

STUDY GUIDE FOR PART 1 (ASTRONOMY)

Introduction and Early Development

INTRODUCTION:

What is Astronomy? **It is the science which describes the celestial bodies according to their locations, sizes, motions, constitutions, and evolutions.**

Astronomy, as the definition states, is a science, and so we will study astronomy from the scientific point of view. The first step in the scientific method is to specify the problem. Our definition of astronomy does this in a general way. The second step in the scientific method is the observation of events and gathering of data. The third step is the making up of a theory that tries to account for the past observations and also tries to predict future events. This theory always involves assumptions. Sometimes these assumptions are made consciously by the scientist, and sometimes they are made unconsciously. The fourth step is the actual comparison of theory to those observations of events both past and predicted. This fourth step is a continuing process and goes hand in hand with step two, the gathering of data. Whenever a theory cannot account for all the data, then it must be modified or abandoned and a new theory tried.

In this first part we will look at the sky with our unaided eyes and gather that same data that the ancients gathered. Then we will look briefly at the theories that have been proposed in the past to explain that data. In Part II we will consider the nature of light and the basic tools that we have used to tremendously expand our collections of data and test our theories. Then in Parts III, IV, and V we will use this additional data to help us understand our present theories of our solar system, our galaxy, and our universe.

A. The Scientific Method

OUTLINE:

1. The scientific method
 - (1) Define the problem (what are you concerned with?)
 - (2) Observe (gather data)
 - (3) Try to explain (relate, hypothesize, then predict)
 - (4) Test the theory (observe - back to step 2!)

Study Questions for Part A:

- *1. List the four steps in the scientific method.

B. Basic Data

OUTLINE:

1. Definitions, terms, and notations
 - a) zenith (directly overhead)
 - b) meridian (north-south line across sky - through the zenith)
 - c) ecliptic (path of the sun through the stars)
 - d) constellations of the zodiac (the twelve constellations that fall along the ecliptic)
 - e) right ascension (celestial longitude, 0-24 hours; 0 hrs is location of sun on ecliptic on first day of spring)
 - f) declination (celestial latitude, from +90° [above north pole: North star] thru 0° [celestial equator] to -90° [above south pole])
 - g) summer and winter solstice (summer solstice: day when position of the rising sun is as far north as it ever gets - longest day of the year; it will start to rise a little bit further)

south each day for the next half year; winter solstice: day when position of the rising sun is as far south as it ever gets - shortest day of the year.)

- h) equinox (day when the sun rises due East and sets Due West - exactly 12 hours of day and 12 hours of night - happens on first day of spring and first day of fall)
- i) heliacal rising (day when a star first rises BEFORE the sun)

2. Basic data [apparent size, shape, brightness, position, motion]

- a) the sun (moves across the sky from East to West; moves along the ecliptic from West to East)
- b) the moon (moves across the sky from East to West; rises a little later each day; moves along the ecliptic from West to East)
- c) the stars (move around the North Star once a day; stay essentially in the same place relative to one another - artificially build constellations out of the stars)
- d) the planets (move across the sky from East to West; move along the ecliptic usually from West to East but occasionally move backward [backward motion is called retrograde motion])

Study Questions for Part B:

1. What are the: zenith? meridian? ecliptic? celestial equator?
spring equinox? fall equinox? summer solstice? winter solstice?
2. In which direction does the sun move relative to the stars?
3. Do the stars rise a little earlier or later each day?
4. Be able to convert miles to kilometers (and back again).
- *5. List two bits of OBSERVATIONAL data about each of the following: the sun, moon, stars, and planets.
- *6. Be able to draw a diagram of the Big Dipper and the North Star, and be able to specify the approximate right ascension and declination for the Big Dipper.
- **7. Name the twelve constellations of the zodiac and for each give: its declination, right ascension, the month when it will cross the meridian at 9 pm, and the month it will cross the meridian at noon.
8. Circle the correct choice(s): A star that is at the zenith in Memphis at 10 pm (Memphis time) on June 20 will also be:
 - a) at the zenith in a place 1000 miles due north at the same time on June 20;
 - b) at the zenith in a place 1000 miles due north but at a different time of day;
 - c) at the zenith in a place 1000 miles due west at the same time on June 20;
 - d) at the zenith in a place 1000 miles due west at 10 pm local time on June 20.

