Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Pd: \_\_\_

**Physical Science Honors**

Semester Exam Study Guide

**NATURE OF SCIENCE**

1. 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 by the investigator*

***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) for all samples*

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. 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 SCIENTIFIC THEORY represents the most powerful explanation scientists have to offer and why it can never become a LAW.

*SCIENTIFIC THEORIES are* ***heavily-tested*** *and* ***well-supported*** *by the empirical evidence. They are not merely “guesses”, but are explanations that have been backed up by evidence time and time again. Theories can never become laws because they are totally different things. SCIENTIFIC LAWS simply describe a phenomenon, while* ***theories attempt to explain the phenomenon****.*

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. 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)*

***REPLICATION****: Multiple Investigations (re-doing another scientists investigation to confirm results)*

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.*

1. How are scientific CLAIMS affected by the concept of scientific CONFIRMATION?

*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. 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. Describe various types of MODELS used in science to test or communicate an idea.

*A* ***SCIENTIFIC MODEL*** *is a tool used by scientists to understand an object or idea. It can take the form of a 3D representation, a 2D model, a physical analogy, or a theoretical analogy or metaphor.*

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”? List better alternatives to the word, “prove”.

*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 the six characteristics of science and discuss its limitations.

***CONSISTENT – OBSERVABLE – NATURAL – PREDICTABLE – TESTABLE – TENTATIVE****…Science must exhibit all six of these characteristics. Science is limited to studying natural, testable questions about the natural world.*

1. How does PSEUDOSCIENCE compare to science? How can you tell the difference?

***PSEUDOSCIENCE****refers to theories & practices that some people claim are scientific, but have no actual basis in science. They do not share the characteristics of science (CONPTT).*

**PROPERTIES OF MATTER**

1. Why do we say that “everything” is made of “MATTER”? What role do atoms play?

*Everything is made of atoms, which have mass and take up space. Therefore, everything is considered “matter”.*

1. Identify and compare the three types of matter.

***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*** *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 examples of each type of matter.

*ELEMENT – aluminum can, oxygen*

*COMPOUND – limestone rock, spring water*

*MIXTURE – beach sand, ocean (salt) water*

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. Differentiate materials known as “CONDUCTORS” from those known as “INSULATORS”. What role does density play?

***CONDUCTORS*** *allow energy to flow through the substance easily, while* ***INSULATORS*** *inhibit (resist) the flow of energy. Materials with* ***higher density tend to be better conductors****, while those with lower density tend to be better insulators.*

1. Identify and describe common CHEMICAL PROPERTIES of matter.

***Flammability*** *– the ability of a substance to ignite (catch on fire)*

***Reactivity*** *– the ability of a substance to react chemically with other substances*

1. How are the chemical properties of substances observed?

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

1. How does thermal energy influence the motion of the particles in a substance? How does this influence their PHYSICAL STATE, or PHASE?

*Adding thermal energy causes the particles in a substance to move faster and farther apart. Removing thermal energy causes them to move slower and closer together. If the energy in the particles changes enough, it may result in a state change (phase change).*

1. Compare the characteristics of shape and volume among SOLIDS, LIQUIDS, GASSES, and PLASMAS.

***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 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****).*

1. Why is density useful in helping us identify unknown samples of a substance?

*The density of a substance is* ***independent of sample size****, so if the density of an unknown substance matches a known density, it can help us identify the unknown substance.*

**PROPERTIES OF MATTER**

1. What type of matter is WATER?

*Water is a* ***compound****, consisting of hydrogen and oxygen atoms.*

1. Describe the structure of a water molecule. Why is it called a “POLAR MOLECULE”?

*A water molecule is made of two hydrogen atoms bonded to one oxygen atom. It is considered a* ***POLAR MOLECULE*** *because the oxygen atom has a stronger pull on the shared electrons than the hydrogen atoms, so the* ***electrons are shared “unequally”****. This causes the oxygen side of the molecule to have a slightly negative charge, while the hydrogen side of the molecule has a slightly positive charge. As a result, the water molecule behaves similar to a small magnet.*

1. Describe the properties of COHESION and ADHESION that result from the hydrogen bonds between water molecules.

***COHESION*** *– water molecules attracted to other water molecules*

***ADHESION*** *– water molecules attracted to other substances*

1. Discuss the density of water. Explain why ice floats and discuss how the density of water affects how other objects sink or float in water.

