



Science

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FPT8

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Science

Directions

Time – 40 minutes

25 Questions

This is a test of your skills in analyzing science information. Read each question and decide which of the four options best answers the question. Then mark your choice on your answer sheet. Sometimes several questions are based on the same material. You should carefully read this material and then answer the questions.

Work as quickly as you can without becoming careless. Do not spend too much time on any question that is difficult for you to answer. Instead, skip it and return to it later if you have time. Try to answer every question even if you have to guess.

Mark all your answers on the answer sheet. Give only one answer to each question.

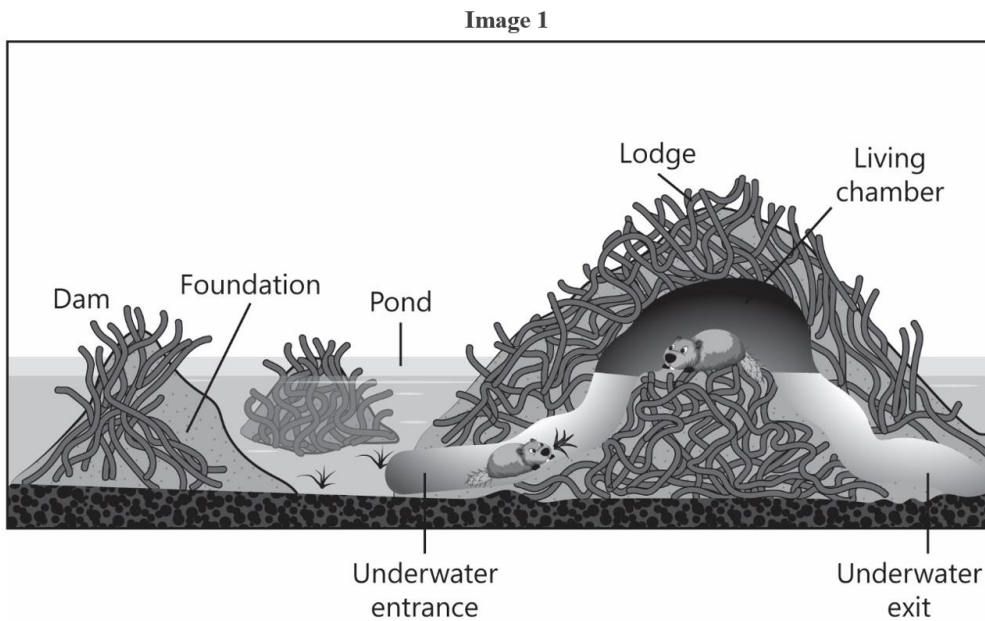
If you decide to change one of your answers, be sure to erase the first mark completely.

Be sure that the number of the question you are answering matches the number of the row of answer choices you are marking on your answer sheet. The answer sheet may contain more rows than you need.

Questions 1 through to 5 refer to the following information.

