Senior High School

General Physics 1

Quarter 1 – Module 5:
Newton's Laws of Motion

SELF-LEARNING MODULE

General Physics 1 – Grade 12
Quarter 1 – Module 5: Newton's Laws of Motion
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DEPARTMENT OF EDUCATION

Introductory Message

For the facilitator:

Welcome to this **Grade 12 General Physics 1** Self-Learning Module entitled "**Newton's Laws of Motion**"!

This has been developed and reviewed to help you deliver the lessons to the learner in this new normal mode of delivery – modular distance learning. As this learning material was developed, the needs and context of the learners were considered to make their learning experience relevant.

There are a series of activities in this module, complete with content and instructions on how our learners will do these tasks. Please be reminded to tell the learners that they will use separate sheets for their answers in all activities such as pre-test (Let Us Try), self-check exercises (Let Us Practice, Let Us Practice More, Let Us Enhance, Let Us Reflect), and Post Test (Let Us Assess).

For the learner:

Welcome to this **Grade 12 General Physics 1** Self-Learning Module entitled "**Newton's Laws of Motion**"!

This module has been developed to assist you in mastering the learning competency/ competencies even outside the face-to-face instruction. This module contains instructions on how you will use the module.

The module contains the following parts with descriptions:

Let Us Learn	This states the lesson objectives.
Let Us Try	This assesses how much you already know about the topic.
Let Us Study	This discusses the main topic of the lesson.
Let Us Practice	This helps you discover the main concept of this module.
Let Us Practice More	This gives you more practice of the concepts you gained from the lesson.
Let Us Remember	This summarizes the key concepts in this module.
Let Us Assess	This is a 15-item multiple-choice test that assesses your understanding of the concepts.
Let Us Enhance	This serves as an enrichment activity that increases the strength of your response as repetitions of your learning.
Let Us Reflect	This serves as a closing note for the relevance or application of concepts.

Let Us Learn!

Before we start, it is very important to keep in mind the focus of learning this module. This learning material addresses the topic ***"Newton's Laws of Motion"*** in General Physics 1, which has the following Most Essential Learning Competencies (MELCs):

1	Define inertial frames of reference	STEM_GP12N-Id-28
2	Identify action-reaction pairs	STEM_GP12N-Id-31
3	The students will be able to draw free-body diagrams	STEM_GP12N-Id-32
4	Apply Newton's 1st law to obtain quantitative and qualitative conclusions about the contact and noncontact forces acting on a body in equilibrium	STEM_GP12N-Ie-33
5	Differentiate the properties of static friction and kinetic friction.	STEM_GP12N-Ie-34
4	The students will be able to apply Newton's 2nd law and kinematics to obtain quantitative and qualitative conclusions about the velocity and acceleration of one or more bodies and the contact and noncontact forces acting on one or more bodies	STEM_GP12N-Ie-36
5	The students will be able to solve problems using Newton's Laws of motion in contexts such as, but not limited to, ropes and pulleys, the design of mobile sculptures, transport of loads on conveyor belts, the force needed to move stalled vehicles, determination of safe driving speeds on banked curved roads	STEM_GP12N-Ie-38

This module has three (8) lessons, to wit:

Lesson 1	***Inertial Reference Frame and Action-Reaction Pairs***
Lesson 2	***Applications of Newton's Laws to single-body and multibody dynamics***
Lesson 3	***Problem-solving using Newton's Laws***

It is expected that by the end of this module, you will gain a concrete understanding of Newton's Laws of Motion. Be sure to coordinate closely with your subject teacher in General Physics.

Let Us Try!

How far do you know the topic of Newton's Laws of Motion?

Read the questions carefully and choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What is Newton's law telling us to use the seatbelt?
   A. first law
   B. second law
   C. third law
   D. law on universal gravitation

2. According to the second law of motion, the net force is the product of mass and acceleration. Which of these has the highest acceleration?
   A. With a 10 N net force, a 5,000 kg stone was pulled.
   B. With a 9 N net force, a 0.5000 kg toy car is pulled.
   C. By a 17 N net force, a 7,000 kg metal ball is pushed.
   D. A 500.0 kg truck accelerated from its engine with a net force of 1000 N.

3. The net force acting on an object is zero. Which of the following is always true?
   A. The object is at rest
   B. The object is moving at a constant velocity
   C. The object is not accelerated
   D. No force acts on the object

4. The inertia of an object is determined by its ______________.
   A. Force
   B. Gravity
   C. Speed
   D. Mass

5. A boy jumps into a dock from a boat. The boat moves backward as the boy moves forward to the dock. Which statement describes the above situations?
   A. An object at rest remains at rest.
   B. Friction opposes an object's motion.
   C. An equal and opposite reaction exists for every action.
   D. The net force is inversely proportional to acceleration.

Lesson 1 Inertial Reference Frame and Action-Reaction Pairs

Let Us Study

The work on motion by Galileo attracted Isaac Newton's attention. He studied and further developed Galileo's ideas on motion. In his famous book Principia Mathematica, released in 1687, he introduced these three laws of motion. His first law of motion is known as the Inertia Law. Newton's second law is known as the Law of Acceleration, and the third law of motion is called the Law of Interaction. These three laws are the basis for understanding many physical phenomena and are useful in making assumptions about the motion of various bodies around us.

With any reference frame, the position is the object's location at a given moment in time. A frame of reference is a physical entity that can be used in that frame to determine the object's positions and speeds. In other words, it is the observer of a motion point of view. For example, we say the school clinic is 50 m to the left of the main building. Our reference is the main building in this example.

