Physics 110: Descriptive Astronomy
Exam 2

12 March 2009

Optics and Telescopes

1. **A spectragraph is an instrument on a telescope which allows sensitive measurement of a spectrum. This can be usefully applied to:**
   (a) Finding extrasolar planets via Doppler shifts.
   (b) Identifying chemical elements in the atmosphere of Titan.
   (c) Probing the interior of the Sun via Doppler-based helioseismology.
   (d) All of the above.

2. **Compared to the speed of visible light in a vacuum (or in space), its speed in glass is**
   (a) greater.
   (b) less.
   (c) exactly the same.
   (d) much greater.

3. **A radio telescope**
   (a) is very similar to a refracting optical telescope.
   (b) is very similar to a reflecting optical telescope.
   (c) is completely different in design from any optical telescope.
   (d) combines major features of both refracting and reflecting optical telescopes.

4. **The two ranges of electromagnetic radiation for which Earth's atmosphere is reasonably transparent are**
   (a) UV and radio waves.
   (b) X-rays and visible radiation.
   (c) visible and far infrared radiation.
   (d) visible and radio radiation.

5. **Which of the following statements is *not correct* in describing a disadvantage of large refracting telescopes when compared to large reflecting telescopes?**
   (a) Air bubbles in the lens are more of a problem in refracting than reflective telescopes.
   (b) Sagging of the primary optical element under its own weight is bigger a problem with refracting telescopes than with reflecting telescopes.
   (c) Refracting telescopes suffer from atmospheric distortion and reflecting telescopes do not.
   (d) Refracting telescopes suffer from chromatic aberration and reflective telescopes do not.

The Solar System: contents and formation

6. **The main characteristics of our solar system are**
   (a) two large planets close to the Sun, two small planets next out, and four large planets farthest from the Sun.
   (b) two small planets close to the Sun, five larger planets much farther from the Sun, and one small planet very far from the Sun.
   (c) four small planets close to the Sun and four large planets far from the Sun.
   (d) three small planets close to the Sun and five large planets far from the Sun.

7. **The correct sequence of planets in our solar system from the Sun outward is**
   (a) Mercury, Venus, Earth, Mars, Saturn, Uranus, Jupiter, Neptune.
   (b) Mercury, Earth, Venus, Mars, Jupiter, Saturn, Uranus, Neptune.
   (c) Mercury, Venus, Mars, Earth, Jupiter, Saturn, Uranus, Neptune.
   (d) Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune.

8. **The average density of which of the following solar system groups is closest to that of water? (Hint: think about the density of water compared to rock.)**
   (a) Mercury and Venus, because they are close to the Sun
   (b) terrestrial planets, because they are of relatively low mass and have been compressed very little by gravitational forces
   (c) asteroids, because they are very small objects
   (d) Jovian planets, because of their H and He composition

9. **The most geologically active object in the planetary system at the present time is**
   (a) Io, a moon of Jupiter.
   (b) the Earth's Moon.
   (c) the Earth.
   (d) Mars.

10. **The trans-Neptunian objects (such as Pluto, Sedna, Quaoar, etc.) are**
    (a) asteroids in the outer part of the asteroid belt.
    (b) small planets that circle the Sun between the orbits of Neptune and Uranus.
    (c) small worlds of rock and ice, most of which orbit within the Kuiper belt.
    (d) asteroids captured as moons by the Jovian planets.

11. **In general, large bodies in the solar system show less evidence of cratering than do small bodies. Why should we expect this correlation?**
    (a) The gravity of large bodies deflects incoming projectiles and thus there are fewer collisions.
    (b) Large bodies are more likely to retain an atmosphere, and thus most large projectiles burn up before striking the ground.
    (c) Large bodies actually receive more hits because of their larger size, but later craters obliterate earlier ones, and we only see evidence of the most recent.
    (d) Large bodies cool more slowly and are more likely to retain internal heat and be geologically active, capable of resurfacing the planet and obliterating craters.

