

Name _____

**NATS 102 – Prather
Final Exam – May 2004
Test Form A**

*Answer all of the following questions on the bubble sheet provided using a #2 pencil. Make sure that your **Name, Student ID Number** and **test form letter** are on the answer sheet and that all answers are recorded in the correct position. **ALWAYS SELECT THE BEST ANSWER.** Each question is worth 1 point. This is a closed-book, closed-note exam and you have approximately two hours to complete it. If you have questions, please raise your hand.*

**Be sure to write and bubble in your ID number and test form letter.
If your ID number begins with an ‘S’, write that in and bubble a ‘0’.**

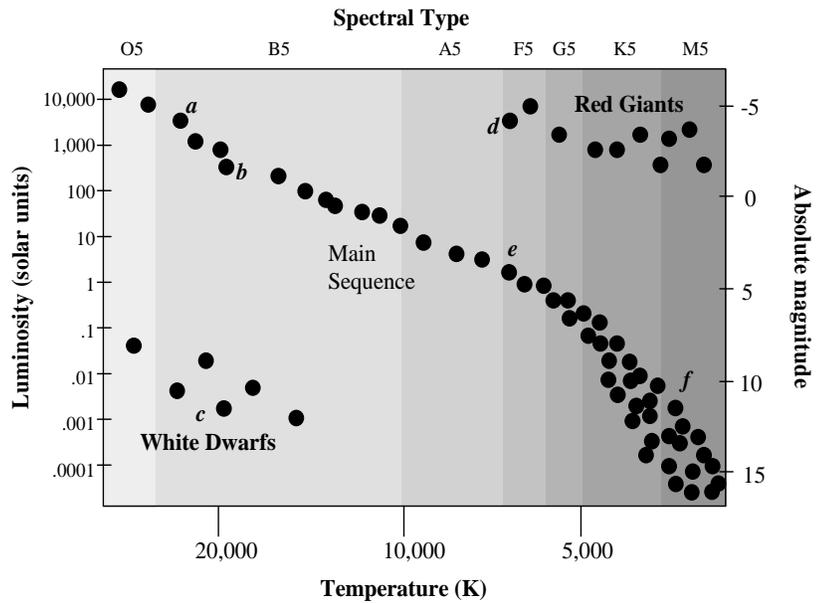
**DO NOT START THE EXAM UNTIL YOU ARE TOLD
TO DO SO!**

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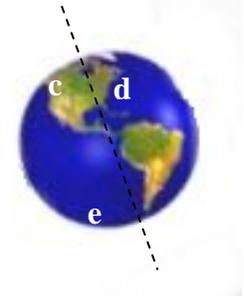
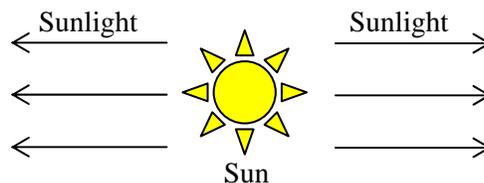
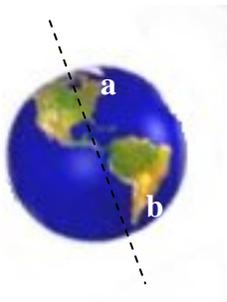
ASSUME THAT YOU ARE VIEWING THE SKY FROM TUCSON UNLESS OTHERWISE SPECIFIED WITHIN A QUESTION.

The HR Diagram at right is provided to assist with answering the following two questions.

- Which is hotter, a main sequence star with an absolute magnitude of $M=4$ or a white dwarf with a luminosity 100 times smaller than the Sun?
 - the main sequence star
 - the white dwarf
 - They have the same temperature.
 - There is insufficient information to determine this.
- Which statement is the most correct about the comparison between a K5 main sequence star and a B5 main sequence star?
 - The K5 star is cooler, dimmer, smaller, and will not live as long as the B5 main sequence star.
 - The K5 star is hotter, dimmer, larger, and will live longer than the B5 main sequence star.
 - The K5 star is smaller, hotter, brighter, and will not live as long as the B5 main sequence star.
 - The K5 star is hotter, brighter, smaller, and will live longer than the B5 main sequence star.
 - The K5 star is dimmer, cooler, smaller, and will live longer than the B5 main sequence star.



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- Looking at the two images of Earth below, which letter (a-e) best represents winter in the United States?

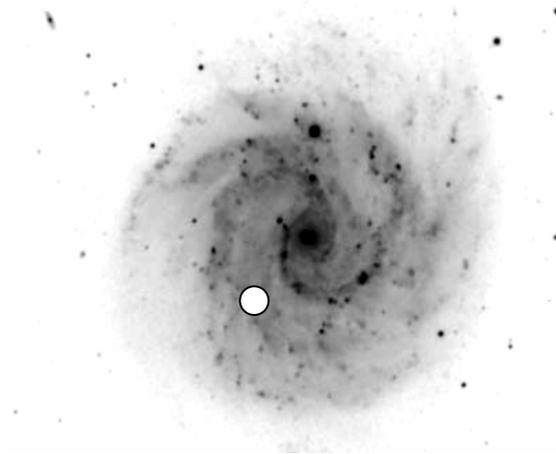


Note: this drawing is not to scale. In fact you could fit more than 11,000 Earths between the Sun and the Earth.