Inertial Frame of Reference

The inertial frame of reference defines as a frame of reference in which Newton's Laws are valid. It has zero acceleration. That is, it is moving at a constant speed in a straight line, or it is standing still. It has no fictitious forces that arise. Meaning, no external forces are acting on a body, and therefore it holds the law of inertia. An object within this frame would change its velocity only if the actual non-zero net force applied to it.

Suppose that passenger A is riding a bus, for passenger B sitting next to him, he is at rest while he is in motion for an observer standing along the road. In this scenario, which is our inertial frame here? The inertial frame is a relative term. In general, the inertial frame is at rest or moves with constant velocity to the assumed inertial reference frame.

Non-inertial Frame of Reference

A non-inertial frame of reference is a frame that is accelerated to the assumed inertial frame of reference. Within this frame, Newton's law will not hold. As such, in the example above, if we assume that the bus is an inertial reference frame, person C standing along the road becomes a non-inertial reference frame as it is in accelerated motion with respect to the bus.

Action-Reaction Pairs

In the previous lesson in junior high school, it was discussed that every time we exert force on the body, that body exerts a force on us. The law that governs this property of force is called the Law of Interaction. According to Newton, every time two objects interact, they exert force on each other. Such forces are called forces of action and reaction, subject to Newton's third law of motion, and always come in pairs. It explains that there is a reaction force equal in magnitude for every force but opposite in direction. For example, when a man's foot pushes against the floor, the floor pushes back on foot. Similarly, when the book is on the table, the book's weight exerts a force of action on the table, while the surface of the table exerts a force of reaction on the book. Thus, the forces of action and reaction may be equal in magnitude and opposite in direction.

The examples above are the forces of action and reaction when the bodies are at rest. These forces, forces of action and reaction, never cancel. On the other hand, let us take an example of a moving body's action and reaction force. The force exerted on the bullet when the gun is fired precisely equal to the reaction force exerted on the gun. Therefore the gun kicks backward.

Let Us Practice

Let us do the following activity to check our understanding of the concept.

Activity 1.1

Direction: Identify if the following circumstances demonstrate an inertial frame of reference or a non-inertial frame.

1. The car is turning at a constant speed.
2. The car is moving with constant velocity.
3. A man sits on the accelerating train watching three kids running.
4. The ball is going to bounce.
5. The body is moving in a straight line at a uniform speed.

Let Us Practice More

Okay! Let us have this activity to let you apply your knowledge in Action-Reaction Pairs.

Let's do this!

Activity 1.2

Direction: Identify the action-reaction pairs of the following situations. Make an illustration of these situations and use vectors to describe these paired forces accurately.

1. A man takes a step on the ground
2. A swimmer swims forward in the pool
3. A ball hits a man in the head
4. A person is diving off a raft
5. A player catches the ball

Lesson 2 Applications of Newton's Laws to Single-body and Multibody Dynamics

Let Us Study

Newton's first law of motion or law of inertia states that an object must remain in its state of rest or uniform motion at a constant velocity and the same direction unless it is acted upon by an unbalanced force. This law explains that all objects resist changing their state of motion and that resistance, called inertia. Inertia explains why car passengers appear to travel backward when vehicles suddenly push forward and travel forward when vehicles suddenly stop.

Newton's second law of motion or law of inertia states that an object's acceleration is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object. The second law relates to the behavior of objects under unbalanced forces. Unbalanced forces cause an object to accelerate. The law of acceleration identifies the net force acting on the object, which affects the object's acceleration and the mass of the object. This law gives the relationship between acceleration, net force, and mass of the object. The object's acceleration is directly proportional to the force and is in the same direction. This statement can be written as:

$$a \propto \frac{\sum F}{m}$$

Also, the preceding equation is formulated as

$$a = \frac{F}{m} \text{ or } F = ma$$

The equation $F = ma$ can be written in terms of components as

$$\sum Fx = ma_x \qquad \sum Fy = ma_y$$

According to Newton, every time two objects interact, they exert force on each other. Such forces are called forces of action and reaction, which are subject to the Newton third law of motion, and they are always coming in pairs. It explains that there is a reaction force equal in magnitude but opposite in direction for every force. This law has practical applications for analyzing the origin of forces and the identification of forces external to a system.

The effect of a force or forces acting on the body is to change the state of motion. The first condition of equilibrium is necessary to determine the net force acting on the body. The vector sum of all forces acting on the body requires to be equal to zero to maintain the translation motion. The force components equation can be stated in equation form as follows:

$$\sum F_x = 0 \quad and \sum F_y = 0$$

The first stage in identifying and evaluating certain natural phenomena includes the thorough drawing of a free-body diagram. Throughout this module, free-body diagrams were used in examples. Note that a free-body diagram must involve only specific external forces operating on the body. When we have drawn a detailed free-body diagram, we can apply Newton's laws of motion.

Problem-Solving Strategy

1. Read the question carefully.
2. Draw a system image, identify the primary interest object, and indicate forces.
3. Label the forces in the picture in a way that reminds you of what physical quantity the label stands for.
4. Draw a free-body diagram based on the picture labeled for the object of interest.

Types of Forces

1. **Applied Force ($\boldsymbol{F_{app}}$)** is a force that is applied by a person or another object to an object. If an individual moves a table across the room, an applied force will act on the object. The force applied is the force exerted by the individual on the table.

