. A block of wood lying on a table.
Illustrated by: Rosa Mia L. Pontillo

Questions:

1. Is the block of wood at rest or in motion? _______________
2. Refer to the figure below. Draw the forces acting on the block of wood. Use the dot as the origin of the forces.



Illustrated by: Rosa Mia L. Pontillo

Activity 3. Balance of forces

Objectives:

After performing this activity, you should be able to:

1. Examine the situation when the forces are balanced; and
2. Explain the effect of balanced forces on the state of motion of an object.

Materials:

Pictures

Procedure:

Examine the pictures below:

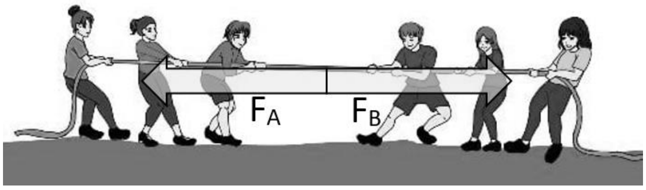


Figure 18. Balanced forces in a tug-of-war.
Illustrated by: Rosa Mia L. Pontillo

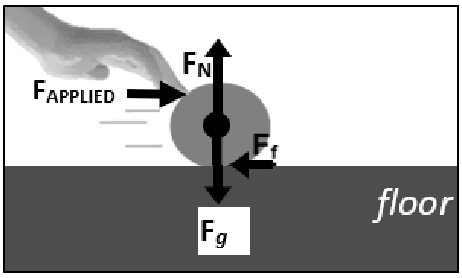


Figure 19. A ball pushed on the floor
Illustrated by: Rosa Mia L. Pontillo

F_A - applied force on the rope by Team A
F_B - applied force on the rope by Team B

F_N – force exerted by the floor on the ball
F_g - force exerted by the Earth on the ball
F_f - opposite force in the direction of the motion or frictional force
$F_{APPLIED}$ – applied force on the ball

For question numbers 1-3, refer to Figure 18.

1. If two groups in the game are exerting equal and opposite forces on the rope, will the rope move?
   ____

2. In the same condition, what happens to the net force acting on the rope?
   ____

3. What are the forces present on the rope?
   ____

4. Refer to Figure 19. If you place a ball on the floor then push it gently to one side, observe the motion of the ball as it rolls down the floor.

   a. What makes the ball stop rolling after sometime?
   ____

   b. What are the forces that act on the ball?
   ____

Activity 4. Unbalanced forces

Objectives:

After performing this activity, you should be able to:

1. Examine the situations when the forces are unbalanced; and
2. Explain the effect of unbalanced forces on the state of motion of an object.

Materials:

Pictures

Procedure:

Examine the pictures below.

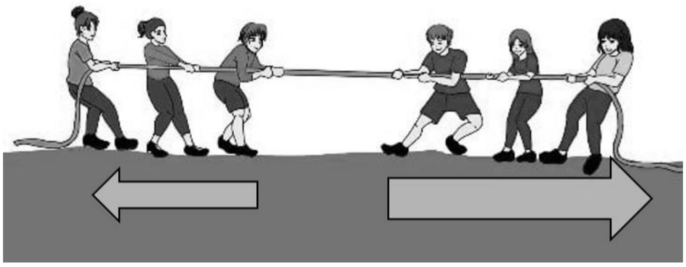


Fig 20. Unbalanced forces in a tug-of-war

Illustrated by: Rosa Mia L. Pontillo

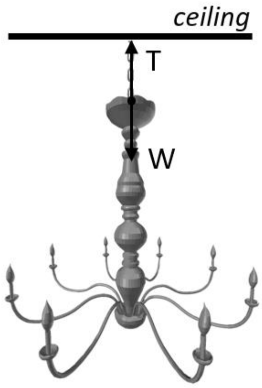


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Fig 21. A chandelier hangs on a chain.

For question numbers 1-2, refer to figure 20.

1. If two groups in the game are exerting unequal and opposite forces on the ground, will the rope move?
   ____
2. Will the net force be equal to zero?
   ____
3. To what direction does the rope move?
   ____

For question numbers 4 – 6, refer to figure 21.

4. Are the forces acting on the chandelier unbalanced?
   ____
5. What force can cause the chandelier to fall?
   ____
6. What type of force is your answer in number 4?
   ____

What I Have Learned

Fill in the blanks with correct word/s. Write your answers on a separate sheet of paper.

1. Any push or pull is called ________________.
2. ________________ refers to the size or strength of the force while ________________ points to where the object goes. The direction of the arrowhead indicates the direction of the force. The length of the arrow represents the amount of force (relative magnitude).
3. There are two types of forces, namely ________________ and ________________.
4. Applied, friction, normal and tensional forces are examples of ________________ forces.
5. Gravitational and magnetic forces are examples of ________________ forces.
6. ________________ are forces that are equal in magnitude but opposite in direction.
7. ________________ are forces that cause a change in the motion of an object.
8. The sum of all forces acting in an object is called ________________.
9. If the forces in an object are balanced, the net force is ________________.
10. If the forces in an object are unbalanced, the net force is ________________.