4. Your remote satellite orbits close to the Sun and detects a solar flare erupting at 10:00 AM, as measured by the satellite's clock. Your clock here on Earth is exactly synchronized with the satellite clock. The Sun is located 8 light minutes away from Earth. What time will it be when you observe the light from the flare here on Earth?
- 9:52 A.M.
 - 10:00 A.M.
 - 10:08 A.M.
 - None of the above is correct, since this flare has already occurred.

Answer the following two questions using the image at right, which represents the Milky Way Galaxy.

5. Approximately how far is it from the white circle to the center of the Milky Way Galaxy?
- 1,000 light years
 - 10,000 light years
 - 25,000 light years
 - 100,000 light years
 - 500,000 light years
6. Approximately how large is the diameter of the white dot?
- 1,000 light years
 - 10,000 light years
 - 50,000 light years
 - 100,000 light years
 - 500,000 light years

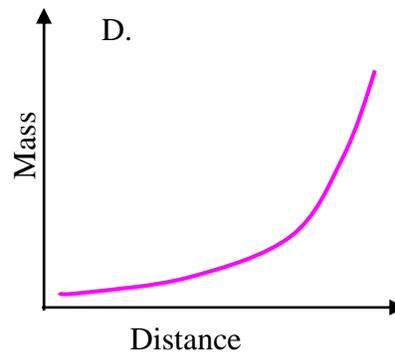
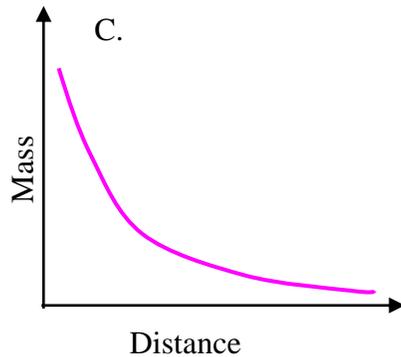
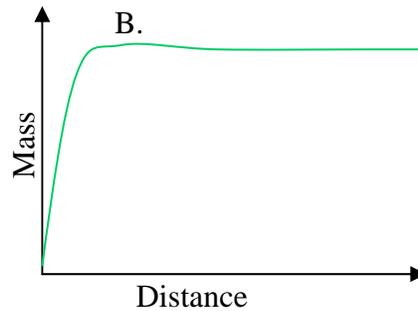
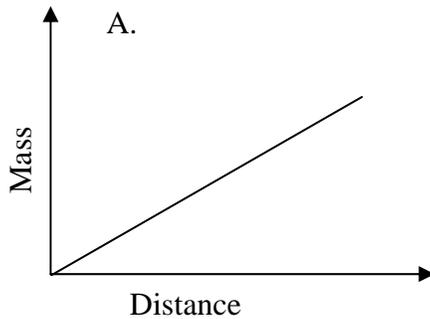


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7. The atoms in the plastic of your chair were formed
- Choose all that are correct.*
- in our Sun.
 - by a star existing prior to the formation of our Sun.
 - during a supernova event.
 - about 100 million years ago.
 - in a distant galaxy in a different part of the early universe
8. Which of the following most accurately describes the Big Bang theory for the beginning of our Universe?
- an event that instantaneously created all the matter in the universe
 - the explosive event that forced matter to expand throughout the universe
 - an enormous explosion that organized pre-existing matter into the current arrangement of galaxies and stars
 - an event that marks the beginning of the universe as a singularity of enormously high energy and temperature but no matter
 - a gigantic sphere containing all the matter and energy of the current universe

9. From the observation of the microwave background radiation we know that
Choose all that are correct.
- the Universe was once much hotter.
 - there were times during the early universe when light could not freely travel through space.
 - the Universe began during an event we call the Big Bang.
 - the Universe is approximately 14 billion years old.

10. Which of the following lists, in the correct order, a possible evolutionary path for a star?
- Red Giant, Neutron Star, White Dwarf, Nothing
 - Red Giant, Type I Supernova, Black Hole
 - Red Giant, Type II Supernova, Planetary Nebula, Neutron Star
 - Red Giant, Planetary Nebula, White Dwarf
 - Red Giant, Planetary Nebula, Black Hole

11. If we were to make a curve that shows how all the mass of the Milky Way Galaxy is distributed *based only on the rotation rate of matter in the galaxy*, the curve would look like which of the following?



12. Hubble's observation that galaxies farther away from us are moving faster implies that
- the universe is expanding.
 - the universe is contracting.
 - we are located at the center of the universe.
 - our Galaxy repels other galaxies.

