Michigan

TEST FOR TEACHER CERTIFICATION

STUDY GUIDE

97 Physical Science

MI-SG-FLD097-02

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National Evaluation Systems, P.O. Box 226, Amherst, MA 01004

PART 1: General Information About the MTTC Program and Test Preparation

The first section of the study guide is available in a separate PDF file. Click the link below to view or print this section.

General Information About the MTTC Program and Test Preparation

PART 2: Test Objectives and Sample Test Questions

INTRODUCTION

This section includes a list of the test objectives, immediately followed by sample test questions and an answer key for the field covered by this study guide.

Test Objectives

As noted, the test objectives are broad, conceptual statements that reflect the knowledge, skills, and understanding an entry-level teacher needs in order to teach effectively in a Michigan classroom. Each field's list of test objectives represents the **only** source of information about what a specific test will cover and, therefore, should be studied carefully.

The test objectives are organized into groups known as "subareas." These subareas define the major content areas of the test. You will find a list of subareas at the beginning of the test objective list. The percentages shown in the list of subareas indicate the approximate weighting of the subareas on the test.

Sample Multiple-Choice Test Questions

The sample multiple-choice test questions included in this section are designed to give the test-taker an introduction to the nature of the test questions included on the MTTC test for each field. The sample test questions represent the various types of test questions you may expect to see on an actual test; however, they are **not** designed to provide diagnostic information to help you identify specific areas of individual strengths and weaknesses or predict your performance on the test as a whole. Use the answer key that follows the sample test questions to check your answers.

To help you identify which test objective is being assessed, the objective statement to which the question corresponds is listed in the answer key. When you are finished with the sample test questions, you may wish to go back and review the entire list of test objectives and descriptive statements once again.

Physical Science (97) Field-Specific Information

For the Physical Science (97) test, you will be provided with one of the following models of scientific calculators at the test administration. You may not use your own calculator or calculator manual for this test. The models distributed are subject to change; directions for use will not be provided at the test site.

- Texas Instruments TI-30X
- Texas Instruments TI-30X Solar
- Texas Instruments TI-30Xa
- Texas Instruments TI-30Xs
- Texas Instruments TI-30XIIs

TEST OBJECTIVES

All examinees taking the Physical Science test (Field 97) will be provided with a Texas Instruments scientific calculator with functions that include the following: addition, subtraction, multiplication, division, square root, percent, sine, cosine, tangent, exponents, and logarithms. **You may NOT bring your own calculator to the test.**

Subarea	Approximate Percentage of Questions on Test
Foundations of Scientific Inquiry	20%
Concepts and Principles of Chemistry	40%
Concepts and Principles of Physics	40%

FOUNDATIONS OF SCIENTIFIC INQUIRY

Understand the principles and procedures of scientific inquiry.

Includes formulating research questions and investigations in physical science; developing valid experimental designs for collecting and analyzing data and testing hypotheses; recognizing the need for controlled experiments; understanding procedures for collecting and interpreting data to maintain objectivity; recognizing independent and dependent variables and constants, and analyzing the role of each in experimental design; identifying an appropriate method (e.g., graph, table, equation) for presenting data for a given purpose; applying mathematics to investigations in physical science and the analysis of data; interpreting results presented in different formats; evaluating the validity of conclusions; and assessing the reliability of sources of information.

Apply knowledge of methods and equipment used in scientific investigations.

Includes selecting and using appropriate measurement devices and methods for collecting data; evaluating the accuracy and precision of measurement in a given situation; identifying uncertainties in measurements and results; identifying procedures and sources of information related to the safe use, storage, and disposal of materials and equipment related to physical science investigations; identifying hazards associated with laboratory practices and materials (e.g., chemical safety, heat sources, electricity); and applying procedures for preventing accidents and dealing with emergencies.

Understand the development of scientific thought and inquiry.

