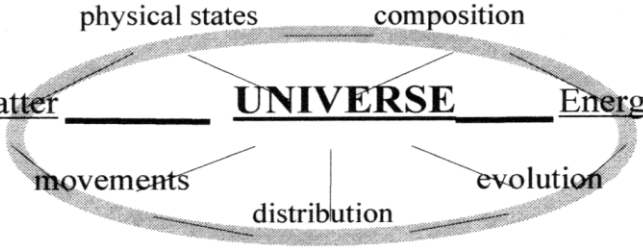
SESSION ONE: INTRODUCING ASTRONOMY
D E F I N E A S T R O N O M Y !

Write all of the words that you believe to be directly or indirectly related to astronomy. Be sure to consider the consequences of each word that you write. As an example, the word "planet" is certainly an appropriate choice, but this word can also lead to a variety of other choices such as "Mercury," "Jupiter," "canals," "Great Red Spot," as examples. You'll have five minutes to complete this task. The record is 80 words held by Moravian Music Major Missy Salvadeo in 2019. Much Success!!



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Astronomy is the science that investigates all _____.

1. _____,	24. _____,	47._____,
2. _____,	25. _____,	48. _____,
3. _____,	26. _____,	49. _____,
4. _____,	27. _____,	50. _____,
5. _____,	28. _____,	51. _____,
6. _____,	29. _____,	52. _____,
7. _____,	30. _____,	53. _____,
8. _____,	31. _____,	54. _____,
9. _____,	32. _____,	55. _____,
10. _____,	33. _____,	56. _____,
11. _____,	34. _____,	57. _____,
12. _____,	35. _____,	58. _____,
13. _____,	36. _____,	59. _____,
14. _____,	37. _____,	60. _____,
15. _____,	38. _____,	61. _____,
16. _____,	39. _____,	62. _____,
17. _____,	40. _____,	63. _____,
18. _____,	41. _____,	64. _____,
19. _____,	42. _____,	65. _____,
20. _____,	43. _____,	66. _____,
21. _____,	44. _____,	67. _____,
22. _____,	45. _____,	68. _____,
23. _____,	46. _____,	69. _____,

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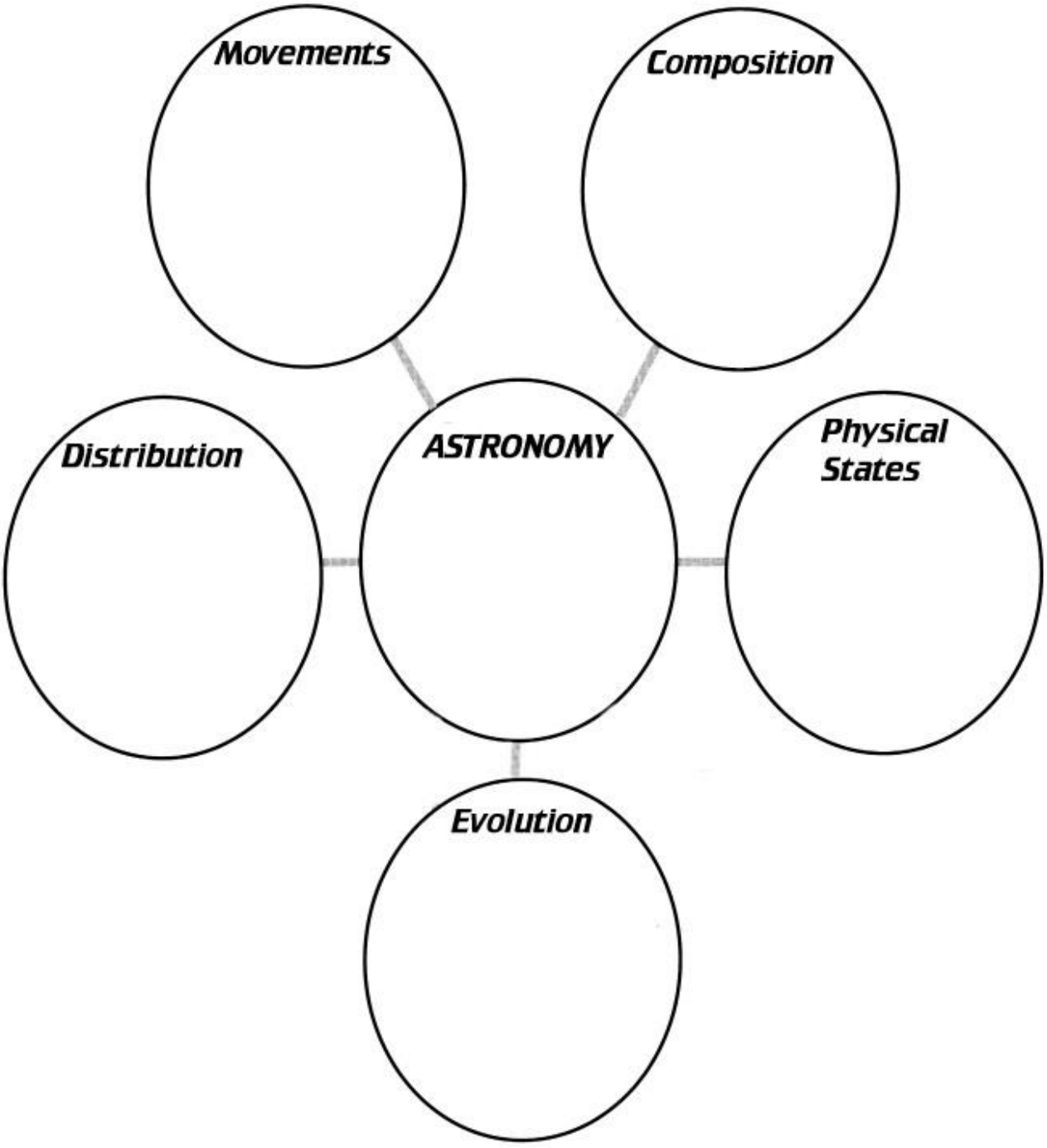
WHAT IS ASTRONOMY?