13. If a small weather satellite and the large International Space Station are orbiting Earth at the same altitude above Earth's surface, which of the following is true?
- The large space station will take longer to go around Earth.
 - The small weather satellite will take longer to go around Earth.
 - They will each take the same amount of time to go around Earth.
14. Imagine that you throw a ball directly upward. Which of the following statements best describes how Newton's Second Law accounts for the motion of the ball when it reaches its maximum height?
- The ball has a velocity that is zero and an acceleration that is zero.
 - The ball has a velocity that is upward and an acceleration that is downward.
 - The ball has a net force that is downward and an acceleration that is downward.
 - The ball has a net force that is downward and a velocity that is downward.
 - The ball has a net force that is downward and an acceleration of zero.
15. Shown below are the spectra of stars A and B. How does the temperature of the two stars compare? Assume that the left end of each spectrum corresponds to shorter wavelengths (blue light) and that the right end of each spectrum corresponds with longer wavelengths (red light).



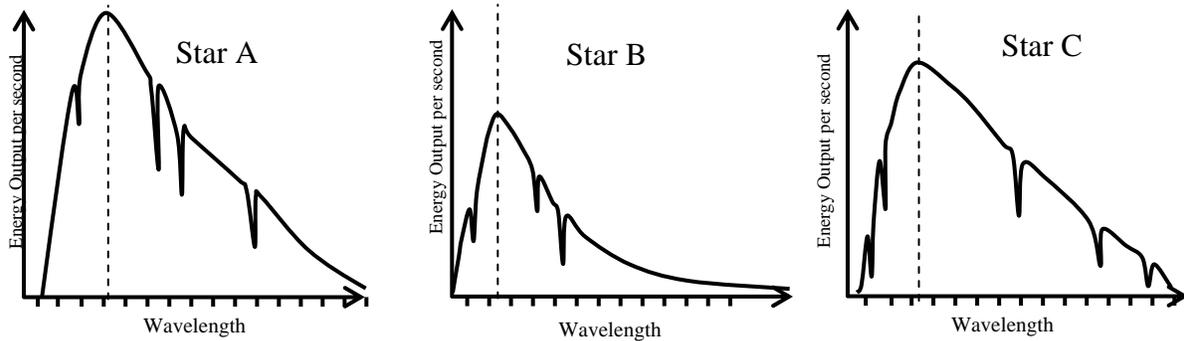
Star A



Star B

- Star A is at the higher temperature.
 - Star B is at the higher temperature.
 - Both stars are the same temperature.
 - The relative temperatures of the stars cannot be determined from this information.
16. Kepler's second law says "a line joining a planet and the Sun sweeps out equal areas in equal amounts of time." Which of the following statements means nearly the same thing?
- Planets move fastest when they are moving toward the Sun.
 - Planets move equal distances throughout their orbit of the Sun.
 - Planets move slowest when they are moving away from the Sun.
 - Planets move farther in a given time when they are closer to the Sun.
 - Planets move the same speed at all points during their orbit of the Sun.
17. Energy is released from atoms in the form of light when electrons
- move from high energy levels to low energy levels.
 - become bound to an atom
 - leave the atom.
 - move from low energy levels to high energy levels.

18. The three spectral curves shown in the graphs below illustrate the energy output versus wavelength for three unknown stars A, B, and C. Which of the stars has the highest temperature?



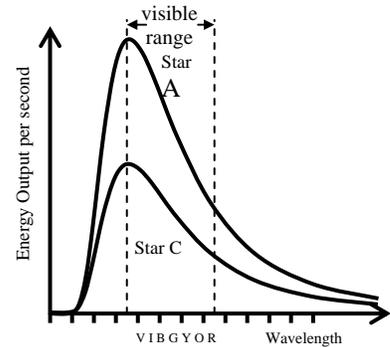
- Star A
 - Star B
 - Star C
 - All three stars have the same temperature.
19. Which is the correct reasoning for why an x-ray telescope located in Antarctica that is to be used to look for evidence of black holes in the centers of galaxies would not get funded?
- There are no such things as black holes.
 - x-rays are too energetic to detect with a telescope.
 - You can't build a telescope in Antarctica.
 - x-rays don't completely penetrate Earth's atmosphere.
20. A planet is moving with retrograde motion. Over the course of several weeks, how will the planet appear to move relative to the background stars?
- east to west
 - west to east
 - It will not move at all, as planets do not move with respect to the stars.
 - It will move randomly, as planets move differently than the stars.
21. Imagine that you observe the Sun while in your space ship in orbit around the Moon. Which of the following spectra would you observe by analyzing the sunlight?
- dark line absorption spectrum
 - bright line emission spectrum
 - continuous spectrum
22. Black holes are formed by
- a lack of any light in a region of space.
 - supernovae from the most massive stars.
 - supernovae from binary stars.
 - collapsed dark nebulae.