Includes demonstrating knowledge of the reliance of scientific investigations on empirical data, verifiable evidence, and logical reasoning; recognizing the effect of researcher bias on scientific investigations and the interpretation of data; demonstrating an awareness of key contributions made to physical science by prominent groups and individuals of diverse cultures and from different time periods; and recognizing the dynamic nature of scientific knowledge, including ways in which scientific knowledge changes.

Understand the relationships of physical science to technological and social issues, both contemporary and historical.

Includes analyzing the role of science in human affairs; recognizing the relationships between science and technology; identifying political and social factors that influence developments in physical science, including current issues and controversies related to physical science research and technology (e.g., energy sources and use, applications and effects of various types of radiation); and evaluating the credibility of scientific claims made in various forums (e.g., the Internet, professional journals, advertising).

Understand interrelationships among the physical, life, and earth/space sciences.

Includes recognizing major unifying themes and concepts that are common to the various scientific disciplines (e.g., patterns, cause and effect, conservation laws, entropy); and demonstrating knowledge of the integration and interdependence of the sciences, the interdisciplinary connections among the sciences, and their applications in real-world contexts.

CONCEPTS AND PRINCIPLES OF CHEMISTRY

Understand chemical properties of matter.

Includes using atomic and molecular structure to explain chemical behavior; relating atomic structure to the structure and organization of the periodic table; differentiating among elements, compounds, and mixtures; identifying the structures of various types of compounds (e.g., acids, bases, polymers, aromatic and aliphatic hydrocarbons); identifying the structure and reactivity of major functional groups; demonstrating basic knowledge of isomers (e.g., stereoisomers, geometric isomers, optical isomers); and recognizing the structure and function of biomolecules (e.g., carbohydrates, proteins, lipids).

Understand the physical properties of matter.

Includes demonstrating knowledge of the physical characteristics of matter (e.g., density, mass, atomic structure); applying knowledge of the characteristics of the states of matter; applying the kinetic theory of matter; analyzing phase changes; demonstrating knowledge of the physical properties of common materials (e.g., metals, nonmetals, water); identifying colligative properties of solutions; relating the structure of substances to physical properties (e.g., melting point, conductivity, solubility); comparing the physical properties of mixtures and solutions; and demonstrating knowledge of the gas laws and their relationship to the ideal gas law.

Understand the properties and characteristics of chemical bonds.

Includes relating the electron configuration of an atom to its chemical reactivity; comparing and contrasting the character and properties of covalent, metallic, and ionic bonds; identifying the nature of intermolecular and intramolecular forces; analyzing the relationship between intermolecular forces and the physical properties of a given substance; analyzing chemical bonds in terms of electronegativity, electron affinity, and oxidation state; and analyzing energy changes in the formation and dissociation of chemical bonds.

Understand the types and characteristics of chemical reactions.

Includes analyzing common chemical changes (e.g., acid-base reactions, oxidation-reduction reactions, aliphatic and alicyclic reactions); analyzing the effects of concentration, pressure, temperature, and catalysts on chemical equilibrium and applying Le Chatelier's principle to chemical systems; analyzing electrochemical reactions in electrochemical cells; analyzing how temperature, concentrations, and catalysts affect reaction rates; demonstrating knowledge of the basic principles of chemical thermodynamics; and analyzing energy-reaction coordinate diagrams.

Apply the principles and methods of stoichiometry and the rules of chemical nomenclature and notation for inorganic and organic substances.

Includes applying basic rules of nomenclature; interpreting symbols and chemical notation for elements, isotopes, ions, molecules, and compounds; defining a mole and recognizing the significance of the mole concept; calculating the number of moles in a given mass or volume of a substance; solving problems involving molecular and formula masses and percent composition; determining empirical and molecular formulas; applying the law of conservation of mass to solve problems involving moles, mass, and volume and problems involving solution chemistry; balancing chemical equations; solving problems involving limiting reagents and percent yield; and recognizing net ionic equations.

Understand analytical techniques.

