Chapter 3 Forces and Newton’s Laws of Motion

Learning outcomes

1) familiar with forces and categories of forces
2) understand the relationships between force and motion
3) familiar with Newton’s laws of motion and their applications.

Essential Vocabulary (5 – 10 essential vocabulary) (highlighted or bolded)

3.1 What is force? How are a force and motion related?

A brief history of understanding Force

Force is one of the basic concepts in mechanics and is the external reason that causes objects to gain acceleration or deformation. In dynamics it is equal to the mass of an object times its acceleration.

A brief history of the concept of force was starting with the fact that one can intuitively realize the vague concept of "force" when pushing and pulling objects. The movement of pushed and pulled objects would be gradually slowing down and finally come to a stop due to friction as they slide on a non-perfect smooth surface. The ancient time, the concept of force was summarized as "force is the source of motion." That is to say, force is what makes objects move. Therefore, the concept of force reflects the human consciousness to understand what so naturally happens when there is a force. However, people have experienced a long struggle from intuitively realizing the concept of "force" to obtaining a strict scientific definition of "force".

In the West, before the concept of force proposed in physical science, the debate over force occurred in philosophy. Thales and others of the ancient Greek cosmology school believed that nature is alive, and like the human body, is a living tissue that moves on its own. With this kind of philosophical thought, there would be no proposition about the origin of motion, and there would be no concept of "force". Later, Parmenides proposed that motion does not exist from logical reasoning. His opponents proposed that the source of motion is "force" which allows for the existence of motion. The original view that “force is the cause and movement is the effect" was recognized.

Plato's concept of force was essentially immaterial, and he believed that the nature of motion was entirely because of an immortal living spirit. The final source of all forces in nature is the hidden soul of the world, which is the source of all physical activities. Of course, this metaphysical point of view can hardly be convincing when explaining the motion caused by gravity.

In the writings of Aristotle, force was seen as radiating from one body to another. The emitted force per se is not a substance, but a "form" that depends on the substance for its existence. According to this concept of force, its action is limited to objects in contact with each other; they can only influence each other by pushing or pulling. The Aristotelian's concept of force completely negates the existence of forces that do not come into contact with each other but act on each other at a distance like gravity, magnetic force or electric force. Under such circumstances, we can only assume that the planets drive themselves to move; the stars themselves are also alive. But Aristotle first proposed the so-called "law of motion", which believed that the speed of a moving object is proportional to the resistance it encounters when passing through the medium. However, he did not propose the units of measurement for the quantities, nor the methods for measuring these quantities. Aristotle believed that the weight of an object represents "natural motion", that is, it represents the tendency of the object to return to its natural position, rather than the reason why the object is forced to move. This understanding contradicts the possibility of using weight as a unit of measure of force.

Galileo made important contributions to the establishment of classical mechanics, but he did not form a complete concept of force. His definition of mass is vague, so he cannot give a clear definition of force that applies to both statics and dynamics. Of course, he had a basic understanding of the principle of inertia. His principle of inertia pointed out that an object can continue to move at a constant speed without being acted upon by external forces. He connected changes in force and speed, which was a breakthrough from Aristotle 's long-term ideological shackles of linking force with speed.

Newton blazed the trail by linking force with acceleration. The concept of force predominates in Newtonian mechanics. Newton proposed in 1664 that the definition of force is the time rate of change of momentum (momentum is equal to mass times velocity). Newton's first law (law of inertia) is the qualitative definition of force. It gives the qualitative circumstances, some of which force exists and some of which force does not exist. Newton's second law gives a quantitative definition of force, that is, force is equal to the time rate of change of momentum; if the mass does not change, force is also equal to mass times acceleration. Newton's third law states that for every force, there must be an equal and opposite reaction force. It states that all forces are pairs and only occur when two objects interact (see Newton's Laws of Motion)

Force is the interaction between objects (matter) and objects (matter). The magnitude, direction and point of action of force are the three elements of force. According to the nature of the force, it can be divided into: gravity, universal gravitation, elastic force, friction force, molecular force, electromagnetic force, nuclear force, etc. (Note that gravity is not equal to gravity under all conditions). (Gravity does not point to the center of the earth under all conditions. Gravity is one component of the earth's gravitational force on objects. The other component is the centripetal force. Only on the equator does the direction of gravity point to the center of the earth.)

