tpo_16_passage_1

The periodic table is a chart that reflects the periodic recurrence of chemical and physical properties of the elements when the elements are arranged in order of increasing atomic number(the number of protons in the nucleus). It is a monumental scientific achievement, and its development illustrates the essential interplay between observation, prediction, and testing required for scientific progress. In the 1800`s scientists were searching for new elements. By the late 1860's more than 60 chemical elements had been identified, and much was known about their descriptive chemistry. Various proposals were put forth to arrange the elements into groups based on similarities in chemical and physical properties. The next step was to recognize a connection between group properties (physical or chemical similarities) and atomic mass (the measured mass of an individual atom of an element). When the elements known at the time were ordered by increasing atomic mass, it was found that successive elements belonged to different chemical groups and that the order of the groups in this sequence was fixed and repeated itself at regular intervals. Thus when the series of elements was written so as to begin a new horizontal row with each alkali metal, elements of the same groups were automatically assembled in vertical columns in a periodic table of the elements. This table was the forerunner of the modern table. When the German chemist Lothar Meyer and (independently) the Russian Dmitry Mendeleyev first introduced the periodic table in 1869-70, one-third of the naturally occurring chemical elements had not yet been discovered. Yet both chemists were sufficiently farsighted to leave gaps where their analyses of periodic physical and chemical properties indicated that new elements should be located. Mendeleyev was bolder than Meyer and even assumed that if a measured atomic mass put an element in the wrong place in the table, the atomic mass was wrong. In some cases this was true. Indium, for example, had previously been assigned an atomic mass between those of arsenic and selenium. Because there is no space in the periodic table between these two elements, Mendeleyev suggested that the atomic mass of indium be changed to a completely different value, where it would fill an empty space between cadmium and tin. In fact, subsequent work has shown that in a periodic table, elements should not be ordered strictly by atomic mass. For example, tellurium comes before iodine in the periodic table, even though its atomic mass is slightly greater. Such anomalies are due to the relative abundance of the "isotopes" or varieties of each element. All the isotopes of a given element have the same number of protons, but differ in their number of neutrons, and hence in their atomic mass. The isotopes of a given element have the same chemical properties but slightly different physical properties. We now know that atomic number (the number of protons in the nucleus), not atomic mass number (the number of protons and neutrons), determines chemical behavior. Mendeleyev went further than Meyer in another respect: he predicted the properties of six elements yet to be discovered. For example, a gap just below aluminum suggested a new element would be found with properties analogous to those of aluminum. Mendeleyev designated this element "eka-aluminum" (eka is the Sanskrit word for "next")and predicted its properties. Just five years later an element with the proper atomic mass was isolated and named gallium by its discoverer. The close correspondence between the observed properties of gallium and Mendeleyev's predictions for eka-aluminum lent strong support to the periodic law. When elements are arranged in order of their atomic number, most of the properties of the elements reoccur at regular intervals. Additional support came in 1885 when

eka-silicon, which had also been described in advance by Mendeleyev, was discovered and named germanium. The structure of the periodic table appeared to limit the number of possible elements. It was therefore quite surprising when John William Strutt, Lord Rayleigh, discovered a gaseous element in 1894 that did not fit into the previous classification scheme. A century earlier, Henry Cavendish had noted the existence of a residual gas when oxygen and nitrogen are removed from air, but its importance had not been realized. Together with William Ramsay, Rayleigh isolated the gas (separating it from other substances into its pure state) and named it argon. Ramsay then studied a gas that was present in natural gas deposits and discovered that it was helium, an element whose presence in the Sun had been noted earlier in the spectrum of sunlight but that had not previously been known on Earth. Rayleigh and Ramsay postulated the existence of a new group of elements, and in 1898 other members of the series (neon, krypton, and xenon) were isolated.

question 1

According to paragraph 1, what pattern did scientists notice when the known elements were written in order of increasing atomic mass?

A The elements of the group of alkali metals were the first elements in the order of increasing atomic mass.

B Repetition of the same atomic masses for elements in different groups appeared.

C Elements with similar chemical properties appeared in the listing at regular intervals.

D Elements were chemically most similar to those just before and after them in the order.

question 2

In paragraph 2, what is the author' s purpose in presenting the information about the decision by Meyer and Mendeleyev to leave gaps in the periodic table?

A To illustrate their confidence that the organizing principles of the periodic table would govern the occurrence of all chemical elements

B To indicate that some of their analyses of periodic physical and chemical properties were later found to be wrong

C To support the idea that they were unwilling to place new elements in the periodic table

D To indicate how they handled their disagreement about where to place new elements

question 3

What reason does the author provide for the claim that “Mendeleyev was bolder than Meyer” ?

A Mendeleyev corrected incorrect information Meyer had proposed.

B Mendeleyev assumed that some information believed to be true about the elements was incorrect.

C Mendeleyev argued that Meyer had not left enough gaps in the periodic table.

D Mendeleyev realized that elements were not ordered by atomic mass in the periodic table.

question 4

According to paragraph 2, why did Mendeleyev suggest changing the atomic mass of indium?

A Because indium did not fit into the periodic table in the place predicted by its atomic mass

B Because there was experimental evidence that the atomic mass that had been assigned to indium was incorrect

C Because there was an empty space between cadmium and tin in the periodic table

D Because the chemical properties of indium were similar to those of arsenic and selenium

question 5

It can be inferred from paragraph 2 that tellurium comes before iodine in the periodic table even though tellurium’ s atomic mass is slightly greater because

A iodine is less common than tellurium

B both iodine and tellurium have no isotopes

C the chemical behavior of tellurium is highly variable

D the atomic number of tellurium is smaller than that of iodine

question 6

Paragraph 3 suggests that Mendeleyev predicted the properties of eka-aluminum on the basis of

A the atomic mass of aluminum

B the position of the gap in the periodic table that eka-aluminum was predicted to fill

C the similarity of eka-aluminum to the other five missing elements

D observation of the properties of gallium

question 7

It can be inferred from paragraph 3 that the significance of the discovery of gallium was that it supported which of the following?