Includes demonstrating knowledge of various separation techniques (e.g., distillation, filtration, chromatography) and their basic principles; selecting an appropriate separation technique in a given situation; demonstrating knowledge of methods and equipment used for determining the types of substances present in a sample using spectroscopy (i.e., mass, IR, visible, and UV); and identifying common techniques of qualitative analysis.

CONCEPTS AND PRINCIPLES OF PHYSICS

Analyze forces and motion in one and two dimensions.

Includes analyzing information related to displacement, speed, velocity, and acceleration presented in one or more representations (e.g., graphs, tables, equations); solving problems involving constant acceleration (e.g., free fall); applying principles of trigonometry and properties of vectors to analyze two-dimensional situations (e.g., equilibrium, uniform circular motion, projectile motion, rotational dynamics); applying Newton's laws of motion to solve a variety of problems involving different types of forces (e.g., normal, tension, friction, buoyant); analyzing the vector nature of force; identifying action-reaction forces; identifying methods for measuring force; differentiating between mass and weight; and applying the law of universal gravitation in a variety of situations (e.g., satellite and planetary motion).

Understand conservation laws and thermodynamics.

Includes applying the concepts of work, forms of energy, and power in a variety of situations (e.g., inclined planes, pulleys); analyzing the kinetic and potential energy of various systems (e.g., a simple harmonic oscillator, a spring that obeys Hooke's law, a satellite in orbit); applying the principles of conservation of energy and conservation of linear and angular momentum to a variety of situations; differentiating between temperature, internal energy, and heat; calculating heat loss or gain using specific heat; identifying processes of thermal energy transfer (i.e., convection, conduction, radiation); applying the principles of enthalpy, internal energy, and thermodynamic work; and analyzing the relationship between entropy and the availability of energy to perform work.

Understand the characteristics of waves and wave motion, including the principles of sound and acoustics.

Includes describing the transfer of momentum and energy by wave motion; comparing longitudinal and transverse waves; analyzing characteristics of waves (e.g., amplitude, wavelength, frequency, speed); demonstrating knowledge of reflection, refraction, diffraction, and the Doppler effect; analyzing the production and propagation of mechanical waves; applying the principle of superposition to investigate the properties of constructive and destructive interference; and analyzing resonance and the production of musical sounds in vibrating strings and air columns.

Understand basic principles of electromagnetism.

Includes demonstrating knowledge of principles of electrostatics; identifying the properties of conductors, insulators, semiconductors, and superconductors; applying Ohm's law to the analysis of series and parallel circuits; analyzing energy transfer and conservation in electrical circuits; applying Coulomb's law to determine forces and fields due to various charge distributions (e.g., electric dipole); applying the concepts of electric potential; identifying the sources and properties of magnetic fields (e.g., strength, direction); determining the effect of a magnetic field on moving charges; analyzing the role of magnetic force in the operation of technological devices (e.g., solenoids, galvanometers, motors, loudspeakers); and using the principle of electromagnetic induction to explain the operation of technological devices (e.g., generators, transformers, dynamic microphones).

Understand the electromagnetic spectrum and the properties of electromagnetic waves.

Includes analyzing the generation and propagation of electromagnetic waves; demonstrating knowledge of the properties of the electromagnetic spectrum (e.g., wavelength, frequency, energy per photon); using the wave theory of light to analyze reflection, refraction, dispersion, interference, diffraction, and polarization; using ray diagrams and formulas for lenses and mirrors; demonstrating knowledge of the operation of optical instruments and materials (e.g., microscope, telescope, fiber optic cable); and recognizing technological applications of electromagnetic waves (e.g., cell phones, remote controls, medical x-rays).

Understand the basic concepts and applications of modern physics.

Includes demonstrating knowledge of the Bohr model of the atom and its limitations; using quantum numbers to describe atoms; identifying the wave-particle duality of radiation and matter; demonstrating knowledge of black body radiation and the photoelectric effect; relating nuclear structure and forces to radioactivity; solving problems involving half-life; differentiating among fission, fusion, and chemical reactions and their applications; and demonstrating a basic understanding of the theory of special relativity as it relates to time dilation, length contraction, and mass-energy equivalents.