According to the effect, force can be classified into: pulling force, tension, pressure, support force, power, resistance, centripetal force, restoring force, etc. According to the research object, it can be categorized into: external force and internal force. According to the mode of action of force, it can be divided into: non-contact force (such as gravity, electromagnetic force, etc.) and contact force (such as elastic force, friction force, etc.). Overall, there are four basic interactions (forces): gravitational interaction, electromagnetic interaction, strong interaction, and weak interaction.

Definition of Force

A force is a pull or push which could change a motion state of an object. When considering forces acting upon one object, most times we are talking about unbalanced forces. If there are two forces acting upon one object, they have the same size but in opposite directions. As they cancel each other out, the result is no net force acting on the object. Therefore, when we talk about the force on an object, it must be the net force or overall force on it. For instance, if there is a 30 Newtons to right, and 10 Newton to left, the net force would be 20 newtons to right. If there are two forces acting upon one object, which are the same in magnitude and opposite in direction, there is no net force on the object because they cancel each other out as shown in Figure 3.2, in which an object is at rest and sits on a table. The table supports the object upward, and the gravity pulls the object downward. They are equal in size and opposite in direction, therefore there is no net force acting upon the object, which is at rest on the table.

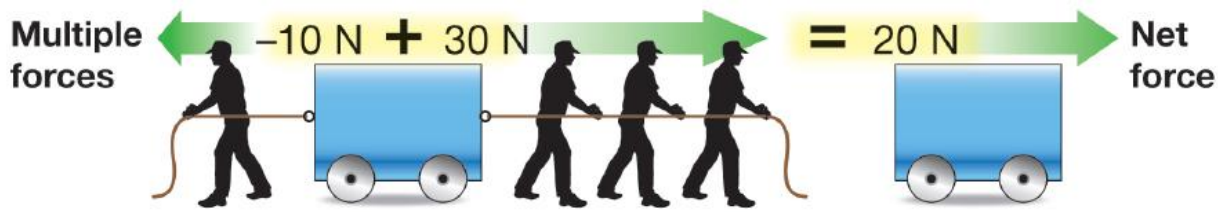

Figure 3.1 a net force is a result of multiple forces. Adapted from McGraw Hill Publishing company.

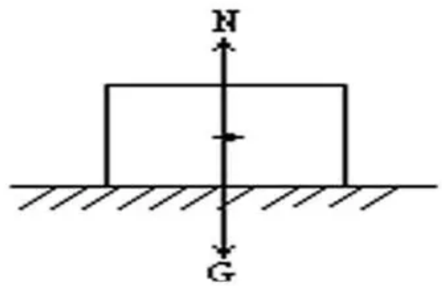

Figure 3.2 an object at rest on the table with a supporting force and gravity which cancel each other out.

When an object is acted upon by several forces, if it remains stationary or moves in a straight line at a constant speed, we say that the object is in equilibrium, for instance like books on table, or the lights hanging on the ceiling, objects being transported at a constant speed on the conveyor belt, and cars are moving at a constant speed along a straight road, all of them are called to be in equilibrium.

The common question is to ask: is a force the reason for a motion? For a long time, people have often intuitively believed that force is the cause of object motion. For instance, to make an object move, you must push or pull it. According to such experience, Aristotle concluded: a force must act on an object, and the object can move; without the action of force, the object will stay still somewhere. The clues led to a case of wrong judgment, and this "wrong case" lasted for a long time. It was not until nearly four hundred years ago that Galileo Galilei created an effective method of "reconnaissance", and discovered the correct clues, revealed the essence of things and phenomena. Galileo believed objects move under normal circumstances, friction is unavoidable. Galileo noticed that when a ball rolled down an inclined surface, its speed increased; as the ball rolled upward, the speed decreased. He guessed that when the ball moves along a flat surface, its speed should not increase or decrease. However, the actual situation is that even if it rolls along a horizontal plane, the ball would roll slower and slower, and finally stop. Galileo believed this was the result of friction. Without friction, the ball would always keep moving. As shown in Figure 3.2, imagine we have two moving balls, one on a perfectly smooth surface, the other one on a bumpy surface, which ball could move a longer distance? It must be the ball moving on the smooth surface because of Zero or a lack of friction or resistance. This tells us that there is no force needed to keep a motion. Instead, the force exists which stops a motion.