2. **Gravitational Force ($\boldsymbol{F_{grav}}$)** is the force by which the Earth and other large object attract another object to itself. This force is the weight(**W**) of the material. The direction of this force is always directed towards the center of the Earth.

$$\boldsymbol{F_{grav} = W = mg}$$

where $\boldsymbol{g} = \mathbf{9.8}\frac{m}{s^2}$ on Earth and $\boldsymbol{m} = \boldsymbol{mass}$ in kg

3. **Normal Force ($\boldsymbol{F_N}$)** is the contact force that a surface exerts on an object. It is always perpendicular in its direction but away from the surface.

4. **Frictional force (F_f)** is a contact force exerted by a surface to oppose the sliding motion as an object passes across it or travels through it. Static friction and kinetic friction are at least the two types of friction. The direction of this force is parallel to the surfaces in contact and opposite the sliding direction.

   Static Friction

$$f_s = \mu_S F_N$$

where $f_s = \textit{static friction}$, $\mu_S = \textit{coefficient of static friction}$ and $F_N = \textit{normal force}$

   Kinetic Friction

$$f_k = \mu_k F_N$$

where $f_k = \textit{kinetic friction}$, $\mu_k = \textit{coefficient of kinetic friction}$ and $F_N = \textit{normal force}$

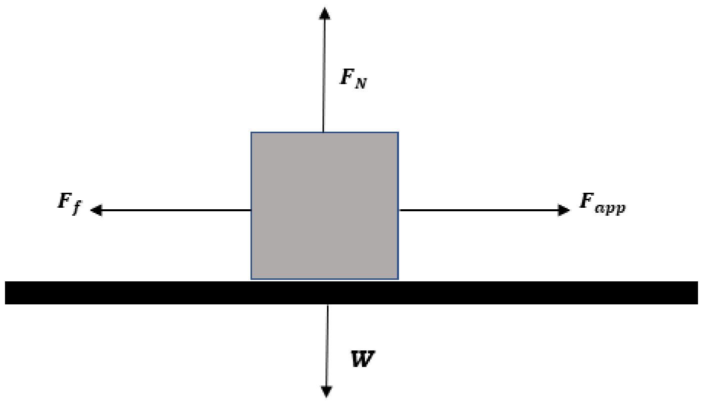
5. **Tension (T)** is the force transmitted along the length of a string, a rope, a cable, or a wire when pulled tightly by forces acting from the opposite end. For example, an object connected to a string and weighing **W** hangs to a ceiling. The tension force is directed along the string length and draws on the object at the opposite ends of the string in equal measure. Its weight W and tension T supplied to the string are the only external forces acting on the mass.

$$T - W = 0; \quad T = W \text{ and } W = mg$$

$$T = mg$$

Example 1.

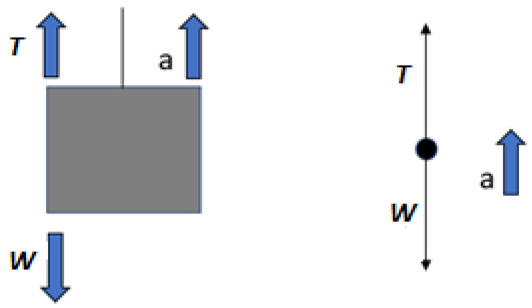
A force is applied to a box to move it across a floor with a rightward acceleration. Construct a free-body diagram for the given situation.



Example 2

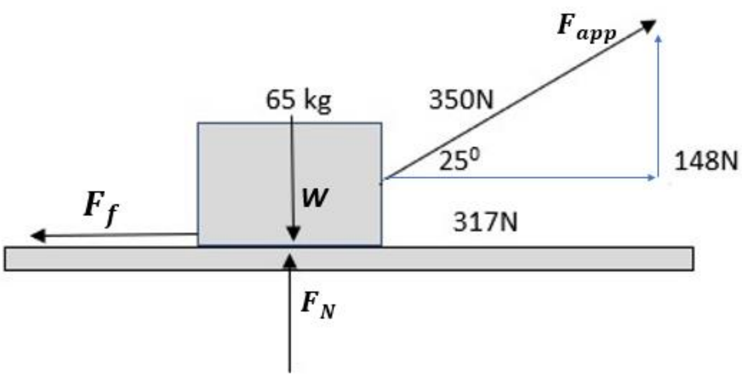
The cable raises the elevator, and its speed is increasing. How are the forces on the elevator related to the change in speed? Construct a free-body diagram for the given situation.

The elevator is moving upward, and the speed is accelerating, so the direction of the acceleration is positive. There is an upward tension (T) supporting the downward weight of the elevator (W).



Example 3

Suppose that a 350-N force pulls a 65-kg box at an angle of 25⁰ to the horizontal. The coefficient of kinetic friction is 0.50. Find the acceleration of the box.



$$F_{ax} = F_{app}cos\theta$$

$$F_{ax} = 350cos25^O = 317$$

$$F_{ay} = F_{app}sin\theta$$

$$F_{ay} = 350sin25^O = 148$$

Summation of forces along the y-axis:

$$\sum F_y = 0$$

$$F_N + F_{ay} - W = 0$$

$$F_N + 148N - mg = 0 \quad \text{but } mg = (65kg)\left(\frac{9.8m}{s^2}\right) = 638N$$

$$F_n = 489\text{N}$$

Friction force acting on the box:

$$F_f = \mu_k F_N = (0.50)(489N) = 244.5N$$

Summation of forces along the x-axis:

$$\sum F_x = ma_x$$

$$F_{ax} - F_f = ma_x$$

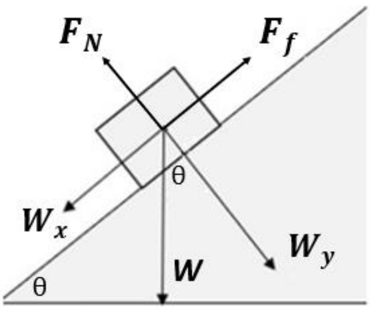
$$(317 - 245)N = (65kg)(a_x)$$

$$a_x = 1.11\, m/s^2$$

Example 4.