PERIODIC TABLE OF THE ELEMENTS

1 **IA**																	18 **VIIIA**
1 **H** 1.01	2 **IIA**											13 **IIIA**	14 **IVA**	15 **VA**	16 **VIA**	17 **VIIA**	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 23.0	12 **Mg** 24.3	3 **IIIB**	4 **IVB**	5 **VB**	6 **VIB**	7 **VIIB**	8	9 **VIIIB**	10	11 **IB**	12 **IIB**	13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 39.9
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.8	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** (98.9)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57–71	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89–103	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (266)	107 **Bh** (264)	108 **Hs** (277)	109 **Mt** (268)	110 **Ds** (271)	111	112	113	114	115	116	117	118

Lanthanide Series	57 **La** 138.9	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
Actinide Series	89 **Ac** (227)	90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

Some of the elements 111 and above have been reported but not fully authenticated and named.

CONSTANTS

Description	Value
Acceleration of gravity on Earth (g)	9.8 m/s^2
Speed of light in a vacuum (c)	3.00×10^8 m/s
Planck's constant (h)	6.63×10^{-34} J•s = 4.14×10^{-15} eV•s
Electron rest mass	9.11×10^{-31} kg
Proton rest mass	1.67×10^{-27} kg
Charge of electron	-1.60×10^{-19} C
Coulomb's constant (k_e)	9.0×10^9 N•m^2/C^2
Boltzmann's constant (k)	1.38×10^{-23} J/K
Gas constant (R)	8.31 J/mol-K
Gravitational constant (G)	6.67×10^{-11} N•m^2/kg^2
Permeability of free space (μ_0)	$4\pi \times 10^{-7}$ T•m/A
Permittivity of free space (ε_0)	8.85×10^{-12} C^2/N•m^2
Avogadro's number	6.02×10^{23} particles/mole

SAMPLE MULTIPLE-CHOICE TEST QUESTIONS

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1. A researcher collects data on the structure of the atom by directing alpha particles at a thin sheet of gold foil. After repeated trials, as predicted, most of the alpha particles pass through the gold foil without being significantly deflected from their path. To the surprise of the researcher, a small percentage of the alpha particles are scattered back from the gold foil. Given the small percentage of alpha particles that do not pass through the foil, which of the following should the researcher do?

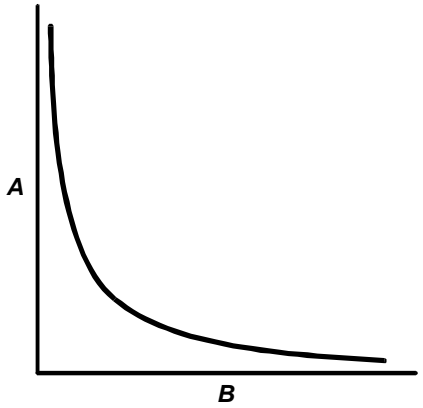
   A. Disregard the anomalous events since they are unrepresentative of the majority of the data.

   B. Develop an explanation for the anomalous events and disregard the results that were predicted.

   C. Continue the experiment until the results match the predictions that were made by the researcher.

   D. Incorporate the anomalous data and the expected results into an explanation that can account for both.

2. The graph below shows the relationship between two variables, A and B.



Which of the following is most likely to result in a straight-line graph?