***Water has a density of about 1 g/mL****. As a result, anything with a density less than 1 g/mL will float in water, while substances that are more dense than 1 g/mL will sink in water. Ice floats because it is less dense than 1 g/mL. When the water freezes, the molecules align in a crystalline structure, allowing more space between them than when they are in liquid form. This causes ice to be less dense than liquid water and float.*

1. Identify some of the special properties of water that make it so unique and so important to life on Earth.

***Universal Solvent*** *– easily dissolves many substances*

***High Specific Heat*** *– it takes a lot of energy to change its temperature, keeping Earth’s climate moderate for life*

***Melting Point and Boiling Point*** *– both are within common temperature ranges for Earth*

**PROPERTIES OF GASES**

1. Describe BOYLE’S LAW (*include the mathematical relationship and a rough sketch of a line graph*).

*PRESSURE is inversely proportional to VOLUME, P α 1/V*



1. Describe CHARLES’ LAW (*include the mathematical relationship and a rough sketch of a line graph*).

*VOLUME is directly proportional to TEMPERATURE, V α T*



1. Describe GAY-LUSSAC’S LAW (*include the mathematical relationship*).

*PRESSURE is directly proportional to TEMPERATURE, P α T*



1. Describe AVOGADRO’S LAW (*include the mathematical relationship*).

*VOLUME is directly proportional to the AMOUNT of gas, V α n*



1. Explain how the four gas laws above combine into the IDEAL GAS LAW (*include the equation and discuss the relationships between temperature, pressure, and volume for an ideal gas*).

PV=nRT

Pressure (P) and volume (V) are directly proportional to the temperature (T) and amount (n) of an ideal gas, where “R” represents the gas constant.

**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*

1. Discuss the evolution of the atomic model, including the discovery of ELECTRONS, the NUCLEUS, PROTONS, NEUTRONS, and VALENCE ELECTRONS.

*The word, “****ATOM****”, comes from the Latin “atomos” meaning “****uncuttable****”.* ***DEMOCRITUS*** *theorized that if you cut an object in half over and over, eventually you’ll be left with the* ***smallest individual particle of matter****.*

***JOHN DALTON*** *modernized atomic theory, saying that all matter is composed of atoms, each element has a specific type of atom, and atoms cannot be subdivided or destroyed. He envisioned atoms as* ***tiny, solid balls of matter****.*

***JJ THOMSON*** *put a magnet near a cathode ray tube and bent the beam inside. He concluded that the beam was made of negatively charged particles that became known as* ***electrons****. These electrons were embedded into the tiny, solid ball model (****muffin model****).*

***NAGAOKA*** *envisioned the atom like a* ***solar system****, with the Sun as a positive nucleus orbited by negative electrons (like planets), however, he lacked evidence for his theory.* ***ERNEST RUTHERFORD*** *provided evidence for Nagaoka’s idea when he shot alpha particles at gold foil, expecting them to pass right through. While most of them did, some bounced back. This provided evidence that while* ***most of the atom is made of empty space****, there is a* ***very small, dense, positively charged nucleus in the center****.*

*Rutherford eventually realized that the alpha particles he shot at the gold foil were made from the nuclei of hydrogen atoms. Over time, he realized that these nuclei consisted of a positive sub atomic particle which became known as a* ***proton****.*

*Up until the 1930’s the mass of atoms that scientists predicted based on the number of protons was always less than the observed mass of atoms.* ***JAMES CHADWICK*** *solved this problem with the discovery of* ***neutrons****,* ***uncharged particles in the nucleus*** *of the atom with a mass equal to that of protons. Neutrons* ***explained where the “extra mass” came from****.*

**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 including atomic number, atomic mass, element symbol, classification, standard state, and natural vs. synthetic.
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.*

1. Describe the patterns that are present in the periodic table, both among the periods and the groups.

*The atomic number and atomic mass increase left to right. Elements in columns share similar properties, including the number of valence electrons. Metals are found on the left, nonmetals on the right, and metalloids form a diagonal line in between. Most of the elements are solid, many of the nonmetals are gas, and only two are liquid.*

1. Explain the role of electrons in the structure of the periodic table.

*The blocks in the periodic table represent the* ***electron configuration****. Each section corresponds to a certain* ***orbital*** *(ie: the “s” block, the “p” block, the “d” block, or the “f” block).*

1. Explain the OCTET RULE and why it is important.

*The* ***OCTET RULE*** *states that the outer shell is full when it has* ***8 valence electrons****. Atoms become more stable when their outer shell is “full”, so atoms bond in a way that can help them “fill” their outer shell.*

1. Create and/or interpret various element diagrams such as ELECTRON CONFIGURATION, BOHR DIAGRAMS, or ELECTRON-DOT DIAGRAMS.

***Ga31: 1s22s22p63s23p64s23d104p1*** *or* ***[Ar]4s23d104p1***