23. How do we know that galaxies farther away from us are moving faster than nearby galaxies?
- by measuring the masses of galaxies
 - by measuring the redshifts of galaxies
 - by measuring the brightness of galaxies
 - by measuring the sizes of galaxies
24. Imagine that you simultaneously receive the satellite transmission of two pictures of two people that live on planets orbiting two different stars. Each image shows the people at their 21st birthday parties. Consider the following possible interpretations that could be made from your observations. Which do you think is the most plausible interpretation?
- Both people are the same age but at different distances from you.
 - The people are actually different ages but at the same distance from you.
 - The person that is closer to you is actually the older of the two people.
 - The person that is farther from you is actually the older of the two people.
25. The shape of our Galaxy's rotation curve implies the existence of
- a mysterious, unknown force.
 - dark matter.
 - dark energy.
 - pulsars.
 - missing gas and dust.
26. Which of the following statements is true about the location of the Sun at sunrise during the middle of winter?
- The Sun will rise north of East.
 - The Sun will rise directly in the East.
 - The Sun will rise south of East.
 - None of the above.
27. What two conditions must be met in order for a solar eclipse to occur?
- The Moon must be full and cross the Earth-Sun orbital plane.
 - The Moon must be full and not cross the Earth-Sun orbital plane.
 - The Moon must be new and not cross the Earth-Sun orbital plane.
 - The Moon must be new and cross the Earth-Sun orbital plane.
28. If the Moon is in the waxing gibbous phase tonight, approximately how long will it be until the Moon is in the waning crescent phase?
- one day
 - one week
 - two weeks
 - three weeks
 - a month
29. If the seasons on Earth were the same in both the northern and southern hemispheres at the same time, what would have to change about the current state of the Earth-Moon-Sun system?
- The Sun would need to give off the same amount of energy all the time.
 - The Earth would have to stay the same distance from the Sun all the time.
 - The amount of direct sunlight and hours of daylight would have to stay the same all year long.
 - The Earth would have to orbit the Sun at the same speed all the time.
 - All of the above.

Use the graph at right to answer the next two questions.

30. Which of the following relationships is possible to infer about stars A and C based on the information provided in the graph at right?

- a. Star A is smaller than Star C.
- b. Star A is larger than Star C.
- c. The stars are the same size.
- d. It is not possible to infer any of these relationships.



31. Which of the two stars (A or C) is at a higher temperature?

- a. Star A
- b. Star C
- c. The two stars have the same temperature.
- d. It is not possible to infer this relationship.

32. Which of the following best describes what the microwave background radiation is?

- a. The shockwave or echo that travels throughout the Universe that marks the event we call the Big Bang.
- b. The total light we observe when we look at the blackbody curve for all the wavelengths of light given off by all the stars in the Universe.
- c. Light that is present everywhere in the Universe that came from the time when light first was able to travel through the early universe without being absorbed.
- d. The particles that move throughout the Universe that were created during the Big Bang and thrown out in all directions.

33. The eventual fate of our Sun is to

- a. collapse into black hole.
- b. form a neutron star.
- c. become a steadily cooling white dwarf.
- d. explode as a type Ia supernova, leaving no remnant.

34. Why are the spiral arms of spiral galaxies blue in color?

- a. They are usually moving toward us and are Doppler shifted to blue wavelengths.
- b. The gas and dust in the arms filter out all but the blue light from stars in the arms.
- c. Stars are forming in the spiral arms so there are many more high mass, hot, blue stars present.
- d. Almost all the stars of the disk are in the arms of the galaxy and their light makes it appear blue.

35. For a white dwarf to become a nova, it is necessary for it to

- a. have a companion.
- b. become a black hole.
- c. have begun life as a high-mass star.
- d. rejoin the main sequence.

36. According to modern ideas and observations, what can be said about the location of the center of our expanding universe?

- a. Earth is at the center.
- b. The Sun is at the center.
- c. The Milky Way Galaxy is at the center.
- d. The universe does not have a center.

37. During the new moon phase, how much of the Moon's total surface is being illuminated by sunlight?
- none
 - less than half
 - half
 - more than half