A. Plot $\frac{1}{A}$ versus B.

B. Plot $\frac{1}{A}$ versus $\frac{1}{B}$.

C. Plot A^2 versus B.

D. Plot B versus A.

3. A chemist is analyzing the concentration of a particular contaminant in a water sample. After running the test repeatedly, the chemist calculates the standard deviation of the concentration data. In this situation, the standard deviation of the data is most useful for:

   A. evaluating the accuracy of the analysis.

   B. determining the cause of variability in the results.

   C. assessing the precision of the measurements.

   D. establishing the average value of the data.

4. A researcher announces a major breakthrough in nuclear fusion that could make it a commercially viable energy source. After reviewing the research and evaluating the researcher's claims about fusion, scientists in the same field reject the findings. Which of the following provides an acceptable reason for the scientific community to reject the researcher's findings?

   A. The results do not support the claim that the breakthrough will make fusion commercially viable.

   B. The researcher did not publish the complete data set generated by the investigation.

   C. The results could not be reproduced by independent scientists using the same research procedures.

   D. The researcher was not well known in the field before announcing the breakthrough.

5. Which of the following is most important in assessing the credibility of scientific claims?

   A. the researcher's previous work on the same subject

   B. the researcher's results are reproducible

   C. the researcher's affiliation with a major university or institution

   D. the researcher's findings are consistent with earlier work

6. The concept of entropy is most closely associated with which of the following physical laws?

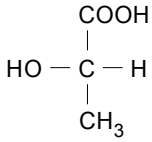
   A. second law of thermodynamics

   B. law of the conservation of energy

   C. Newton's law of inertia

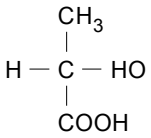
   D. law of universal gravitation

7. Use the structural formula for lactic acid below to answer the question that follows.

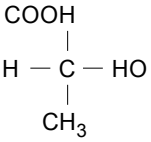


Which of the following is the optical isomer for the lactic acid molecule shown above?

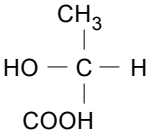
A.



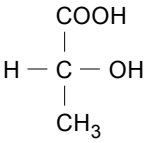
B.



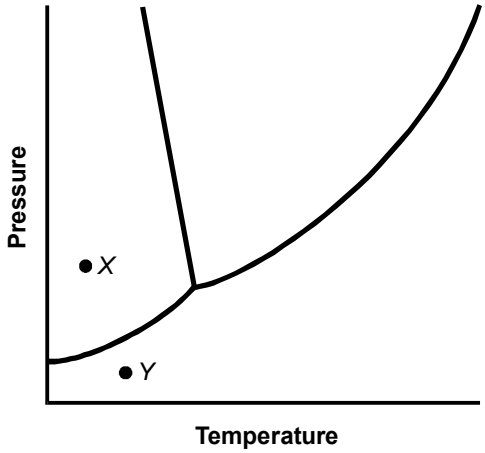
C.



D.



8. Use the phase diagram below to answer the question that follows.



In the phase diagram for water shown above, *X* and *Y* represent different pressure and temperature conditions. Which of the following processes occurs as water makes the transition from the pressure and temperature conditions at point *X* to the conditions at point *Y*?

A. liquefaction

B. sublimation

C. evaporation

D. condensation

9. Water does not break down into its constituent atoms until its temperature is raised to approximately 2,700°C. Which of the following is responsible for the great stability of water molecules?

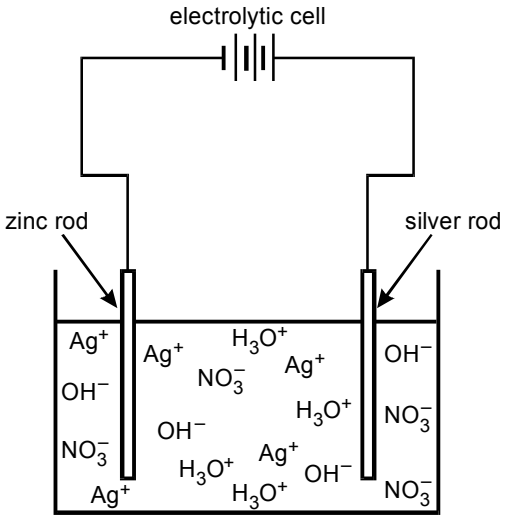
   A. high heat capacity

   B. strong covalent bonds

   C. low chemical reactivity

   D. flexible hydrogen bonds

10. Use the information below to answer the question that follows.



Two rods, one made of silver and one of zinc, are placed in a solution of silver nitrate, as shown in the diagram above. Which of the following is primarily responsible for the increase in the mass of the zinc rod?