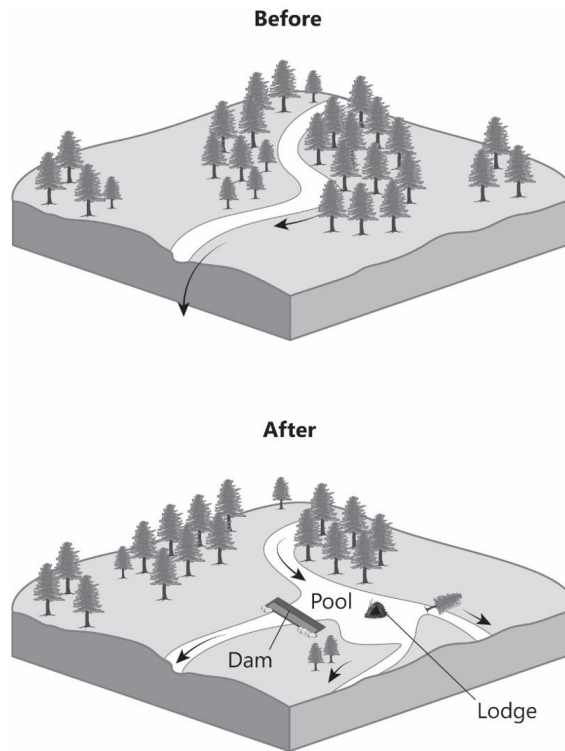
Beaver Dam

Beavers are large rodents. They are herbivores that feed on tree bark, grasses, and water plants. They use their sharp incisors to chop down trees to make a dam over streams, rivers, or creeks. The dam creates a small pond upstream. In the middle of the pond, beavers make a small island using tree branches and mud, generally called a beaver lodge. The lodge (Image 1), with an underwater entrance and exit, is home to the beaver family.



Beavers change their habitat, which has an impact on the ecosystem of the area. To study the impact of beavers on the environment, scientists introduced a male and a female beaver in a fenced three-hectare region in 2011 and closely monitored them for six years. Image 2 shows the region before and after the introduction of the beavers.

Image 2



The scientists collected water samples from above the beavers' pool and downstream to check for nutrients in the samples after storms. Table 1 shows the average amount of sediments, nitrogen, and phosphate in the collected water samples.

Table 1

	Above Beavers' Pool	Downstream
Sediments (mg/L)	120	50
Nitrogen (mg/L)	3.2	2.0
Phosphate (mg/L)	1.0	0.2

1 _____

The warm and moist environment of a beaver's stomach is home to microorganisms which help it digest the cellulose in the wood they feed on. Which statement correctly explains the type of interaction shared by the beaver and the microorganisms?

- A. Parasitism, as the microorganisms live inside the beaver and feed on the food consumed by it.
- B. Commensalism, as the beaver benefits while the microorganisms are unharmed in the interaction.
- C. Mutualism, as the microorganisms are getting space and nutrients while helping the beaver.
- D. Competition, as the beaver and the microorganisms depend on the wood consumed by the beaver.

2 _____

Nearly 80% of the trees chopped down by beavers are mainly located up to 10 m from the stream, and most of the chopped trees have a diameter of less than 10 cm. The percentage of chopped trees decreases with increased distance from the stream. Which statement explains how the felling of trees by beavers causes a major change to the habitat?

- A. It removes the tree canopy that acts as a windbreak, increasing the rate of wind erosion.
- B. It restricts the growth of native plants, helping invasive plant species to take over.
- C. It reduces the vegetation in and around the stream, resulting in the formation of a desert-like habitat.
- D. It allows more sunlight to reach the ground, enabling better growth of understory vegetation.

3 _____

Based on Table 1, what can likely be concluded about the impact of the beaver dam on water quality during a storm?

- A. The water downstream is clear and less polluted.
- B. The water downstream is turbid and more polluted.
- C. The water downstream is warm and less polluted.
- D. The water downstream is cooler and more polluted.

4 _____

Image 2 shows a beaver dam built over a stream. By chopping down trees to build their dam, beavers clear the area and create a pool.

It is claimed that by building dams, beavers help provide a unique habitat for insects and other organisms. Is this claim correct?

- A. No, the beaver dam disrupts the ecosystem near the stream.
- B. No, the beaver dam reduces the quality of water upstream.
- C. Yes, the beaver dam increases the wetted area by the stream.
- D. Yes, the beaver dam clears a large area for animals to dwell.

