Science-1A Lecture: Week-10, Monday, March 15, 2021

Quiz-5 is the first quiz after the Physics Midterm.

Quiz-5 is next week, so today I will go over the Example Questions for Quiz 5 and their solutions. These are at *https://yosemitefoothills.com/Science-1A/QuizAndTestPractice/SampleQuestions-Quiz-5.pdf* and *https://yosemitefoothills.com/Science-1A/QuizAndTestPractice/SampleQuestions-Quiz-5-Solutions.pdf* .

See the boxed note at the start of the Week-2 Monday lecture at *https://yosemitefoothills.com/Science-1A/OnlineLectureAndLabNotes/Week-02-Lecture-Monday-January-18-2021.pdf* for an explanation of the Equation Sheet and its use.

Study this note carefully because you must do the work without any reference to this note while taking Quiz 5. Only a clean Equation sheet is to be used when taking the Quizzes and Tests.

This quiz has no calculations questions, but don't take it lightly. Understanding the logic behind the questions and answers is more effective than just trying to memorize answers. Understanding science is largely a matter of knowing the vocabulary of science, so many questions are about the special words used in physics. Also, remember, the questions on the quizzes and tests may look like the practice questions, but may have wording changes that require you to read carefully and think!

In the photoelectric effect, light of a particular frequency *f* is sent at a metal plate inside of an evacuated chamber and electrons are sometimes emitted from the plate. When they are, their energy is measured.

Fill in the blanks in the following paragraph using words chosen from the following list:
electron, **electrons**, **photon**, **photons**, **frequency**, **proportional**, **inversely proportional**

Question 1: (9 points) Einstein's explanation of the photoelectric effect was that light came in chunks called **_photons__**, each with an energy **__proportional__** to the light **__frequency___**, and that the number of electrons was equal to the number of **__photons___**. Greater light intensity simply meant that there were more **__photons__** and therefore more **__electrons__** were emitted. The electron energies were given by the **__photon__** energies minus an energy required to escape from the metal. That escape energy varied depending on the metal and its surface details and caused there to be a threshold light **__frequency__** below which no **__electrons__** were emitted.

The photoelectric effect was summarized at *https://yosemitefoothills.com/Science-1A/Handouts/Week-07/NatureOfLight-PhotoelectricEffect.pdf* .

The paragraph in this question highlights the key points of the Photoelectric Effect. The first part uses words to describe the equation on the second to the last line of the Chapter 7 section on page 3 of your Equation Sheet, $E_{\text{photon}} = h f_{\text{photon}}$. The second sentence states the "one electron for one photon" rule. There is no sharing of the photon energy; it goes completely to only one electron. Light intensity is given by the number of photons. Finally, a certain amount of energy that the photon gives to an electron must be used to escape from the metal, so no electrons will have enough energy to escape until the photon frequency, and therefore photon energy, is greater than a threshold value.

Question 2: (2 points) A radio wave is formed by large numbers of very weak, coherent **_photons__** that act together to produce an electric field strong enough to move the electrons in an antenna.

One radio wave photon is too weak to detect. Many incoherent photons cannot add in a useful way. A great number of coherent photons with matching polarizations, phases, and directions are needed.

Question 3: (2 points) Einstein's Special Theory of Relativity is based on the postulates that the measured speed of ___**light**___ and the end result of (**all**, ~~electromagnetic~~, ~~mechanical~~) physics experiments do not depend on the speed of a passing observer.

This and the next question were explained in
https://yosemitefoothills.com/Science-1A/OnlineLectureAndLabNotes/Week-07-Lecture-Friday-February-26-2021.pdf .

Question 4: (4 points) Einstein's Special Theory of Relativity concludes that ___**time**___ and __**length**__ measurements give different values for observers moving at different speeds.

Strange, but true. This is what will cause the traveling twin to end up younger than the one that stayed home.

Question 5: (4 points) Einstein's General Theory of Relativity concludes that mass causes space to distort in a way that explains __**gravity**__ and predicts the existence of __**black**___ ___**hole**___ objects in the universe.

You just need to remember this also.

Question 6: (1 points) The Global Positioning System depends on the predictions of both Einstein's Special and General Theories of Relativity being correct. (**true**, ~~false~~)

At the speed and altitude of satellite orbits, both of Einstein's Theories of Relativity are needed to make the system accurate. Newton's laws are not sufficient.

Question 7: (2 points) A typical atom has a size of about

(~~2 µm, 200 nm, 20 nm, 2 nm~~, **200 pm**, ~~20 pm, 2 pm, 200 fm, 20 fm, 2 fm~~) Circle one.

The correct answer is the first choice smaller than 2 nanometers.

Question 8: (2 points) A typical atomic nucleus has a size of about

(~~5 µm, 500 nm, 50 nm, 5 nm, 500 pm, 50 pm, 5 pm, 500 fm, 50 fm~~**, 5 fm**) Circle one.

The smallest unit prefix you are expected to know is fempto- (f). This answer is 5 femptometers, about 40000 times smaller than that of a typical atom.

Question 9: (4 points) Atoms are composed of a small __**nucleus**__ surrounded by an __**electron**__ cloud.