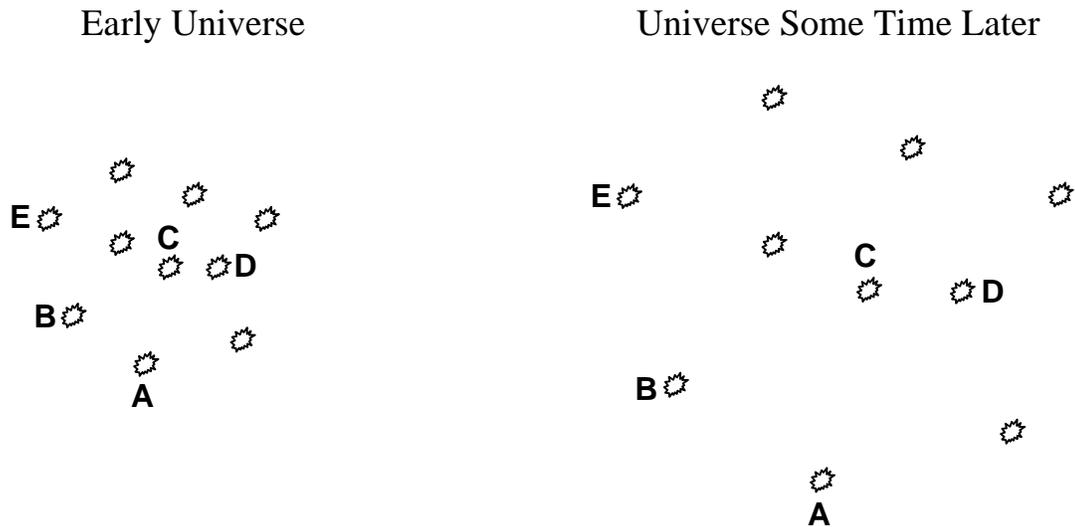
38. Consider three widely separated galaxies in an expanding universe. Imagine that you are located in galaxy 1 and observe that both galaxies 2 and 3 are moving away from you. If you asked an observer in galaxy 3 to describe how galaxy 2 appears to move, what would he or she say?



- “Galaxy 2 is not moving.”
- “Galaxy 2 is moving toward me.”
- “Galaxy 2 is moving away from me.”

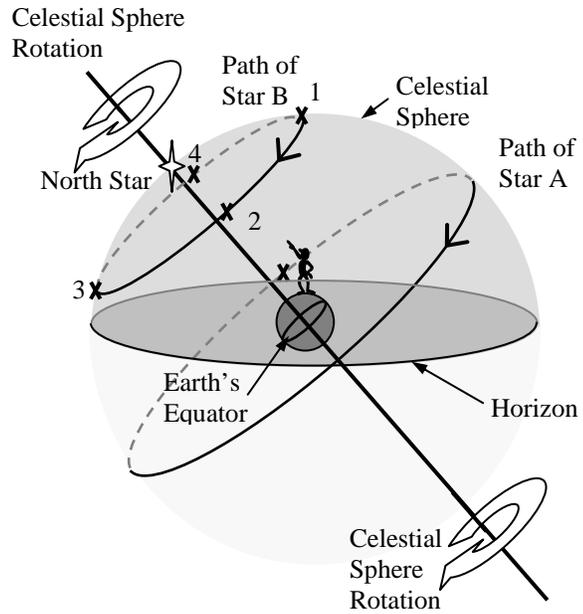
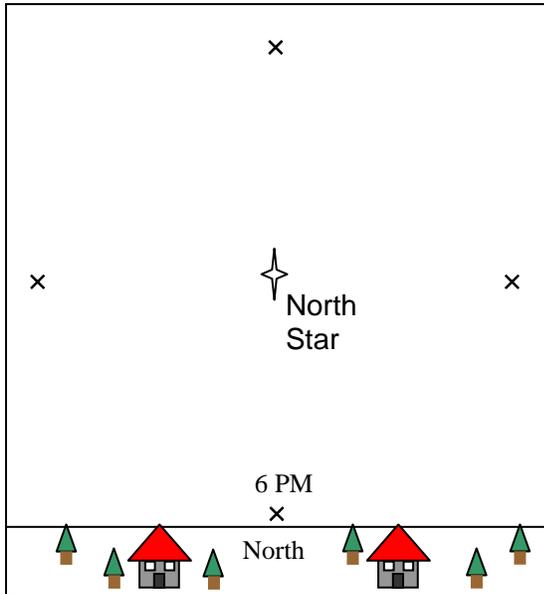
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The drawing below represents the same group of galaxies at two different times during the history of the Universe. Use this drawing to answer the following two questions.



39. For an observer in galaxy B, which of the following rankings lists the speeds (from fastest to slowest) at which galaxies A, C, and D would be moving away?
- $A > C > D$
 - $D > A > C$
 - $C > D > A$
 - $D > C > A$
40. Which one of the following conclusions can you draw about the expansion of the universe from the drawing shown?
- Galaxy C is the center of the universe.
 - All galaxies move the same amount during the expansion of the universe.
 - Nearby galaxies move more during the expansion of the universe.
 - All galaxies appear to move away from each other during the expansion of the universe.
-

For the three questions, use the two figures provided below, which show the motion of stars A and B in the sky. Note that Star A reaches its maximum height above the horizon at 6:00 pm.