12. **The most common elements in the universe are**
    (a) large quantities of heavy elements, with smaller quantities of hydrogen and helium.
    (b) equal amounts of hydrogen and helium with small amounts of heavier elements.
    (c) equal amounts of all elements up to iron but very little of any heavier elements.
    (d) hydrogen, smaller quantities of helium, and very small quantities of heavier elements.

13. **According to radioactive age-dating techniques, our solar system formed how long ago?**
    (a) 50,000 years
    (b) 5 million years
    (c) 5 billion years
    (d) 13.5 billion years

14. **What was the form of the material from which the solar system formed?**
    (a) a nebula made mostly of hydrogen and helium gas, but enriched in heavier elements from supernova explosions
    (b) a nebula made mostly of heavy elements, but enriched in hydrogen and helium from the supernova explosions
    (c) a nebula made entirely of hydrogen and helium gas
    (d) debris from a stellar collision

15. **Which physical parameter probably controlled the early evolution of the planetary system, dictating the location, type, and composition of the planets that eventually formed?**
    (a) overall rotation of the nebula
    (b) density of hydrogen gas in the nebula
    (c) mix of chemical constituents
    (d) temperature distribution within the nebula

The Sun

16. **Hydrogen to Helium "burning" by fusion reactions occurs only in the deep interior of the Sun, because this is the only place where**
    (a) there is sufficient hydrogen.
    (b) neutrinos necessary to catalyze the reaction reside.
    (c) there are few electrons, which would impede the reaction.
    (d) sufficiently high temperatures and densities occur to overcome the electrical repulsion of the protons.

17. **Energy is transported from the center of the Sun to the surface**
    (a) by radiation in the central thermonuclear core and convection through the rest of the interior.
    (b) mostly by convection but with radiation in the outer layers.
    (c) by convection in the central thermonuclear core and radiation through the rest of the interior.
    (d) mostly by radiation but with convection in the outer layers.

18. **From the center outward, the order of the layers or parts of the Sun is**
    (a) radiative zone, convection zone, photosphere, chromosphere, corona.
    (b) radiative zone, convection zone, corona, chromosphere, photosphere.
    (c) radiative zone, convection zone, chromosphere, photosphere, corona.
    (d) corona, chromosphere, convection zone, photosphere, radiative zone.

19. **Recently, one successful method to investigate the deep interior of the Sun has been to observe**
    (a) the spectrum and behavior of sunspots, whose roots are deep inside the Sun.
    (b) the deep atmospheric conditions, as encountered by a spacecraft as it entered the solar atmosphere.
    (c) regular oscillations and fluctuations of the surface, measured by Doppler shifts.
    (d) the progress of a solar-impacting comet.

20. **What happens to the neutrinos produced by the nuclear reactions in the core of the Sun?**
    (a) They collide and stick together with protons to form helium nuclei.
    (b) Since they react only weakly, they quickly escape from the Sun into space.
    (c) They combine with protons to form neutrons.
    (d) They collide with electrons, producing energy.

21. **What causes the granular appearance of the surface of the Sun?**
    (a) the regular impact of meteoroids and comets on the solar surface
    (b) differential rotation of the surface layers
    (c) thermonuclear fusion in its interior
    (d) convective motion under the solar surface

22. **The temperature of the corona of the Sun**
    (a) is about the same as that of the photosphere, 5800 K.
    (b) is about twice as hot as the photosphere, 12,000 K.
    (c) is very cool, because it is farthest from the heat source.
    (d) is very hot—about 10^6 K.

23. **Sunspots are**
    (a) cooler regions of the Sun's high corona.
    (b) the shadows of dark curtains of matter, hanging above the solar surface.
    (c) cooler, darker regions on the Sun's surface.
    (d) hotter, deeper regions in the Sun's atmosphere.