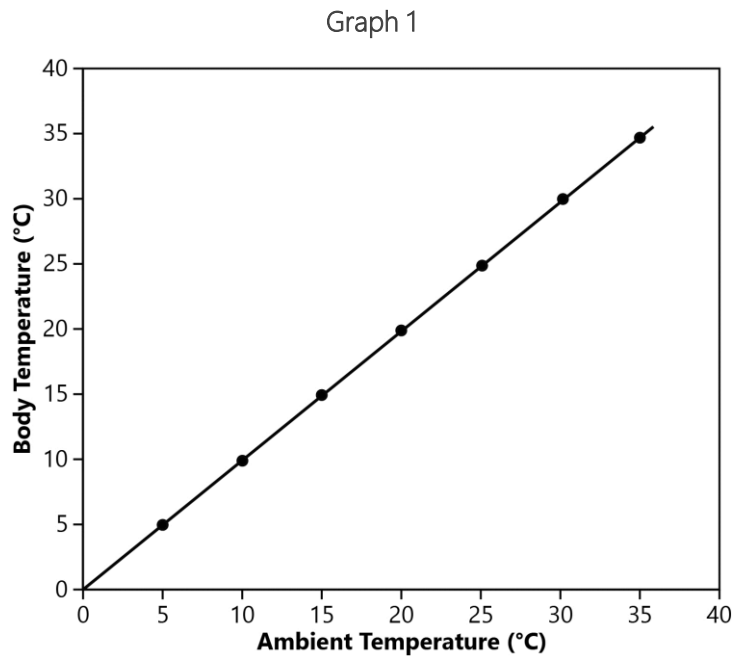
5 _____

Beavers use tree trunks, branches, leaves, and mud to create their dam. It forms a barrier that slows the river flow by storing water upstream and slowly releasing it downstream. What is the likely benefit of this?

- A. It prevents water flow downstream during drought.
 - B. It allows multiple streams to be formed downstream.
 - C. It reduces the risk of flooding downstream during storms.
 - D. It allows fish and other aquatic animals to swim easily in the stream.
-

Questions 6 through to 10 refer to the following information.

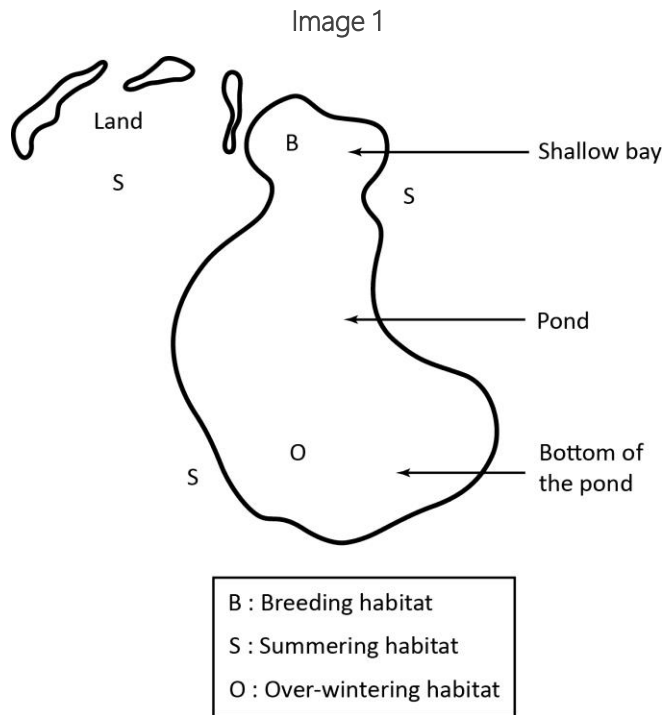
Frogs are cold-blooded animals that cannot generate their own body heat. Graph 1 shows the body temperature of frogs in relation to the ambient temperature.



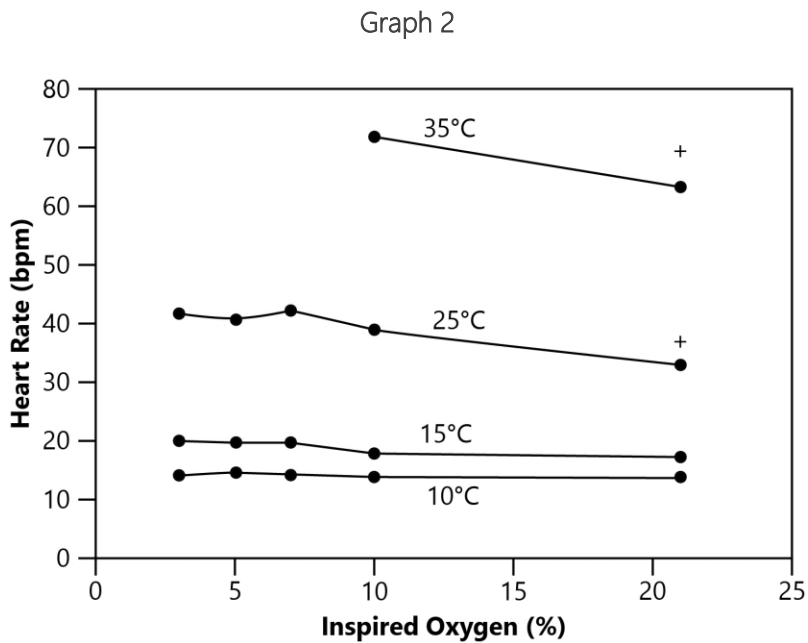
Frogs, like the northern leopard frog and the bull frog, can survive in freezing winters. However, reproduction and other life processes depend on changing seasons.