Figure 3.2 a motion on a smooth surface(a) and a motion on a bumpy surface(b)

3.2 The First Law of Motion

Newton’s first law of motion states:

In the absence of external force, one object will retain its original motion states of being stationary or a uniform motion along a straight line unless unbalanced forces acting upon it.

In other words, any object must maintain uniform linear motion or rest until an external force forces it to change its state of motion.

Newton's first law reveals the relationship between motion and force: force is not the cause to sustain object ‘s motion, but the cause of changing the object's motion state. This law can be regarded as the definition of object motion. Newton's first law of motion states that all changes in the velocity of an object in motion, whether in direction or speed, must be caused by external forces. When an object slides on the ground, friction slows it down. But on the air hockey table, the air ejected from the table can make the ball hang in the air, and it can basically maintain its original speed in an environment without friction until external forces affect it, for example, with the boundary.

It is also called the law of inertia as inertia is the tendency of an object to resist any changes in its motion. Without an external force, one object retains its original motion state either at rest or keeping on a uniform motion.

The inertia of an object is proportional to its mass. When we change the state of motion of an object, we will experience the inertia of the object. For example, if two rocks with different masses are thrown in the same way, in order to get the same speed, the different forces must be required. The more massive one requires more force than the smaller one. Another example is that it would be easier to stop a ball than to stop a moving car. All of the examples illustrate that objects with different masses have different inertia. In other words, the "ability" of different objects to maintain their original state of motion is different. The physical quantity that describes the inertia of an object is called mass. The more massive an object is, the harder to change its motion. Inertia is not imposed on it by the outside world. It is inherent in the objects. All objects have inertia.

Newton's first law tells us that an object at rest will always remain at rest, and an object moving at a uniform speed in a straight line will always move at a constant speed in a straight line, unless the object is acted upon by a force (resultant force). It can also be stated this way: an object with a constant speed will continue to move at this constant speed until a net force acts on the object. This statement includes the case of rest, which can be seen as: the speed is constant zero. Therefore, the content of Newton's first law is: Any object must maintain uniform linear motion or rest until an external force forces it to change this state of motion.

Newton's first law laid a solid foundation for the development of classical mechanics.

3.3 **Newton’s Second Law of Motion**

This law states that a force is the reason to a change in motion state. It means the force causes an acceleration of an object, indicating by the change of a motion state such as, a moving object comes to a stop or an object at rest starts to move. For a motion state of at rest or keeping on uniformly moving, there is no acceleration involved which does not require an unbalanced force.