   A. the changing concentration of silver ions in solution caused by the oxidation of the silver rod due to the flow of electrons through the circuit

   B. the changing mass of the silver nitrate solution caused by the oxidation of the nitrate ions and silver ions in solution

   C. the reduction of silver ions in solution that are then deposited on the zinc rod due to the flow of electrons in the circuit

   D. the oxidation of zinc ions at the zinc rod caused by the different reduction potentials of the zinc ions and silver ions in solution

11. Use the balanced chemical equation below to answer the question that follows.

$NaHCO_3(s) + HCl(aq) \longrightarrow NaCl(s) + H_2O(aq) + CO_2(g)$

A scientist puts 4.20 g of $NaHCO_3$ into an evaporating dish and adds dilute HCl until the production of a gas ceases. The scientist then slowly evaporates water from the evaporating dish and recovers 3.04 g of NaCl. The reaction is depicted in the chemical equation shown above. What is the experimental value for the mole ratio of sodium chloride to sodium bicarbonate?

A. 1.00 : 1

B. 1.04 : 1

C. 1.38 : 1

D. 1.44 : 1

12. Which of the following provides the best example of qualitative analysis?

A. identifying the number of moles of a particular compound in a sample

B. determining the ratio of two specific elements in a compound

C. identifying the different types of ions present in a sample

D. determining the average density of a mixture

13. Which of the following describes a difference between the concepts of mass and weight?

    A. Weight provides a measure of the force acting on an object, while mass does not.

    B. Weight takes volume into account, while mass does not.

    C. Mass takes the gravitational force acting on an object into account, while weight does not.

    D. Mass provides a measure of density, while weight does not.

14. The buoyant force exerted by a fluid on an entirely submerged object is equal to:

    A. the mass of the submerged object.

    B. the gravitational force acting on the submerged object.

    C. the density of the submerged object.

    D. the weight of the fluid displaced by the submerged object.

15. Which of the following best describes the concept of temperature?

    A. the thermal energy transferred between objects as a result of conduction

    B. the total internal energy contained in the atoms or molecules composing a substance

    C. the total heat energy contained within an object or substance per unit volume

    D. the average kinetic energy of the atoms or molecules composing a substance

16. A child is standing at a bus stop on the side of the road when a fire truck goes by at a constant speed sounding its alarm. The sound heard by the child rises in pitch as the fire truck approaches and then falls in pitch after the fire truck passes and travels away from the child. Which of the following best explains the change in pitch heard by the child?

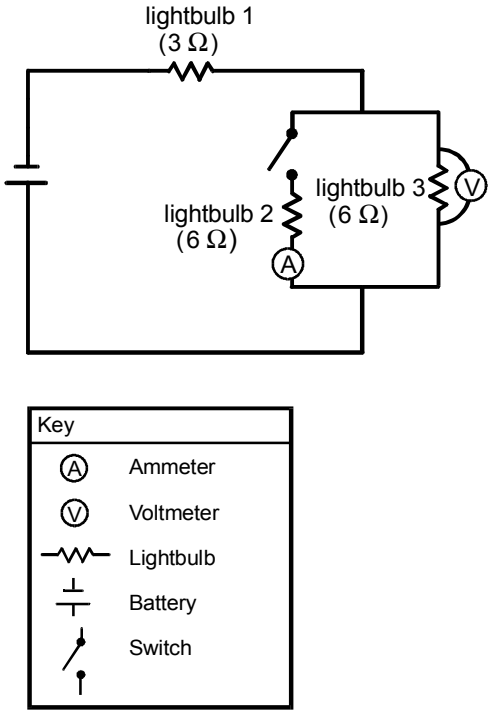
    A. The speed of the sound generated by the truck's alarm changes due to the change in the direction of motion of the sound source relative to the child.