The northern leopard frog lays eggs in shallow ponds, also called breeding ponds. These ponds usually have a depth of 1.5 - 2.0 m, allowing the water to be heated by the sun. This makes the temperature of the pond suitable for the rapid development of eggs into tadpoles and then adult frogs. These ponds lack fish and are not connected to other bodies of water.

Image 1 shows the different habitats occupied by leopard frogs during different seasons.



Frogs also use different modes of breathing in different seasons. The northern leopard frogs hibernate in the bottom of ponds during winters, typically covering themselves in with mud and sitting very still. They choose ponds that have enough dissolved oxygen and will not freeze all the way to the bottom. Graph 2 shows the heart rate and amount of oxygen utilized by a northern leopard frog at different temperatures.



6 _____

Based on Graph 1, what can likely be interpreted about the change in the body temperature of the frog in relation to the ambient temperature?

- A. The body temperature decreases as the ambient temperature increases.
- B. The body temperature increases as the ambient temperature increases.
- C. The body temperature remains constant even if the ambient temperature increases.
- D. The body temperature increases even if the ambient temperature increases or decreases.

7 _____

Based on Graph 2, what can be predicted about the heart rate of 30°C for a 10% inspired oxygen level?

- A. 8bpm
- B. 20bpm
- C. 60bpm
- D. 100bpm

8 _____

The table below lists the characteristics of the breeding pond in which the northern leopard frog lays eggs.

- | |
|---|
| <ol style="list-style-type: none">1. Ponds are shallow, with a depth of 1.5 - 2.0m.2. Ponds are not interconnected with other bodies of water.3. Ponds have enough dissolved oxygen for other organisms to survive.4. Ponds get heated quickly by the sun, making the water unsuitable for life. |
|---|

These ponds lack fish and other predators. Which of the listed characteristics is the likely reason for this?

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

9 _____

The breeding ponds in which northern leopard frogs lay eggs usually have a depth of 1.5 - 2.0 m. However, these ponds should not be too shallow.

What could be the likely reason for this?

- A. The pond will dry up before tadpoles grow into adults.
- B. The pond will expose tadpoles to other animals for them to eat.
- C. The pond will have less space to accommodate all adult frogs.
- D. The pond will not have enough food for adult frogs to eat.

10 _____

What is likely the reason that northern leopard frogs hibernate at the bottom of the pond during winter?

- A. To avoid being noticed by any predator
 - B. To expend less oxygen from their body
 - C. To prevent the loss of heat from their body
 - D. To avoid being swept away by the flow of the water
-

Questions 11 through to 15 refer to the following information.

Acid-Base Titration

An acid-base volumetric titration is a precise laboratory technique to determine the concentration of an unknown acid or base using a neutralization reaction. In this method, a solution of known concentration is added drop by drop to a solution of an unknown concentration until the endpoint is reached, which is the point at which the two solutions are neutralized. The endpoint is determined by the color change in solution indicated by acid-base indicators.

