

## Physical Science: Content Knowledge (0481)

### Test at a Glance

Test Name	Physical Science: Content Knowledge		
Test Code	0481		
Time	1 hour		
Number of Questions	60		
Format	Multiple-choice questions; calculator use prohibited		
	Content Categories	Approximate Number of Questions	Approximate Percentage of Examination
	I. Methodology; Math, Measurement, Data; Science, Technology, and Society	20	33%
	II. Laboratory Procedures and Safety; Matter and Energy	22	37%
	III. Heat and Thermodynamics; Atomic and Nuclear Structure	18	30%

## About This Test

The Physical Science: Content Knowledge test measures fundamental knowledge common to physics and chemistry, and competencies necessary for a beginning teacher of one of the physical sciences in a secondary school. Examinees have typically completed or nearly completed a bachelor's degree program in one of the physical sciences, with appropriate coursework in education.

The 60 multiple-choice questions address examinees' breadth of knowledge in topics common to physics and chemistry, embracing scientific principles, facts, methodology, philosophy, laboratory procedures, and data manipulation. The test covers the content areas of atomic and nuclear structure, heat and thermodynamics, matter and energy, and science, technology, and society.

Topics are typically covered in one of the introductory college-level physical science courses, although some questions of a more advanced nature are included since secondary school instructors must understand the subject matter from a more advanced viewpoint than that presented to their students.

This test may contain some questions that will not count toward your score.

Examinees are not permitted to use calculators during the test. Test books contain a periodic chart of the elements and a table of information that presents various physical constants and a few conversion factors among SI units. Whenever necessary, additional values of physical constants are printed with the text of the question.

## Topics Covered

Representative descriptions of topics covered in each category are provided below.

### I. Methodology; Math, Measurement, Data; Science, Technology, and Society

- Scientific methodology and philosophy:
  - scientific methods
  - science process skills
  - experimental design
  - historical roots of science
- Mathematics, measurement, and data manipulation:
  - measurement and notation systems
  - data presentation and interpretation, including error analysis
- Science, technology, and society:
  - impact of science and technology on the environment and human affairs
  - ethical issues and moral responsibilities associated with applications of science
  - management of natural resources
  - use of science and technology in daily life
  - issues associated with energy production, transmission and use, and management
  - issues associated with the production, storage, use, management, and disposal of consumer products
  - social, political, and economic issues arising from science and technology

### II. Laboratory Procedures and Safety; Matter and Energy

- Laboratory procedures and safety:
  - safe preparation, storage, use, and disposal of laboratory and field materials
  - selection and use of appropriate laboratory equipment
  - emergency procedures for laboratory accidents
- Matter and energy:
  - organization of matter
  - physical and chemical properties and changes of matter
  - forms and transformations of matter and energy
  - conservation of mass/energy

### III. Heat and Thermodynamics; Atomic and Nuclear Structure

- Heat and thermodynamics:
  - measurement and transfer of thermal energy and its effects on matter
  - kinetic molecular theory and gas laws
  - phase changes
  - laws of thermodynamics
  - heat and temperature: concepts, measurement, and units
- Atomic and nuclear structure:
  - atomic models and their experimental bases
  - atom structure and spectra
  - radioactivity: radioactive decay and nuclear reactions
  - electromagnetic radiation

## Sample Test Questions

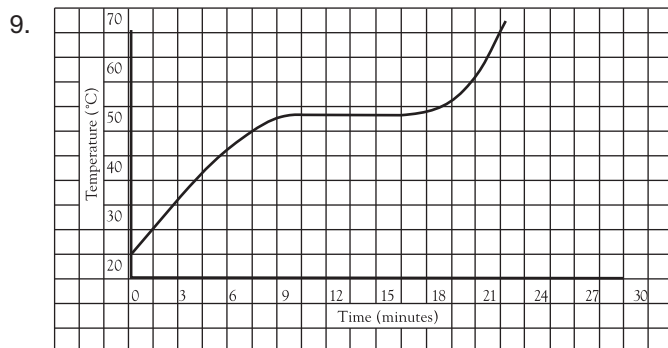
The sample questions that follow illustrate the kinds of questions in the test. They are not, however, representative of the entire scope of the test in either content or difficulty. Answers with explanations follow the questions.