(Graphic organizer)



The Scientific Method: It is a Little Like Dating

Observe and Question, Hypothesize, Experiment;
Test, Test, Test; Share Results

Gary A. Becker, Moravian University Astronomy

Consider the scientific method before starting this blog.
Define a Question to Investigate: Scientists conduct research, make observations, collect data, and see relationships.
Make Predictions: Scientists will often develop a hypothesis based on research and observations.
Gather Data: Test the prediction.
Analyze the Data: Does it confirm the original premise?
Draw a Conclusion and communicate with others.
On the second evening that we met, I proposed to my astronomy class that there was a relationship between dating and the scientific method. I have an interesting population of learners this semester. There are 12 females and five males in my class, so I was particularly interested in the reactions of the women to my observation. In addition, how I met my wife is a question I am usually asked as the semester progresses. The story will be told analytically.
I Defined a Question. It was October 3, 1978, and I was giving a talk on the moon for the Lehigh Valley Amateur Astronomical Society, Inc. When I entered the meeting space, I surveyed my audience as I always did when presenting, and my gaze fell upon a young woman sitting quietly in the center of the room. She was beautiful, and all sensors went on high alert as I visually gathered data about her. Nonetheless, there was a nagging question that brought me back to reality. **Was she wearing a ring?** I sat down behind her to investigate, and eventually, she raised her left hand. Her ring finger was devoid of any ornamentation.
I Made A Prediction: This woman might be responsive to conversation and possibly a date.
I Continued to Gather Data. I was called forward and introduced as the speaker. I have always focused holistically on my audiences, so I did not pay much attention to her until the Question and Answer Section. Her hand was up, but she had changed her position to the front of the room. She asked if the moon had caves. Yes, lava tube caves but not karst caves where acidic water (carbonic acid) has dissolved soluble limestone. After my talk, a small group gathered to query me further, and she was present for the first three or four questions. I tried to get closer to her but was unsuccessful, and then she was gone. After another ten minutes of discussions with this small cadre of people, I packed up my gear and left. When I exited the building, she was waiting for me. We talked for nearly two hours on that cold, blustery October evening. She gave me her phone number, and she accepted my invitation for a date the following day.
I Analyzed the Data: The first date was to the Franklin Institute in Philadelphia. We ate dinner that evening at a local restaurant called "The Load of Mischief." There was a teacher in the restaurant, who taught in the section of Dieruff High School where I taught astronomy. He flagged me down the following day, pointing his finger at me as he approached and said, "Someday, you're going to marry that woman." He then continued by saying he had never seen two people focused on each other as we were that evening. Date after successful date followed. We traveled to Maine over the Winter Break and the Southwest the following summer and had many other adventures, including a trip to Egypt over the next three years.

I Drew a Conclusion: "I think I could live with this person for my entire life." She agreed that I was the special one, too. We communicated that message to our family and friends, and Susan and I were married on June 25, 1982. We will be celebrating our 43 anniversary this coming summer.

I am not trying to convince anyone that this is the perfect example of the scientific method. Still, it does give students a hook to understand that we are constantly exploring, gathering data, and drawing conclusions about the world around us. My music and art majors continuously tell me that they abhor mathematics, and yet, for musicians, harmonics is all about math. Concepts like the golden triangle and the golden rectangle are mathematical constructs instilled innately within my learners who want to become artists. The scientific method is not just for scientists to explore and utilize, but also for everyone to employ as we navigate the world around us. Ad Astra!

NOTES

Basic Astronomy Definition: What Are Astronomers Trying to Accomplish?

Definition of Astronomy: The science that investigates all of the matter-energy in the universe: its distribution, composition, physical states, movements, and evolution.

- **Distribution:** The position, arrangement or frequency of matter/energy over an area or throughout a space.
  - The universe looks like a sponge or better yet Halloween spiderwebbing with clusters of galaxies composing the spongy or webbing material.
  - Most of the solar system's mass is contained within the sun (99.98%).
  - The bulk of the mass in the Earth-moon system is found in the Earth (98.8%).
- **Movements:** Any condition related to the change of position of matter in space or on a coordinate grid. Objects in space change their position because they are in motion and the observation platform from which those observations are being made, Earth, is also in motion.
  - Rotation: Period of time a body takes to complete one spin about its axis.
  - Revolution: Period of time a less massive body takes to complete one orbit around a more massive object.
  - Precession: The conical wobbling of Earth's axis. One cycle takes about 26,000 years and causes the pivot position of Earth's axis to point to different stars along its path.
- **Physical States:** The conditions that permit matter to be found as a solid, a liquid, a gas, or a plasma.
  - Solid: Matter has a shape/volume caused by strong atomic or molecular bonds.
  - Liquid: Matter cannot retain a definite shape because bonds between atoms and molecules are too weak, but it does retain a definite volume.
  - Gas: A fluid that has neither independent shape nor volume, but tends to expand indefinitely.
  - Plasma: A hot gas that is not electrically neutral. Plasma is composed of ions and electrons in free association. The ions that compose the substance have either an excess or a deficiency of electrons in comparison to the number of protons that they contain.
- **Composition:** The qualitative and quantitative chemical makeup of matter.
  - Qualitative example: Components are identified in a descriptive way without being quantified. The sun is composed of hydrogen and helium.
  - Quantitative example: Components are identified in a numerical fashion. The sun by volume is composed of 95% hydrogen and 5% helium, but by mass it is composed of 78% hydrogen, 20% helium and 2% heavier atoms all called metals.
  - Composition of Universe: 68% dark energy, 27% dark matter, 5% baryonic matter. Baryonic matter contains the protons, neutrons and electrons which we are familiar with in every day matter. Dark matter/energy does not react with the matter that is baryonic, that we can see. Dark matter does possess gravity, so we can see its effects on baryonic masses.

