

Question Source:

CSET (California) General Science Sample Test

Which of the following is an example of heat transfer by convection?

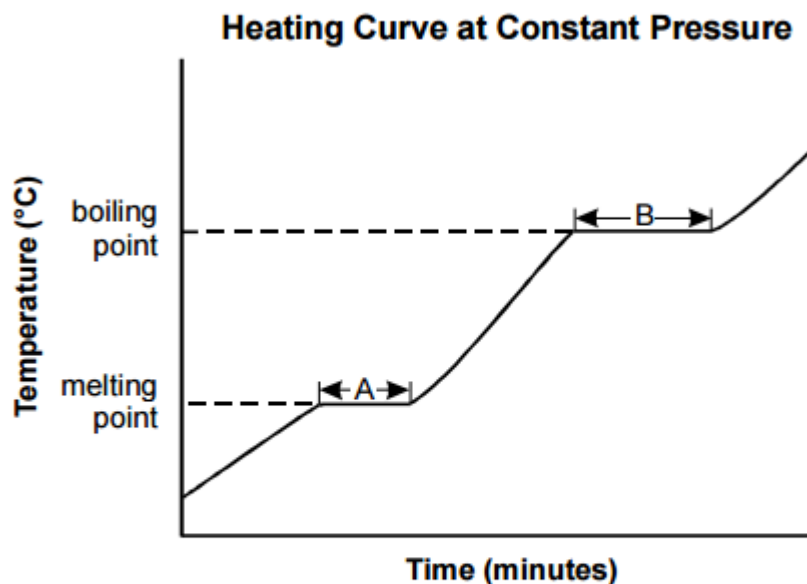
- A. Currents are formed in a household water heater as warm water rises to the top and cool water sinks to the bottom.
- B. A cup of hot coffee placed outside on a cold day becomes cool.
- C. A rock sitting in the sun decreases in temperature when it is sprayed with water from a hose.
- D. Sunlight coming through a window warms the window sill.

Correct Response: A. (SMR Code: 11.1) Convection is the process by which heat is transferred through the movement of a heated fluid. In a household water heater, the water is heated from below by conduction of heat from the heating element to the water. Heating the water causes it to become less dense and, therefore, more buoyant. The heated water rises due to its increased buoyancy, forming currents that rise into the cooler water. As the heated water rises, it transfers some of its heat to the surrounding cooler water. The rising current of water becomes cooler itself, until eventually it becomes cool and dense enough to start sinking.

Question Source:

CSET (California) General Science Sample Test

Use the graph below to answer the question that follows.



The graph above shows the heating curve of a substance. Which of the following best explains why section B of the graph is longer than section A?

- A. The energy required to change the substance from liquid to gas is greater than to change it from solid to liquid.
- B. The average kinetic energy of the molecules increases as the temperature increases.
- C. The entropy increases more when the substance changes from solid to liquid than when it changes from liquid to gas.
- D. The volume of the substance and the time required to heat it increase as the substance changes phase.

Correct Response: A. (SMR Code: 11.1) Section B of the graph is longer than section A because more energy is required to vaporize the substance than to melt it. During a phase change, energy is used to rearrange molecules in a melting solid or to spread molecules apart in a vaporizing liquid. For this reason, the substance stays at a steady temperature until the phase change is complete, at which time the applied energy begins increasing the substance's temperature again.

Question Source:

CSET (California) General Science Sample Test

Use the data table below to answer the question that follows.

Substance	Phase	Mass	Volume
1	liquid	6 g	8 cm ³
2	liquid	9 g	9 cm ³
3	liquid	20 g	5 cm ³
4	solid	5 g	4 cm ³
5	solid	8 g	9 cm ³

The mass and volume of five substances are measured and recorded. Which of the following is a valid conclusion that can be drawn from the data above?

- A. Substance 4 will float in Substance 2 when both are in the liquid phase.
- B. Substance 4 will float in Substance 1.
- C. Substance 3, in solid form, will float in the liquid form of Substance 3.
- D. Substance 5 will float in Substance 2.

Correct Response: D. (SMR Code: 12.1) A substance, whether solid or liquid, will float on another liquid substance if the density of the first substance is less than the density of the second. Only response choice D definitively meets this criterion. Density (d) is defined as the mass (m) per unit volume (V) of a material, shown by the formula $d = m/V$. The density of Substance 5 equals 0.9 g/cm^3 , while the density of Substance 2 equals 1 g/cm^3 . Therefore, Substance 5 will float in Substance 2.