Suppose a block with a mass of 3.0 kg rests on a ramp that makes an angle of θ with the horizontal. The coefficient of static friction between the block and the ramp is 0.35; find the angle the ramp can make with the horizontal at which the block starts to slip down?

We define the x-axis to be along the plane and the y-axis to be perpendicular to the plane.



$$W = mg$$

$$W_x = Wsin\theta = mgsin\theta$$

$$\sum Fx = F_f - mgsin\theta = 0$$

$$F_f = mgsin\theta$$

$$W = mg$$

$$W_y = Wcos\theta = mgcos\theta$$

$$\sum Fy = F_N - mgcos\theta = 0$$

$$F_N = mgcos\theta$$

$$F_f = \mu N$$

$$\boldsymbol{\mu} = {F_f}/{F_N}$$

$$\mu = \frac{mgsin\theta}{mgcos\theta}$$

$$\mu_{s=} tan\theta$$

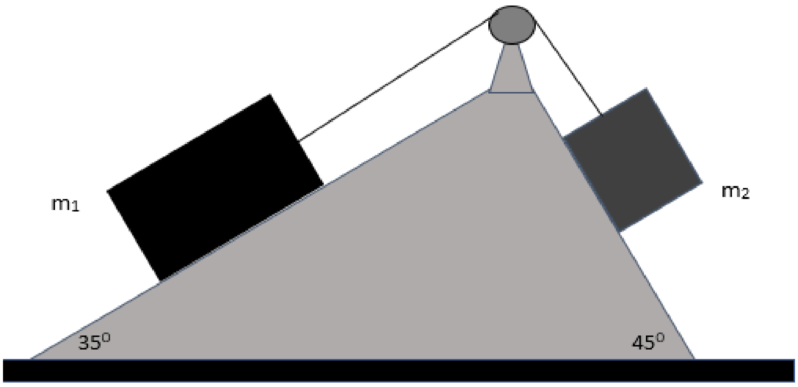
$$\theta = tan^{-1}(\mu_s) = tan^{-1}(0.35)$$

$$\theta = 19.29^O$$

Example 5

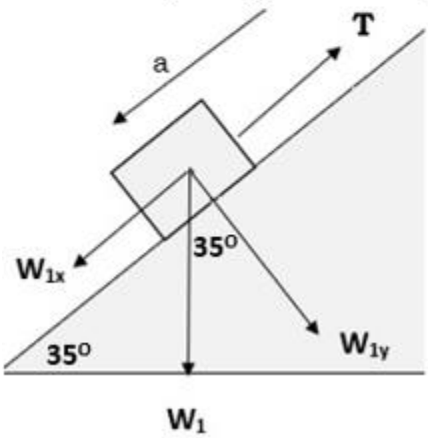
Two blocks, **m_1=150.00kg** and **m_2=100.00kg**, are connected as shown. The planes and the pulley are frictionless.

A. Which way is the system going to move?
B. What is the acceleration of the blocks?



Assume **m_1** will go down the plane, and **m_2** is going to go up the plane. We define the x-axis and y-axis to be, respectively, along the plane and perpendicular to the plane.

Free –body diagram of $\mathbf{m_1}$



$$W_{1x} = W_1 Sin35^O = m_1 g Sin35^O$$

$$W_{1x} = (150)(9.8)(Sin35^O)$$

$$W_{1x} = 843.157\ N$$

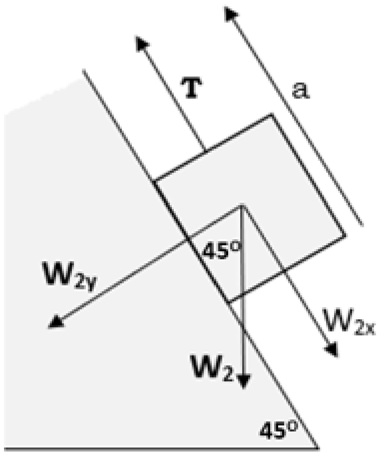
$$F_{net} = m_1 a \quad and \qquad F_{net} = W_{1x} - T$$

$$W_{1x} - T = m_1 a$$

$$T = W_{1x} - m_1 a$$

$$T = 843.157 - 150a \ \ (\boldsymbol{Equation\ 1})$$

Free – body diagram of $\mathbf{m_2}$



$$W_{2x} = W_2 Sin45^O = m_2 g Sin45^O$$

$$W_{2x} = (100)(9.8)(Sin45^O)$$

$$W_{2x} = 692.965N$$

$$F_{net} = m_2 a \quad and \quad F_{net} = T - W_{2x}$$

$$T - W_{2x} = m_2 a$$

$$T = m_2 a + W_{2x}$$

$$T = 100a + 692.965 \quad (\boldsymbol{Equation\ 2})$$

To solve for acceleration a, solve equation 1 and 2 simultaneously

$$843.157 - 150 = 100a + 692.965$$
$$843.157 - 692.965 = 100a + 150a$$
$$150.192 = 250a$$
$$a = 150.192/250$$
$$a = 0.601\ m/s^2$$

The assumption is correct because acceleration a is positive; m1 will go down the plane, and m2 will go up the plane.