- **Evolution:** The process of change from a beginning to an end.
  - Big Bang: The universe started with a Big Bang (pop) and will expand forever.
  - Oscillating Universe: The universe started with the Big Bang, but possesses enough mass (gravity) to halt the expansion so that it will one day collapse upon itself creating the Big Crunch. With proof of the accelerating universe, the oscillating universe theory has become obsolete. By observing galaxies at different distances, it is possible to see the rate of expansion of the universe at different times in the past. The expansion was slower in the early universe.
  - Big Chill: Dark energy causes the universe to accelerate forever or effects of dark energy decrease with time slowing but never stopping the universe's expansion.
  - Superclusters of galaxies will collapse into black holes that over several hundred billion years will evaporate their mass back into space.

NOTES

Name _____ Date _____ Moravian University

DISTILL THE DEFINITION TO ITS BASIC MEANING

Instructions: Take the word on the left and find the most important information, words, or numbers associated with it to complete a shortened definition on the right. The full definitions of these words can be found elsewhere in this chapter. **You may not use more than six words for your core definition**. **Abbreviations will count as words,** such as mi./sec., equals miles/second, equals two words. Numbers, symbols, and punctuation will not count as words unless used incorrectly. Here is an example of an incorrect usage. "2 b or not 2 b" will mean "To be or not to be," and will have six words, not four. The grammar police will also be arresting you! The word or a similar word may **NOT** be used in the definition unless there is an asterisk with the word underlined. The asterisk is only good for the word directly next to it. In Electromagnetic Force*, only "Force" applies to this situation.

DEFINE THE WORD	DEFINITION: NO MORE THAN SIX WORDS MAXIMUM
Astronomical Unit	
Astronomy	
Baryonic Matter*	
Big Bang	
Black Hole	
Composition	
Dark Energy	
Dark Matter	
Density	
Distribution	
Ecliptic	
Electromagnetic Force*	
Electromagnetic Spectrum	
Evolution	
Galaxy	
Gravity	
Hydrogen	
Inverse Square Law	
Ion	

DEFINE THE WORD	DEFINITION: NO MORE THAN SIX WORDS MAXIMUM
Light* Year*	
Mass	
Meridian	
Move*ments	
Oscillating Universe*	
Physical States of Matter	
Planet	
Plasma	
Precession	
Qualitative	
Quantitative	
Quantum Mechanics	
Revolution	
Rotation	
Solar System	
Speed of Light*	
Stellar System	
Star	
String Theory	
Strong Nuclear Force*	
Universe	
Weak Nuclear Force*	

BASIC ASTRONOMY WORD LIST

1. **Astronomical Unit**: The average distance from the Earth to the sun, approximately 93 million miles or 149 million kilometers.
2. **Astronomy**: The science which investigates all matter and energy in the universe.
3. **Baryonic Matter**: The protons, neutrons, and electrons which govern the chemical makeup of the universe which we can observe. It comprises about five percent of the known universe.
4. **Big Bang**: A theory for the beginning of the evolution of the universe. The hypothesis purports that the universe appeared or "popped" from a small primordial atom or from "nothingness" and will keep expanding/accelerating forever. The notion that an explosion occurred is no longer considered valid; but the big bang has been impossible to remove from the literature, and so the words remain.
5. **Black Hole**: The volume of space surrounding a collapsed star in which the escape velocity equals or exceeds the speed of light.
6. **Composition**: The (qualitative and quantitative) chemical make-up of matter.
7. **Dark Energy**: An unknown force that can be quantified and is responsible for the expansion and acceleration of the universe. The amount of dark energy in the universe remains constant with volume and represents about 68 percent of the known universe.
8. **Dark Matter**: An unseen mass of unknown substance which can be quantified and comprises about 27 percent of the known universe. Its only similarity to baryonic matter is that is possesses gravity.
9. **Density**: The mass of an object divided by its volume. Mass per unit volume.
10. **Distribution**: The position or arrangement of matter/energy through an area or a space.
11. **Ecliptic**: The reference plane of the solar system which is created by the Earth orbiting the sun. It can also be defined as the path of the sun in the sky created by the Earth's orbital motion, or the plane of the Earth's orbit projected into space.
12. **Electromagnetic Force**: It governs how electrons orbit the nucleus of atoms and how atoms interact with each other to form the chemical bonds of the matter which we see all around us.
13. **Electromagnetic Spectrum**: All of the forms of energy which travel at the speed of light in a vacuum. They are represented by an electrical as well as a magnetic component—(**most intense to least intense**)—gamma rays, X-rays, ultraviolet, visible, infrared, microwaves, and radio energy.
14. **Evolution**: The process of change over time from a beginning to an end.
15. **Galaxy**: The basic manner in which matter clumps or congregates in the universe. Galaxies can be composed of millions to trillions of stars.
16. **Gravity**: The force of attraction acting between two bodies. That force is directly related to the mass of the bodies and inversely correlated to the square of their distances ($1/d^2$).
17. **Hydrogen**: The most abundant element in the universe as well as the simplest element on the Periodic Table of Elements. It is composed of one proton and one electron.
18. **Inverse Square Law**: The intensity of a force varies as one over the distance multiplied by itself ($1/d^2$). It governs how the strength of electromagnetic energy (light), magnetism, and gravity (even sound) varies with distance from the source.
19. **Ion**: An atom or molecule (radical) which is not electrically neutral because it has either gained or lost one or more electrons.
20. **Light Year**: The distance that light travels in one year, approximately 5.8 trillion miles.