Question Source:

CSET (California) General Science Sample Test

A chemist mixed two solutions in a test tube. The chemist observed that a white precipitate formed and the test tube became warm. Which of the following best explains what occurred in the test tube?

- A. A chemical change caused atoms to be rearranged and new substances to be formed.
- B. A chemical change occurred, and heat from the reaction caused a phase change in the reactants.
- C. A physical change caused atoms to be rearranged and new substances to be formed.
- D. A physical change occurred, and heat from the reaction caused a phase change in the reactants.

Correct Response: A. (SMR Code: 12.1) Chemical change involves a rearrangement of atoms through the making and breaking of chemical bonds. Changes in temperature and the formation of a solid precipitate when two solutions are mixed are signs that a chemical change has occurred and the chemical identities of the substances have changed.

CSET (California) General Science Sample Test

A blank periodic table is shown, with the title "Periodic Table" centered at the top. The table is a grid of cells representing elements. Four specific locations are labeled with letters:

- A** is located in the 4th row, 14th column (Carbon).
- B** is located in the 4th row, 16th column (Sulfur).
- C** is located in the 3rd row, 17th column (Chlorine).
- D** is located in the 3rd row, 18th column (Argon).

- A. is poor at all temperatures.
- B. increases with increasing temperature.
- C. is good at all temperatures.
- D. decreases with increasing temperature.

Correct Response: A. (SMR Code: 12.1) The section of the periodic table labeled C encompasses the nonmetals. Nonmetals are characterized by poor electrical conductivity at any temperature, whereas the metals (Section A) have good conductivity that decreases with increasing temperatures.

Question Source:

CSET (California) General Science Sample Test

A certain gas at STP exists as a monatomic species and is chemically unreactive. In which part of the periodic table is this element most likely found?

- A. Group 1 (IA)
- B. Groups 13 (IIIA) through 17 (VIIA)
- C. Group 18 (VIII A)
- D. Groups 3 (IIIB) through 7 (VIIB)

Correct Response: C. (SMR Code: 12.1) Since the gas is made up of individual atoms and is chemically unreactive, the atoms of which it is composed must have completely filled valence shells. This property is characteristic of the noble gases in Group 18 (VIII A).

Question Source:

CSET (California) Chemistry Sample Test

Which of the following statements about the properties of elements in the periodic table is generally true?

- A. Elements in same period of the periodic table have the same atomic radius because they have the same number of orbitals in their electron configuration.
- B. Elements in Group 1 (IA) and Group 3 (IIIB) have similar chemical properties because they have the same number of valence electrons.
- C. Moving down the periodic table, the ionization energies of the elements within a group increase as the number of orbitals in their electron configurations increases.
- D. Elements in the same group of the periodic table have similar chemical properties because they have the same number of valence electrons.

Correct Response: D. (SMR Code: 1.1) Valence electrons occupy the outermost energy level of an atom and are primarily responsible for determining an element's chemical properties. Elements with the same number of valence electrons belong to the same group, or column, of the periodic table. For example, the elements in Group 1 (IA) have one valence electron and are highly reactive, whereas the elements in Group 18 (VIIIA) have eight valence electrons that fill the outermost level, making these elements chemically unreactive.

Question Source:

CSET (California) Chemistry Sample Test

The bright-line spectrum of the hydrogen atom is not continuous because electron transitions:

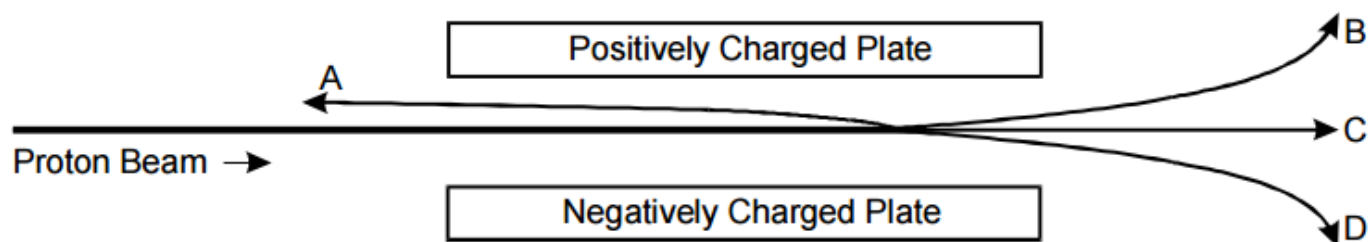
- A. involve discrete amounts of energy.
- B. always involve electron pairs.
- C. are not possible according to the quantum model.
- D. involve random amounts of energy.