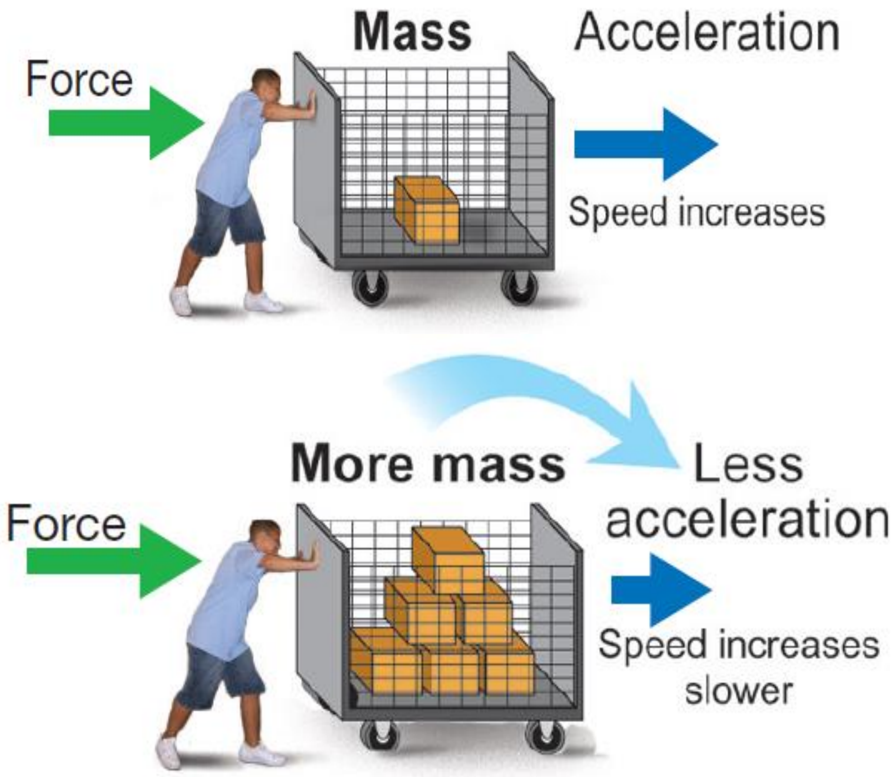

Figure 3.2 diagrams for Newton's second law, Adapted from McGraw Hill publishing company.

Newton's second law states that the acceleration is proportional to the force applied and inversely proportional to the mass of the involved object.

Mathematically,

$$F = m * a.$$

In which F is the resultant force on an object; m is the mass of it while a is the acceleration of it.

In order to commemorate Newton, the unit of force is called "Newton" and is represented by the symbol N. 1 Newton force is defined as the amount force needed to accelerate an object with a mass of 1 kg to obtain 1.0 $\frac{m}{s^2}$ acceleration, then we will get

$$1N = 1\, kg * \frac{m}{s^2}$$

Newton's second law determines the relationship between motion and force, allowing us to relate the movement of an object to the force it receives. Therefore, it has wide applications in basic science and engineering technology to analyze the relationships between motion and forces. For example, if the force on the object is known, the acceleration of an object can be calculated from Newton's second law. Or if the motion of an object is known, combined with the acceleration, the force scenarios can be analyzed by calculating the force according to Newton's second law.

Example: if there is a force of 30 N acting upon an object with a mass of 10 kg, what is its acceleration?

According to Newton's second law:

$$F = m * a.$$

Given m=10kg and F=30N,

Therefore, $30 = 10*a$

So, $a=\frac{30}{10}=\boxed{3.0\ \frac{m}{s^2}}$

Example: a 60 kg bicycle and a rider accelerate at 0.5 m/s^2, how much the force was applied?

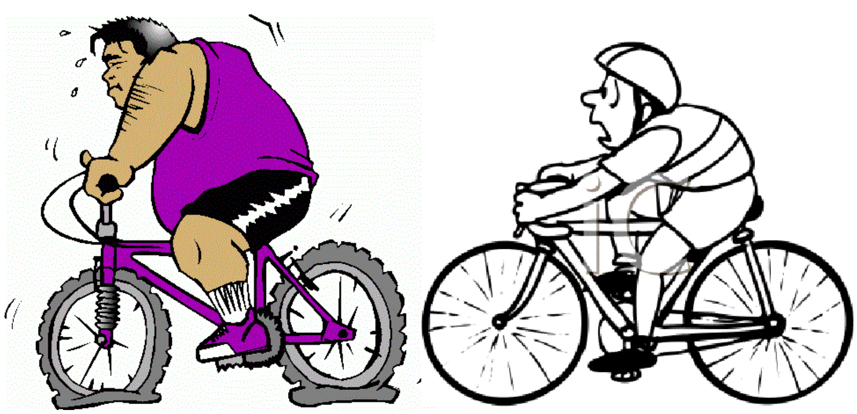

Figure 3.3 Application of Newton's second law. Adapted from McGraw Hill publishing company

Solutions:

According to Newton's second law:

$$F = m * a.$$

Given m=60 kg, and a=0.5 m/s^2,

Plugging all given variables into the equation

We have $$F = 60 * 0.5 = \boxed{30\ N}$$

Mass and Weight

In everyday conversation, mass and weight are often used interchangeably. For example, our medical records often show our weight in kilograms, but never in the correct Newton units. However, in physics, there is an important distinction. Weight is the pull of the earth on an object. It depends on the distance from the center of the earth. Unlike weight, mass does not vary based on location. The mass of an object is the same on Earth, in orbit, or on the surface of the Moon.

