

TEST 1, 2, & 3 – ALL STUDY POINTS FOR FINAL EXAM

(bolded items apply to final test questions – this is a rough approximation)

Test 1 Study Points

INTRODUCTION

- Define moon, planet, star, solar system, galaxy and universe. (Look these up in your text or online, then make and study a flashcard for each.)
- **List the 3 hallmarks of science.** Distinguish science from non-science. (flashcards good here too)

SCALING

- **Picture/rank the size of the following objects: our Moon, Earth, Sun (or a star), our solar system, the Milky Way galaxy (our galaxy), the universe.**
- **Picture/rank the distances to the following objects: our Moon, Earth, Sun (or a star), our solar system, the Milky Way galaxy (our galaxy), the Andromeda Galaxy (nearest big neighbor galaxy to the Milky Way).**
- **Define Astronomical Unit.** Know its abbreviation.
- **Define light year.** Know its abbreviation.
- **Identify objects that are about a m in size, a cm in size, a mm in size.**
- Be able to measure in m, cm, mm and know examples of each.
- **Learn the name, meaning, and symbol for SI system prefixes giga, mega, kilo, centi, milli, micro, nano.**
- **Given a number in scientific notation, write it in standard form.**
- Given approximate sizes and the scale, build a scale model of the Earth-Moon system and the Sun-Earth system.
- **Given approximate sizes and the scale, build scale models of other objects or systems in the universe.**

STAR GAZING

- Describe positions of stars, Moon, Sun on the sky using direction and altitude. Do this when looking at the sky or a star chart.
- **Measure altitudes using the fist method.**
- **Define and use horizon and zenith. Know how many degrees are between horizon and zenith.**
- Describe how to correctly hold and orient a star chart and use it to find stars and constellations.
- Practice star hopping to locate stars and constellations.
- Explain why the date and time are included on star charts and what causes each to change.
- **State the magnitude scale for stars. Given a star's magnitude, identify if it is bright or faint.**
- **Define rotation and revolution as used by astronomers. Use them correctly when describing the motion of Earth, other planets, Sun and Moon.**
- Identify and use the correct color light to maintain dark adaptation when stargazing.

MOON: CYCLES OF THE SKY PART 1

- What is a mare?
- What causes craters, especially on the Moon?
- What is the Moon's terminator?
- **Explain why the Moon exhibits phases. Draw the Sun-Earth-Moon system showing the Moon's orbit (not to scale), draw Moon in 8 different positions in its orbit and shade in Earth and Moon indicating which side is lit and which is dark. Use that drawing to explain what phase you will see for each of the Moon's locations you drew. How much of the Moon is always lit?**
- **Knowing when New Moon occurs, predict about when First Quarter, Full, and Last Quarter Moons will occur. Know about how many days are in between the phases.**
- **Explain why the Sun, Moon and stars appear to rise in the east and set in the west. Explain why we have day and night using a sketch of Sun-Earth-Moon system to help.**
- In one hour, the Moon, Sun, and stars move about how many degrees in the sky? (hint: how many degrees does the Earth rotate in 24 hours)?
- In one day, the Moon moves about how many degrees in the sky? (hint: about how many degrees does the Moon revolve in 30 days)?
- What direction does the Moon move from one night to the next? Explain?
- Explain why you always see the same face of the Moon.

CYCLES OF THE SKY PART 2

- Predict the approximate time of day/night you should look for first quarter moon, full moon, last quarter moon.
- Explain how astronomers think the Moon formed and give evidence.
- **What causes a solar eclipse? What causes a lunar eclipse? What phase is the moon for each?**
- **Explain why the Earth undergoes seasons. Explain why it is hot in the summer. Explain why the Sun appears high in the sky during the summer but low in winter?**
- What is the zodiac? Why is it significant? What does the word zodiac mean? How many constellations are in the zodiac according to astronomy?
- What is the ecliptic plane? Where is the Sun in this plane? the Moon? the planets? the stars?
- What is meant by "the Sun is in Leo"? Explain why you only see some of the constellations of the zodiac at a given time.
- What is meant by the Earth's precession? Is Earth's precession a long or a short time?
- Explain why Polaris is the North Star? Explain why the stars appear to revolve around the North Star?
- Explain why the Sun is not in the constellation horoscopes say it is in when you are born.
- What distinguishes science from non-science? Give an example.
- Name the five North Circumpolar Constellations. Why are these important to us in MN?
- Define equinox and solstice? Sketch the Sun, Earth, and Earth's orbit. Draw Earth with the axis tilt and label the location of Earth at the solstices and equinoxes.