21. **Mass**: The quantity of matter which an object contains.
22. **Meridian**: An imaginary great circle that intersects the south point on the horizon, the point directly overhead (zenith), the North Celestial Pole (near to the North Star), and the north point on the horizon. The meridian divides the eastern sky (a.m.—antemeridian, before the meridian) from the western sky (p.m.—post meridian, after the meridian).
23. **Movements**: The change in the position of a celestial object due to a change in the position of the Earth or the object itself.
24. **Oscillating Universe**: An outdated theory which states that the universe started with a big bang, but has a sufficient amount of matter to collapse upon itself, regenerating into another big bang in an endless cycle. Astronomers now know that the universe is not only expanding, but it is also accelerating. There will be no future collapse only endless acceleration.
25. **Physical States of Matter**: Solid, Liquid, Gas, and Plasma… Solid (volume/shape remains constant), Liquid (volume remains constant/shape changes), Gas (volume/shape change), and plasma (see specific definition)…
26. **Planet**: A round object, which is not the satellite of another planet; it is in orbit around the sun, and it is massive enough to clear its orbital path from debris.
27. **Plasma**: A hot, ionized gas in which ions and electrons are in free association.
28. **Precession**: The conical wobbling of the Earth's axis created by the sun's unequal pull on the equatorial bulge of the Earth. One precession cycle takes about 25,800 years.
29. **Qualitative**: A description of something…
30. **Quantitative**: Putting a numeric value on something…
31. **Quantum Mechanics**: The physics of the very small which governs the interactions of the parts of an atom and the interactions of atoms and molecules with each other.
32. **Revolution**: The orbiting motion of one body around another body. The Earth completes one orbit around the sun in a period of 365.24 days.
33. **Rotation**: The spinning motion of a body around its axis. The Earth rotates in a period of 23 hours, 56 minutes, 4 seconds.
34. **Solar System**: Our family of planets, moons, dwarf planets, and smaller bodies that are in orbit around the sun.
35. **Speed of Light**: The distance covered by electromagnetic radiation in a unit time interval. In a vacuum it is equivalent to 186,000 miles per second or 300,000 kilometers per second. The symbol "c" which represents the speed of light comes from the Latin word ***celeritas***, which means speed.
36. **Stellar System**: A star surrounded by other stars in orbit around it, or a family of planets, moons, and lesser bodies orbiting around a star other than our sun.
37. **Star**: A self-luminous body which maintains its energy output because of the conversion of matter into energy within its core.
38. **String Theory**: A hypothesis which proposes that the universe is ultimately composed of minuscule vibrating strands of energy which are found within subatomic particles known as quarks. The vibrations of the strings are governed by six additional tiny point dimensions which create the physical constants which allow us to describe the universe in which we live. According to String Theory the universe has a total of 11 dimensions.
39. **Strong Nuclear Force**: It is the "glue" which binds the nucleus of an atom together.
40. **Universe**: All matter and energy everywhere…
41. **Weak Nuclear Force**: It is the force which governs how radioactive isotopes decay.