What is the definition of mass? In our daily life, we do not differentiate the mass and weight of an object and we consider they are the same. However, in physics, they are totally different concepts. The mass means how much matter one object contains while the weight is the pull of gravity of one object. Usually, kilograms, grams or milligrams are adopted units for mass while the unit of gravity is Newton, a unit of force in the SI system, because the weight is one of forces. It represents the attraction that is exerted by the Earth. According to the Newton's second law,

$$W = m * g,$$

in which m is the mass of an object, and g is the gravitational acceleration of $9.81\frac{m}{s^2}$ on the surface of the Earth, averagely. Also, the weight is a force, suggesting it has a direction. Regardless where you stand on the surface of the Earth, the direction of gravity is always downward pointing to the center of the Earth.

When an object falls, it accelerates toward the center of the Earth. Newton's second law says that the net force on an object is responsible for its acceleration. If air resistance is negligible, the net force on a falling object is gravity, often called its weight $\vec{w}$, or the force of gravity acting on an object of mass m. Weight can be represented as a vector because it has a direction; by definition, downward is the direction of gravity, so weight is a downward force. The magnitude of the weight is expressed as w. Galileo was helpful in showing that in the absence of air resistance, all objects fall with the same acceleration g. Using Galileo's results and Newton's second law, we can derive the equation for weight. When the net external force on an object is its weight, we say it is in free fall, that is, the only force acting on the object is gravity. However, when objects on Earth fall downward, they are never truly in free fall because there is always some upward resistance from the air acting on the object.

The acceleration due to gravity g varies slightly across the Earth's surface, so the weight of an object depends on its position and is not an intrinsic property of the object. If we leave the Earth's surface, the weight changes significantly. For example, on the moon, the acceleration due to gravity is only 1.67 m/s ^2 . Therefore, a mass of 1.0 kg weighs 9.8 N on Earth and only 1.7 N on the Moon.

In this sense, the broadest definition of weight is that an object's weight is the gravitational force exerted on it by the nearest large object, such as the Earth, Moon, or Sun. This is the most common and useful definition of weight in physics. However, it differs significantly from the definition of weight used by NASA and the popular media in relation to space travel and exploration. When they talk about "weightlessness" and "microgravity," they are referring to what we in physics call "free fall." We use the previous definition of weight as the force of gravity acting on an object of mass m and carefully distinguish between free fall and actual weightlessness.

Note that weight and mass are different physical quantities, although they are closely related. Mass is an inherent property of an object: it is the quantity of matter. The quantity or quantity of an object is determined by the number of various types of atoms and molecules it contains. Because these numbers don't change, in Newtonian physics, the mass doesn't change; therefore, its response to an applied force doesn't change. In contrast, weight is the gravitational force acting on an object, so it does change depending on gravity. For example, someone at a lower altitude closer to the center of the Earth (such as New Orleans) would weigh slightly more than someone at a higher altitude in Denver, even though their mass might be the same. It's tempting to equate mass with weight because most of our examples take place on Earth, where the weight of an object changes very little with the object's location. Additionally, it is difficult to count and identify all the atoms and molecules in an object, so mass is rarely determined in this way. If we consider the case of a constant on Earth, we find that the weight $\vec{w}$

Proportional to mass m, because $\vec{w} = m\vec{g}$

For, that is, the larger the object, the greater its weight. $\vec{g}$ Operationally, the mass of an object is determined by comparison to the standard kilogram, as we discussed in Units and Measurement. However, by comparing an object on Earth to an object on the Moon, we can easily see a change in weight, but not a change in mass. For example, on Earth, a 5.0-kg object weighs 49 N; on the Moon, g is 1.67 m/s 2 and the object weighs 8.4 N. However, the mass of the object on the Moon is still 5.0 kg.

Example: what is the weight of a 60.0 Kg person on the surface of the Earth?

According to the equation:

$$W = m * g,$$

Given m=60.0kg, and g=9.81$\frac{m}{s^2}$, and plug them into the equation,

Then: $w = 60kg * 9.81\frac{m}{s^2} = \boxed{588.6\ N}$

From this example, we can see the difference between mass and weight.