**Directions:** Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case.

- In a laboratory experiment, crystals are heated in a dry glass test tube using a Bunsen burner. During heating, a clear liquid is observed inside the mouth of the test tube. Which of the following is the most reasonable conclusion drawn from this observation?
  - The gas fuel used to heat the crystals forms water as it burns.
  - The crystals give off water when heated.
  - The crystals give off both hydrogen and oxygen gases that combine to form water.
  - Condensation from the air collects on the test tube as the crystals are heated
- Suppose that a mixture of 8 g of sugar, 5.20 g of salt, and 100.01 g of flour is prepared. What is the total mass of the mixture expressed in exponential notation and with the correct number of significant figures?
  - $1 \times 10^2$
  - $1.1 \times 10^2$
  - $1.13 \times 10^2$
  - $1.132 \times 10^2$
- The symbol for a specific isotope of gold is  $^{197}_{79}\text{Au}$ . Which of the following is consistent with this symbol?
  - 197 neutrons in the nucleus
  - 79 neutrons in the nucleus
  - 118 protons in the nucleus of each of its atoms
  - 79 electrons in a neutral atom
- Use of a small quantity of which of the following gases in a classroom requires special consideration because the gas is poisonous?
  - Steam
  - Hydrogen
  - Hydrogen sulfide
  - Carbon dioxide
- Supplies appropriate for the measurement in a school laboratory of the density of a small rock sample include all of the following EXCEPT
  - water
  - a graduated cylinder
  - a platform balance
  - a thermometer
- Which of the following properties of a substance depends on the amount of the sample?
  - Temperature
  - Half-life
  - Density
  - Inertia
- Which of the following is NOT a unit by which energy is measured?
  - Joule
  - Calorie
  - Electron-volt
  - Newton

8. The purpose of generators in a power plant is to transform energy from

- (A) chemical to electrical
- (B) electrical to chemical
- (C) mechanical to chemical
- (D) mechanical to electrical



A sample of a pure solid substance is heated at a constant rate and its temperature recorded as a function of time. A graph of the data is shown above. At about what temperature is the heat added being used to melt the substance?

- (A) 25°C
- (B) 41°C
- (C) 53°C
- (D) 60°C

10. Changes in which the entropy of the system increases include which of the following?

- I. Melting ice at room temperature
- II. Evaporating water at room temperature
- III. Dissolving NaCl in room-temperature water

- (A) I only
- (B) III only
- (C) I and II only
- (D) I, II, and III

11.

Isotope	Isotopic Mass (amu)	Percent Abundance
41	40.9	10.0%
44	43.9	30.0%
46	45.9	60.0%

A fictional element with the three naturally occurring isotopes described above would be listed in the periodic table with an atomic mass of

- (A) 42.1
- (B) 43.6
- (C) 44.8
- (D) 45.9

12. In an attempt to compare the half-lives of two radioactive elements, X and Y, a scientist set aside 400 g of each. After six months, the scientist found that 25 g of X and 200 g of Y remained. Which of the following statements is true?

- (A) The half-life of Y is twice the half-life of X.
- (B) The half-life of Y is four times the half-life of X.
- (C) The half-life of Y is eight times the half-life of X.
- (D) Unless the exact time interval is established, a comparison cannot be made.

## Answers

**1.** The crystals when heated may give off water in the form of steam. When this moist air reaches the top of the tube, condensation occurs inside the top of the tube because the tube is cooler than the rising warmer air. The correct answer is B.

**2.** For addition, the correct number of significant figures to the right of the decimal point in the answer is the same as the smallest number of digits to the right of the decimal point in any of the terms to be added. In this example, that number is zero.

$$\begin{array}{r} 8. \\ 5.20 \\ \hline 100.01 \\ 113. \end{array}$$

The number is then converted to exponential notation. The correct answer is C.

**3.** The correct answer is D. The numbers before the symbol for an element have the following meanings:

Top number: isotopic mass = the sum of the number of protons plus the number of neutrons in the nucleus of each of its atoms.

Bottom number: atomic number = the number of protons in the nucleus of each of its atoms.

Thus, each nucleus of this isotope contains 79 protons and  $197 - 79 = 118$  neutrons. In a neutral atom, the number of electrons is equal to the number of protons, 79 in this case.

**4.** Of the gases listed, only hydrogen sulfide is poisonous in small quantities. The correct answer is C.

**5.** The density of a rock is subject to very small variations with temperature, so the thermometer is not important. The other pieces of equipment are needed for the determination since density is mass per unit volume. The correct answer is D.

**6.** Inertia is an extensive property of a substance, proportional to its mass, and therefore depends on the amount of the sample. The correct answer is D.

**7.** A newton is a unit of force, and the other choices are units of energy. The correct answer is D.

**8.** A generator converts mechanical energy into electrical energy. The correct answer is D.

**9.** When a substance is heated, its temperature increases unless it is undergoing a phase change. During melting, the temperature remains constant since the energy absorbed is being used to do work against the attractive forces in becoming liquid particles. In the diagram, melting begins around 9 minutes and a temperature around  $53^{\circ}\text{C}$ . The correct answer is C.

**10.** Entropy is a measure of disorder. In all three cases, the disorder of the system increases. The correct answer is D.

**11.** A quick calculation using the isotope number,  $(0.1 \times 40.9) + (0.3 \times 43.9) + (0.6 \times 45.9) = 44.8$ , gives the correct answer, C.

**12.** Element X decayed from 400 g to 25 g, in a time period of 4 half-lives. Element Y decayed from 400 g to 200 g, in a time period of 1 half-life. Y decays slower than X, and the half-life of Y is 4 times that of X. The correct answer is B.



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