The periodic table

www.webelements.com

1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Hydrogen 1 **H** 1.008																		Helium 2 **He** 4.0026
Lithium 3 **Li** 6.94	Beryllium 4 **Be** 9.0122												Boron 5 **B** 10.81	Carbon 6 **C** 12.011	Nitrogen 7 **N** 14.007	Oxygen 8 **O** 15.999	Fluorine 9 **F** 18.998	Neon 10 **Ne** 20.180
Sodium 11 **Na** 22.990	Magnesium 12 **Mg** 24.305												Aluminium 13 **Al** 26.982	Silicon 14 **Si** 28.085	Phosphorus 15 **P** 30.974	Sulfur 16 **S** 32.06	Chlorine 17 **Cl** 35.45	Argon 18 **Ar** 39.948
Potassium 19 **K** 39.098	Calcium 20 **Ca** 40.078(4)		Scandium 21 **Sc** 44.956	Titanium 22 **Ti** 47.867	Vanadium 23 **V** 50.942	Chromium 24 **Cr** 51.996	Manganese 25 **Mn** 54.938	Iron 26 **Fe** 55.845(2)	Cobalt 27 **Co** 58.933	Nickel 28 **Ni** 58.693	Copper 29 **Cu** 63.546(3)	Zinc 30 **Zn** 65.38(2)	Gallium 31 **Ga** 69.723	Germanium 32 **Ge** 72.63	Arsenic 33 **As** 74.922	Selenium 34 **Se** 78.96(3)	Bromine 35 **Br** 79.904	Krypton 36 **Kr** 83.798(2)
Rubidium 37 **Rb** 85.468	Strontium 38 **Sr** 87.62		Yttrium 39 **Y** 88.906	Zirconium 40 **Zr** 91.224(2)	Niobium 41 **Nb** 92.906(2)	Molybdenum 42 **Mo** 95.96(2)	Technetium 43 **Tc** [97.91]	Ruthenium 44 **Ru** 101.07(2)	Rhodium 45 **Rh** 102.91	Palladium 46 **Pd** 106.42	Silver 47 **Ag** 107.87	Cadmium 48 **Cd** 112.41	Indium 49 **In** 114.82	Tin 50 **Sn** 118.71	Antimony 51 **Sb** 121.76	Tellurium 52 **Te** 127.60(3)	Iodine 53 **I** 126.90	Xenon 54 **Xe** 131.29
Caesium 55 **Cs** 132.91	Barium 56 **Ba** 137.33	57-70 *	Lutetium 71 **Lu** 174.97	Hafnium 72 **Hf** 178.49(2)	Tantalum 73 **Ta** 180.95	Tungsten 74 **W** 183.84	Rhenium 75 **Re** 186.21	Osmium 76 **Os** 190.23(2)	Iridium 77 **Ir** 192.22	Platinum 78 **Pt** 195.08	Gold 79 **Au** 196.97	Mercury 80 **Hg** 200.59	Thallium 81 **Tl** 204.38	Lead 82 **Pb** 207.2	Bismuth 83 **Bi** 208.98	Polonium 84 **Po** [208.98]	Astatine 85 **At** [209.99]	Radon 86 **Rn** [222.02]
Francium 87 **Fr** [223.02]	Radium 88 **Ra** [226.03]	89-102 **	Lawrencium 103 **Lr** [262.11]	Rutherfordium 104 **Rf** [265.12]	Dubnium 105 **Db** [268.13]	Seaborgium 106 **Sg** [271.13]	Bohrium 107 **Bh** [270]	Hassium 108 **Hs** [277.15]	Meitnerium 109 **Mt** [276.15]	Darmstadtium 110 **Ds** [281.16]	Roentgenium 111 **Rg** [280.16]	Copernicium 112 **Cn** [285.17]	Ununtrium 113 **Uut** [284.18]	Flerovium 114 **Fl** [289.19]	Ununpentium 115 **Uup** [288.19]	Livermorium 116 **Lv** [293]	Ununseptium 117 **Uus** [294]	Ununoctium 118 **Uuo** [294]

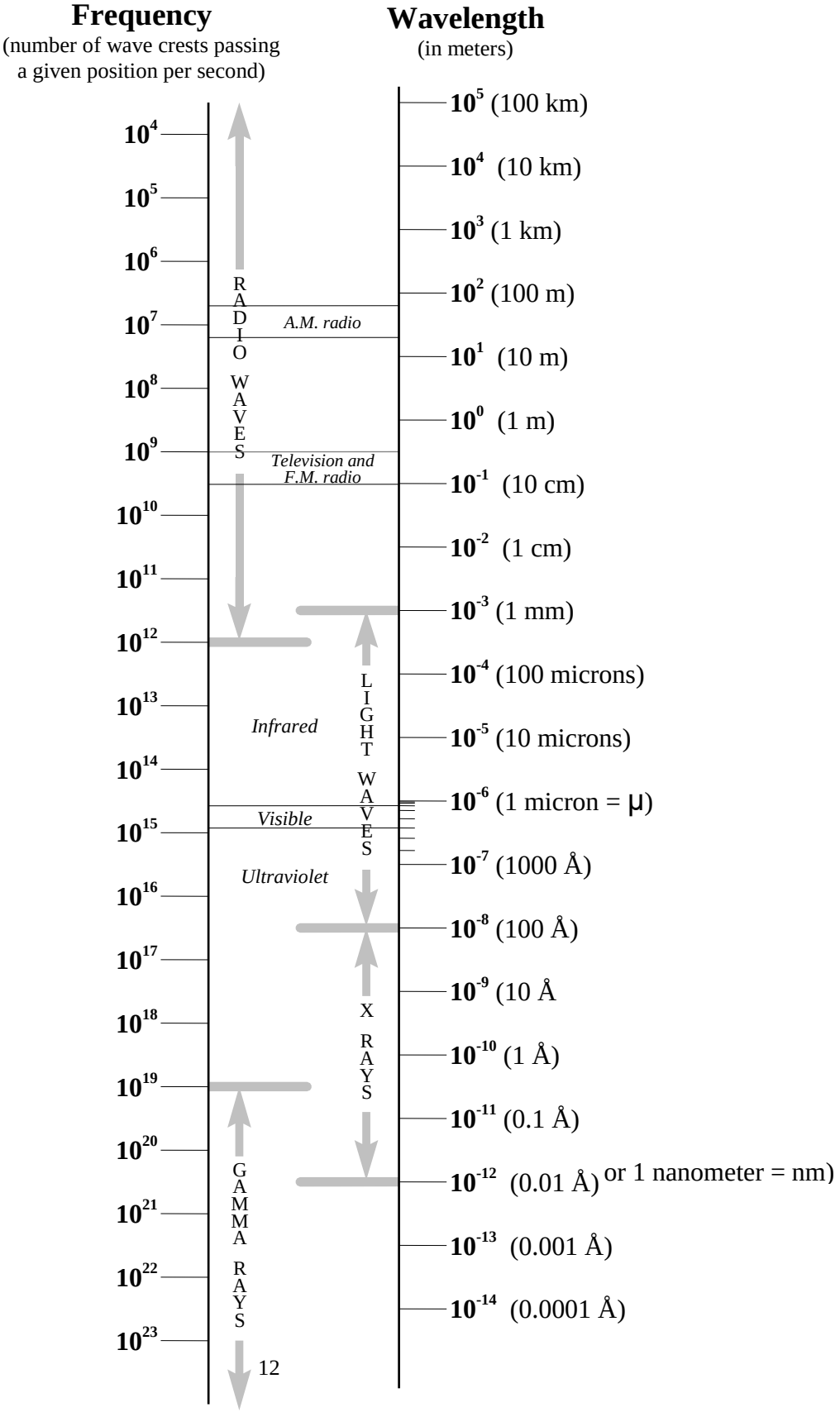
Key:

Element Name
Atomic number
Symbol
Atomic weight (mean relative mass)

*lanthanoids	Lanthanum 57 **La** 138.91	Cerium 58 **Ce** 140.12	Praseodymium 59 **Pr** 140.91	Neodymium 60 **Nd** 144.24	Promethium 61 **Pm** [144.91]	Samarium 62 **Sm** 150.36(2)	Europium 63 **Eu** 151.96	Gadolinium 64 **Gd** 157.25(3)	Terbium 65 **Tb** 158.93	Dysprosium 66 **Dy** 162.50	Holmium 67 **Ho** 164.93	Erbium 68 **Er** 167.26	Thulium 69 **Tm** 168.93	Ytterbium 70 **Yb** 173.05
**actinoids	Actinium 89 **Ac** [227.03]	Thorium 90 **Th** 232.04	Protactinium 91 **Pa** 231.04	Uranium 92 **U** 238.03	Neptunium 93 **Np** [237.05]	Plutonium 94 **Pu** [244.06]	Americium 95 **Am** [243.06]	Curium 96 **Cm** [247.07]	Berkelium 97 **Bk** [247.07]	Californium 98 **Cf** [251.08]	Einsteinium 99 **Es** [252.08]	Fermium 100 **Fm** [257.10]	Mendelevium 101 **Md** [258.10]	Nobelium 102 **No** [259.10]

Symbols and names: the symbols and names of the elements, and their spellings are those recommended by the International Union of Pure and Applied Chemistry (IUPAC - http://www.iupac.org/). Names have yet to be proposed for elements 113, 115, 117, and 118 and so those used here are IUPAC's temporary systematic names. In some countries, the spellings **aluminum**, **cesium**, and **sulphur** are usual.
Group labels: the numeric system (1–18) used here is the current IUPAC convention.
Atomic weights (mean relative masses): these are the IUPAC 2009 values and given to 5 significant figures. The last significant figure of each value is considered reliable to ±1 except where a larger uncertainty is given in parentheses. Representative values for those elements having an atomic weight interval are given (H, Li, B, C, N, O, Si, S, Cl, Tl). Elements for which the atomic weight is given within [brackets] have no stable nuclides and are represented by the element's longest lived isotope reported in the IUPAC 2009 values.
 For updates to this table see http://www.webelements.com/nexus/Printable_Periodic_Table (Version date: 7 June 2012).

ELECTROMAGNETIC SPECTRUM



MATH RULES

RULE FOR ROUNDING UP OR DOWN

Five and above, give it a shove; four and below leave it alone. Leo Andreoli (2021)

RULES FOR SIGNIFICANT NUMBERS

1. **Any nonzero digit is significant.** …8.45 cm has three significant figures; 1.234 m has four significant figures.
2. **Zeros between nonzero digits are significant**. …606 meters has three significant figures while 40,501 has five significant figures…
3. **Zeros to the left of the first nonzero digit are NOT significant**. Their purpose is to indicate the placement of a decimal point. …0.08 liters has only one significant figure, while 0.0000349 has three significant figures…
4. **If a number is greater than one**, then all zeros written to the right of the decimal point are significant. Thus 2.0 has two significant figures, 2.00 would have three significant figures. …40.062 has five significant figures and 3.040 has four significant figures…
5. **Trailing zeros in a number containing a decimal point are significant.** For example, 0.090 kg has two significant figures, 0.3005 liter has four significant figures, and 0.00420 has three significant figures.
6. **For numbers that do not contain any decimal points,** the trailing zeros which are the zeros after the last nonzero digit may or may not be significant. Thus 400 cm may have one significant figure (4), two significant figures (40), or 3 significant figures (400). We cannot know which is correct without more information. In this particular case we can express the number 400 as 4×10^2 for one significant figure, 4.0×10^2 for two significant figures or 4.00×10^2 for three significant figures.
7. **Assume that a single whole number digit** has as many significant figures to the right of the decimal as desired, unless otherwise stated.
8. **When numbers are multiplied or divided** to get the calculated quantity, the result may have no more significant figures than the measurement with the fewest significant numbers.
9. **When numbers are added or subtracted** to give a calculated quantity, it may have no column which represents a smaller quantity than the smallest numerical column common to both measurements. Thus the sum of 1.12 cm plus 21 cm is 22 cm, where the unit position represents the smallest numerical column common to both measurements. The addition or subtraction of numbers may have no decimal places greater than the measurement with the least number of decimal places.
10. **If a calculation has multiple steps, retain additional nonsignificant figures until the answer is achieved.** This helps to avoid any rounding errors (*California Institute of Technology*). The final answer must then be brought back into sync with the significant numbers of the original datum.