3.4 **Newton's third Law of Motion**

Force is the action of an object on another object. As long as we talk about force, there must be two objects with one -receiving force and the other exerting force. For instance, when the springs are pulled by hands, the springs are subjected to the pulling force F of the hands, and at the same time, the hands are also subjected to the tension F' of the springs as shown in Figure 3.4. Another example is that when sitting on a wheeled chair, if we push the table hard, we will feel that the table is also pushing against us and then chair gets moving. We often say that objects on the ground and near the earth are attracted by the earth (heavy force). In fact, the earth is also attracted by them, and the relationship between the earth and objects is mutual.

Figure 3.4 the springs are pulled by hands while hands are subjected to forces as well. Adapted from McCraw Hill Publishing company.

Observations and experiments show that the interaction between two objects is always mutual. When one object exerts a force on another object, the latter object, at the same time, applies a force on the former object. This pairs of opposing forces are usually called acting(action) force and reacting(reaction) force. Action and reaction forces always depend on each other and exist simultaneously. When we call any of the forces the action force, the other force is called the reaction force as indicated in Figure 3.5.

Newton's third law of motion describes that "**Whenever two objects interact, the force exerted on one object is equal in size and opposite in direction to the force exerted on the other object**."

Mathematically: $F_{\text{A due to B}} = -F_{\text{B due to A}}$.

$F_{\text{A due to B}}$ is the force exerted by object B on object A; while $F_{\text{B due to A}}$ is the force exerted by object A on object B.

Figure 3.5 Action and reaction forces, Adapted from McCraw hill publishing company

In order to get moving, the skate roller pushes the wall, applying the pushing force on the wall. At the same time, the wall applies the anti-pushing force on the roller and then she could get moving.

Many examples of Newton's third law are in our daily life. For instance, when a person rows a boat, the oar pushes water backward, and the water pushes the oar to move forward. Similarly, the propeller of a ship rotates in the direction of backward by pushing water backwards, the water also gives a reaction force to the propeller, pushing the ship forward. The car's engine drives the wheels to rotate due to the friction between the tires and the ground. The wheels push the ground backward, and the ground gives the wheels a forward reaction force, causing the wheels to move forward. This is how the driving force on the car is generated.

For any interactions, if one force is called an action force, the other one is called reaction force. The action and reaction force are the same in size and opposite in direction. For instance, the giant truck runs into a small car, even the small car gets totally damaged during the collision. The force exerted by the car on the truck is still equal to the force applied by the truck on the car. The only difference is their masses, which allow them to react differently to the same impact. The more massive truck could stand more impact barely being dented, while the light car could be totally deformed because it would not stand too much impact(force).

Action force and reaction force are the same in size and opposite in direction, can they cancel each other out like what we learned before, if there are two forces acting **on one object**, they would cancel each other out when they are the same in magnitude and opposite in direction. It is noteworthy that a pair of action and reaction forces are also "equal in magnitude and opposite in direction, acting on the same straight line." But the difference is that they act upon **two objects.** Therefore, action force and reaction force could not cancel each other out.

3.5 **Newton's Law of Universal Gravitation**

One of the most brilliant achievements in natural science is Newton's discovery of the law of universal gravitation. There was an interesting story about his discovery. During the holidays Newton often came to his mother's house and sat in the garden. Once, as happened many times in the past, an apple fell from the tree. The accidental falling of an apple was a turning point in the history of human science. It inspired the man who was sitting in the garden and caused him to ponder: why all objects are affected by the force that always points towards the center of the earth? What about attraction? Newton thought. Finally, he discovered gravity, which was an epoch to mankind. He believed that the sun attracts planets and planets attract planets. The forces that attract all objects on the ground are with the same nature. He also used calculus to prove that the force of the sun on the planets in Kepler's law is an attraction, proving that how (1) planets move in elliptical orbits with the Sun as a focus, (2) a planet covers the same area of space in the same amount of time no matter where it is in its orbit, and (3) a planet's orbital period is proportional to the size of its orbit (its semi-major axis). The centripetal force is directly proportional to the product of masses, and the centripetal force is inversely proportional to the square of the radius.