COPERNICAN REVOLUTION PART 1

- **Describe the geocentric and the heliocentric models of the solar system.**
- The word planet derives from the Greek "planetes" which means wanderer. Why were the planets called wanderers?
- Explain Aristotle's main argument against the heliocentric model.
- What was Aristotle's other (and weaker) argument against the heliocentric model?
- Who gave the first evidence in favor of the heliocentric model? What was the evidence?
- Who added the mathematical calculations to the geocentric model?
- When a planet undergoes retrograde motion, what does it look like in the sky and what direction does the planet move day to day?
- How did the geocentric model explain retrograde motion?
- How did the heliocentric model explain retrograde motion?

COPERNICAN REVOLUTION PART 2

- What did Brahe contribute to the heliocentric vs. geocentric debate?
- Define perihelion and aphelion.
- Considering Kepler's three laws of planetary motion (don't memorize them):
 - What is the shape of a planet's orbit?
 - When a satellite orbits the Earth, does it move faster at perigee or apogee? When a comet orbits the Sun, does it orbit faster at perihelion or at aphelion?
 - What is meant by the period of a planet? **In our solar system, what planet has the longest period? The shortest? Which planet orbits with the highest speed? Slowest?**
- What did Galileo notice about the Moon, the Sun, Jupiter, and Venus? What did he conclude from these observations?
- Why does Venus exhibit phases but Mars does not? (Hint: Draw the Sun as well as Venus, Earth and Mars in their orbits. Shade in Venus and Mars. What do they look like from Earth's view?)
- **State Newton's Universal Law of Gravity. If the mass of 1 of the 2 objects increases, what happens to the gravitational force between the objects? If the distance between the 2 objects increases, what happens to the force?**
- How can you tell if a process is science (what parts are needed)?
- When science uses the term "theory" such as the "Theory of Evolution," is that a weak or a strong statement? What backs up any theory in science?

Test 2 Study Points

WAVES & ELECTROMAGNETIC SPECTRUM

- **What is a wave?**
- **Define**, write the symbol for, and write the units for **each of the following: wavelength, frequency, and speed (velocity)**. Define and give the abbreviation of an Ångstrom.
- **State the approximate wavelengths of red and violet (blue) light** in both Ångstroms and nm.
- Review the definitions and abbreviations of the metric prefixes giga, mega, **kilo**, centi, milli, micro, and **nano** so that you can define, know the meaning of and give the symbol for each.
- For a sound wave, which wave property corresponds to pitch?
- Use the terms longer, shorter, higher, and lower to compare a high pitch sound to a low pitch sound in terms of their frequency and wavelength.
- **Use the terms higher, lower, greater, lesser, longer and shorter to compare the light from the red rod to the light from the blue flame in terms of their energy, frequency, wavelength, and temperature.**
- **State the colors of the visible spectrum in order from coolest to hottest. Is a blue flame hotter or cooler than the red rod it is heating? If you see a red star and a blue star, which is hotter?**
- **What does the color of a star or hot, dense object tell you? (T? λ ? f? E?)**
- If you detect an astronomical object emitting short wavelengths, what can you conclude? What can you conclude for the object with long wavelengths? (T? λ ? f? E?)
- **Name the seven types of EM radiation in order from lowest to highest f, from longest to shortest wavelength, from lowest to highest energy.**

SPECTRA TYPES

- What kind of electromagnetic radiation comes from radioactive material? Is used to look at bones? Causes skin damage? Can you see? Feels warm & penetrates smoke & dust? Warms food? Can you hear?
- How much of the universe can you see with your eyes or a telescope?
- What is similar about these EM waves?
- What is different about these EM waves?
- State the two kinds of EM waves that go through Earth's atmosphere?
- Given a type of EM wave, give some idea of the energy of the source of that EM wave. For example, does a radio wave come from a very energetic source or a medium energy source or a not so energetic source?
- Given a type of EM wave, give some idea of the temperature of the source of that EM wave. For example, does a radio wave come from a cool, a warm, or a hot source?
- **Name and describe the three types of spectra. Describe a source or process that produces each type of spectrum.** Give a density description for each spectra type.
- **Recognize that each element has a unique spectrum.**
- **What type of spectrum is produced by our Sun?**

SPECTRA – BLACKBODIES & ATOMS

- Define blackbody radiation.
- Draw two graphs of intensity vs wavelength for the low temperature object (reddish) and the high temperature object (bluish). What happens to the graph if the temperature of the body increases?
- Define and differentiate between the following: atom, element, molecule
- Identify the three basic particles in an atom. Know whether their charge is positive or negative or neutral. Know their approximate relative masses (not the mass itself, just how they compare). Know where each is located in the atom.
- Describe or sketch a simple model of the atom (the Bohr model) including permitted orbits.
- **Given a model of the atom, show which jumps correspond to emission spectra and which to absorption spectra.**
- Given a model of the atom showing several energy levels, identify which photon comes from which electron transition.
- **What information can astronomers obtain from the spectrum of a star, galaxy or gas cloud?**
- What did Annie Cannon contribute to the study of spectra? Cecilia Payne?
- **State the two chief components of stars. What percent is each?**
- Discuss how astronomers can tell what elements are in a gas cloud or in a star.