Correct Response: A. (SMR Code: 1.2) Electron transitions from one orbit to another result in specific amounts of energy being released or absorbed. These quanta of energy appear as characteristic lines on the spectrum for each element. Since the released or absorbed energy is not continuous over a range of values, the bright-line spectrum also is not continuous.

Question Source:

CSET (California) Chemistry Sample Test

Use the diagram below to answer the question that follows.



Which path would a beam of protons follow in this experiment?

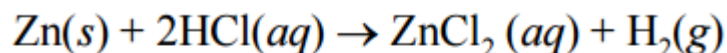
- A. path A
- B. path B
- C. path C
- D. path D

Correct Response: D. (SMR Code: 1.2) A proton has a unit-positive charge, so protons in the beam will be repelled by the positively charged plate and be attracted by the negatively charged plate. This will tend to deflect the beam of protons downward, as shown by path D.

Question Source:

CSET (California) Chemistry Sample Test

Use the equation below to answer the question that follows.



During the reaction of zinc metal with hydrochloric acid, hydrogen is released according to the equation above. If 54.0 g of Zn reacts with excess HCl, what is the volume of H₂ gas that is formed at STP?

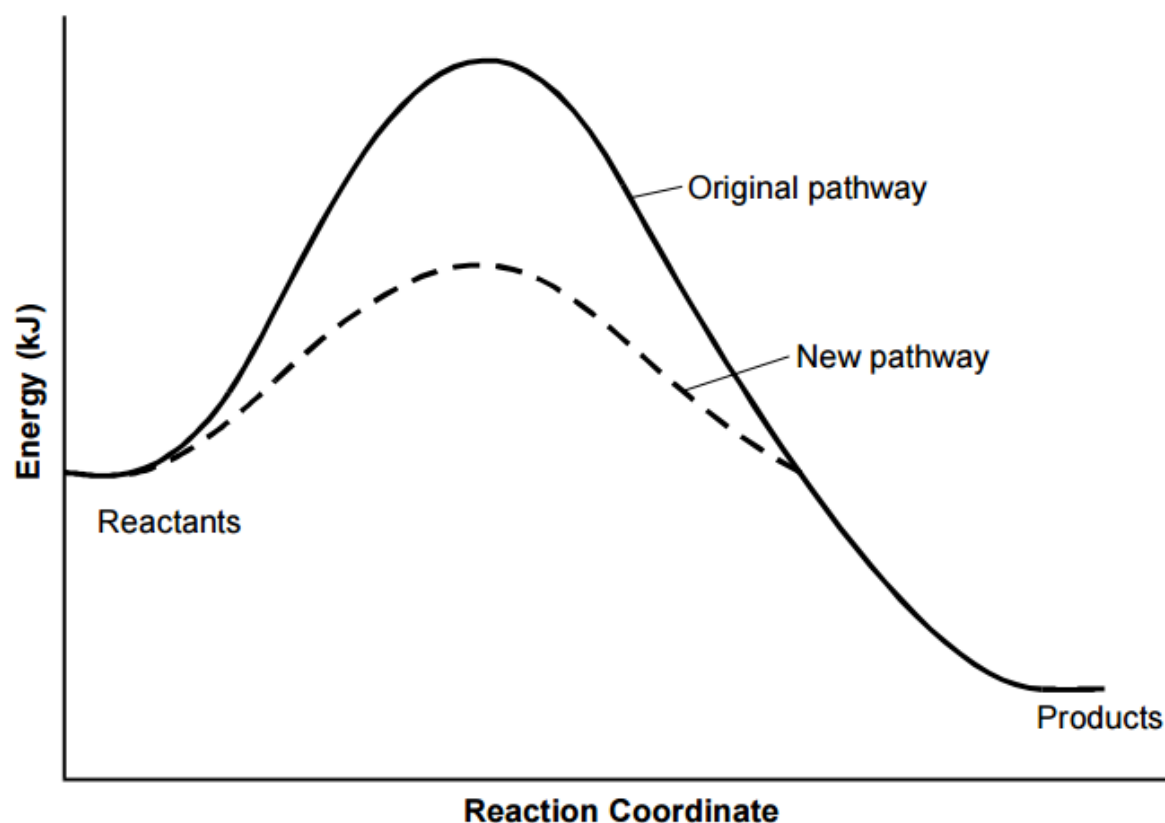
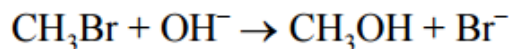
- A. 11.9 L
- B. 18.6 L
- C. 22.4 L
- D. 23.9 L