Shown in "Our Friend the Atom", but I prefer to just draw a fuzzy cloud, not orbiting electrons.

Question 10: (2 points) The percentage of atomic mass from electrons is about

(~~50%, 5%, 0.5%~~, **0.05%**, ~~0.005%~~) Circle one.

Remember in "Our Friend the Atom" how neutrons shot at a gold foil would usually pass through hundreds of gold atoms in the foil without striking the tiny, massive nuclei in them. 99.95% of the atoms mass is in the nucleus, only 0.05% is from its electrons.

Question 11: (4 points) Except for the simplest hydrogen nucleus, all nuclei are composed of both __**protons**__ which have a positive charge and _**neutrons**_ which have no charge.

Question 12: (4 points) Without **_neutrons_**, nuclei with more than one **_proton__** would fly apart.

Protons are positively charged and therefore repel each other. Within a nucleus, there is "nuclear glue" that helps hold protons to protons, protons to neutrons, and neutrons to neutrons, but the proton-proton attraction is not enough by itself; neutrons must be added. Very large atoms need a greater percentage of neutrons to keep them together. At the size of uranium and larger, even neutrons cannot always provide enough "nuclear glue".

Question 13: (1 points) All hydrogen atoms have the same mass. (~~true~~, **false**)

Hydrogen nuclei exists in three forms: a lone proton, a proton+neutron, a proton+2 neutrons. Each neutron adds nearly as much mass as the proton itself.

Question 14: (4 points) In our Periodic Table of Elements, the number in the upper-left corner of each element block is called the **_atomic_ _number_** of the element and equals the number of **__protons/electrons__** in the atom.

See the legend at the lower-left corner of the Periodic Table at
https://yosemitefoothills.com/Science-1A/Handouts/Week-09/PeriodicTableOfElements.jpg .
The first page of the Lecture note at
https://yosemitefoothills.com/Science-1A/OnlineLectureAndLabNotes/Week-09-Lab-Wednesday-March-10-2021.pdf
discusses this legend in detail.

The next few questions are all discussed in
https://yosemitefoothills.com/Science-1A/OnlineLectureAndLabNotes/Week-09-Lab-Wednesday-March-10-2021.pdf .

Question 15: (2 points) In our Periodic Table of Elements, the number just below name of the element is the average **_atomic__ __weight__** of that element as found in nature.

Question 16: (2 points) The “Period” number shown at the left of each row in our Periodic Table of Elements, is the number of the outermost energy **__shell__** for the elements in that row.

Question 17: (1 points) The elements in a particular (**column**, ~~row~~) of the Periodic Table of Elements have similar chemical properties.

Question 18: (4 points) The elements in the right-most column of the periodic table have **_filled/full/complete_** outermost shells and are called the **__noble__** gases.

Question 19: (1 points) The elements in column 17 of the Periodic Table of Elements are called the halogens and are highly reactive because they want to (**take**, ~~give~~) an electron in a chemical reaction.

Question 20: (1 points) The elements in column 1 of the Periodic Table of Elements are called the alkali metals and are highly reactive because they want to (~~take~~, **give**) an electron in a chemical reaction.

Question 21: (2 points) Metal elements tend to be closer to the (**lower-left**, ~~upper-left, lower-right, upper right~~) parts of the Periodic Table of Elements.

Question 22: (2 points) Insulators tend to be closer to the (~~lower-left, upper-left, lower-right~~, **upper right**) parts of the Periodic Table of Elements.

Question 23: (2 points) The element **__silicon___** is the basis for most semiconductor devices.

Silicon Valley just south of San Francisco gets its name from this important semiconductor element.

Question 24: (2 points) The element **__carbon__** is the basis for all life on the earth.

As we study biochemistry in the coming weeks, nearly all biochemical molecules are based on carbon.

Question 25: (1 points) There are only 114 (now 118) elements shown in our Periodic Table of Elements, but astronomers have found others when searching the universe. (~~true~~, **false**)

You just need to remember this.

Question 26: (2 point) The atomic number of sodium shown in our Periodic Table of Elements is **___11____**.

Remember the legend shows you how to find this.

Question 27: (2 point) The atomic weight of sodium shown in our Periodic Table of Elements is **_22.989770_**.

Remember the legend shows you how to find this.

Question 28: (2 point) Using our Periodic Table of Elements, write the name of a radioactive element **__radon/radium/uranium/__**.

Our Periodic Table highlights "artificially prepared" elements, but does not explicitly show radioactive ones. Our Friend the Atom discussed radium and uranium extensively. Radon is a radioactive inert gas which is a serious health hazard.

Question 29: (4 points) A neutral atom has the same number of **__protons__** as **_electrons_**.

The key word here is "neutral" meaning balanced positive and negative charges. Ions have different numbers of electrons, and are not neutral.

Question 30: (1 points) A positive ion of an atom has one (~~more~~, **fewer**) electrons than the neutral atom.

Fewer electrons make a neutral atom into a positive ion since electrons have a negative charge.

Question 31: (1 points) A negative ion of an atom has one (**more**, ~~fewer~~) electrons than the neutral atom.

More electrons make a neutral atom into a negative ion since electrons have a negative charge.