DOPPLER EFFECT

- Describe an example of the Doppler Effect that involves sound. Describe the pitch, frequencies, and wavelengths.
- **Describe an example of the Doppler Effect that involves light. Describe the frequencies and wavelengths.**
- **What is the Doppler Effect?**
- Describe how the Doppler Effect is used to measure the speed of a star or planet relative to the Earth.
- **What is meant by a red shift or a blue shift?**
- **Given the spectrum of a star and a reference spectrum, identify if the star's spectrum is red or blue shifted, whether the Earth and the star are moving toward or away from each other, and whether the Earth and the star have large or small relative speeds.**
- What did Vera Rubin and her colleagues measure with the Doppler Effect? What did they discover about a galaxy's rotation? About a galaxy's mass?
- What is gravitational lensing and why is it helpful?

PLANET TOUR & COMPARATIVE ENVIRONMENTS

- List the order of the planets. List the terrestrial planets. List the Jovian planets.
- Describe one method that astronomers use to measure the age of a surface of a planet or moon.
- **What is the age of our solar system?**
- Know the diameter size comparison of our Moon to Earth, Earth to Jupiter, Jupiter to Sun, and Earth to Sun. About how many of each object fit across the diameter of the compared object?
- **List four similarities among the terrestrial planets.**
- **List four similarities among the Jovian planets.**
- **List four ways Jovian planets differ from terrestrial planets.**

DWARF PLANETS, METEORS & COMETS

- What is the major difference between a planet and a dwarf planet?
- Name a dwarf planet.
- Where are the dwarf planets in our solar system?
- Distinguish between a meteor, a meteorite, and a meteoroid.
- **What is a "shooting star"? Why do we see it? On average, how big is one?**
- Why do we study meteorites?
- What is a comet?
- Describe a comet including the nucleus, head and tail. Why do we see a comet?
- Roughly, how big are comets?
- **What is the Asteroid Belt? the Oort Cloud? the Kuiper Belt? Where is each located?**
- Why study comets?
- What is a meteor shower? What is the comet connection to a meteor shower?

ENVIRONMENTAL HAZARDS

- **What is the Greenhouse Effect? Is it a natural process?**
- On what other terrestrial planet besides Earth has it had the most influence?
- Name the top four gases that cause the Greenhouse Effect on Earth? State both natural and human-made sources for each of these.
- List at least four consequences for us on Earth if this temperature rise occurs.
- List at least four steps we could be taking to slow this effect.
- What do scientists use radioactivity to do?
- Define: ion, isotope
- Define radioactivity.
- What is meant by parent & daughter in radioactivity?
- Define half-life. If you start with 100 grams of radioactive material, how much is left after one half-life? After 2 half-lives? After 3?
- **What evidence suggests that a meteor strike killed the dinosaurs? When?**

Test 3 Study Points

SUN, FUSION, AURORA

- Our sun is a star, one of billions of other stars.
- **Why does our star look so much bigger than other stars?**
- Is it bigger than other stars?
- **How many Earths can fit across the diameter of our sun?**
- What state of matter is our sun?
- Describe how the Sun's "surface" and the Earth rotate differently?
- What is the composition of our sun? What percent by counting? What percent by weight?
- What is the corona? What is the photosphere?
- **What is a sunspot?** Discuss the sunspot cycle.
- What is a solar flare? A solar prominence? A coronal mass ejection (CME)?
- What are some of the consequences of CMEs?
- **What powers the Sun and other stars? Describe the process.**
- What is the solar wind?
- **Explain what you are seeing when you see aurora?**
- **Where is almost all the mass in our solar system?**

STAR & PLANET BIRTH

- **What is a nebula?**
- What is a protostar?
- **Why are the Terrestrial planets dense but the Jovian planets are not?**
- **Give a brief overview of how scientists think stars and planets formed.**
- List and describe evidence from our solar system that supports that overview.
- List and describe evidence from outside our solar system that supports that overview.
- **Name an excellent example of a star birth region.**
- **Name and describe the two most common ways to find exoplanets (1. Doppler Shift a.k.a. radial velocity, 2. Transit).**