A student conducts an experiment to determine the concentration of acetic acid in a vinegar solution (in molarity, M) by titrating it with sodium hydroxide solutions with a known concentration (in molarity, M). The molarity of a substance is defined as the number of moles of the substance per liter solution. The student follows the following steps:

1. Take 5 mL of vinegar solution in a conical flask and add 2 - 3 drops of phenolphthalein indicator.
2. Add 0.1 M NaOH solution drop by drop to the conical flask until the solution turns pink, then note the volume of NaOH used.
3. Repeat step 2 with a 10 mL and 15 mL vinegar solution.
4. Repeat the procedure again with NaOH solutions of different concentrations: 0.5 M NaOH and 1.0 M NaOH.

Table 1 records the titration of vinegar solution with NaOH solution in nine trials. The trials are grouped into sets of three: trials 1-3, trials 4-6, and trials 7-9. Each set of trials has a different NaOH concentration. The table shows the concentration of NaOH solution (M_2), volume of vinegar solution used (V_1), volume of NaOH used (V_2), and concentration of vinegar solution (M_1) in each trial. The concentration of vinegar solution is calculated by using the equation $M_1V_1=M_2 \cdot V_2$.

Table 1

Trial	Concentration of NaOH Solution (M_2)	Volume of Vinegar Solution in Conical Flask (V_1) (mL)	Volume of NaOH Used (V_2) (mL)	Concentration of Vinegar Solution $M_1 = \frac{M_2 \cdot V_2}{V_1}$
1	0.1	5	27.0	0.540
2	0.1	10	54.0	0.540
3	0.1	15	81.2	0.541
4	0.5	5	5.4	0.540
5	0.5	10	10.8	0.540
6	0.5	15	16.2	0.540
7	1.0	5	2.7	0.540
8	1.0	10	5.4	0.540
9	1.0	15	8.1	0.540

11 _____

The use of an indicator helps the student visually see a color change in the solution once the neutralization point has been reached. How would the addition of 2-3 drops of a phenolphthalein indicator change the color of the acid-base titration?

- A. Red to blue
- B. Blue to red
- C. Colorless to pink
- D. Pink to colorless

12 _____

Based on Table 1, what volume of 1.0 M NaOH would be needed if the volume of vinegar solution used is 12 mL?

- A. Less than 2.7 mL
- B. Between 2.5 mL and 5.4 mL
- C. Between 5.4 mL and 8.1 mL
- D. Greater than 8.1 mL

13 _____

Why is sodium hydroxide solution added to the vinegar solution drop by drop?

- A. To increase the acidity of the vinegar solution
- B. To prevent any temperature change in the vinegar solution
- C. To speed up the reaction between sodium hydroxide and acetic acid
- D. To measure the precise volume of sodium hydroxide required to neutralize the acetic acid

14 _____

Which conclusion is correct about the relationship between the volume of vinegar solution and the volume of NaOH solution used in the reaction?

- A. The volume of NaOH solution used is independent of the volume of the vinegar solution.
- B. The volume of NaOH solution increases with the increase in the volume of the vinegar solution.
- C. The volume of NaOH solution increases with the decrease in the volume of the vinegar solution.
- D. The volume of NaOH solution decreases with the increase in the volume of the vinegar solution.

15 _____

Based on Table 1, which statement correctly compares the volume of NaOH of a particular concentration used in the titration?

- A. The volume of NaOH used is more for 1.0 M solution than for 0.5 M solution in titration with 5 mL vinegar.
- B. The volume of NaOH used is more for 1.0 M solution than for 0.1 M solution in titration with 10 mL vinegar.
- C. The volume of NaOH used is more for 0.5 M solution than for 0.1 M solution in titration with 5 mL vinegar.
- D. The volume of NaOH used is more for 0.1 M solution than for 0.5 M solution in titration with 10 mL vinegar.

Questions 16 through to 20 refer to the following information.

Force and Its Effects on the Motion of Objects

A student is playing with a toy cart on a flat surface, pushing it with their hand and letting it go. The cart moves for a while and then stops. The student wonders what makes the cart move and stop and if any change can make it move faster or slower. These questions can be investigated by learning about forces and motion.