BASIC TRIGONOMETRIC FUNCTIONS—SOH, CAH, TOA

1. Sine function = SOH = **S**ine = **O**pposite **H**ypotenuse
2. Cosine function = CAH = **C**osine = **A**djacent **H**ypotenuse
3. Tangent function = TOA = **T**angent = **O**pposite **A**djacent

From Zack Egizio, Dieruff High School/East Stroudsburg University

TEMPERATURE CONVERSIONS

1. Centigrade to Fahrenheit: $F^o = \frac{9 \times C^o}{5} + 32$
2. Fahrenheit to Centigrade: $C^o = \frac{5}{9} \times (F^{o-} - 32)$
3. Kelvin (no degrees used because it is an absolute): $K = C^o + 273$

THE BASICS OF SCIENTIFIC NOTATION

Scientific Notation is a shorthand way of expressing large numbers based on the number 10.

10^9	= 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10	= 1,000,000,000.
10^8	= 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10	= 100,000,000.
10^7	= 10 x 10 x 10 x 10 x 10 x 10 x 10	= 10,000,000.
10^6	= 10 x 10 x 10 x 10 x 10 x 10	= 1,000,000.
10^5	= 10 x 10 x 10 x 10 x 10	= 100,000.
10^4	= 10 x 10 x 10 x 10	= 10,000.
10^3	= 10 x 10 x 10	= 1,000.
10^2	= 10 x 10	= 100.
10^1	= 10	= 10.
10^0	= 1	= 1.
10^{-1}	= 1/10	= 0.1
10^{-2}	= 1/10 x 1/10	= 0.01
10^{-3}	= 1/10 x 1/10 x 1/10	= 0.001
10^{-4}	= 1/10 x 1/10 x 1/10 x 1/10	= 0.0001
10^{-5}	= 1/10 x 1/10 x 1/10 x 1/10 x 1/10	= 0.00001
10^{-6}	= 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10	= 0.000001
10^{-7}	= 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10	= 0.0000001
10^{-8}	= 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10	= 0.00000001
10^{-9}	= 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10 x 1/10	= 0.000000001

RULES FOR GRAPHING

1. **Title the graph.**
2. **Label the horizontal (x) and vertical (y) axes with the independent variable and include units of measurement.**
3. **Create a scale, also known as an interval, for each axis based upon the range of the data.**
4. **Try to utilize as much of the graphing space available.**
5. **Plot the points in the dataset accurately.**
6. **In a bar graph include the numeric values above the bars.**
7. **Where applicable, sketch a line of best fit. Don't simply connect points.**
8. **Neatness always counts in graphing.**

Adapted from graphing instructions by Matthew Rach, Wm. Allen H. S., Allentown, PA…

RULES FOR PASSING THE CRAAP TEST (2010)

(Identifies six criteria readers should use to evaluation the credibility of information)

1. **Currency** (timeliness) of the information (date of posting or publication).
2. **Relevance** of the information for your needs (consider the intended audience for the material).
3. **Authority** of the source (qualifications, potential for bias or conflict of interest).
4. **Accuracy** or content (supported by evidence, peer-reviewed).
5. **Purpose** of the message (intended to inform, teach, entertain, persuade, or sell a product?).

GUIDELINES FOR EVALUATING THE CREDIBILITY OF NEW STORIES/BLOGS

(FactCheck.org)

1. Consider the source.
2. Read beyond headlines for details that might contradict or modify the meaning of the headline.
3. Evaluate supporting evidence (if any).
4. Check the date of publication.
5. Consider whether the "news" is intended as satire.
6. Consider your own biases (we tend to be less critical of sources that support our existing beliefs.
7. Consult expert authorities to corroborate assertions in the story.

NOTES

Name _____ Date _____ Moravian University

Name _____ Name _____

Name _____ Name _____

TEST YOUR VISUAL KNOWLEDGE OF ASTRONOMY

1. a. _____ Above is the (A),

   b. _____ and to the left is the (B)

2. _____ The curved streaks are…

   _____ What is causing them to streak in curves?

3. _____ Hit me with your best shot! What is the name of this planet?

4. _____ These are…

5. _____ What is it? These are two pictures of M51, a…

6. _____ Arching across the sky is the…

7. a. _____ What is it?

   b. _____ The dim area is called…

   c. _____ Does it have gravity?

8. a. _____ This nebula of glowing hydrogen was named after a state in the US.

   b. _____ In what state of matter is the hydrogen?

9. a. _____ This is the…

   b. _____ The black areas are called…

   c. _____ Are they hotter or cooler?

10. _____ Inside the big dome (top) and the sphere (bottom) are…

11. a. _____ It is the most famous… in the heavens.

    b. _____ In which constellation is it located?

12. _____ The straight streaks are…

13. _____ Most observers believe that this is the most spectacular object…

14. _____ What kind of eclipse is this?

15. a. _____ Constellation

    b. _____ Constellation

    c. _____ Star

16. a. _____ Are these solar or lunar eclipses?

    b. _____ The type of eclipse that is most frequently shown in the photos.

17. _____ Your first telescope should really be two.

18. _____ The mushroom-shaped instruments near the bottom of the photo are…

19. a. _____ Optical feature

    b. _____ Optical feature

    c. _____ Optical feature

20. a. _____ Optical feature

    b. _____ Optical feature

21. _____ Identify this planet.

22. _____ It is the most famous of its kind in the heavens.

23. _____ Telescopes are kept in them.

24. _____ Found in galaxies, they are the specific locations where stars are born.