Correct Response: B. (SMR Code: 2.1) The number of moles of zinc reacted is calculated by dividing the molar mass of zinc into the mass used, $54.0 \text{ g} \div 65.4 \text{ g/mol} = 0.826 \text{ moles}$. Since the coefficients for Zn and H_2 in the balanced reaction are both 1, 0.826 moles of H_2 gas must be formed. The ideal gas equation can be used to determine the volume of H_2 at STP. Solving for volume gives $V = \frac{nRT}{P}$. The known values can be inserted into the equation, giving $V = \frac{(0.826 \text{ mol})(0.08206 \text{ L}\cdot\text{atm/K}\cdot\text{mol})(273 \text{ K})}{1 \text{ atm}} = 18.6 \text{ L}$.

Question Source:

CSET (California) Chemistry Sample Test

Use the information below to answer the question that follows.



The graph above shows the energy profile for the given reaction. Which of the following actions will result in the new pathway illustrated on the graph?

- A. adding a catalyst
- B. adding Br^-
- C. adding OH^-
- D. increasing the temperature

Correct Response: A. (SMR Code: 2.2) Adding a catalyst will result in the new pathway indicated on the graph. Catalysts increase the rate of reaction, almost always by lowering the amount of activation energy needed to initiate the reaction. The catalyzed reaction will follow a path requiring less energy than if the catalyst had not been present.

Question Source:

CSET (California) Chemistry Sample Test

A sample of N_2 occupies a volume of 2.50 L at -120°C . To which of the following approximate temperatures should the gas be heated in order to double the volume of the gas without changing its pressure?

- A. -240°C
- B. -60°C
- C. 33°C
- D. 306°C

Correct Response: C. (SMR Code: 3.1) According to Charles's law, the volume of a fixed amount of gas at a constant pressure is directly proportional to the gas's absolute temperature. Therefore, doubling the absolute temperature of the sample of N_2 gas will double its volume. The gas's starting absolute temperature is $-120^\circ\text{C} + 273 = 153\text{ K}$. Doubling the absolute temperature gives 306 K , or 33°C .

Question Source:

CSET (California) Chemistry Sample Test

The velocity of H_2 molecules is 1838 m/s at 0°C . Which of the following is a likely value for the velocity of O_2 molecules at the same temperature?

- A. 115 m/s
- B. 460 m/s
- C. 1838 m/s
- D. 7352 m/s

Correct Response: B. (SMR Code: 3.1) When two gas samples are at the same temperature, the particles of both samples have the same average kinetic energy. The kinetic energy of a particle is given by $KE = \frac{1}{2}mv^2$. Therefore, in this example:

$$KE_{H_2} = KE_{O_2}$$

$$\frac{1}{2}(m_{H_2})(v_{H_2})^2 = \frac{1}{2}(m_{O_2})(v_{O_2})^2$$

$$(m_{H_2})(v_{H_2})^2 = (m_{O_2})(v_{O_2})^2$$

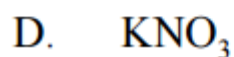
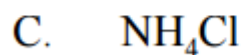
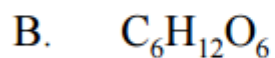
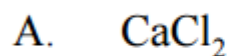
$$(2.02 \text{ amu})(1838 \text{ m/s})^2 = (32.0 \text{ amu})(v_{O_2})^2$$

$v_{O_2} = 461.8 \text{ m/s}$, so of the options listed, 460 m/s is the most reasonable velocity for the O_2 molecules.

Question Source:

CSET (California) Chemistry Sample Test

Which of the following compounds, when dissolved in water in equal molarities, will generate the greatest number of dissolved particles?