Through a large number of experiments, Newton proved that there is an attraction between any two objects, and summarized the law of universal gravitation.

Newton's law of Universal Gravitation states that **for any pairs of massed objects, an attractive force between all masses exists which is proportional to product of the masses; and It is inversely proportional to the separation distance squared.**

Mathematically,

$$F = G * \frac{m_1 m_2}{d^2}$$

in which G= $6.67 * 10^{-11} \frac{N*m^2}{kg^2}$ is a universal constant; m_1 and m_2 are the masses of two objects and d is the distance between two objects.

Newton is the natural founder of classical mechanical theory. He systematically summarized the work of Galileo, Kepler, Huygens and others, and obtained the famous law of universal gravitation and Newton's three laws of motion. The law of universal gravitation unifies the laws of motion of objects on the ground with the laws of motion of celestial bodies which impacts profoundly on the development of physics and astronomy.

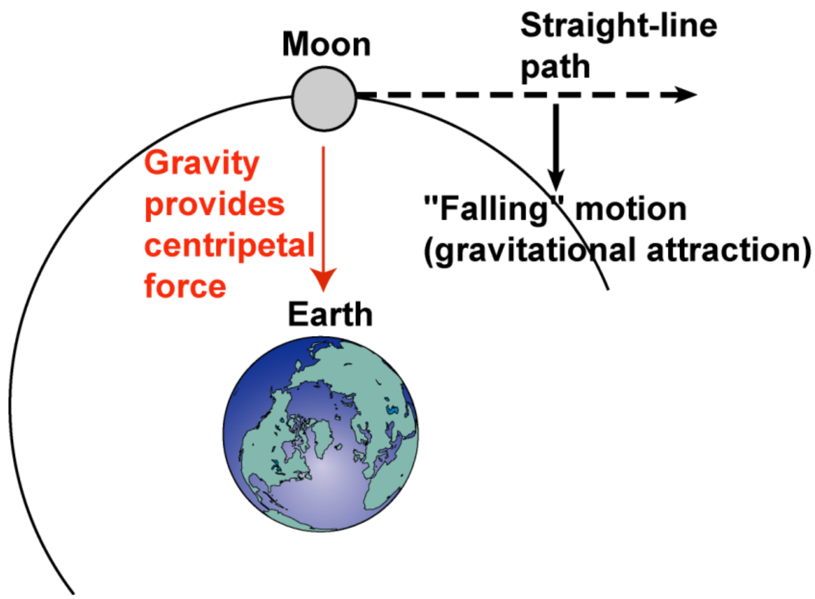

Figure 3.6 Gravitational force between the Earth and the Moon, adapted from McCraw Hill publishing company.

This gravitational force exists anywhere in the universe between two objects. For example, it is also the reason the moon and earth are attracted to each other or why the planets stay in orbits in the solar system.

Example: What is the force of gravitational attraction between two 60.0kg students who are standing 1.00m apart?

According to the equation, we have $m_1 = 60.0kg, and\ m_2 = 60.0kg\ and\ d = 1.0meter$

Plugging them into the equation, $F = 6.67 * 10^{-11} * \frac{60*60}{1.0^2} = \boxed{2.401 * 10^{-7} N}$

The force is too small to be detected between two students!

Example: The surface of the Earth is approximately 6398km from its center. If the mass of the Earth is 6.0*10^24 kg, what is the acceleration due to gravity near the surface of the Earth?

We can assume all mass of Earth concentrate on its center, and then the distance between the object and the Earth is the radius 6400km=6.4*$10^7 m$

On the surface on the Earth, $w = m_1 * g = G\frac{m_1 * m_2}{d^2}$

Then we will have: $g = G * \frac{m_2}{d^2} = 6.67 * 10^{-11} * \frac{6.0*10^{24}}{(6.389*10^7)^2} = 0.980 * 10 = \boxed{9.80 \frac{m}{s^2}}$

Circular Motion: **Newton's Law of Gravity and Artificial Satellites**

The motion that one object is running along a circular path is call a circular motion. It is an accelerated motion as the centripetal force is required to keep the object moving along a circular path. In mathematical terms,

$$F = m\frac{v^2}{r}$$

in which m is the mass of the object, V is moving speed and R is the radius. Then according to Newton's second law, the circular acceleration

$$a = \frac{v^2}{r}$$

By making use of the gravity of Earth, a satellite or artificial satellite could be placed into orbit in outer space. In particular, a geosynchronous orbit (sometimes abbreviated GSO) allows the orbiting object (for example, an artificial satellite or a moon) to take the same amount of time to complete an orbit, which is (an Earth-centered orbit with an orbital period that matches Earth's rotation on its axis, 23 hours, 56 minutes, and 4 seconds (one sidereal day).