41. At what time will Star B be located high in the Northwestern sky?
 - a. 4:00 am
 - b. 11:00 am
 - c. 2:00 pm
 - d. 7:00 pm
 - e. 1:00 am

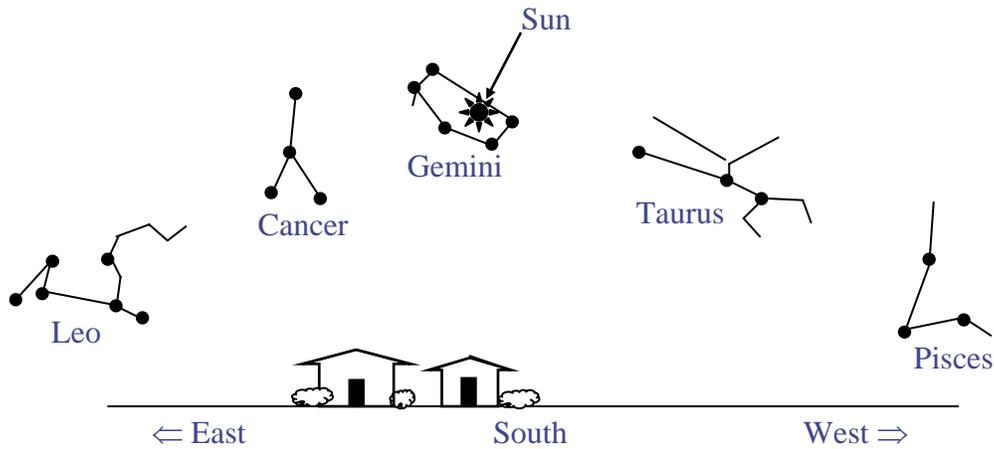
42. At what time would you see Star A in the southern part of the sky?
 - a. 6:00 am
 - b. Noon
 - c. 6:00 pm
 - d. Midnight

43. At what time would you see Star A in the west?
 - a. 6:00 am
 - b. Noon
 - c. 6:00 pm
 - d. Midnight

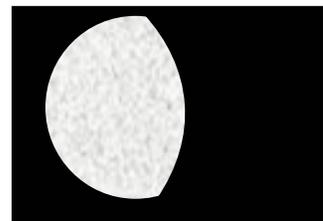
44. In Einstein's theories about the universe, how is the concept of gravity described?
 - a. by the amount of expansion of space time
 - b. by the density of space time
 - c. by the amount of curvature of space time
 - d. by the amount of tension in space time

Star A appears brighter than Star B, but Star A actually gives off less light than Star B. The apparent magnitude and absolute magnitudes for Star A are $m = 0$ and $M = 1$, respectively. Use this information to answer the following four questions.

45. Which of the following are the best possible values for the apparent and absolute magnitudes of Star B?
- $m = 1$ and $M = 1$
 - $m = -1$ and $M = 1$
 - $m = 1$ and $M = -1$
 - $m = -1$ and $M = -1$
46. Which is the most correct statement about the distance of Star A from Earth?
- Star A is closer than 10 pc from Earth.
 - Star A is exactly 10 pc from Earth.
 - Star A is farther than 10 pc from Earth.
47. If both stars are main sequence stars, which is true about the temperatures of Star A and Star B?
- Star B is hotter than Star A.
 - Star B is cooler than Star A.
 - Star B is the same temperature as Star A.
48. If both stars are main sequence stars, which is true about the lifetimes of Star A and Star B?
- Star B will live longer than Star A.
 - Star A will live longer than Star B.
 - Star B will have the same lifetime as Star A.
-
49. The idea of dark matter is provided to explain which one of the following?
- the location and shape of the arms in the disk of spiral galaxies
 - the location of the maximum in the distribution of globular clusters of stars in the halo of the galaxy
 - that the rotation speeds of objects in Milky Way are approximately the same throughout the disk and halo
 - that a spiral density wave moves through the disk of spiral galaxies
 - that spiral galaxies slowly evolve into elliptical galaxies

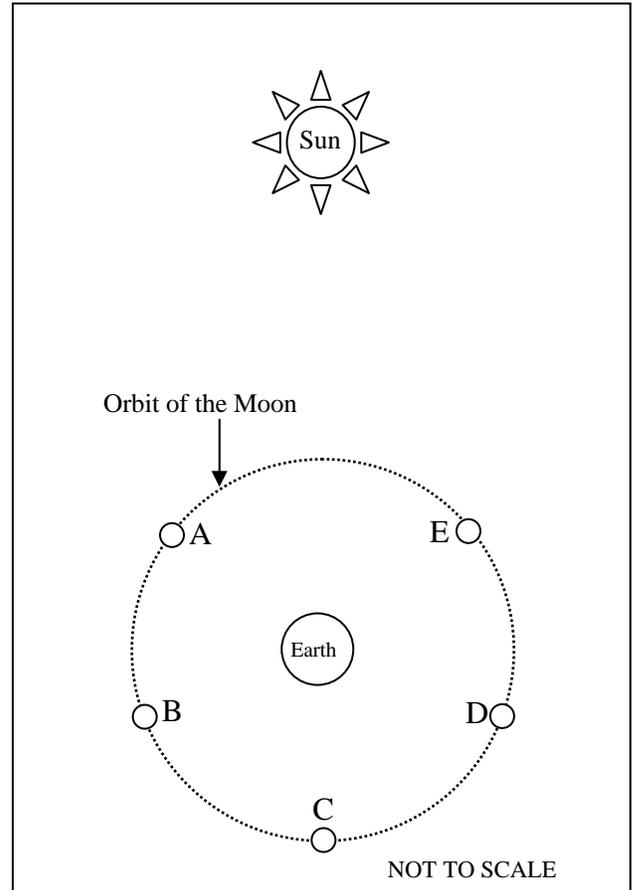
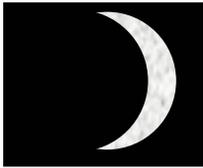


