

Molecules and Extended Structures: Mastery Check

Learning target: I can read and build models of molecules and extended structures, state a substance's composition as a count or a ratio, and explain how composition and structure decide what a substance is and how it behaves.

Retrieval and mastery check

About 35 min

Individual

MS-PS1-1 · assesses

independent practice

writing

Name _____

Date _____

Period _____

Directions

Work alone. Part A has twelve retrieval items; answer every one, showing calculations where numbers are involved and following the drawing rules for the model item. Part B is one paragraph that pulls the chapter together. You may not use notes or the textbook. Budget about 20 minutes for Part A and 15 for Part B.

You will need: This worksheet, Pencil, Scrap paper

Part A: Retrieval (12 items)

- Which of these is a molecule? 1 pt
☐ A. A grain of table salt
☐ B. One particle of water, H_2O
☐ C. A chip of diamond
☐ D. A crystal of quartz
- Hydrogen peroxide has the formula H_2O_2 . In one molecule: hydrogen atoms ____ oxygen atoms ____ total atoms ____ 1 pt

- True or false: Oxygen gas, O_2 , is not a molecule, because both of its atoms are the same element. 1 pt
Explain.
☐ True ☐ False Explain your thinking:

4. Which statement about solid table salt, NaCl, is correct? 1 pt

- ☐ A. Each salt molecule contains one sodium and one chlorine.
- ☐ B. Sodium and chlorine alternate in a repeating pattern in all directions, one for one, with no separate molecules.
- ☐ C. A large grain has a higher sodium-to-chlorine ratio than a small grain.
- ☐ D. Salt is a polymer made of a chain of sodium and chlorine.

5. Quartz has one silicon atom for every two oxygen atoms. A quartz fragment contains 350 silicon atoms. How many oxygen atoms does it contain, and how many atoms in total? Show your work. 2 pts

6. Butane and isobutane both have the formula C_4H_{10} . State what is the same about them, what is different, and whether they are the same substance. 2 pts

7. Graphite and diamond are both pure carbon. Why does graphite leave a mark on paper while diamond does not? 1 pt

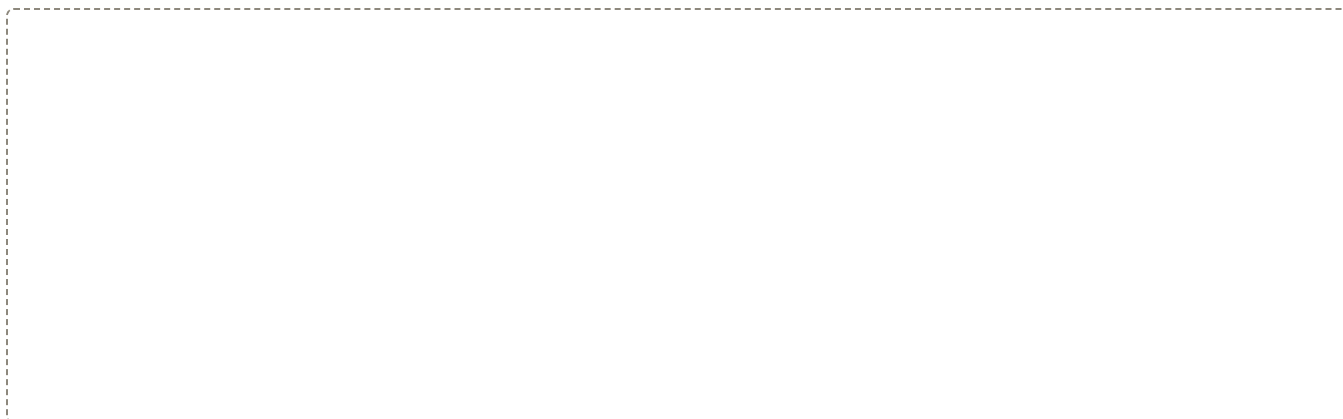
- ☐ A. Carbon atoms in graphite are softer than carbon atoms in diamond.
- ☐ B. Graphite's carbon atoms are bonded in flat sheets held together only by weak attractions, so the sheets slide off; diamond's atoms are bonded in all directions.
- ☐ C. Graphite is a mixture of carbon and clay, and the clay makes the mark.
- ☐ D. Graphite's atoms are farther apart than diamond's, so they fall off more easily.

8. Label each substance as **molecule**, **crystal** or **polymer**: ice _____ PVC pipe _____ ammonia (NH_3) _____ diamond _____ 2 pts

9. In a ball-and-stick model, the oxygen spheres are red. What does the red color tell you, and what does it **not** tell you about real oxygen atoms? 1 pt

10. Caffeine has the formula $C_8H_{10}N_4O_2$. How many atoms are in one caffeine molecule? What is the ratio of hydrogen atoms to carbon atoms, in lowest terms? Show your work. 2 pts

11. Draw a ball-and-stick model of one ammonia molecule, NH_3 . Nitrogen forms three bonds and hydrogen forms one. Write the letter of each element inside its sphere, add a legend, and write the atom counts beneath the model. 3 pts



12. Why is the composition of an extended structure written as a ratio instead of a count? 1 pt
- ☐ A. Because scientists have no way to count its atoms.
 - ☐ B. Because it has no fixed size, so only the proportion of its elements stays the same.
 - ☐ C. Because its atoms are all the same element.
 - ☐ D. Because its atoms are not held together by chemical bonds.

Part B: Synthesis

13. Write a paragraph (5-7 sentences) answering: **How can fewer than one hundred kinds of atoms make millions of different substances?** Use the words **molecule**, **composition**, **structure**, **extended structure** and **ratio**, and support your answer with two specific examples from this chapter. 6 pts

If you get stuck

Skip any item that stalls you and come back to it; the items do not depend on one another. For q5 and q10, write the formula's numbers in a column before you add or multiply. For q11, draw the nitrogen first, then attach exactly three sticks and put a hydrogen on each. For q13, outline four points on scrap paper before writing: atoms join; counts can differ; connections can differ; patterns can repeat without end. Then write one sentence for each point and add your two examples.

Two more arrangements

Propane has the formula C_3H_8 and pentane has the formula C_5H_{12} . Using the rule that carbon forms four bonds and hydrogen one, draw ball-and-stick models and decide how many different arrangements (structures) each formula allows with no rings. Then explain, in two sentences, why the number of possible substances grows faster than the number of atoms in the formula, and what that says about the 'millions of substances' question in Part B.