Summary

Understanding newton's laws of motions is essential to understanding the correlation between forces and various motions. Also based upon the force scenarios, the motion states could be predicted. Vice versa, the motion states could help analyzing the force scenarios.

Exercises

1. A force of 60N acts on a 30-kg waiter. What is waiter' acceleration?

a. 0.5 m/s^2

c. 5 m/s^2

b. 2.2 m/s^2

d. 12 m/s^2

2. The force is the reason of a motion

a. sometimes

c. always

b. never

d. no clue

3. if the radius of the circle in which an object is moving at constant speed is doubled. The required centripetal force is

a.one-quarter as great as before

b.one-half as great as before

c. Twice as great as before

d.4 times as great as before

4. a massive truck runs into a car, and the car is totally damaged. It means the truck applied more forces on the car than the force applied by the car on the truck.

a. true

b. false

5. A 200-kg car with a speed of 0.6 m/s, moves around a circle with a radius of 30 m. The centripetal force on the car is

a. 4.8 N

b.14.7 N

c. 2.40 N

d.14.40 N

6. If the earth were 3 times as closer from the sun as it is now, the gravitational force exerted on it by the sun would be

a. 3 times as large as it is now

b. 9 times as large as now

c. one-third as large as it is now

d. one-ninth as large as it is now

7. A woman with a mass of 60 kg on the earth's surface, what is her mass on the moon?

a. 15 kg

b. 30 kg

c. 60 kg

d. 120 kg

8. The weight of an object depends on its surroundings, while the mass of an object does not depend on its surroundings.

a. true

b. False

9. A box weighs 50 N. Its mass is

a. 5.1 kg

b. 1.36 kg

c. 6.6 kg

d. 29.4 kg

10. Since the pair of action and reaction forces are the same in magnitude and opposite in direction, they cancel each other out.

a) true

b) false.

Problems:

1. A car with a mass of 3000kg reaches speed from 0 in 10 s100 km/h, what is its acceleration? what was the driving force?
2. A box of 15 kg moves with a 5.0 m/s^2, what is the pushing force?
3. A box of 30 kg on the table, what is its weight?
4. The speed of a train also changes from 0 in 300 s to reach 100 km/h, what is the acceleration? If the train has a mass of 3.0*10*6 Kg, what is force required?
5. A car moves at 0.6 m/s^2 with a mass of 1000kg, what is driving force required?
6. A car of a mass 1200kg is in a decelerated motion when braking with an acceleration is 6 m/s^2, what is the braking force?
7. A student with a mass of 50kg jumps with an acceleration of 6 m/S^2, what is the force required on the student from the air?
8. A bike and a rider with a total mass of 80 kg, moves from rest to 3.0m/s in 30 seconds, what is the acceleration and what is force to required?
9. What is the force which could accelerate a bike of mass 50 kg with a 15m/s^2 ?
10. A box with a weight of 500 N on the surface of Earth, what is its mass?

References:

1.https://byjus.com/physics/motion-in-physics/#:~:text=In%20physics%2C%20motion%20is%20the,Displacement

2. https://www.toppr.com/guides/physics/laws-of-motion/motion-in-physics/#:~:text=Motion%20in%20physics%2C%20is%20a,of%20a%20body%20is%20rotation.

3. https://www.mheducation.com/

4. https://www.physicsclassroom.com/class/circles/Lesson-1/Mathematics-of-Circular-Motion

5. https://www.khanacademy.org/science/physics/centripetal-force-and-gravitation/centripetal-forces/a/what-is-centripetal-force#:~:text=A%20centripetal%20force%20is%20a,a%20%3D%20v%202%20r%20%E2%80%8D%20.