A The idea that aluminum was correctly placed in the periodic table

B Mendeleyev' s prediction that eka-silicon would be discovered next

C The organizing principle of the periodic table

D The idea that unknown elements existed

question 8

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 Ramsay found evidence of helium in the spectrum of sunlight before he discovered that the element was also contained in natural gas deposits on Earth.

B Ramsay thought he had discovered a new element present in natural gas

deposits, but he was wrong since that element had been previously observed elsewhere on Earth.

C After Ramsay had discovered a new element, called helium, in natural gas deposits on Earth, he also found evidence of its presence in the Sun.

D Ramsay later discovered that helium, an element that was already known to be present in the Sun, was also present in natural gas deposits on Earth.

question 9

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

The periodic table is a chart that reflects the periodic recurrence of chemical and physical properties of the elements when the elements are arranged in order of increasing atomic number(the number of protons in the nucleus). It is a monumental scientific achievement, and its development illustrates the essential interplay between observation, prediction, and testing required for scientific progress. In the 1800`s scientists were searching for new elements. By the late 1860's more than 60 chemical elements had been identified, and much was known about their descriptive chemistry. Various proposals were put forth to arrange the elements into groups based on similarities in chemical and physical properties. [] The next step was to recognize a connection between group properties (physical or chemical similarities) and atomic mass (the measured mass of an individual atom of an element). [] When the elements known at the time were ordered by increasing atomic mass, it was found that successive elements belonged to different chemical groups and that the order of the groups in this sequence was fixed and repeated itself at regular intervals. [] Thus when the series of elements was written so as to begin a new horizontal row with each alkali metal, elements of the same groups were automatically assembled in vertical columns in a periodic table of the elements. [] This table was the forerunner of the modern table. When the German chemist Lothar Meyer and (independently) the Russian Dmitry Mendeleyev first introduced the periodic table in 1869-70, one-third of the naturally occurring chemical elements had not yet been discovered. Yet both chemists were sufficiently farsighted to leave gaps where their analyses of periodic physical and chemical properties indicated that new elements should be located. Mendeleyev was bolder than Meyer and even assumed that if a measured atomic mass put an element in the wrong place in the table, the atomic mass was wrong. In some cases this was true. Indium, for example, had previously been assigned an atomic mass between those of arsenic and selenium. Because there is no space in the periodic table between these two elements, Mendeleyev suggested that the atomic mass of indium be changed to a completely different value, where it would fill an empty space between cadmium and tin. In fact, subsequent work has shown that in a periodic table, elements should not be ordered strictly by atomic mass. For example, tellurium comes before iodine in the periodic table, even though its atomic mass is slightly greater. Such anomalies are due to the relative abundance of the "isotopes" or varieties of each element. All the isotopes of a given element have the same

number of protons, but differ in their number of neutrons, and hence in their atomic mass. The isotopes of a given element have the same chemical properties but slightly different physical properties. We now know that atomic number (the number of protons in the nucleus), not atomic mass number (the number of protons and neutrons), determines chemical behavior. Mendeleyev went further than Meyer in another respect: he predicted the properties of six elements yet to be discovered. For example, a gap just below aluminum suggested a new element would be found with properties analogous to those of aluminum. Mendeleyev designated this element "eka-aluminum" (eka is the Sanskrit word for "next")and predicted its properties. Just five years later an element with the proper atomic mass was isolated and named gallium by its discoverer. The close correspondence between the observed properties of gallium and Mendeleyev's predictions for eka-aluminum lent strong support to the periodic law. When elements are arranged in order of their atomic number, most of the properties of the elements reoccur at regular intervals. Additional support came in 1885 when eka-silicon, which had also been described in advance by Mendeleyev, was discovered and named germanium. The structure of the periodic table appeared to limit the number of possible elements. It was therefore quite surprising when John William Strutt, Lord Rayleigh, discovered a gaseous element in 1894 that did not fit into the previous classification scheme. A century earlier, Henry Cavendish had noted the existence of a residual gas when oxygen and nitrogen are removed from air, but its importance had not been realized. Together with William Ramsay, Rayleigh isolated the gas (separating it from other substances into its pure state) and named it argon. Ramsay then studied a gas that was present in natural gas deposits and discovered that it was helium, an element whose presence in the Sun had been noted earlier in the spectrum of sunlight but that had not previously been known on Earth. Rayleigh and Ramsay postulated the existence of a new group of elements, and in 1898 other members of the series (neon, krypton, and xenon) were isolated.

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. Lord Rayleigh provided evidence that the structure of the periodic table limited the potential number of elements.

B. Ramsay and Lord Rayleigh challenged the importance of the chemical research that Henry Cavendish had done a century earlier.

C. Mendeleyev and Meyer organized the known elements into a chart that revealed periodic recurrences of chemical and physical properties.

D. Isotopes of a given element have exactly the same physical properties, but their chemical properties are slightly different.

E. Mendeleyev’ s successful prediction of the properties of then-unknown elements lent support to the acceptance of the periodic law.

F. In the 1890’ s, Ramsay and Lord Rayleigh isolated argon and proposed the existence of a new series of elements.