C. Brief History of Astronomy

OUTLINE:

1. Ancient Civilizations (constellations, summer/winter solstices, heliacal risings, eclipses, planets, etc.)

- a) Chinese at 4000 B.C. ?
- b) Egyptians - pyramids & alignments
- c) Stonehenge alignments (4000 B.C. - 1500 B.C.)
- d) Mayans (500 B.C.- 1500 A.D.) - temples & alignments
- e) North American Indians - Medicine Wheels

2. The Greeks

- a) Homer, 8th century B.C. (Iliad & Odyssey: flat earth, dome for sky)
- b) Thales ≈ 600 B.C. (stars are not gods, length of year)
- c) Pythagoras ≈ 500 B.C. (geometry: spherical bodies)
- d) Plato ≈ 400 B.C. (pure form)
- e) Aristotle ≈ 350 B.C. (real world, observations, 4 elements + quintessence)
- f) Eratosthenes ≈ 250 B.C. (determined circumference of earth)
- g) Greeks in Alexandria - Ptolemy ≈ 150 A.D. (book: Almagest)

3. Classical Developments

- a) Copernicus (1473-1543) [sun centered view proposed]
- b) Brahe (1546-1601) [great data collected]
- c) Kepler (1571-1630) [elliptical orbits based on above data]
- d) Galileo (1564-1642) [used telescope for astronomical data]
- e) Newton (1642-1727) [laws of motion, law of gravity, invented reflecting telescope, wrote book on optics, played with spectrum of light, invented calculus to help in work with motion and gravity, ... one of world's top geniuses!]

4. Modern Developments

- a) relativity: motion and the speed of light
- b) quantum theory & light: waves AND particles

Study Questions for Part C:

- *1. Be able to briefly discuss **one** of the ancient (non-Greek) civilization's ideas on astronomy.
- *2. Be able to briefly discuss **one** of the Greek's ideas on astronomy and be able to give the approximate year (within 50 years) for his life.
- *3. Be able to briefly discuss **one** of the following: Copernicus, Brahe, Kepler, Galileo, or Newton and relate his accomplishments in the context of the other four.
4. Be able to locate in time each of the people in question #3 in relation to the following major world events: Columbus discovers America (1492), the Spanish Armada defeated by Britain (1588), Pilgrims land at Plymouth rock (1620), Declaration of Independence (1776)
- *5. Know Newton's three laws of motion: be able to describe them in words.
- *6. Describe Newton's law of gravitation.

Study TRUE/FALSE questions for all of Part I:

(Questions similar to these may appear on the test. There is an executable Windows program that has more sample True/False questions on the course web page.)

- a) If a star appears at the zenith in Memphis at midnight Memphis time, that same star will appear at the zenith in Phoenix (assume same latitude but different longitude) at midnight Phoenix time.
- b) If a star appears at the zenith in Memphis at midnight Memphis time, that same star will appear at the zenith in Chicago (assume same longitude but different latitude) at midnight Chicago time.
- c) The stars move in a circle around the North Star approximately once a day.
- d) You can see the North Star from any place on earth (on a clear night)
- e) The moon follows approximately the same path as the sun through the sky.
- f) The sun appears to move easterly through the constellations of the zodiac (it never moves westward).
- g) On or around March 21, the sun appears to rise the farthest south of due east.
- h) The celestial equator crosses the ecliptic at only one point.
- i) Venus, Mercury, Mars, Jupiter, and Saturn are the only planets visible to the naked eye (at one time or another).
- j) The planets are called wandering stars because they wander around the sky without ANY limits on where they might be found.
- k) Galileo came after Newton and verified Newton's laws of motion and gravity.
- l) Newton came after Kepler and Newton's laws of motion and gravity explained Kepler's laws of planetary motion.
- m) Galileo lived during the time the Pilgrims were landing in America.
- n) It is possible to determine the speed of a star by measuring the speed of the light that comes from that star.