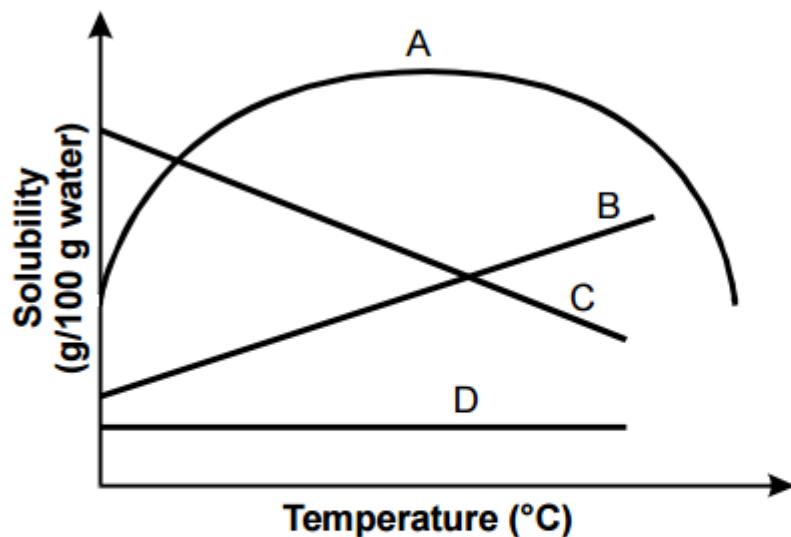


Correct Response: A. (SMR Code: 4.1) Of the compounds listed, CaCl_2 is the one that will dissociate into the greatest number of separate particles. Each mole of CaCl_2 will dissociate in water into 3 moles of ions—1 mole of Ca^{2+} ions and 2 moles of Cl^{-} ions.

Question Source:

CSET (California) Chemistry Sample Test

Use the graph below to answer the question that follows.



Which of the lines in the graph above represents the general relationship between solubility and solution temperature for most soluble solids dissolved in water?

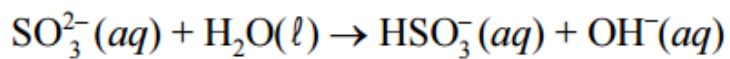
- A. Line A
- B. Line B
- C. Line C
- D. Line D

Correct Response: B. (SMR Code: 4.1) The solubility of many solids in water increases as the temperature increases, as represented by Line B on the graph. As the temperature of the solution increases, there is more energy available to overcome ionic or intermolecular forces in the solid.

Question Source:

CSET (California) Chemistry Sample Test

In the following reaction, as written, which species is acting as a Brønsted-Lowry acid?



A. H_2O

B. SO_3^{2-}

C. HSO_3^{-}

D. OH^{-}

Correct Response: A. (SMR Code: 4.2) According to the Brønsted-Lowry definition of acids and bases, an acid is a proton (H^+) donor, while a base is a proton acceptor. In the acid-base reaction shown in this example, water acts as the Brønsted-Lowry acid, donating a proton to the Brønsted-Lowry base, SO_3^{2-} , resulting in OH^- and HSO_3^- .

Question Source:

CSET (California) Chemistry Sample Test

A solid aluminum ingot with a mass of 4110 grams cools from 660.0°C to 25.0°C. During the process, 2.36×10^6 joules of heat are released. What is the specific heat of the aluminum?

- A. 0.838 J/g°C
- B. 0.870 J/g°C
- C. 0.904 J/g°C
- D. 23.0 J/g°C

Correct Response: C. (SMR Code: 5.1) The heat transfer relationship is given by the equation $q = mc\Delta T$, where q = heat transfer, m = mass, c = specific heat, and ΔT = change in temperature. Inserting the known quantities and solving gives $2.36 \times 10^6 \text{ J} = (4110 \text{ g})(c)(635^\circ\text{C})$, or $c = 0.904 \text{ J/g}^\circ\text{C}$.

Question Source:

CSET (California) Chemistry Sample Test

Use the information below to answer the question that follows.

Specific heat of water = $4.184 \text{ J/g}^\circ\text{C}$

Specific heat of steam = $2.02 \text{ J/g}^\circ\text{C}$

$\Delta H_{\text{fus}} = 334 \text{ J/g}$

$\Delta H_{\text{vap}} = 2.26 \times 10^3 \text{ J/g}$

A 25.0 g sample of water is heated from 52.0°C to steam at 140.0°C . How much heat is needed to complete this process?

