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**M/J Physical Science Advanced**

Semester Exam Study Guide

**PRACTICE OF SCIENCE**

1. What characterizes a controlled experiment as a scientific investigation?

*A controlled experiment isolates a single variable (the independent variable) to test and controls (keeps constant) all other variables.*

1. Be able to identify the INDEPENDENT VARIABLE and the DEPENDENT VARIABLE by reading the research question or a brief description of a CONTROLLED EXPERIMENT.

*INDEPENDENT VARIABLE: variable being tested, or changed on purpose*

*DEPENDENT VARIABLE: variable being measured or observed, that may or may not change as a result of changing the independent variable*

*CONTROLLED VARIABLES: variables that are kept constant (the same)*

1. Explain why it is important to use CONTROLLED VARIABLES in an EXPERIMENT.

*If an investigator does not control the variables in an experiment, then he/she cannot know that a change in the outcome is caused by the independent variable. Controlling all other variables allows him/her to link the outcome (DV) to the test variable (IV).*

1. How is a HYPOTHESIS related to a PREDICTION?

*A prediction is used to test a hypothesis. If the hypothesis is true, then the prediction should be observed.*

1. Explain the difference between DATA and EVIDENCE.

*Data is the information gathered during an investigation, while evidence is the specific data that supports a claim. All evidence is data, but not all data is evidence.*

1. Explain the role of SCIENTIFIC CONFIRMATION.

*Scientific confirmation is the pursuit of consistent and predictable results through repetition and replication. It does NOT mean we have gotten the correct answer…simply a consistent one. Consistent results allow scientists to have confidence in their explanations.*

1. Be able to identify examples of REPETITION and REPLICATION; describe how they are useful in confirming results.

*Repetition and replication are types of confirmation. They allow scientists to confirm that their results are consistent and predictable, which can improve their confidence in their explanations.*

*Repetition: Multiple Trials (doing a test multiple times or having multiple samples for each trial)*

1. How does an investigator know whether he/she has performed enough TRIALS in their investigation?

*The number of trials an investigator should run depends on the type of investigation they are performing. When their results are consistent and predictable, meaning that every time they do a trial, the results are either the same or within a predictable range, they have done enough trials.*

**SCIENTIFIC KNOWLEDGE**

1. Describe the characteristics of science (CONPTT).

*Consistent – Observable – Natural – Predictable – Testable – Tentative…Science must exhibit all six of these characteristics.*

1. How are scientific CLAIMS affected by the concept of scientific CONFIRMATION and debate (ARGUMENTATION)?

*Scientific claims can be strengthened or weakened by confirmation and argumentation. If results are “confirmed” through repetition and replication, then we can place more confidence in a claim. If however, there is an argument to be made against that claim with evidence to support it, then our confidence in the claim decreases.*

1. What is EMPIRICAL EVIDENCE and how does it influence SCIENTIFIC EXPLANATIONS?

*Scientific explanations are based on the empirical evidence, or the cumulative body of information on a topic. The empirical evidence MUST support a scientific explanation, or that explanation must be modified so that it does.*

1. Discuss the benefits of using SCIENTIFIC MODELS as well as the possible drawbacks, or limitations, of models.

*Using models in science can save money, time, and effort. They can allow scientists to safely investigate a dangerous question. They can also help scientists effectively communicate a complicated idea by simplifying it or making it more relatable.*

*However, models can also create misconceptions, introduce error, or highlight assumptions. All of these can lead to incorrect interpretations, predictions, or understanding of scientific topics.*

1. Why do we describe SCIENTIFIC KNOWLEDGE as “TENTATIVE”?

*The word, tentative, means to be open to change. Scientific knowledge must be allowed to grow and change based on the empirical evidence.*

1. Describe how a SCIENTIFIC THEORY and a SCIENTIFIC LAW can be related to one another.

*A scientific theory can be used to explain a scientific law. The theory explains how or why we observe the law.*

1. Explain why a THEORY can never become a LAW.

*A theory will never become a law because they serve two different purposes. A scientific law DESCRIBES a phenomenon while a scientific theory attempts to EXPLAIN a phenomenon. Both laws and theories are heavily tested and well supported, and a scientific theory represents the most powerful explanation that science can offer on a topic.*

1. Identify an instance from the history of science in which scientific knowledge changed when new evidence or new interpretations emerged.

* *The evolution of atomic theory (the atomic model)*
* *The structure and motion of objects in our solar system (geocentric vs heliocentric)*
* *The classification of planets based on observations of other celestial bodies (Pluto)*

**PROPERTIES OF MATTER**

1. Distinguish between mixtures and pure substances (*include the three types of matter*).

*PURE SUBSTANCES:*

*Elements are the most basic form of matter, consisting of specific types of atoms. They cannot be broken down into any other substance.*

*Compounds are made of multiple elements that are chemically combined in a specific ratio. Compounds have different properties from the elements that make them up.*

*MIXTURES:*

*Mixtures include multiple elements and/or compounds that are together in the same place but are not chemically combined. Each substance retains its original properties, and can be separated back out of the mixture through physical means (without a chemical reaction).*

1. Identify and describe common physical properties of matter.

*Density - measurement/calculation of how much mass is contained in a given volume*

*Conductivity (thermal or electrical) – the ability of a substance to allow energy to flow through it*

*Solubility – the ability of a substance to dissolve in a solution*

*Magnetism – the ability of a substance to attract or repel iron*

*Melting Point & Boiling Point – the temperature at which a substance undergoes a phase change, from a solid to a liquid (melting) or from a liquid to a gas (boiling/vaporization).*

1. How are the chemical properties of substances observed?

*Chemical properties can only be observed through a chemical reaction.*

1. Compare the characteristics of shape and volume among solids, liquids, and gasses.

*SOLID = Definite Shape, Definite Volume*

*LIQUID = Indefinite Shape, Definite Volume*

*GAS = Indefinite Shape, Indefinite Volume*

1. How can you use the term, “viscosity,” to describe a liquid?

*Viscosity refers to a liquid’s resistance to flowing. Liquids with a low viscosity will flow freely and easily (such as water); liquids with a high viscosity will flow slowly (such as honey).*

1. Explain how “weight” and “mass” are different from each other, but also related to one another.

*“Mass” refers to the amount of matter in an object, while “weight” refers to the force of gravity on that mass. Mass is independent of location, while weight is dependent on gravitational changes.*

1. Explain how density is calculated (*What measurements do you need?*) and be able to use the formula to calculate the density of a substance.