A force is a push or a pull that can change an object's speed, direction, or shape. When the toy cart is pushed, a force is applied to it, which makes the cart start moving. The cart also has other forces acting on it, such as gravity, which pulls it down, and friction, which slows it down. The net unbalanced force is the total force that is not canceled out by other forces acting on an object. An unbalanced force acting on the cart makes it accelerate or increase its speed. The student decides to perform two investigations to study how net unbalanced forces acting on an object affect its motion. The student uses carts, weights, timers, and rulers to measure and compare the motion.

Investigation 1

The student places a cart on a horizontal plane and notes how it moves for a fixed time due to the applied force in four different trials.



The mass of the cart is kept the same in each trial, while the force applied to it is varied. The student measures the distance the cart covers in a fixed time and calculates the acceleration of the cart in each trial, as shown in Table 1.

Table 1

Trial	Mass of cart (kg)	Applied force (N)	Acceleration (m/s^2)
1	10	25	2.5
2	10	35	3.5
3	10	45	4.5
4	10	55	5.5

Next, the student varies the mass of the cart in four trials, keeping the applied force the same in each trial. The distance the cart covers in the fixed time is noted, and the student calculates the acceleration of the cart, as shown in Table 2.

Table 2

Trial	Mass of cart (kg)	Applied force (N)	Acceleration (m/s^2)
1	8	55	6.9
2	10	55	5.5
3	12	55	4.6
4	14	55	3.9

Investigation 2

The student takes another cart to test how the motion of objects changes when objects collide and labels the two carts R and S. The carts moving with the same initial velocity of 20 m/s are moved toward each other on the horizontal plane in three different trials.

Before collision



The carts hit each other and move away to a distance in opposite directions.

After collision



The mass of cart S is varied, keeping the mass of cart R the same in each trial, and the velocity of each cart after the collision is noted in Table 3.

Table 3

Trial	Mass of cart R (kg)	Mass of cart S (kg)	Velocity of cart R after collision (m/s)	Velocity of cart S after collision (m/s)
1	10	10	20	20
2	10	12	24.2	16.5
3	10	8	16	25

The student calculates the momentum of the carts before and after collision in each trial, as shown in Table 4.

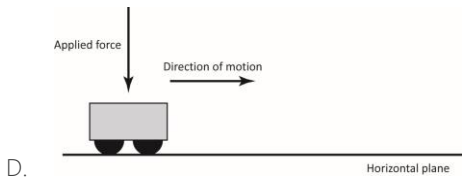
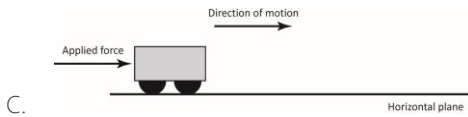
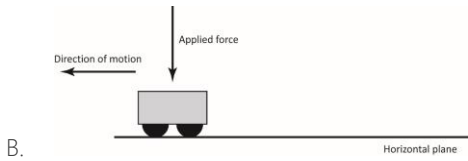
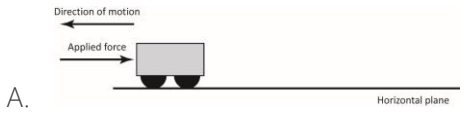
Table 4

Trial	Momentum of cart R before collision (kg·m/s)	Momentum of cart R after collision (kg·m/s)	Momentum of cart S before collision (kg·m/s)	Momentum of cart S after collision (kg·m/s)
1	200	200	200	200
2	200	242	240	198
3	200	160	160	200

The student calculates that the total momentum of the system of two carts remains the same in each trial.

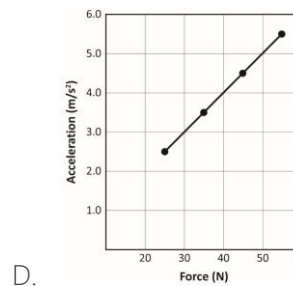
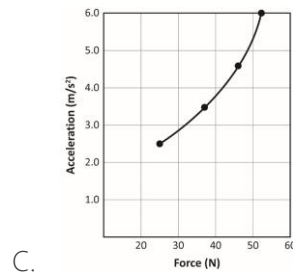
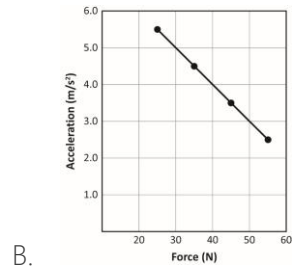
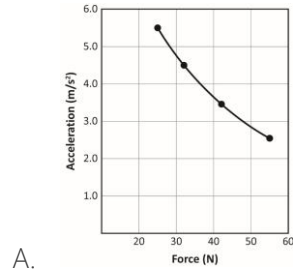
16 _____

Which image correctly shows the direction of the applied force on the cart and the direction the cart accelerates, demonstrating that the force is causing the acceleration?