A. $4.44 \times 10^3 \text{ J}$

B. $6.35 \times 10^4 \text{ J}$

C. $6.57 \times 10^4 \text{ J}$

D. $7.49 \times 10^4 \text{ J}$

Correct Response: B. (SMR Code: 5.1) The heating process can be divided into three distinct segments.

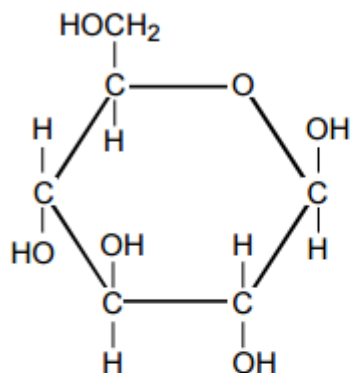
- 1) heating the liquid water from 52°C to 100°C
using the equation $q = mc\Delta T$
 $q = (25.0 \text{ g})(4.184 \text{ J/g}^\circ\text{C})(48^\circ\text{C}) = 5.02 \times 10^3 \text{ J}$
- 2) the phase change from liquid to vapor at 100°C
using the equation phase change energy = $m\Delta H_{\text{vap}}$
phase change energy = $(25.0 \text{ g})(2.26 \times 10^3 \text{ J/g}) = 5.65 \times 10^4 \text{ J}$
- 3) heating the steam from 100°C to 140°C
using the equation $q = mc\Delta T$
 $q = (25.0 \text{ g})(2.02 \text{ J/g}^\circ\text{C})(40^\circ\text{C}) = 2.02 \times 10^3 \text{ J}$

The total energy for this heating process is the sum of the energy for all the segments.
 $(5.02 \times 10^3 \text{ J}) + (5.65 \times 10^4 \text{ J}) + (2.02 \times 10^3 \text{ J}) = 6.35 \times 10^4 \text{ J}$

Question Source:

CSET (California) Chemistry Sample Test

Use the diagram below to answer the question that follows.



The structural formula shown above is the monomer for which of the following types of molecules?

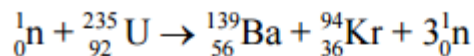
- A. polysaccharide
- B. polypeptide
- C. phospholipid
- D. nucleotide polymer

Correct Response: A. (SMR Code: 6.1) The structural formula represents a glucose monomer. When many of these monomers chemically join together, they form a polysaccharide, such as cellulose or glycogen.

Question Source:

CSET (California) Chemistry Sample Test

Use the equation below to answer the question that follows.



The equation above represents one of the possible nuclear reactions that takes place during the fission of uranium-235 as currently used in power plants. Which of the following statements regarding mass in this reaction is true?

- A. The mass of the products equals the mass of the reactants.
- B. The mass of the products is less than the mass of the reactants.
- C. The mass of the products is more than the mass of the reactants.
- D. The mass of the products is unpredictable compared to the mass of the reactants.

Correct Response: B. (SMR Code: 7.1) In this nuclear reaction, the combined mass of $^{139}_{56}\text{Ba}$ and $^{94}_{36}\text{Kr}$ ($139 + 94 = 233$) is less than the mass of $^{235}_{92}\text{U}$. Since the total number of protons remains the same (92) between reactant and products, the loss in mass must result from the release of free neutrons during the reaction.

Question Source:

CSET (California) Chemistry Sample Test

Thyroid cancer can be treated by giving the patient radioactive iodine-131. Iodine-131 accumulates exclusively in the thyroid gland, thus exposing the cancerous cells to the radiation. If a patient is given a 1.0 g dose of iodine-131 and 0.0625 g remains after 32 days, what is the half-life of iodine-131?

- A. 2 days
- B. 8 days
- C. 17 days
- D. 30 days

Correct Response: B. (SMR Code: 7.1) The half-life of a radioactive isotope is the time it takes for half of a sample of the isotope to decay. In this example, since 0.0625 g is one-sixteenth of the original 1.0 g of iodine-131, the iodine must have undergone four half-lives during the 32 days, since $\frac{1}{16} = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$. Therefore, the half-life of iodine-131 is $32 \div 4 = 8$ days.