tpo_22_passage_1

Sometime after midnight on February 8, 1969, a large, bright meteor entered Earth's atmosphere and broke into thousands of pieces, plummeted to the ground, and scattered over an area 50 miles long and 10 miles wide in the state of Chihuahua in Mexico. The first meteorite from this fall was found in the village of Pueblito de Allende. Altogether, roughly two tons of meteorite fragments were recovered, all of which bear the name Allende for the location of the first discovery. Individual specimens of Allende are covered with a black, glassy crust that formed when their exteriors melted as they were slowed by Earth's atmosphere. When broken open, Allende stones are revealed to contain an assortment of small, distinctive objects, spherical or irregular in shape and embedded in a dark gray matrix (binding material), which were once constituents of the solar nebula-the interstellar cloud of gas and dust out of which our solar system was formed. The Allende meteorite is classified as a chondrite. Chondrites take their name from the Greek word chondros-meaning "seed" -an allusion to their appearance as rocks containing tiny seeds. These seeds are actually chondrules: millimeter-sized melted droplets of silicate material that were cooled into spheres of glass and crystal. A few chondrules contain grains that survived the melting event, so these enigmatic chondrules must have formed when compact masses of nebular dust were fused at high temperatures-approaching 1,700 degrees Celsius-and then cooled before these surviving grains could melt. Study of the textures of chondrules confirms that they cooled rather quickly, in times measured in minutes or hours, so the heating events that formed them must have been localized. It seems very unlikely that large portions of the nebula were heated to such extreme temperatures, and huge nebula areas could not possibly have lost heat so fast. Chondrules must have been melted in small pockets of the nebula that were able to lose heat rapidly. The origin of these peculiar glassy spheres remains an enigma. Equally perplexing constituents of Allende are the refractory inclusions: irregular white masses that tend to be larger than chondrules. They are composed of minerals uncommon on Earth, all rich in calcium, aluminum, and titanium, the most refractory (resistant to melting) of the major elements in the nebula. The same minerals that occur in refractory inclusions are believed to be the earliest-formed substances to have condensed out of the solar nebula. However, studies of the textures of inclusions reveal that the order in which the minerals appeared in the inclusions varies from inclusion to inclusion, and often does not match the theoretical condensation sequence for those metals. Chondrules and inclusions in Allende are held together by the chondrite matrix, a mixture offine-grained, mostly silicate minerals that also includes grains of iron metal and iron sulfide. At one time it was thought that these matrix grains might be pristine nebular dust, the sort of stuff from which chondrules and inclusions were made. However, detailed studies of the chondrite matrix suggest that much of it, too, has been formed by condensation or melting in the nebula, although minute amounts of surviving interstellar dust are mixed with the processed materials. All these diverse constituents are aggregated together to form chondritic meteorites, like Allende, that have chemical compositions much like that of the Sun. To compare the compositions of a meteorite and the Sun, it is necessary that we use ratios of elements rather than simply the abundances of atoms. After all, the Sun has many more atoms of any element, say iron, than does a meteorite specimen, but the ratios of iron to silicon in the two kinds of matter might be comparable. The compositional similarity is striking. The major difference is that Allende is depleted in the most volatile

elements, like hydrogen, carbon, oxygen, nitrogen, and the noble gases, relative to the Sun. These are the elements that tend to form gases even at very low temperatures. We might think of chondrites as samples of distilled Sun, a sort of solar sludge from which only gases have been removed. Since practically all the solar system's mass resides in the Sun, this similarity in chemistry means that chondrites have average solar system composition, except for the most volatile elements; they are truly lumps of nebular matter, probably similar in composition to the matter from which planets were assembled.

question 1

Which of the following can be inferred from paragraph 1 about the large meteor that entered Earth’ s atmosphere on February 8, 1969?

A It was almost ten miles wide.

B It was the biggest meteor ever to hit Mexico.

C It weighed more than two tons.

D It broke into more pieces than most meteors do.

question 2

Which of the sentences below best expresses the essential information in the highlighted sentence in the passage? Incorrect choices change the meaning in important ways or leave out essential information.

A Allende meteorites were formed when constituents of the interstellar cloud of gas and dust got trapped inside small, roughly spherical objects and these objects became bound together in a dark gray matrix.

B Inside Allende meteorites is a dark gray matrix that binds together small, spherical or irregular objects formed from the interstellar cloud of gas and dust out of which the solar system was made.

C By breaking open Allende meteorites, scientists were able to find out what the solar nebula was made of.

D Allende meteorites were filled with material formed almost entirely from interstellar gas and dust.

question 3

According to paragraph 3, what does the presence of grains inside some of the

chondrules indicate?

A The chondrules were formed of silicate material.

B The chondrules were formed at high temperatures and then cooled rapidly.

C The grains were formed in huge areas of the solar nebula.

D The grains were formed after the chondrules were fused together into chondrites.

question 4

According to paragraph 4, all of the following are true about the minerals found in the refractory inclusions EXCEPT:

A These minerals are among the most resistant to melting of all the major elements in the solar nebula.

B These minerals are believed to be some of the first elements to have condensed out of the solar nebula.

C These minerals are among the least commonly found elements on Earth.

D These elements occur in the order that scientists would have predicted.

question 5

According to paragraph 5, which of the following is indicated by studies of the mixture holding the inclusions together?

A Large amounts of this material were formed by condensation or melting in the nebula.

B This material contains more iron and iron sulfide than had previously been thought.

C This material is very similar to the material from which the refractory inclusions are made.

D The grains in this material are made from the same elements as chondrules are.

question 6

In paragraph 6, why does the author mention that "the Sun has many more atoms of any element, say iron, than does a meteorite specimen" ?