17 _____

Based on Table 1, which graph correctly represents the relationship between the cart's acceleration and applied force?



18 _____

Suppose in the fifth trial, the mass of the cart is changed to 6 kg, and 55 N force is applied to it. Based on Table 2, what would be the acceleration of the cart?

- A. Equal to 5.5 m/s^2 as objects of the same mass have similar acceleration irrespective of the amount of force
- B. More than 6.9 m/s^2 as lighter objects accelerate more than heavier objects with the same force
- C. Less than 3.9 m/s^2 as lighter objects accelerate less than heavier objects with the same force
- D. Equal to 4.6 m/s^2 as objects have equal acceleration with the same force irrespective of the mass

19 _____

Based on investigation 2, which statement is correct about the final velocities after an elastic collision when two objects collide with the same initial velocity?

- A. Objects with equal mass will have different final velocities.
- B. Objects with unequal masses will have the same final velocity.
- C. The lighter object will have a lower final velocity than the heavier object.
- D. The heavier object will have a lower final velocity than the lighter object.

20 _____

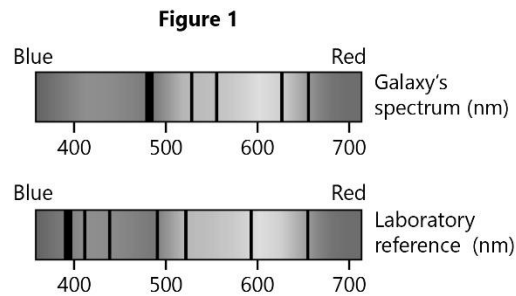
During investigation 2, in another trial, the mass of cart S is changed to 15 kg, and the mass of cart R is kept the same at 10 kg. The two carts are made to move with the same initial velocity of 20 m/L and collide with each other. Based on Table 3, how would the total momentum of the carts be affected when no external force is applied after the collision?

- A. It will remain the same because the total momentum is conserved.
 - B. It will double because each cart gains momentum after collision.
 - C. It will reduce to zero because the momentum of each cart is equal.
 - D. It will reduce to half because each cart loses momentum after collision.
-

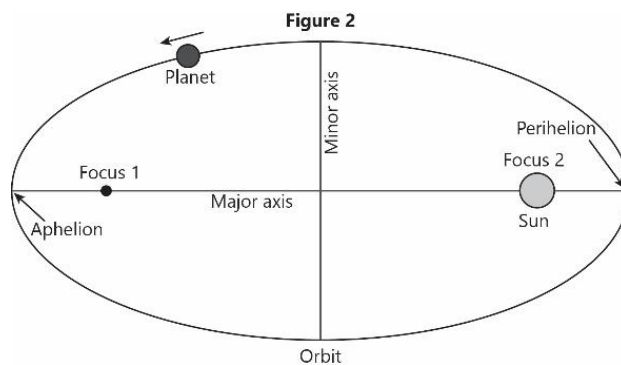
Questions 21 through to 25 refer to the following information.

Motion of Objects in the Solar System

Most celestial objects have some form of motion. The motion of each object is studied to understand the universe over time. The motion of galaxies is used to study the change in the size of the universe since it was formed. In 1920, an astronomer named Edwin Hubble noticed that the light from galaxies was red-shifted and stated that galaxies were moving away from Earth. Figure 1 compares the spectrum of a red-shifted galaxy with laboratory reference.