*Density refers to how tightly packed the particles are in a substance. It is a ratio of the amount of matter in a given space, or mass per unit of volume (d=m/v). In other words, how many grams of matter are contained in a cubic centimeter of space.*

1. How can density be used to make predictions about a sample of matter (*its identity and its ability to float*)?

*Each substance has a characteristic density, so two samples of the same substance will have the same density, independent of sample size (5 mL of water will have the same density as 500 mL of water).*

*Objects that are less dense than the fluid they are in (whether it’s water or air) will float. Objects that are more dense than the fluid they are in will sink. Because the density of water is 1 g/mL, anything that is less dense than 1 g/mL (or 1 g/cm3) will float.*

**ATOMS**

1. Interpret/describe a model of the atom and its parts (*the modern electron cloud model*).

*It is made of three sub-atomic particles; protons and neutrons in the small, dense nucleus surrounded by a cloud of tiny negatively-charged electrons.*

1. What is the atom mostly made of? Where does basically all of its mass come from?

*The atom is mostly empty space. Nearly all of the mass is contained in the nucleus (protons and neutrons).*

1. Describe the characteristics of the three sub atomic particles, including size (mass), charge, and location.

*Electron – 2000xless mass than a proton, negatively charged (-1), located in the electron cloud surrounding the nucleus*

*Proton – 2000xmore mass than an electron, positively charged (+1), located in the nucleus*

*Neutron – same mass as a proton, neutral charge, located in the nucleus*

1. Discuss the role of sub atomic particles in the formation of different elements (ie: atomic number, atomic mass, isotopes, and ions).

*Atomic Number – number of protons determines the type of element*

*Atomic Mass – average number of particles (protons and neutrons) in the nucleus*

*Isotopes – atoms of an element with a different number of neutrons*

*Ions – charged atoms as a result of having gained or lost electrons*

**PERIODIC TABLE**

1. Explain how the modern periodic table is slightly different than the one Mendeleev created. (Why didn’t he use atomic number?)

*Mendeleev used atomic mass because protons hadn’t been discovered yet. Today, we use atomic number because the number of protons is what makes each element unique.*

1. What is “periodic” about the periodic table?

*“Periodic” means a regular and repeating pattern; such as the characteristics of the elements across each row in the table*

1. Interpret the information included in the boxes of elements on the periodic table.
2. Explain the importance of the atomic number to an element.

*The atomic number dictates the type of element, based on the number of protons.*

1. Differentiate between groups and periods on the periodic table.

*Groups are vertical columns in the periodic table consisting of elements with similar properties. Periods are horizontal rows of elements that exhibit a repeating pattern of characteristics.*

**CHEMICAL REACTIONS**

1. Differentiate between an element and a compound. How can you interpret a chemical formula to determine the elements that make up a molecule of a substance?

*Elements are the most basic form of matter, made of specific types of atoms (# of protons).*

*Compounds are made of multiple elements chemically bonded together.*

*In a chemical formula, each element in the molecule is represented by its chemical symbol. An element will have only one capital letter, while a compound will have multiple capital letters. Numbers written as subscripts indicate how many atoms of each element are present in the molecule.*

1. What causes atoms to form compounds/molecules (*discuss the octet rule*)?

*Atoms form compounds in order to fill up their “outer shell” with valence electrons. According to the octet rule, most atoms bond so that they have 8 valence electrons (with the exception of those in period 1, which are full with only 2 valence electrons).*

1. Describe physical signs that a chemical reaction has occurred.

*A chemical reaction is indicated by a change in energy (temperature, light, sound) and/or a change in properties (color, smell, texture, etc…).*

1. Identify the reactants and products in a chemical reaction. How are they shown in a chemical equation?

*Reactants are the chemicals present BEFORE the reaction. They are shown as chemical formulas to the left of the arrow in a chemical equation.*

*Products are the chemicals present AFTER the reaction. They are shown as chemical formulas to the right of the arrow in a chemical equation.*

1. How do the atoms present in the reactants compare to those present in the products? Why is this important?

*The atoms that make up the products are the same exact atoms that made up the reactants; no matter is created or destroyed in a chemical reaction. As a result, chemical equations must be “balanced”, meaning that the number of atoms of each element must be equal on the left and right side of the arrow. Without a balanced chemical equation, we would violate the law of conservation of mass.*

1. How is the law of conservation of mass observed during an actual chemical reaction?

*The law of conservation of mass states that matter cannot be created or destroyed during any physical or chemical process. This means that the mass of the products of a chemical reaction must be equal to the mass of the reactants, indicating that the same atoms are present before and after the reaction.*

1. Describe and explain the effect of temperature on the rate of a chemical reaction.

*Increasing the temperature of the reactants can increase the rate of the reaction by causing more frequent collisions between the particles (because they are moving faster). Decreasing the temperature of the reactants will decrease the rate of the reaction by decreasing the rate at which particles collide.*