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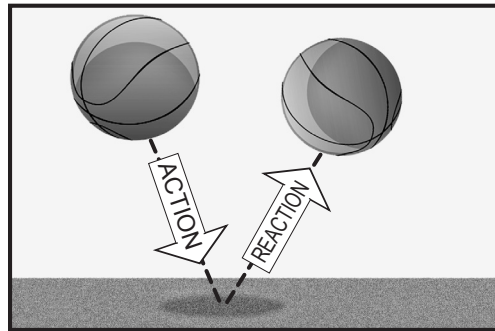
7. Force and Motion

A ¹You may associate Sir Isaac Newton with an apple falling from a tree. ²His book, *Principia*, published in 1686, was about much more. ³In this book he combined his ideas on the motion of objects with the ideas of many other scientists. ⁴A **force** is a push or a pull that has size and direction. ⁵The force of wind can push a piece of paper. ⁶Force can be applied by your arms to pull a rope. ⁷**Friction** is the force that resists the movement of one surface past another. ⁸**Kinetic friction**, sometimes referred to as “sliding friction,” opposes the motion of a moving body. ⁹Sledding or skiing down a snowy hill is an example of kinetic friction. ¹⁰**Static friction** opposes movement from a resting position, so there is no movement.

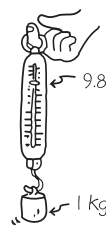
B ¹¹**Newton’s first law of motion** is also known as the law of inertia. ¹²The law of **inertia** states that unless a force is applied, an object in motion continues to move with a constant **velocity** (speed and direction), while a motionless object remains still. ¹³A soccer ball that is sitting still will remain that way until a force of some type moves it, such as your foot kicking it. ¹⁴The ball will continue to move until it encounters a force that changes its velocity, such as the friction against the ground or the force of hitting the soccer net. ¹⁵Inertia is the reason you need to wear your seatbelt while riding in a car. ¹⁶The force of a car’s brakes being applied changes its velocity. ¹⁷When the car brakes quickly, your body’s inertia continues to move at the speed the car had been traveling before braking, causing you to feel like you are thrown forward.

C ¹⁸**Newton’s second law of motion** explains that force causes an object to accelerate. ¹⁹**Acceleration** is a change in the motion of an object. ²⁰Acceleration of an object is related to the object’s mass (amount of matter) and to the amount of force applied to the object. ²¹Objects with a greater mass have less acceleration, and objects given a greater force have greater acceleration. ²²If a box of books is too heavy for you to move, you could reduce the mass by removing some of the books or increase the force by asking for someone else to help you move the box.

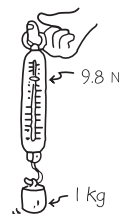
D ²³**Newton’s third law of motion** explains action and reaction. ²⁴When force is applied to an object, the object exerts an equal force in the opposite direction. ²⁵The reaction of a basketball against the ground is one way to understand this force. ²⁶The basketball exerts force on the ground, and the ground exerts force on the ball.



E ²⁷Isaac Newton also explained laws of momentum. ²⁸**Momentum** is the quantity that measures both the mass of an object and how fast the object is moving. ²⁹A large truck has more momentum than a small car that is moving at the same speed because the truck has more mass. ³⁰However, the car can have more momentum than the truck if the car is moving at a great enough speed.



F ³¹**Gravitational force** is the force of attraction between any two objects in the universe. ³²Isaac Newton explained that the gravitational force is greater between objects with larger masses. ³³He also explained that this force increases as objects move closer to each other. ³⁴You can measure the gravitational force of the earth on an object by weighing it. ³⁵This is known as the object’s **weight**. ³⁶Force can be measured in metric units called **Newtons (N)**. ³⁷One Newton is the force needed to change the speed of a one-kilogram object by one meter per second each second. ³⁸It takes about the force of one Newton to lift a deck of cards. ³⁹A **spring scale** is used to measure force. ⁴⁰The measurement of weight would decrease at places where there is less gravity, such as on the moon. ⁴¹Study the diagram to see how a spring scale is used to measure the force of 1 kilogram.