A To show how difficult it is to compare the composition of a meteorite with that of the Sun

B To explain why a comparison of the compositions of a meteorite and of the Sun has to be done in terms of ratios of elements

C To identify the most common element in both the Sun and meteorite specimens

D To emphasize how much larger the Sun is than any meteorite specimen is

question 7

According to paragraph 6, the composition of chondritic meteorites differs from the composition of the Sun primarily in

A containing nebular matter

B containing many fewer atoms of iron

C the relative amount of volatile elements

D the ratio of iron to silicon

question 8

According to paragraph 6, what is the significance of the similarity in composition between chondrites and the Sun?

A It indicates what the matter from which planets were formed was probably like.

B It may explain how the Sun originally developed.

C It helps scientists estimate the variations in the chemical composition of different meteors.

D It suggests that most meteorites may contain large quantities of volatile elements.

question 9

Look at the four squares [ ] that indicate where the following sentence could be added to the passage.

Sometime after midnight on February 8, 1969, a large, bright meteor entered Earth's atmosphere and broke into thousands of pieces, plummeted to the ground, and scattered over an area 50 miles long and 10 miles wide in the state of Chihuahua in Mexico. The first meteorite from this fall was found in the village of Pueblito de Allende. Altogether, roughly two tons of meteorite fragments were recovered, all of which bear the name Allende for the location of the first discovery. Individual specimens of Allende are covered with a black, glassy crust that formed when their exteriors melted as they were slowed by Earth's atmosphere. When broken open, Allende stones are revealed to contain an assortment of small, distinctive objects, spherical or irregular in shape and embedded in a dark gray matrix (binding material), which were once constituents of the solar nebula-the interstellar cloud of gas and dust out of which our solar system was formed. The Allende meteorite is classified as a chondrite. Chondrites take their name from the Greek word chondros-meaning "seed" -an allusion to their appearance as rocks containing tiny seeds. These seeds are actually chondrules: millimeter-sized melted droplets of silicate material that were cooled into spheres of glass and crystal. A few chondrules contain grains that survived the melting event, so these enigmatic chondrules must have formed when compact masses of nebular dust were fused at high temperatures-approaching 1,700 degrees Celsius-and then cooled before these surviving grains could melt. Study of the textures of chondrules confirms that they cooled rather quickly, in times measured in minutes or hours, so the heating events that formed them must have been localized. It seems very unlikely that large portions of the nebula were heated to such extreme temperatures, and huge nebula areas could not possibly have lost heat so fast. Chondrules must have been melted in small pockets of the nebula that were able to lose heat rapidly. The origin of these peculiar glassy spheres remains an enigma. Equally perplexing constituents of Allende are the refractory inclusions: irregular white masses that tend to be larger than chondrules. [] They are composed of minerals uncommon on Earth, all rich in calcium, aluminum, and titanium, the most refractory (resistant to melting) of the major elements in the nebula. [] The same minerals that occur in refractory inclusions are believed to be the earliest-formed substances to have condensed out of the solar nebula. [] However, studies of the textures of inclusions reveal that the order in which the minerals appeared in the inclusions varies from inclusion to inclusion, and often does not match the theoretical condensation sequence for those metals. [] Chondrules and inclusions in Allende are held together by the chondrite matrix, a mixture offine-grained, mostly silicate minerals that also includes grains of iron metal and iron sulfide. At one time it was thought that these matrix grains might be pristine nebular dust, the sort of stuff from which chondrules and inclusions were made. However, detailed studies of the chondrite matrix suggest that much of it, too, has been formed by condensation or melting in the nebula, although minute amounts of surviving interstellar dust are mixed with the processed materials. All these diverse constituents are aggregated together to form chondritic meteorites, like Allende, that have chemical compositions much like that of the Sun. To compare the compositions of a meteorite and the Sun, it is necessary that we use ratios of

elements rather than simply the abundances of atoms. After all, the Sun has many more atoms of any element, say iron, than does a meteorite specimen, but the ratios of iron to silicon in the two kinds of matter might be comparable. The compositional similarity is striking. The major difference is that Allende is depleted in the most volatile elements, like hydrogen, carbon, oxygen, nitrogen, and the noble gases, relative to the Sun. These are the elements that tend to form gases even at very low temperatures. We might think of chondrites as samples of distilled Sun, a sort of solar sludge from which only gases have been removed. Since practically all the solar system's mass resides in the Sun, this similarity in chemistry means that chondrites have average solar system composition, except for the most volatile elements; they are truly lumps of nebular matter, probably similar in composition to the matter from which planets were assembled.

question 10

Directions: An introductory sentence for a brief summary of the passage is provided below. Complete the summary by selecting the THREE answer choices that express the most important ideas in the passage. Some sentences do not belong in the summary because they express ideas that are not presented in the passage or are minor ideas in the passage. This question is worth 2 points.

A. When Allende entered Earth’ s atmosphere, it broke into thousands of pieces called chondrites because they look like glassy, black seeds.

B. The mineral content of chondrules suggests that they were probably formed in isolated regions of the nebula that remained much hotter than the rest.

C. Chondrules are tiny, millimeter-sized drops of silicate materials that probably formed when lumps of nebular dust were fused at extremely high temperatures and then quickly cooled.

D. Irregularly shaped inclusions in Allende are composed of minerals that are resistant to melting and are believed to be the earliest minerals to have condensed out of the nebula.

E. The matrix that holds the chondrules and inclusions together in Allende consists mainly of grains of nebular dust that were trapped inside the meteor before they could be melted.

F. Except for being depleted in volatile elements, chondritic meteorites are probably very similar in composition to the matter from which planets were assembled.