STAR PROPERTIES

- **Define luminosity and brightness.**
- **When you see a bright star, can you tell if it is luminous? If it is close? Explain.**
- Describe how astronomers measure the distance to a nearby star.
- **Describe how to use brightness and luminosity to find the distance to a star.**
- **What is an H-R diagram? Sketch one. Given the position of a star on the H-R diagram, indicate if the star is hot or cold, luminous or not.**
- Roughly describe the luminosity, surface temperature, and size of the following types of stars: main sequence, giant, supergiant, white dwarf, & red dwarf. **Which are the most common?**
- Why are supergiant stars rare?
- Know the comparison of mass and lifetime of main sequence, giant, supergiant, white dwarf, & red dwarf stars. **Which live the shortest lives? Which live the longest lives? Which are most common?**

STAR LIFE & SUPERNOVAS

Life of Stars – Part 1

- **Name the force that tries to compress/collapse a star? Name the process that happens in the core of a star preventing collapse and powering the star.**
- About how long does our sun live as a main sequence star?
- **Explain why a massive star only lives a short time?**
- **What is fusion? Why is it important to a star? What is converted to energy in the fusion process?**
- What elements are created in a sun-like star? What elements are created in a massive star?

Evolution of the Sun – Part 2

- **Name and briefly describe the stages that our sun will go through as it ages.**
- **About how much longer does Earth have until our Sun evolves to a Red Giant?**
- What is a planetary nebula?

Supernovas – Part 3

- Describe a supernova. Name two types (Ia and II) of supernovas and briefly describe the events that happen in each case.
- **Name and describe the leftovers from a supernova (expanding gas cloud and neutron star).**
- **What is meant by “standard candle”?** Describe a neutron star and a pulsar.
- Why are supernovas important? Why can we say that we are made of stardust?
- **Name and describe the stages in the evolution of a sun-like star (low-average mass).**
- Name and describe the stages in the evolution of large mass star.

BLACK HOLES

- **What is a black hole?**
- What is the end of life for low/average mass stars, for high mass stars, and for very high mass stars?
- What is the simplified statement from the Special Theory of Relativity? Has it been tested? Has it been disproved?
- **According to Newton, describe how gravitational force depends on mass and distance.**
- How does the universe make a black hole?
- According to Einstein, what is gravity? Explain why one mass exerts a force on a second mass. (from the General Theory of Relativity)
- Describe the basic structure of a black hole. Describe event horizon. Describe singularity.
- What is an accretion disk?
- **List at least three ways astronomers detect black holes.**

STAR GROUPS

- What are binary stars? Why are binary stars important?
- What is an open cluster of stars? Where are these generally located? Give an example.
- What is a globular cluster? Where are these generally located?
- What is a galaxy?
- Briefly describe or sketch the Milky Way galaxy. How big is it? **How many stars are in it?** Where are we in it? Where are the stars you see at night in it? Where are open clusters? Where are globular clusters?
- **What is our nearest large neighbor galaxy?**
- Do galaxies collide? What is a cluster of galaxies?
- What is the Local Group? About how big is it?
- **When we see objects like stars or galaxies in pictures, are we seeing them as they look now or in the past? Why?**

HUBBLE'S LAW

- What is a supercluster?
- **How are galaxies distributed in the universe? (think strings and voids)**
- What is Hubble' Law? Can you apply it to stars? To galaxies in the Local Group? To more distant galaxies?
- How do astronomers calculate distances to galaxies?
- **What does Hubble's Law tell us about the origin of the universe?**
- **Is the red shift caused by galaxies moving through space or by space-time expanding?**
- **Is the universe expanding, contracting or neither? How do we know?** Is the universe cooling?
- Discuss the raisin bread model or balloon model to explain why we do not have to be at the center of the universe.
- What is the name of the theory of how the universe evolved?
- **How old is our universe? How old is our solar system?**

BIG BANG

- Give a brief timeline for the formation of the universe from Big Bang to present day (BB, first atoms, universe becomes transparent, first stars, galaxies, solar system, humans!)
- What four pieces of observable evidence does the Big Bang predict?
- Explain why we can observe the afterglow of the hot, early universe, and what the CMB tells us.
- **Is the expansion rate accelerating? How do we know? What do we call that force?**
- Describe open, flat, and curved universes and explain which type of universe is supported by observations
- **Know basic properties of the universe including its age and contents (dark matter/dark energy/regular matter)**
- **Explain why inflation is necessary to explain the universe we see today (Horizon Problem and Flatness Problem).**
- Name the four forces that control all physical processes in the universe

LIFE IN THE UNIVERSE

- **What is the Copernican Principle?**
- **What are the basic requirements for life as we know it?**
- Describe the characteristics of a habitable environment
- **What biomarkers do we look for in the search for evidence of life beyond our solar system?**
- What is the Fermi paradox, and what are some possible solutions to it?
- **List efforts to communicate with other civilizations (listening and talking)**