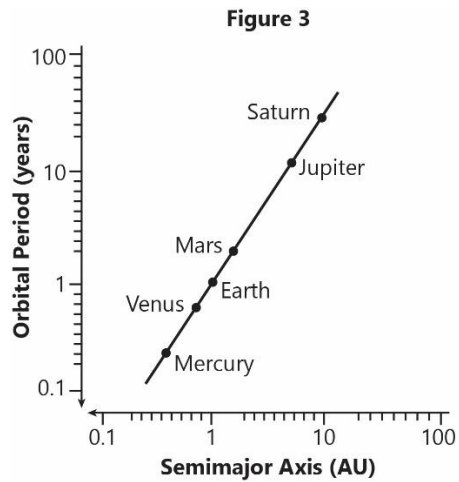


Not all objects in space exhibit the same motion as galaxies. For example, planets do not crash or fall as the Sun's gravity keeps them in their orbits. This is the reason that the distance of a planet from the Sun plays an important role in determining its orbital speed. To prove that a planet's distance from the Sun constantly changes, the first and second laws stated by Johannes Kepler can be used. According to the first law, all planets move in elliptical orbits around the Sun, where the Sun is at one focus of the orbital ellipse. Kepler's second law explains the effect of the Sun's gravity on the orbital speed of a planet as it says that the orbital velocity of an object depends on gravity, which changes based on its distance from the Sun. The gravitational strength varies with distance as it is greater on objects that are nearer, causing them to move faster. Figure 2 illustrates the laws by showing the points where a planet is nearest and farthest from the Sun, labeled as Aphelion and Perihelion.



It is clear from the first and second laws that a planet is at different distances from the Sun while in its orbit, which affects its orbital speed. This suggests that the orbital periods of every planet will be different from

one another. This can be further explained using Kepler's third law, which relates the change of the orbital period to the change in the orbital distance of a celestial object. According to this law, the squares of the orbital period of any planet are proportional to the cube of the semi-major axis of its orbit. Figure 3 shows the orbital period of planets in the solar system.



21 _____

The orbital period of planets in the solar system is shown in Figure 3. If Earth had been closer to the Sun when the solar system formed, what would its orbital period (year length) have been compared to what it is now?

- A. The same because Earth would still orbit the Sun
- B. The same because all planet orbits are the same size
- C. Longer because the Sun's gravity would be stronger
- D. Shorter because Earth would revolve in a smaller orbit

22 _____

The average speed of Earth in its orbit around the Sun is 29.7 km/s. Based on Figure 2 and Kepler's second law, what would be the speed of Earth when it is at Perihelion?

- A. Much faster than Earth's average orbital speed
- B. Slightly more than Earth's average orbital speed
- C. Significantly less than Earth's average orbital speed
- D. Approximately the same as Earth's average orbital speed

23 _____

Based on the data in Figure 3, how do the orbits of planets around the Sun in our solar system compare?

- A. Planets with larger orbits have shorter orbital periods.
- B. Planets with smaller orbits have longer orbital periods.
- C. The orbital period is longer for a planet with a larger orbit.
- D. All planets have the same orbital period regardless of orbit size.

24 _____

Scientists study spectral lines from galaxies to determine their movement relative to Earth. Data was recorded for Galaxy X on the spectrum ranging from 400 nm (blue end) to 700 nm (red end). Scientists observed that the spectral lines for Galaxy X appeared only between 520-690 nm. Based on Figure 1, does this data provide evidence for Hubble's observation that galaxies are moving away from Earth?

- A. Yes, the light is red-shifted to longer wavelengths.
- B. No, the light is blue-shifted to shorter wavelengths.
- C. No, the spectral lines only appear over a narrow range.
- D. Yes, the spectral lines are evenly spread out at all wavelengths.

Which statement correctly analyzes Kepler's work?

- A. Kepler's work focused only on the study of unpredictable motions of objects in the solar system.
 - B. Kepler's work on planetary motion is evidence for the heliocentric model that not everything orbited the Earth.
 - C. Kepler's work on the orbital period is based solely on observational data and not defined by mathematical relationships.
 - D. Kepler's work about the arrangement of objects in the solar system was based on assumptions and lacked empirical evidence.
-