What I Can Do

When we combine or add forces to determine the net or resultant force, we will limit to those forces which act along the same line of action. The algebraic signs + and – are used to indicate the direction of forces. Unlike signs are used for forces acting in opposite directions, see figure 22 below.

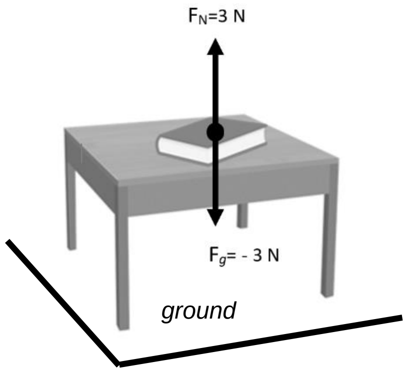

Figure 22. Forces in opposite direction
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The force of gravity (F_g) and the normal force (F_N) are assigned opposite signs. F_N is given a positive (+) sign while F_g is given a negative (-) sign. If both F_g and F_N are given a magnitude value of 3 N, then the net force along this line (vertical) is represented by $\sum F$.

To solve for the net force, you get the sum of all the forces exerted in the object. The symbol sigma, $\sum$, means you add all the existing forces in the same line of action. You cannot add a vertical force to a horizontal force. In Figure 20, we can add the two forces, normal and gravitational force since they are in the same vertical line of action.

$$F_{net} = \sum F$$

$$F_{net} = F_N + F_g$$

$$= 3 \text{ N} + (-3 \text{ N})$$

$$= 0 \text{ N}$$

If the net force equates to zero, they are considered balanced. If the net force is not equal to zero, the forces are not balanced. This unbalanced force would cause a change in a body's state of motion. Refer to the figure 23.

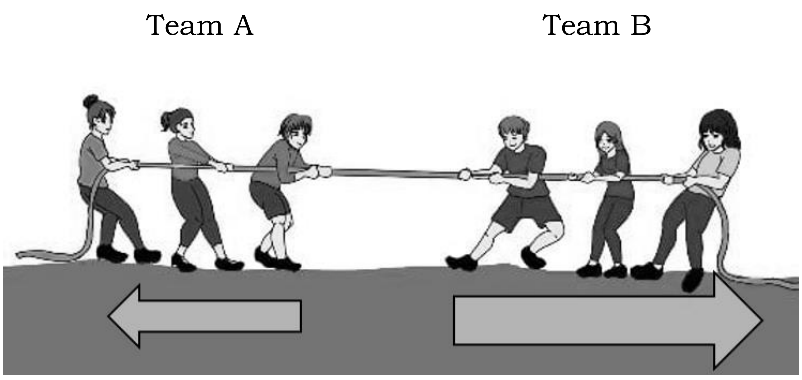


Figure 23. Forces in opposite direction.
Illustrated by: Rosa Mia L. Pontillo

In figure 23, suppose one side in the tug-of-war, team A exerts 1,000 N while the other side, Team B exerts 1300 N. To get the net force,

$$F_{net} = F_A + F_B$$

$$= (-1000 \text{ N}) + 1300 \text{ N}$$

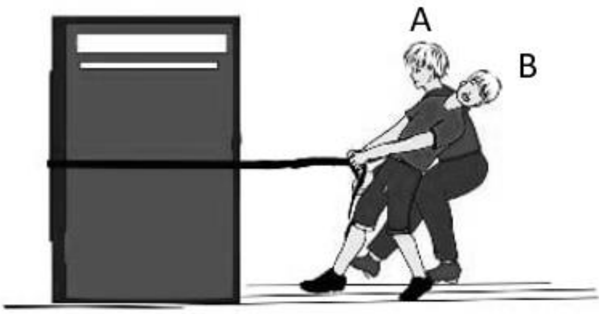
$$= +300 \text{ N or } 300 \text{ N, to the right}$$

This means that Team B won the game, since the F_{net} = 300 N in the direction of Team B (to the right). The negative sign (-1000 N) in the solution means the force is exerted in the opposite side (to the left). Always remember to write the magnitude and direction of the force.

Now, try to answer this concept check in the situations below.

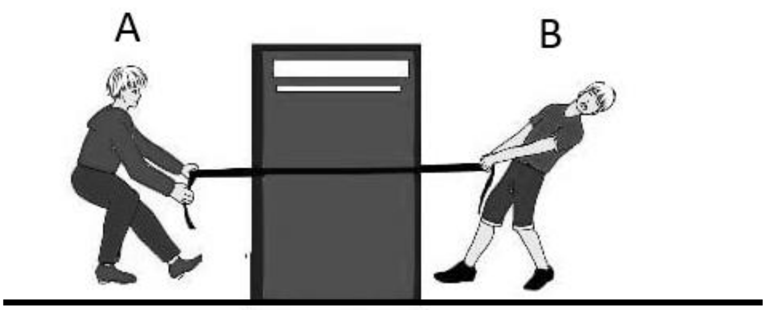
Read and analyze each problem carefully. Write your answers and solutions in your answer sheet.