25. _____ They fall to Earth and are called…

26. _____ Red

27. _____ Alaska, Iceland, northern Canada…

28. _____ A general term for this type of object is…

29. _____ These are examples of…

30. a. _____ This is the planet…

    b. _____ This is…

Packet No. _____

Name _____ Date _____ Moravian University

Name _____ Name _____

Name _____ Name _____

INTRODUCTORY ASTRONOMY WORD SCRAMBLE QUIZ

(10 points)

Instructions for the Scramble Quiz: You will receive a small packet of papers. One color will have the definitions, while the other colored paper will contain the vocabulary words. Complete the quiz by matching the vocabulary word with the correct definition.

Grading: Since students are working in groups, and since this is more of a matching exercise where students need to recognize the correct definition rather than stating it in writing, each mistake will count as a half point deduction. As an example, a team that misses two words will receive a final score of 9/10.

Consider the Following Suggestions:

1. **Mandatory:** Write the first and last name of each team member and note the date.
2. **Note the Packet Number** on this paper. Without a packet number I will not know which group of words to correct.
3. **Don't panic! Work as a team.** Keep focused on the problem at hand, not on what the other teams are doing.
4. **First separate** the colors into two packs.
5. **Consider arranging the vocabulary words in alphabetical order on the left**. Students most likely studied the words in alphabetical order and this will help with remembering the definitions, and particularly words with definitions that are similar. The **vocabulary words are centered** on the page. The **definitions are left justified**. Assemble the packet so that I see the word to be defined first, followed by the definition.
6. **Keep all words and definitions visible on the table** so that all answer possibilities remain viable. Words which are related have definitions which may seem similar. If an incorrect word/definition association is made, and that word/definition is pulled from the table, there will probably be another incorrect word/definition association chosen for the other similar word.
7. **Teams should complete the quiz in about 15 minutes**. This is not a timed exercise, so extra time will be given if needed.

NOTES

CAN YOU ANSWER THE FOLLOWING QUESTIONS/STATEMENTS?

1. State a concise definition for the subject of astronomy. Astronomy is the science which…

2. The quantity of matter per unit volume (density) throughout the universe gives astronomers a feeling about how that material is d_____.

3. Precession, rotation, and revolution of the Earth define three different _____ that affect the Earth and the positions of other objects in the sky.

4. The spinning of a body about its axis is called _____. Its duration for Earth is equivalent to _____.

5. The motion of one body around another is called _____. Its duration for Earth is equivalent to _____.

6. The four physical states in which matter can exist are called a _____, _____, _____, and a _____.

7. Ions and electrons in free association define a _____.

8. _____ consist of atoms or molecules which have lost or gained one or more electrons.

9. The big bang and nebular theories are models that detail the _____ of the universe and the solar system. The big bang is associated with the origin of the _____, while the nebular hypothesis details the beginning of the _____.

10. Knowing what elements comprise an astronomical body tells one about that object's _____.

11. The primary elements that compose the Earth are oxygen, silicon, and iron. This description is _____ in nature since it does not detail numerical amounts.

12. The Earth's atmosphere is composed of 78% nitrogen, 21% oxygen, and 1% argon. This represents a _____ statement.

13. By far the most abundant element in the universe is _____. About _____ percent of the universe is comprised of this element?

14. The most abundant element in the universe is composed of one _____ and one _____.

15. The velocity of light in a vacuum is equivalent to _____ mi/sec or _____ km/sec.

16. A light year measures the _____.

17. _____ The hypothesis which states that the universe was created from a primordial atom which somehow appeared and was expanding.

18. _____ All of the various forms of energy which travel at the speed of light are embraced by this term.

19. _____ The name of the sun and its family of planets goes by this term.

20. _____ Earth's orbit around the sun is defined by this plane. Eclipses must happen on or near it.

21. _____ These objects form the basic way in which matter collects within the universe and are composed of stars which can number from the millions into the trillions.

22. _____ The average distance from the Earth to the sun in miles or kilometers.

23. _____ It is the Earth-sun distance expressed in relative terms.

24. Thermonuclear fusion is how _____ generate their electromagnetic radiation.

25. _____ The theoretical end product of only the most massive stars after they explode.

26. _____ A universe which started with a bang, but which possesses sufficient mass to collapse upon itself at some future time, perhaps only to explode once again.

27. All matter-energy everywhere is a good definition for the _____.

28. The theory of everything which claims to be able to unite the four forces of nature into one consistent theory is called _____.

29. _____The force which binds electrons to the nucleus of an atom and governs the interaction of atoms with other atoms and molecules.

30. _____The weakest force of the four; its effect spans the entire universe and governs the motion of bodies throughout space.

31. _____This force is the glue which binds the protons of an atom and holds them within the nucleus.

32. _____The force dictates how radioactive isotopes decay.

33. _____It is the imaginary great circle which specifies the average location of the sun at noontime, when it is neither in the a.m. or p.m. part of the sky.

NOTES

ANSWERS TO SESSION ONE QUESTIONS

1. The science which concerns itself with the study of all matter-energy in the universe.
2. distributed
3. movements
4. rotation, 23 hours 56 minutes
5. revolution, 365.24 days
6. solid, liquid, gas, plasma
7. plasma
8. ions
9. evolution, universe, solar system
10. composition
11. qualitative
12. quantitative
13. hydrogen, 75
14. proton, electron
15. 186,000 mi/sec, 300,000 km/sec
16. the distance that light travels in one year, approximately six trillion miles (9 trillion km)
17. big bang
18. electromagnetic spectrum
19. solar system
20. ecliptic
21. galaxies
22. 93,000,000 miles (150,000,000 km)
23. astronomical unit
24. stars
25. black hole
26. oscillating or accordion universe
27. universe
28. string theory
29. electromagnetic
30. gravity
31. strong nuclear force
32. weak nuclear force
33. meridian

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