    B. The energy of the sound waves being produced by the truck's alarm increases and then decreases as the truck approaches and then moves away from the child.

    C. The amplitude of the sound generated by the truck's alarm increases and then decreases inversely with the change in its position relative to the child.

    D. The perceived frequency of the sound waves generated by the truck's alarm is altered due to the change in its direction of movement relative to the child.

17. Use the circuit diagram below to answer the question that follows.



The circuit diagram shown above includes three lightbulbs, a voltmeter, an ammeter, and a switch. Which of the following will occur if the switch is closed?

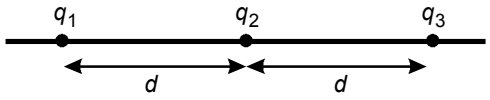
A. The internal resistance of the battery will increase.

B. The brightness of lightbulb 1 will increase.

C. The current through lightbulb 3 will increase.

D. The electric potential measured across lightbulb 3 will increase.

18. Use the information below to answer the question that follows.



In the diagram above, three identical point charges are located on a straight line and are separated by the same distance, d. If F equals the magnitude of the force acting on q_1 due to q_2, what is the magnitude of the force on q_1 due to q_3?

A. $\frac{F}{4}$

B. $\frac{F}{2}$

C. $2F$

D. $4F$

19. Which of the following technologies relies on energy changes of the electrons in the innermost orbital of an atom?

A. fluorescent lighting

B. X-ray photography

C. magnetic resonance imaging

D. microwave ovens

20. During the nineteenth century, researchers demonstrated that shining a light on various metals caused electrons to be released from the surface of the metal. Which of the following best explains this phenomenon?

A. A photon striking the metal's surface is absorbed by the electron it collides with, ejecting the electron from the surface of the metal.

B. A light wave striking the metal's surface increases the thermal energy of the metal atom, causing it to eject valence electrons from the highest energy orbital.

C. Light waves striking the surface of the metal slowly increase the vibration of electrons on the surface until some are able to break free.

D. Photons repeatedly striking atoms at the metal's surface transfer kinetic energy to electrons until the electrons gain enough energy to escape from the surface.

ANSWER KEY FOR THE SAMPLE MULTIPLE-CHOICE TEST QUESTIONS

Item Number	Correct Response	Objective
1.	**D**	Understand the principles and procedures of scientific inquiry.
2.	**A**	Understand the principles and procedures of scientific inquiry.
3.	**C**	Apply knowledge of methods and equipment used in scientific investigations.
4.	**C**	Understand the development of scientific thought and inquiry.
5.	**B**	Understand the relationships of physical science to technological and social issues, both contemporary and historical.
6.	**A**	Understand interrelationships among the physical, life, and earth/space sciences.
7.	**D**	Understand chemical properties of matter.
8.	**B**	Understand the physical properties of matter.
9.	**B**	Understand the properties and characteristics of chemical bonds.
10.	**C**	Understand the types and characteristics of chemical reactions.
11.	**B**	Apply the principles and methods of stoichiometry and the rules of chemical nomenclature and notation for inorganic and organic substances.
12.	**C**	Understand analytical techniques.
13.	**A**	Analyze forces and motion in one and two dimensions.
14.	**D**	Analyze forces and motion in one and two dimensions.
15.	**D**	Understand conservation laws and thermodynamics.
16.	**D**	Understand the characteristics of waves and wave motion, including the principles of sound and acoustics.
17.	**B**	Understand basic principles of electromagnetism.
18.	**A**	Understand basic principles of electromagnetism.
19.	**B**	Understand the electromagnetic spectrum and the properties of electromagnetic waves.
20.	**A**	Understand the basic concepts and applications of modern physics.