50. If you could see stars during the day, the drawing above shows what the sky would look like at noon on a given day. The Sun is near the stars of the constellation Gemini. Near which constellation would you expect the Sun to be located at *sunrise*?
- Leo
 - Cancer
 - Gemini
 - Taurus
 - Pisces
51. Imagine that Earth's orbit were changed to be a perfect circle about the Sun so that the distance to the Sun never changed. How would this affect the seasons?
- We would no longer experience a difference between the seasons.
 - We would still experience seasons, but the difference would be *much less* noticeable.
 - We would still experience seasons, but the difference would be *much more* noticeable.
 - We would continue to experience seasons about the same way we do now.
52. What time is it when the moon phase shown at right first begins to rise above the horizon?
- in the late morning
 - at noon
 - in the mid-afternoon
 - in the evening
 - at midnight



53. Imagine you see Mars rising in the east at 6:30 pm. Six hours later what direction would you face (look) to see Mars?
- toward the north
 - toward the south
 - toward the east
 - toward the west
 - directly overhead

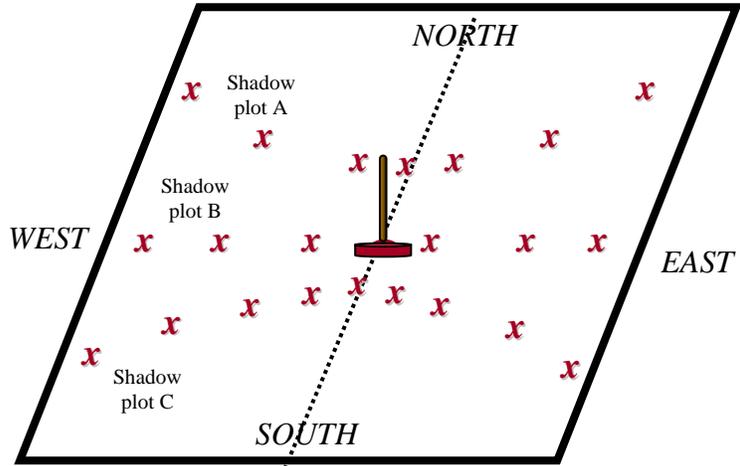
54. Which Moon position (A-E), shown in the diagram at right, best corresponds with the moon phase shown below?



55. If our atmosphere was able to absorb visible light as effectively as it absorbs UV light, which of the following would be true?
- The Earth's surface temperature would be warmer than it is today.
 - The Earth's surface temperature would be cooler than it is today.
 - The Earth's surface temperature would be the same temperature as it is today.
 - There is not enough information to answer this question.

56. If you were constructing a scale model of the solar system that used a Sun that was the size of a basketball (~ 12" diameter), which of the following lengths would most closely approximate the scaled distance between Earth and the Sun?
- 3 feet (length of an outstretched arm)
 - 10 feet (height of a basketball goal)
 - 100 feet (height of an 8 story building)
 - 300 feet (length of a football field)
57. Which of the following is **not** part of the greenhouse effect?
- Visible light from the Sun is absorbed by Earth's surface.
 - Due to the Ozone hole UV light can significantly increase the surface temperature of Earth.
 - Earth's surface and atmospheric gases give off infrared light.
 - The amount of light given off by Earth is equal to the amount of light absorbed from the Sun.
58. How many Moons could fit between the Moon and Earth?
- 2
 - 10
 - 30
 - 110
 - 120
59. The standard model of solar system formation offers what explanation for the different compositions of the terrestrial and Jovian planets?
- During condensation, the heavier elements tended to sink nearer the Sun and, being rare, only provided enough material to build the relatively small terrestrial planets.
 - During the collapse of the gaseous nebula, most of the material tended to collect far from the Sun because of the large centrifugal forces, which provided the necessary material to build the large Jovian planets.
 - The large gravitational forces of Jupiter tended to prevent planet formation in the inner solar system and eventually attracted most of the material into the region of the Jovian planets.
 - The terrestrial planets were formed near the Sun where, because of the high temperatures, only heavier elements were able to condense.
60. A bright star is moving toward Earth. If you were to look at the spectrum of this star, what would it look like?
- an absorption spectrum that is redshifted relative to an unmoving star
 - an emission spectrum that is redshifted relative to an unmoving star
 - a continuous spectrum that is blueshifted relative to an unmoving star
 - an absorption spectrum that is blueshifted relative to an unmoving star
 - a continuous spectrum that is redshifted relative to an unmoving star
61. A moon covered with numerous and very old craters created by meteorite impacts likely
- has no ocean to cover the craters.
 - orbits a large Jupiter sized planet.
 - has a cold, solid interior.
 - has no protective magnetic field.