Why do you think the unit of force is called a Newton?

1. For each statement, circle T for true and F for false. If the statement is false, replace the **bold word(s)** to make the statement true. Then write the number of the sentence(s) that best supports your answer.

- a. T F **Pushing** a door closed is an example of force. ____

- b. T F The fact that a cup of water you set down will remain in that place until you or another force moves it is an example of the law of **momentum**. ____

- c. T F Increased force will **increase** acceleration. ____

- d. T F Increased mass will **increase** acceleration. ____

2. What are the two factors that affect the gravitational force between two objects?

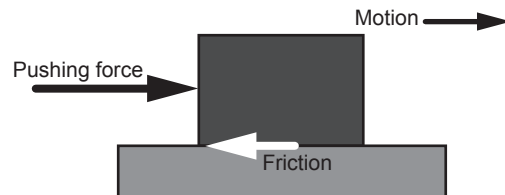
- a. distance and speed
- b. speed and direction
- c. mass and distance
- d. mass and direction

Write the numbers of the two sentences that best support your answer. ____ , ____

3. When a tennis ball is thrown against a wall, the ball bounces back to the person that threw it. This an example of:

- a. Newton's first law of motion.
- b. Newton's second law of motion.
- c. Newton's third law of motion.
- d. momentum.

Write the numbers of the two sentences that best support your answer. ____ , ____



4. Which type of friction is the diagram above showing?

Write the number of the sentence that best supports your answer. ____

5. A baseball will move at the same speed and in the same direction until a force is applied.

- a. List three examples of what this force could be:

- b. This is an example of which law?

6. Explain Newton's third law of motion using a moving car crashing into a large tree.

7. Will a larger bike always have more momentum than a smaller bike? Why or why not?

Write the numbers of the two sentences that best support your answer. ____ , ____

8. Review Newton’s three laws of motion as you fill in the blanks within this table.

Newton’s Laws of Motion	
Newton’s _____ law of motion	This law explains action and _____.
Newton’s _____ law of motion	This law explains that force causes objects to _____.
Newton’s _____ law of motion	This is the law of _____.

Written Response Questions

For the following two questions, apply all of the information you’ve learned when answering.

9. Newton’s laws of motion can be observed every day. Give an example of one of these laws that you’ve observed recently. Tell which law it is an example of and explain why.

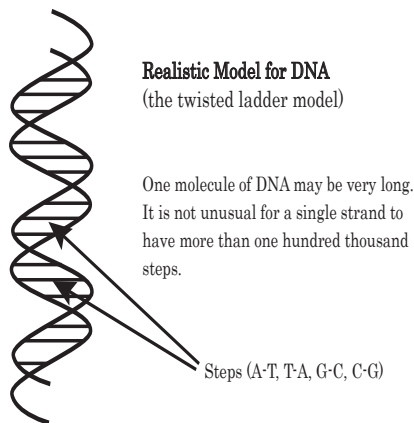
10. A young child is frustrated because he is unable to push or pull a wagon containing two other children. Write two suggestions that you would give this child that would help with the acceleration of the wagon.

21. DNA

A ¹Genes are made up of DNA (**Deoxyribonucleic Acid**), which contains the codes that tell each cell in the human body how to operate. ²DNA is attached to the chromosomes.

B ³A **chromosome** is a long strand in the nucleus, the control center for cells. ⁴Chromosomes act like blueprints for transferring information to the next generation of cells. ⁵This transfer takes place when the male cell joins with the female cell during reproduction. ⁶When these cells join, they create a single cell that has two sets of chromosomes. ⁷Humans have 2 complete sets of 23 chromosomes ($2 \times 23 = 46$), one set from each parent.

C ⁸How does DNA work? ⁹If you picture DNA as a twisted ladder, it's easier to understand.