Let Us Practice

Let us do the following activity to check our understanding of the concept.

Activity 2.1

Direction: Illustrate a free body diagram given the following situations:

1. A laptop on a tabletop is at rest.

2. The egg falls from the nest of a tree. Neglect air resistance.

3. A man is plunging from the sky with a constant velocity. Consider air resistance.

Let Us Practice More

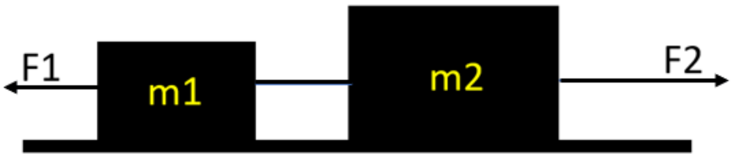
Now that you have understood the basic concepts let us practice what you have learned by applying that in another situation.

Activity 2.2

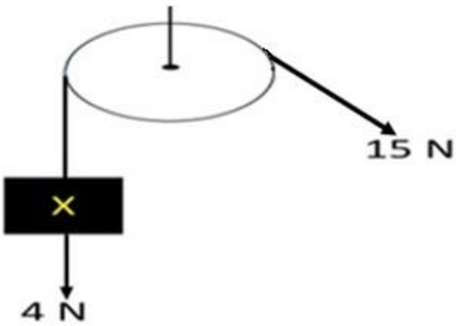
Direction:

Direction: Solve the following problems and show your solutions.

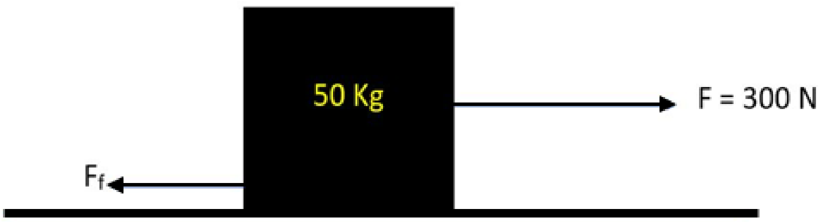
1. Object 1 has a force of 100 N and a mass of 10 Kg. Object 2 has a force of 10 N and a mass of 20 Kg. What is the magnitude of the accelera



2. An object with weight of 8 N supported by a cord and pulley. A force of 4 N acts on the block and one end of the cord is pulled by a force of 15 N. Determine the net force acts on object X.



3. A 50-kg block accelerated by a force of 300 N. Acceleration of the block is 5 m/s^2. Determine the magnitude of friction force experienced by the block.



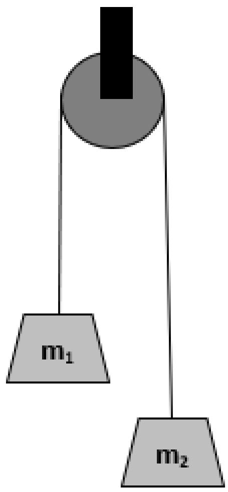
Lesson 3	Problem-Solving Using Newton's Laws

Let Us Study

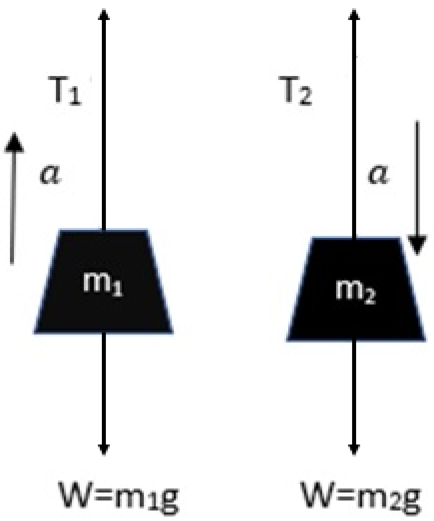
Now let us apply Newton's laws of motion to solve the problems of single-body and multibody dynamics. The pulley system is composed of a pulley and a rope. This system is used to give us a mechanical advantage, where the sum of the input energy is compounded to exert higher forces on the load. This topic is the basic concept of the pulley system. Another application is about the banking curve. This is about the problem of vehicles that turn around a curve. Transport of loads and mobile structures design are other problems involving motion in a different context.

Example 1. Rope and Pulley

A light cable running over a light frictionless pulley suspends two blocks of mass m_1 and m_2. Find the cord tension T, and the typical acceleration, a.



Let the students draw a free-body diagram and divide the system into two parts. Apply Newton's second law individually:



$$T_1 = T_2 = T$$

$$m_2 > m_1$$

$T - m_1 g = m_1 a$ ***Equation* 1** mass $m_1$is accelerated upward

$m_2 g - T = m_2 a$ ***Equation* 2** mass m_2 is accelerated downward

To eliminate T, add Equation 1 and Equation 2

$$m_2 g - m_1 g = m_1 a + m_2 a$$

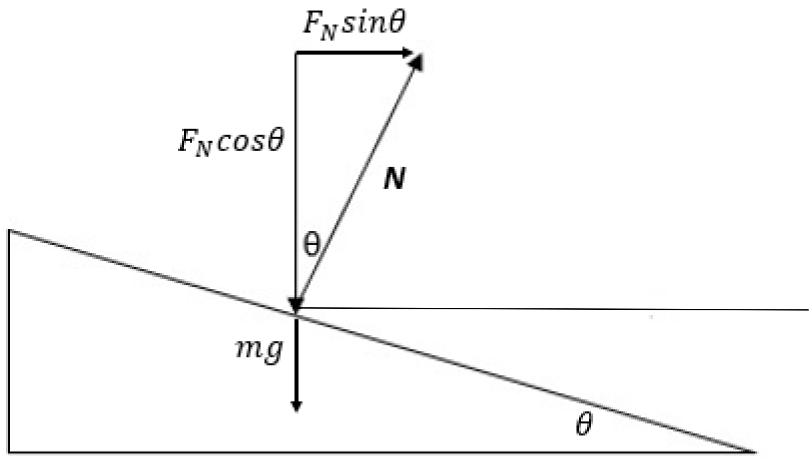
$$a = g\frac{(m_2 - m_1)}{m_1 + m_2}$$

To solve for T, substitute the value of a in any of the original equations

$$T = \frac{2m_1 m_2 g}{m_1 + m_2}$$

Another motion problem is how to turn around the curve. The frictional force may not be sufficient for turning high speeds, mainly when the curvature radius is small, and the centripetal force is increasing. In this situation, when the road is wet and slippery, the car may skid and not make the required turn. That is why most curves are either banked or angled at the road surface to reduce skidding chances.

Centripetal force is proportional to the square velocity, which means that the centripetal force's double velocity will require four times the centripetal force as much to maintain the movement in a circle. If friction alone on a curved road has to provide the centripetal force, an increase in vehicle speed could lead to an unexpected accident by skidding if friction in the tire and the road is insufficient.



- The vertical component of the car supports the weight: $F_N cos\theta = mg$
- The horizontal component gives the centripetal force: $F_N sin\theta = \frac{mv^2}{R}$

Getting the ratio $\frac{Nsin\theta}{Ncos\theta} = \frac{\frac{mv^2}{R}}{mg}$ $\qquad tan\theta = \frac{v^2}{Rg}$

where θ is the angle of banking

Curves are banked to reduce the need for the frictional force between the road and the tire. Curve banking will minimize the risk of skidding because the normal force on the road (acting perpendicular to the road) would have a part towards the center of the circle, and thus less friction is required.

Example 2. Banking Curve

It is essential to set a curve with a radius of 35 m so that a car can turn at a speed of 15 $\frac{m}{s}$ without depending on friction. What does the banking angle have to be?

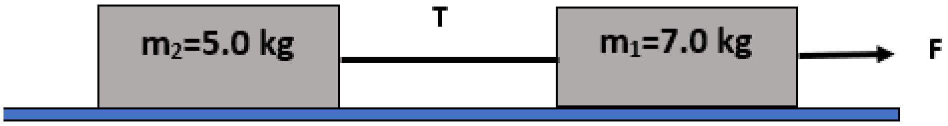
$$tan\theta = \frac{v^2}{Rg}$$

$$tan\theta = \frac{(15m/s)^2}{(9.81m/s^2)(35m)} = 0.655$$

$$\theta = 33^O$$

Example 3. Transport of Load

Two boxes are resting on a frictionless surface connected by a massless, inextensible rope, as shown below. For m1, directly to the right, the 35.0 N horizontal force is applied. Find the acceleration of the boxes and the tension T in the rope.



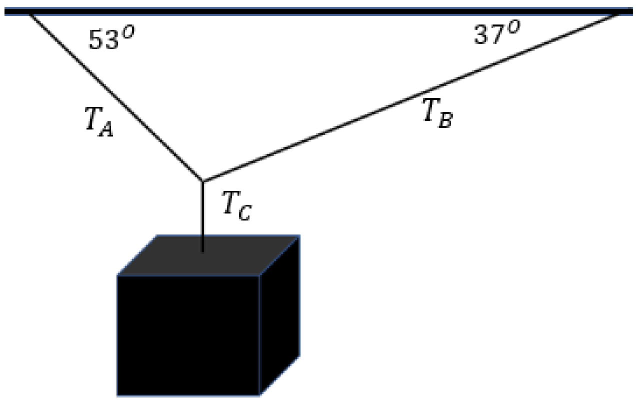
a. $a = \frac{F}{m_2+m_1} = \frac{35\ N}{5.0kg+7.0kg} = \frac{35N}{12\ kg} = \mathbf{2.917\ m/s^2}$

b. Since the surface is frictionless, tension T is the only force responsible for the acceleration of **m₂**.

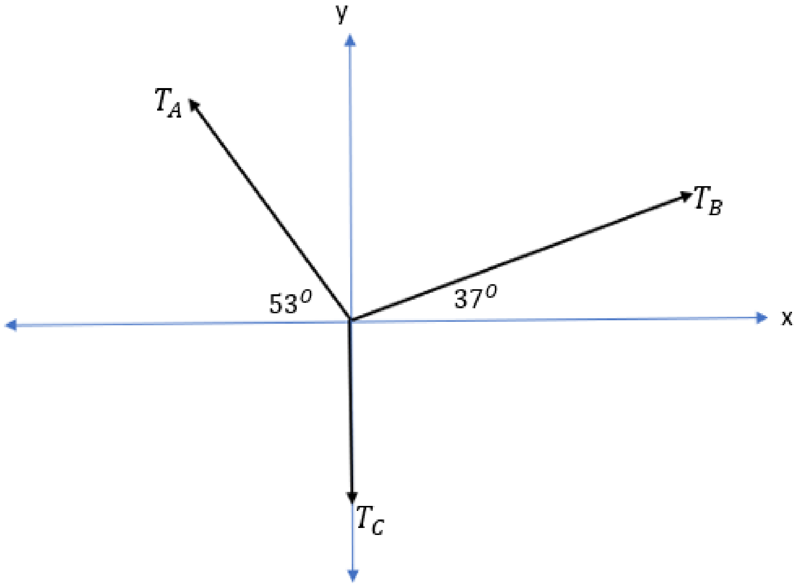
$T = m_2 a = (5kg)\left(2.917\frac{m}{s^2}\right) = \mathbf{14.585\ N}$

