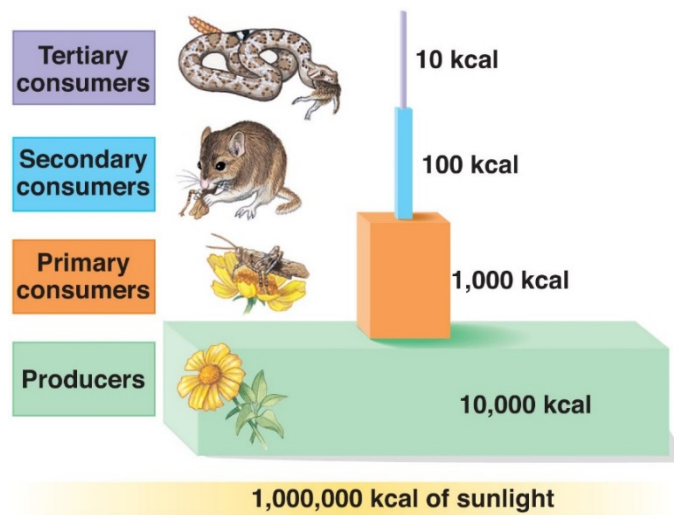


Read Passage A before answering Question 1 and Question 2

Passage A

In a typical terrestrial ecosystem, the distribution of biomass can be portrayed as in **Figure 1**. This type of figure is called an ecological pyramid and it shows that at each transfer of energy in a food chain, there is a loss of energy. For example, the producers, or plants, in this pyramid produce 10,000 kcal (kilocalories) of energy, but the primary consumers are only able to incorporate 10% of this energy, or 1,000 kcal, into their level of the food chain. This is because some energy is lost to respiration and heat at each step.



**Figure 1.** An ecological pyramid showing energy in kilocalories within each level of a food chain.

Question 1

A grassland ecosystem consists of plants that grow on the plains, insects that eat the plants, rodents that eat the insects, and snakes that eat the rodents. Which of these species will account for the smallest proportion of the energy of this ecosystem?

- a) The rodents
- b) The insects
- c) The plants
- d) The snakes

## Question 2

Field ecologists estimated the number of kilocalories at each level of the food chain for an ecosystem. They measured 46,000 kcal in the plants in their study area.

Approximately how many kilocalories would you expect to find in the rodents' level of the food chain based on the information in **Figure 1**?

- a) 4.6
- b) 46
- c) 460
- d) 4,600
- e) 46,000

### Read Passage B before answering Question 3

#### Passage B

The first experimentally-based theory of atomic structure was proposed by John Dalton in the early nineteenth century. The following six postulates were part of Dalton's theory.

1. All matter consists of tiny particles called atoms.
2. An atom cannot be created, divided or destroyed or converted to another type of atom.
3. All atoms of a particular element are identical.
4. Atoms of different elements are different.
5. Atoms of different elements combine in simple whole-number ratios to produce molecules which are stable aggregates of atoms.
6. Chemical changes involve joining, separating or rearranging atoms.

#### Question 3

We now know that not all of Dalton's original postulates are accurate. Which statement below disproves a Dalton postulate?

- a) Every hydrogen molecule contains two hydrogen atoms, every oxygen molecule contains two oxygen atoms, and every water molecule contains two hydrogen atoms and one oxygen atom.
- b) Two hydrogen molecules and one oxygen molecule can undergo a chemical reaction to produce two water molecules.
- c) All carbon atoms contain six protons and six electrons, whereas all oxygen atoms contain eight protons and eight electrons.
- d) There are three naturally-occurring carbon isotopes. Each carbon isotope contains six protons but different numbers of neutrons. There are also three naturally-occurring oxygen isotopes. Each oxygen isotope contains eight protons but different numbers of neutrons.

## Read Passage C before answering Question 4

### Passage C

Avogadro's law is a relationship between the volume ( $V$ ) of a sample of gas and the number of molecules or individual particles ( $n$ ) in the gas sample. According to this law, all gas samples that have the same volumes will have the same number of molecules or particles in the samples as long as the gas samples have identical pressures and have identical temperatures. For example, according to Avogadro's law a 1.00-liter sample of oxygen gas at a temperature of 300 Kelvin that has a pressure of 1.00 atmosphere contains  $2.44 \times 10^{22}$  oxygen molecules. According to Avogadro's law this means the following.

1. A 1.00-liter sample of hydrogen gas at 300 Kelvin that has a pressure of 1.00 atmosphere contains  $2.44 \times 10^{22}$  hydrogen molecules.
2. A 1.00-liter sample of carbon dioxide gas at 300 Kelvin that has a pressure of 1.00 atmosphere contains  $2.44 \times 10^{22}$  carbon dioxide molecules.

One implication of Avogadro's law is that there is a linear and proportional relationship between the volume of a gas sample and the number of molecules in the sample at constant temperature and constant pressure. So for example, the volume of a gas sample will increase as molecules are added to the sample. The volume of the sample will increase linearly and proportionally with the increase in the number of molecules added to the sample as long as the pressure of the sample is kept constant and the temperature of the sample is kept constant.

### Question 4

Which mathematical equation correctly shows the relationship between the volume of a gas sample ( $V$ ) and the number of molecules in the sample ( $n$ ) that is kept at constant pressure and constant temperature according to Avogadro's law?

- a)  $V \times n = \text{constant}$
- b)  $V \div n = \text{constant}$
- c)  $V + n = \text{constant}$
- d)  $V - n = \text{constant}$

## Read Passage D before answering Question 5 and Question 6

### Passage D

The terms velocity and speed are frequently used interchangeably in everyday life. However, technically and in physics, these terms have different definitions. Speed tells us how fast an object is moving, nothing more. Velocity tells us both how fast an object is moving, and in what direction. So in physics, velocity includes speed, but gives us additional information as well.

The concept of acceleration is also an important one. Acceleration is different from both speed and velocity, and is most closely related to velocity. Acceleration measures how rapidly an object's velocity is changing, either in speed or in direction. So any time an object's speed is changing, it is undergoing acceleration, and any time the direction an object is moving changes, it is also undergoing acceleration. Only objects at rest, or moving in a straight line at a constant speed, have zero acceleration.

### Question 5

Two cars are travelling along the same highway. One car is travelling at 50 miles per hour, heading west, and the other car is travelling at 50 miles per hour heading east. Which of these quantities are the same for both cars?

- a) speed
- b) velocity
- c) both speed and velocity

### Question 6

The speeds of the following objects are all constant. Which of them, if any, is undergoing acceleration?

- a) An airplane flying north at 350 miles per hour
- b) An elevator descending at 2 miles per hour
- c) A can of beans at rest on a table
- d) A car driving around a circular track at 28 miles per hour

### Answer key

- 1. d)
- 2. c)
- 3. d)
- 4. b)
- 5. a)
- 6. d)