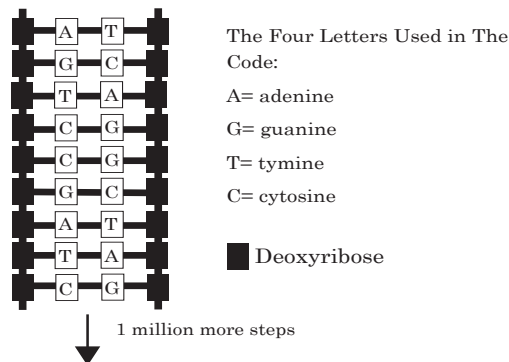
D ¹⁰The steps of the ladder are made of chemical compounds called bases that fit together. ¹¹Geneticists created the 4-letter alphabet of DNA (A, T, C, G) from the first letter of each base compound. ¹²Each step of the DNA staircase is made up of two base compounds: either A and T or G and C.

¹³For example, there might be an A – T, a G – C, a C – G, or a T – A. ¹⁴This order can make many different combinations.

¹⁵The order in which the base compounds (letters) appear on the DNA “stairs” is the code that tells the cell how to function. ¹⁶The letters (ATGCTCGAA...) create “words” (ATG CTC GAA...) which create “sentences” (<ATG CTC GAA TAA>...) that can be “read” on the genes.

E ¹⁷If you know the base arrangement on one side, it is easy to reproduce the other side. ¹⁸DNA duplicates itself by splitting down the middle to separate the bases. ¹⁹Bases floating in the cell then pair with the appropriate separated bases to form two new DNA strands. ²⁰The two resulting DNA molecules are the same as the original one.

Simplified Model of DNA



F ²¹The DNA in each cell of a particular organism is identical, but the DNA of every organism is different from that of every other organism. ²²The exception is **identical twins**, which are formed when one fertilized egg splits. ²³Identical twins are the only people (or animals) with identical DNA. ²⁴**Fraternal twins** do not have the same DNA because they are formed when two different eggs are fertilized.

²⁵This means that if you think you are unique and nobody else has quite the same oddities, abilities, and problems...you are right!

1. For each statement, circle T for true and F for false. If the statement is false, replace the **bold word(s)** to make the statement true. Then write the number of the sentence(s) that best supports your answer.
 - a. T F **DNA** contains the codes that tell each cell how to operate. ____

 - b. T F **Genes** contain the DNA that tell each cell in the human body how to operate. ____

 - c. T F Humans have one set of chromosomes from each of their parents, which gives them a total of **23** chromosomes. ____

 - d. T F Identical twins are the only people (or animals) with **different** DNA. ____

2. What is the most likely meaning of the word **reproduce** as it is used in paragraph E?
 - a. to recall or bring to mind again
 - b. to make a copy
 - c. to produce offspring
 - d. to repeat after memorization
3. Which of the following is not part of the chemical compounds that make up DNA?
 - a. A
 - b. T
 - c. G
 - d. N

Write the number of the sentence that best supports your answer. ____

4. Describe the structure of DNA.

Write the numbers of the sentences that best support your answer.

____, ____ ____

5. Refer to the diagrams and lesson to explain how DNA works.

6. Refer to paragraph B and explain the role of chromosomes in heredity.

Write the number of the sentence that best supports your answer. ____

Organisms with many cells are made up of body cells and sex cells. Skin cells, bone cells, tissues, and organs are composed of body cells. Roots and leaves of plants are also made of body cells. In fact, most of the cells in any organism are body cells. Adult organisms have sex organs, which produce sex cells.

7. What is the difference between body cells and sex cells?

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8. After studying the lesson and diagrams, what do you suppose would happen if the base compounds on the DNA “staircase” did not copy the codes correctly? Explain your answer.

Written Response Questions

For the following two questions, apply all of the information you’ve learned when answering.

9. Apply what you have read to explain why identical twins have the same DNA.

10. Infer what you have read to support the idea that you are unique.

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