Example 4. Hanging Object

A box weighing 15.00 kg is hanging, as shown in the figure below. Find the tensions in ropes A, B, and C.



Free – body diagram



For convenience, resolve all three tension forces into components and construct a table.

Tension	x-component	y-component
T_A	$-T_A\,cos53^0$	$T_A\,sin53^0$
T_B	$T_B cos37^0$	$T_B\,sin37^0$
T_C	0	$-W = mg$

Use the components in the table to apply conditions for equilibrium to the knot.

$$\sum \boldsymbol{Fx = -T_A cos53^0 + T_B cos37^0 = 0 \quad Equation\ 1}$$

$$\boldsymbol{T_B cos37^0 = T_A cos53^0}$$

$$\boldsymbol{T_B = \frac{T_A cos53^0}{cos37^0} = 0.754 T_A}$$

$$\sum \boldsymbol{Fy = T_A sin53^0 + T_B sin37^0 - W = 0 \quad Equation\ 2}$$

$$\boldsymbol{T_A sin53^0 + T_B sin37^0 = W}$$

$$\boldsymbol{T_A sin53^0 + T_B sin37^0 = mg = (15kg)(9.8\ m/s^2)}$$

$$\boldsymbol{T_A sin53^0 + T_B sin37^0 = 147N}$$

Substitute the result of $\boldsymbol{T_B}$ into equation 2 to get the value of $\boldsymbol{T_A}$

$$\boldsymbol{T_A sin53^O + T_B sin37^O = 147N}$$

$$\boldsymbol{T_A sin53^O + (0.754T_A)(sin37^O) = 147N}$$

$$\boldsymbol{T_A = 117.374N}$$

Solve the value of $\boldsymbol{T_B}$

$$\boldsymbol{T_B = 0.754T_A}$$
$$\boldsymbol{T_B = 0.754(117.374N)}$$
$$\boldsymbol{T_B = 88.500N}$$

Solve the value of $\boldsymbol{T_C}$

$$\boldsymbol{\sum Fy = 0}$$

$$\boldsymbol{T_C - W = 0}$$

$$\boldsymbol{T_C = W = mg = (15kg)\left(9.8\frac{m}{s^2}\right) = 147N}$$

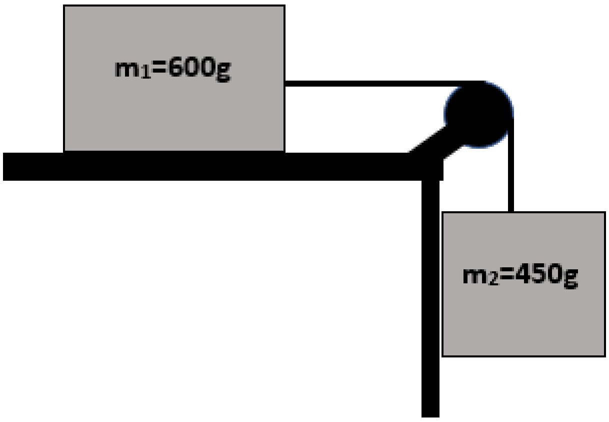
Let Us Practice

Let us do the following activity to check our understanding of the concept.

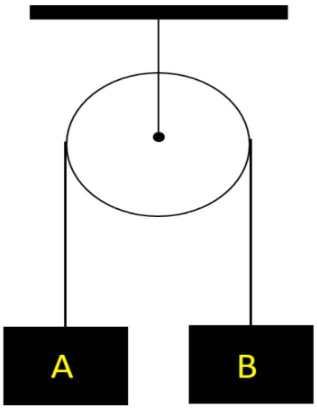
Activity 3.1

Direction: Solve the following problems and show your solutions.

1. As shown, two masses**,** m_1=600.00g and m_2 450.00g, are connected. What is the acceleration of the system of blocks and tension if the friction coefficient between m_1 and the table is 0.4, neglecting the cord's mass that connects both masses and assuming a frictionless pulley?



2. Mass of object A = 15 kg, acceleration due to gravity (g) = 9.8 m/s^2
   Object A moves downward at 3 m/s^2. What is the mass of B?



3. A highway curve has a banking angle of 6 degrees. What is the curve radius such that there will be no lateral pressure between the tires and the roadway at a speed of 30 mph?

