

Final Study Guide

Astronomy 122

Celestial Sphere:

1. What causes the Sun, Moon, and Stars to rise in the east and set in the west once a day?
2. Does Polaris rise and set every day? Why / Why not?
3. Will Polaris always be the North Star? Why / Why not?
4. Can we see the North Star if we are in the southern hemisphere?
5. What causes the seasons?

The Moon:

1. Does the Moon rotate on its axis? (If so, how long does it take to make one complete rotation?)
2. Do we see different sides of the Moon throughout the month? Why / Why not?
3. What causes the Moon to have phases?
4. How much of the Moon's surface is actually lit up by the Sun? Is it always the same amount?

Light:

1. Describe the electromagnetic spectrum. How is it organized?
2. What parts of the spectrum have shorter wavelengths? What parts have longer wavelengths?
3. What parts of the spectrum have smaller frequencies? What parts have longer frequencies?
4. How are wavelength and frequency related?
5. What happens to the energy of a photon as wavelength increases? Decreases?
6. What happens to the energy of a photon as frequency increases? Decreases?
7. What speed does each wavelength of light travel at?

Telescopes:

1. What is angular resolution?
 - a. How does it depend on the size of the telescope and the wavelength of light?
 - b. What is the mathematical formula relating angular resolution, telescope size and wavelength of light? What units are these components in?
 - c. Is there a limit to how much detail telescopes on the Earth can discern? What is the cause of this limit?

Gravity:

1. Why does the Earth orbit the Sun?
2. Gravitational Force – what does it depend on? What is the formula for the gravitational force and what does each term mean? What happens to the gravitational force if you double/triple/quadruple one object's mass? What happens to the gravitational force if you double/triple the distance between the objects?
3. What is Weight? How is it different from Mass? If the Earth doubled/tripled in size, how would your weight and mass change? If the Earth doubled/tripled in mass, how would your weight and mass change?

Parallax:

1. What is Parallax?
2. What causes us to see parallax?
3. What is the mathematical formula relating distance to the parallax angle? What units do you use for each term in the formula? Parallax angle is defined as a change in star's position over what period of time?
4. What is a parsec?

Hydrostatic Equilibrium & Fusion:

1. What is Hydrostatic equilibrium? What pushes inward? What pushes outward?
2. What powers the Sun?
3. What is the strong force? Why is it important?

Black Bodies:

1. What is a blackbody? What determines blackbody's color? What is the formula that relates the temperature to the wavelength of the emission peak? What units are used in the formula? If you double/triple/quadruple the temperature of the blackbody, what happens to the wavelength of the emission peak?
2. What does apparent brightness depend on? What happens to the object's apparent brightness if you move it twice/three times/5 times/half/quarter as far away.

Magnitudes:

1. What is apparent magnitude? The brighter the star, the _____ the magnitude.
2. What is Absolute Magnitude? What happens to the star's absolute magnitude if you move it twice/three times/5 times/half/quarter as far away?
3. What can we tell about star's distance if
 - a. its apparent and absolute magnitudes are equal ($m=M$)?
 - b. its apparent magnitude is higher than its absolute magnitude ($m>M$)?
 - c. its apparent magnitude is lower than its absolute magnitude ($m<M$)?

Spectra:

1. In what way is an element's spectrum like a fingerprint?
2. Spectral features are related to what physical property of a star?

HR Diagram:

1. What spectral classes do we have? What spectral class is the Sun? What spectral class are the hottest stars? What spectral class are the coldest stars?
2. What parameters does star's luminosity depend on? How can a cold star be very luminous? How can a hot star have low luminosity?
3. What is the Hertzsprung-Russel Diagram? What are the axes? Where is the main sequence? Where on the diagram are supergiants, giants, white dwarfs, red dwarfs? Where is the Sun? Where on the diagram are most stars and why? What is happening in the core of the main sequence star?
4. What is a rough range of sizes of main sequence stars? Giants? Supergiants? White dwarfs are roughly the size of _____.
5. What is Kepler's third law? What is Newton's version of Kepler's Third? What units are used in the formula? If the Earth's orbital radius doubled/tripled, what would happen to the period? If the Earth's mass doubled, what would happen to the period?

Doppler Shift:

1. What is Doppler Shift?
2. What does it depend on?
3. Describe the motion of the star that would have no Doppler shift (2 cases). If a star is moving away/towards us, will its light be shifted to longer or shorter wavelength?