1. Boys A and B, are pulling a heavy cabinet at the same time with 5 N of force each. What is the net force acting on the cabinet? ______________________



Illustrated by: Rosa Mia L. Pontillo

2. What if boy A and boy B pull the heavy cabinet at the same time in opposite directions with 10 N and 5 N of force respectively,
   a. what will be the net force on the cabinet? ______________________
   b. will the cabinet move? ______________________
   c. to what direction will it move? ______________________



Illustrated by: Rosa Mia L. Pontillo

3. From problem 2, suppose another boy, Boy C pulls the heavy cabinet with 5 N of force in the same direction with Boy A,
   a. What will be the net force on the cabinet? ____________________
   b. Will the cabinet move? ____________________
   c. In what direction will the cabinet move? ____________________

Illustrated by: Rosa Mia L. Pontillo

Assessment

Choose the letter of the correct answer. Write your answers on a separate sheet of paper.

1. Which is NOT a unit of force?
   A. Dyne
   B. Joules
   C. Newton
   D. Pound

2. What refers to how large or strong is the force?
   A. magnitude
   B. line of action
   C. velocity of the object
   D. direction of the force

3. What force is always directed opposite to the motion of an object?
   A. Friction
   B. Gravitational
   C. Magnetic
   D. Tension

4. What force pulls an object back to the Earth?
   A. Applied
   B. Gravitational
   C. Magnetic
   D. Tension

5. Which surface would be easiest for a bicycle to move?
   A. Sand
   B. Grass
   C. Muddy road
   D. Concrete road

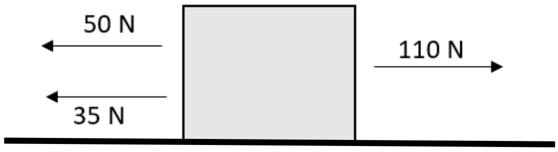
6. What type of forces holds between two celestial bodies like the Sun and Earth?
   A. Applied
   B. Gravitational
   C. Magnetic
   D. Tension

7. What force acts perpendicular to the surface of the object in contact with?
   A. Applied
   B. Gravitational
   C. Normal
   D. Tension

8. Two people pull on a rope in a tug-of-war. Each pull with a 300 N force. What is the net force?
   A. 0 N
   B. 300 N
   C. 600 N
   D. 900 N

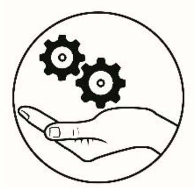
9. Planet Jupiter has a bigger mass than the Earth. If you were able to travel to planet Jupiter, what happens to your weight?
   A. increases
   B. decreases
   C. stays the same
   D. varies with day and night

10. What is the net force in the figure below?



Illustrated by: Rhenan O. Bacolod

A. 25 N, to the left
B. 25 N, to the right
C. 195 N, to the left
D. 195 N, to the right



Additional Activities

Analyze and answer the problems below. Write your answers on a separate sheet of paper.

1. The wheel barrow at rest containing stones has a force of 1000 N. A man exerted a push of 500 N.

   a. Will he able to move the wheel barrow? ______________________________

   b. Suppose another man tried to help him and exerted a force of 500 N. Will they able to move the wheel barrow?
   ____

   c. Another man saw their struggle in pushing the wheel barrow. He tried to help them. He exerted a force of 400 N. Will the three of them move the wheel barrow?
   ____

2. A box is at rest and a force of 250 N is applied to it. If the frictional force is 200 N, determine the net force.

Answer Key

What I Know

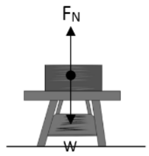
1. C
2. C
3. A
4. A
5. C
6. C
7. D
8. A
9. B
10. A

What's New

1. Yes
2. The ball has to be pushed/ pulled
3. The ball moves in the same direction as the ball
4. Exert a force opposite the motion of the ball
5. The ball has to be pushed sideways

What's More

Activity 1

1. At rest
2. 

3. Frictional force, normal, gravitational force

What's More

Activity 2

1. No
2. 0
3. Tension/Applied
4. a.friction
   b. frictional, normal, gravitational

What's More

Activity 3

1. Yes
2. No
3. To the right
4. No
5. Gravitational force
6. Gravitational force, yes

What I have learned

1. Force
2. Magnitude, direction
3. Contact, non-contact
4. Contact
5. Non-contact
6. Balanced
7. Unbalanced
8. Net or resultant force
9. zero
10. not zero

What I can do

1. $F_{net} = F_A + F_B$
= 5N + 5 N
=+10 N, or 10 N to the right
2. a. $F_{net} = F_A + F_B$
= -10 N + 5 N
=-5 N, or 5 N to the left
b. Yes
c. To the left
3. a. $F_{net} = F_A + F_B + F_C$
= -5N + 5 N
= - 10 N, or 10 N to the left
b. yes
c. to the left

Additional Activities

1. a. No
   b. No
   c. Yes
2. F_{net} = +50 N or 50 N, to the right

Assessment

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

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