62. For an observer in the continental U.S., which of the three shadow plots, shown at right, correctly depicts the Sun's motion for one day?
- Shadow plot A
 - Shadow plot B
 - Shadow plot C
 - More than one of the plots is possible, on different days of the year.
 - None of the plots are possible.



Use the three images of galaxies shown at right (A, B, and C) to answer the following three questions



A



B



C

63. In which of the galaxies would you expect to see many bright blue stars (choose all that apply)?
64. In which of the galaxies would you expect to see mostly red stars (choose all that apply)?
65. In which of the galaxies would you expect to see regions of abundant gas and dust (choose all that apply)?

66. Spiral density waves are used to explain which one of the following?
(Choose all that apply)
- the location and shape of the arms in the disk of spiral galaxies
 - the location of the maximum in the distribution of globular cluster of stars in the halo of the galaxy
 - that the rotation speeds of objects in Milky Way are approximately the same throughout the disk and halo
 - the formation of stars in the disk of spiral galaxies
 - that spiral galaxies slowly evolve into elliptical galaxies

67. Which of the following is part of the greenhouse effect?
- Earth's atmosphere becomes thicker with greenhouse gasses.
 - Infrared light becomes permanently trapped in our atmosphere.
 - The ozone hole causes significant increases in surface temperature.
 - Earth's surface and atmospheric gases absorb energy and then give off infrared light.
 - Heat is transferred in the atmosphere through air circulation.

68. You observe two spectra (shown below) that are redshifted relative to that of a stationary source of light. Which of the following statements best describes how the sources of light that produced the two spectra were moving? *Assume that the left end of each spectrum corresponds to shorter wavelengths (blue light) and that the right end of each spectrum corresponds with longer wavelengths (red light).*



Spectrum A



Spectrum B

- Source A is moving faster than source B.
 - Source B is moving faster than source A.
 - Both sources are moving with the same speed.
 - It is impossible to tell from looking at these spectra.
69. Which one of the planets listed initially formed at the outermost location where the temperature was high enough for water to boil?
- Venus
 - Earth
 - Mars
 - Jupiter
 - Saturn
70. The distribution of globular clusters is used to explain which of the following?
- the location of our solar system within the Milky Way galaxy
 - the age of the Milky Way galaxy
 - how stars form in the Milky Way galaxy
 - why stars cluster in spiral arms in the disk of the Milky Way galaxy

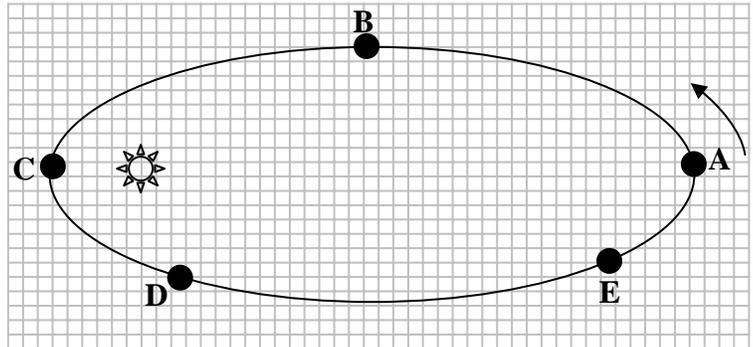
The star map provided below shows the sky at midnight on July 1 as seen from Tucson. Use this chart to answer the next question.

71. What is the name of the star group that will appear high in the southern part of the sky at midnight?
- Auriga
 - Ursa Major
 - Draco
 - Corona Borealis
 - Scorpius



72. How does the Sun produce the energy that heats our planet?
- The gases inside the Sun are on fire; they are burning like a giant bonfire.
 - Hydrogen atoms are combined into helium atoms inside the Sun's core. Small amounts of mass are converted into huge amounts of energy in this process.
 - When the gas inside the Sun is compressed, it heats up. This heat radiates outward through the star.
 - Magnetic energy gets trapped in sunspots and active regions. When this energy is released, it explodes off the Sun as flares that give off tremendous amounts of energy.
 - The core of the Sun has radioactive materials that give off energy as they decay into other elements.

73. The planet shown in the drawing at right obeys Kepler's Second Law. Each lettered position represents the location for the planet during a particular day. At which lettered position would the planet have moved the farthest during that day?



74. Imagine that you are the head of a funding agency that can afford to build only one telescope. Which of the four proposed telescopes below would be best to support?
- A gamma ray telescope in Antarctica
 - A radio telescope in orbit above the Earth
 - A visible telescope located high on a mountain in Peru
 - An ultraviolet telescope located in the Mojave desert
75. If the stars Betelgeuse and Rigel were to have the same luminosity but the temperature of Betelgeuse is cooler than Rigel, which star has the greater surface area?
- Betelgeuse
 - Rigel
 - They are the same size.
 - There is insufficient information to answer this question.