Star Formation:

1. Where do stars form? How do we know?
2. Is the collapse of the gas the only process in the star formation? What other (weird) process is going on?
3. How do planets form?

Exoplanets:

1. What are exoplanets? Why is it difficult to detect them? What are different methods of planet detection?
2. Are most exoplanetary systems that we found similar or different from our solar system? How?
3. Describe the Radial Velocity Method – what do we observe? Can this method help us determine a planet's orbital period, distance from the star, and mass? How?
4. What effect does mass of the planet have on star's wobble? What effect does the distance of the planet have on star's wobble?

5. What were the surprising properties of exoplanets discovered so far?
6. Why have we not found more Earth-like planets with radial velocity method?
7. Which method is our best chance to detect Earth-like planets? How does it work?

Stellar Evolution – low mass:

1. Where are stars born?
2. What is a difference between a protostar and a (main sequence) star?
3. How can we tell ages of stellar clusters?
4. What is the Solar Nebula theory?
5. What happens in a star's core when it is on the main sequence? When does a star move off main sequence?
6. What is the mass-luminosity relation? Is there a relation between stellar mass and main sequence lifetime? What is it?
7. What is a Red Dwarf? What is red dwarf's lifetime?
8. Evolution of Sun-like Stars: What happens to the core when H burning stops? What happens in the shell? What happens to the outer envelope? What happens to the temperature in the core? on the surface? What happens to the size of the star?
9. What is a Red Giant? What happens in its core? in the shell?
10. What is the Helium Flash?
11. What is happening in the core of a Horizontal Branch star? Is there shell burning?
12. What is happening in the core of the Asymptotic Giant Branch star? What about the shell?
13. What are end products of low-mass star evolution? What elements are in the core?
14. What is a White Dwarf? What is its size (roughly)? What supports it against collapse? How does the size of a WD change with increasing mass?
15. Main Sequence star, Asymptotic giant branch, Red giant, helium flash, planetary nebula ejection, horizontal branch → order these into evolutionary sequence
16. What is degenerate matter?

Stellar Evolution – High mass stars:

1. Describe in detail the evolution of a high-mass star. How is the evolution similar to a low-mass star? How is it different?
2. What does a massive star become when it moves off the main sequence? Do high-mass stars undergo a He flash? What happens after He is exhausted in the core? Why are massive stars like onions? What elements are produced in massive stars?
3. What is the final product produced in the core of a massive star? Why can't a star fuse iron to form heavier elements? How are the heavier elements (heavier than iron) ever produced?
4. What happens to the core after fusion stops? What happens to the outer layers?
5. What is a supernova? How often do we see them? Describe what happens during a supernova. In what form does a supernova release most of its energy? What are the end products of massive star's evolution?
6. Why are we "made of stars"?
7. What are possible end products of a supernova?
8. What is a pulsar? What is a neutron star? What is roughly the size of a neutron star? What is its mass?

Special Relativity:

1. To an outside observer, a spaceship flying by near the speed of light will seem to be longer/shorter? What will the earth look like to the person inside the spaceship?
2. To an observer on Earth, the time on the space ship (flying near light speed) will seem to flow faster/slower? To an observer on the space ship, time on Earth will seem to flow faster/slower?
3. Mass of an object appears to increase/decrease/stay the same as the object approaches speed of light?
4. A beam of light is coming towards you. What would you measure the speed of light to be from Earth? From a spaceship moving at half the speed of light towards the light beam?
5. How would the ages of twins compare if one stays on Earth and the other goes on a spaceship flight at 90% speed of light?

General Relativity:

1. According to Newton, a massive object produces a gravitational force on other objects. What does a massive object produce according to GR?
2. How do mass and space-time affect each other?
3. How does a massive object affect the path of the light according to Newton? According to GR?
4. According to Einstein, what is gravity? What is gravitational lensing?
5. What is gravitational redshift?

Black Holes:

1. Why is a black hole called a black hole?
2. What is the actual size of the blackhole? What is the Schwarzschild radius? Are they the same thing?
3. What would happen to Earth if the Sun turned into a black hole?
4. What is a singularity? What is an event horizon? Write the formula for the radius of the event horizon? Describe the path of light from a black hole.
5. What is the Schwarzschild radius for 1 solar mass black hole? 3 solar masses? Half a solar mass?
6. If nothing escapes a black hole, how can we detect it?
7. What happens to you if you are falling into a black hole?

Life in Universe & Drake Equation:

1. What are arguments for the existence of life in our galaxy? What are arguments against it?
2. What is the Drake Equation? Is it an exact equation? What is the Fermi paradox?