Let Us Remember

After going through the activities in the previous parts of this module, you should have learned the following key take away points:

1.	Force is a quantitive measure of the interaction between two bodies.
2.	Newton's first law states that when the vector sum of all forces acting on a body (the net force) is zero, the body is in equilibrium and has zero acceleration.
3.	Its mass characterizes the inertial properties of a body.
4.	The acceleration of a body under the action of a given set of forces is directly proportional to the forces' vector sum (the net forces) and inversely proportional to the body's mass.
5.	The weight of a body is the gravitational force exerted on it by the Earth.
6.	Newton's third law states that when two bodies interact, they exert forces on each other that at each instant are equal in magnitude and opposite in direction.
7.	Contact force acts between two objects that physically touch each other, while a noncontact force acts on an object at a distance without contacting it physically.
8.	Examples of contact forces are frictional force, tension force, normal force, air resistance force, applied force, and spring force.
9.	Examples of noncontact forces are electrical force, magnetic force, and gravitational force.
10.	Frictional forces are classified as static friction and kinetic friction.

Let Us Assess

Now, let us find out how much you have learned from the discussions and activities presented in this module. Fifteen questions would help you express your understanding of concepts. Choose the letter of your choice. Use a separate sheet for your answers.

Direction: Read each question carefully and choose the best answer.

1. Combination of all the forces acting on an object
   A. Friction C. Law of Inertia
   B. Net Force D. Mass
2. The force that opposes the motion of any object
   A. Friction C. Law of Inertia
   B. Net Force D. Mass

3. An object's motion will not change unless an unbalanced force acts on it
   A. Friction
   B. Net Force
   C. Law of Inertia
   D. Mass
4. A block weighs 500kN resting on a ramp inclined with the horizontal at 25 degrees. What is the force that tends to move the ramp down the block?
   A. 121kN
   B. 265kN
   C. 211Kn
   D. 450kN
5. Type of force needed to overcome the inertia of an object
   A. Mass
   B. Net Force
   C. Inertia
   D. Unbalanced Force
6. The force that is directly proportional to a normal force
   A. Frictional force
   B. Weight
   C. Applied force
   D. Tension force
7. What refers to the force between two stationary surfaces in contact that prevents motion between them?
   A. Kinetic friction
   B. Sliding friction
   C. Starting friction
   D. Static friction
8. Doubling the net force acting on an object
   A. Doubles its acceleration
   B. Decreases its acceleration
   C. Cuts its acceleration in half
   D. Acceleration is not affected
9. If you push a 20 kg mass with a force of 40 N, what will be the object's acceleration?
   A. 40 m/s^2
   B. 20 m/s^2
   C. 5 m/s^2
   D. 2 m/s^2
10. What is the maximum value of static friction?
    A. Starting friction
    B. Sliding friction
    C. Kinetic friction
    D. Dynamic friction
11. For the same material in contact, what is true between the coefficient of static friction and kinetic friction?
    A. $\mu_S > \mu_k$
    B. $\mu_S = \mu_k$
    C. $\mu_S < \mu_k$
    D. $\mu_S \leq \mu_k$
12. One newton is equivalent to
    A. Kg·m/s
    B. Kg·m/s^2
    C. m/s^2
    D. Kg·m/s
13. What is the standard acceleration due to gravitational force in ft/s^2?
    A. 32 ft/s^2
    B. 980 ft/s^2
    C. 100 ft/s^2
    D. 98 ft/s^2
14. It shows the forces acting on an isolated object
    A. Force diagram
    B. Schematic diagram
    C. Free body diagram
    D. Force polygon
15. The following forces are examples of contact forces except __________.
    A. Frictional force
    B. Normal force
    C. Gravitational force
    D. Tension

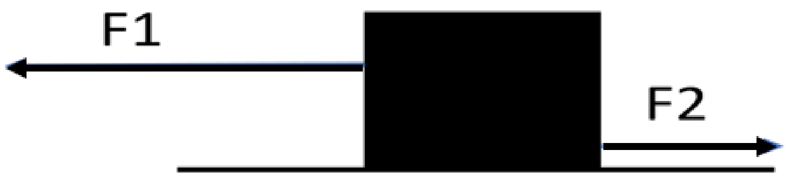
Let Us Enhance

Let us apply what you have learned into real-life situations for you to appreciate Newton's Laws of Motion.

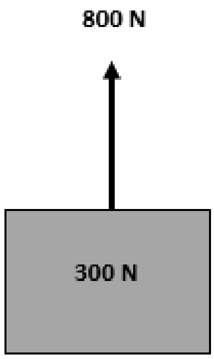
Direction: Solve the following problems and show your solutions.

1. An object rests on a floor. The coefficient static friction is 0.5 , and the acceleration of gravity is 9.8 m/s^2. Determine the maximum force of static friction.

2. Object's mass = 6 kg, F1 = 15 Newton, F2 = 9 Newton. The magnitude of the acceleration is.



3. A person's weight inside an elevator at rest is 300 N. Acceleration due to gravity is 9.8 m/s^2. The tension force was 800 N when lift accelerated. What is the acceleration of the lift?



Let Us Reflect

After going through all the activities, reflect on the key concepts discussed in this module by completing the following sentence starters. Use another sheet for your answers.

The 3 things I learned are:

-
-
-

Answer Key

Let Us Try!

1. A
2. B
3. C
4. D
5. C

Activity 2.2

1. $a = 3\ m/s^2$
2. $\sum F = 3\ N$
3. $F_f = 50\ N$

Activity 3.1

1. $a = 1.96\ m/s^2$, $T = 3.528\ N$
2. $m_B = 8\ kg$
3. $r = 174.39\ m$

Let us Assess

1. B
2. A
3. C
4. C
5. D
6. A
7. D
8. A
9. D
10. A
11. A
12. B
13. A
14. C
15. C

Let us Enhance

1. $Fs = 5\ N$
2. $a = 1\ m/s^2$
3. $a = 16.33\ m/s^2$

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