The Milky Way:

1. Describe the Milky Way.
 - a. How big is it?
 - b. What are its major structural components?
 - c. What kinds of objects can be found in each of these structural components?
2. Do spiral arms always contain the same stars? What causes these spirals?
3. What made Herschel believe the Sun was at the center of the Milky Way? How does interstellar dust affect our observations of the Milky Way? Where is our solar system truly located?
4. What is a globular cluster?
 - a. What kinds of stars are in a globular cluster?
 - b. How old are globular clusters?
 - c. Where are they located?
 - d. How did globular clusters help us locate our place in the Milky Way galaxy?
5. How does our Galaxy rotate?
 - a. Do disk-objects near the center rotate at the same speed as disk-objects near the edge?
 - b. How do halo-objects rotate?
6. What does a rotation curve for the Milky Way show? What is the significance of this result?
7. Describe dark matter: Why is it called “dark”?

Galaxies:

1. What can we use to determine the distances to other galaxies?
2. What is the typical distance between galaxies? How does this compare with the size of the Milky Way?
3. Why do we describe looking at distant galaxies as looking back in time? If we look at a galaxy 5 billion light years away from us, are we seeing that galaxy as it is right now?
4. What are the three kinds of galaxies?
 - a. How are they alike?
 - b. How are they different?
5. What kind of galaxy is the Milky Way?
6. How do the rotation curves of other galaxies compare with the Milky Way's rotation curve? What does this mean?
7. How are galaxies grouped together? Is the Milky Way part of a group of galaxies?

Galaxy Collisions

1. Can galaxies merge with each other?
2. Will the Milky Way collide with another galaxy eventually?
3. Do stars typically collide when galaxies collide?
4. What can be initiated inside galaxies due to galaxy collisions?

5. How do collisions explain why elliptical galaxies are found where ever galaxies are close together?

The Universe:

1. What did Edwin Hubble discover about the motion of galaxies? What was he measuring about galaxies? How does this lead to Hubble's resulting discovery?
2. What is Hubble's Law?
 - a. Describe the components of Hubble's Law.
 - b. What is Hubble's constant? What are the units on this constant?
 - c. What can we use this law for?
3. What makes us believe that galaxy clusters contain a lot of dark matter?
4. How does the amount of dark matter present compare with the amount of visible normal matter? What are the main two components of the visible matter in clusters? Which one has the most mass?
5. How are galaxies clusters distributed throughout the universe?
6. If the universe is homogenous and isotropic, how do we think galaxies formed? What caused galaxies to form differently from each other?
7. How does the amount of normal matter in the universe compare with the amount of dark matter?

Quasars:

1. What do quasars appear to look like? How far away are they? How do we know they are so far away?
2. What is a quasar?
3. Are there quasars in the universe at the current time?
4. What is an Active Galaxy?
5. What mechanism is believed to power active galaxies?
6. How is a supermassive black hole different from a regular black hole?
7. Where are supermassive black holes found?

The Big Bang:

1. What is Cosmology?
2. Describe Olber's Paradox. What significant characteristic of the universe accounts for why the sky is dark?
3. What is the observable universe? How is it different from the whole universe?
4. How do galaxies appear to move relative to the Milky Way galaxy? How would galaxies appear to be moving if we observed them from a different galaxy?
5. What exactly is expanding in the universe?
6. Is there a center to the universe? Is there an edge?
7. Do planets and galaxies and people expand, too? Why/Why not?
8. What is cosmological redshift?
9. Compare the density of the universe today with the density of the universe in the past and future. How does the density change with time?
10. What is the Big Bang? Where did it happen?
11. What are some methods we can use to find the age of the universe?

Cosmic Microwave Background

1. What is the Cosmic Microwave Background radiation?
2. Why is it so significant?
3. What is the isotropy problem with the CMB?
4. What is inflation?
5. How does inflation help explain why the CMB temperature is nearly the same everywhere?

Matter and Antimatter

1. What is antimatter? How is it different from normal matter?
2. What happens when matter and antimatter collide?
3. How do we know that there must have been an imbalance between the amounts of matter and antimatter created in the early universe?

The Universe more...:

1. What kind of Universe do we think we live in today (open, closed, or flat)?
2. What is most of the Universe made out of?
3. What is Big Bang Nucleosynthesis?
4. What are the three strongest pieces of evidence of the Big Bang?
5. What were the seeds of galaxies? What role did quarks play?