24. **How can we characterize the rotation of the Sun?**
    (a) differential rotation, with the equator rotating faster than the poles
    (b) differential rotation, with the equator rotating more slowly than the poles
    (c) like a solid body (all parts rotating equally)
    (d) in a banded pattern, with alternating bands of fast and slow rotation

25. **Overall solar magnetic activity, including sunspots, reaches a maximum on a cycle lasting**
    (a) 11 months.
    (b) 11 years.
    (c) 110 years.
    (d) 1100 years.

26. **A very large arch of gas suspended by the magnetic field over Sun's surface is called**
    (a) a coronal hole.
    (b) a prominence.
    (c) a photosphere.
    (d) a spicule.

Terrestrial Planets

27. **Put the terrestrial planets in order *by mass***
    (a) Venus, Mercury, Mars, Earth
    (b) Mercury, Mars, Venus, Earth
    (c) Mars, Venus, Mercury, Earth
    (d) Mercury, Venus, Earth, Mars

28. **The near and far sides of the Moon are particularly different in that**
    (a) the far side is always in darkness.
    (b) the average height of the overall terrain is much lower on the far side.
    (c) the far side has almost no maria.
    (d) the number of craters differs markedly, with fewer on the far side.

29. **The reason most of the terrestrial planets have dense, iron cores is because**
    (a) terrestrial planets were at one point molten, and the dense iron sank to the center.
    (b) iron is magnetic, so there was a rapid accretion of iron dust grains into a core, followed by a slow accretion of rocky grains.
    (c) iron has a high melting temperature, so the iron core condensed first from the solar nebula. Rocky material condensed onto the iron core as the nebula cooled.
    (d) iron has a high melting temperature, so the iron core condensed first from the solar nebula. Rocky planetesimals then formed as the nebula cooled further, and gradually impacted onto the iron core.

30. **The planet that rotates in the "wrong" direction (retrograde, *i.e.* opposite to the planet's direction of revolution around the Sun) is**
    (a) Mars.
    (b) Earth.
    (c) Venus.
    (d) Mercury.

31. **The central core of Mercury is probably composed of**
    (a) molten rock.
    (b) ices of H_2O and CH_4.
    (c) solid rocks of relatively low density.
    (d) solid and/or molten iron.

32. **Why has the greenhouse effect been much more effective in raising the surface temperature on Venus than on Earth?**
    (a) The solar wind, the major cause of heating in the greenhouse effect, is far more intense at Venus's distance from the Sun and Venus has no magnetic field to deflect it.
    (b) The oceans on Earth have acted as a thermostat in absorbing much of the heat that would otherwise have raised Earth's temperature significantly.
    (c) CO_2, which traps heat from the planet's surface, is the major component in the very dense Venusian atmosphere but only a minor constituent of Earth's atmosphere.
    (d) The surface of Venus is much more effective than that of Earth in absorbing solar visible and UV radiation.

33. **The surface features and topology of Venus have been determined primarily by**
    (a) radar methods from Earth and from Venus-orbiting spacecraft detecting reflected radio waves from the surface.
    (b) surface lander vehicles that have explored the surface.
    (c) visible light and UV photography from the Hubble Space Telescope and Earth-bound telescopes.
    (d) balloon-borne spacecraft launched into the Venus atmosphere by spacecraft.

34. **The huge volcano Olympus Mons on Mars and the Hawaiian Islands are similar, but differ in one important respect:**
    (a) Olympus Mons is close to the Martian north pole where tidal stress from the Sun is small, whereas the Hawaiian Islands are close to the equator where tidal stresses from Moon and Sun have formed the fault.
    (b) Olympus Mons is formed almost solely of sulfur, whereas the Hawaiian Islands are formed of rock from the solidification of lava.
    (c) Olympus Mons is a very steep-sided volcano, whereas the volcanoes of Hawaii are rather flat, with gentle slopes right up to their calderas.
    (d) In the Hawaiian Islands, plate tectonic motion has moved the Pacific Ocean floor over a hot spot, forming a line of volcanoes. No such motion occurred for Olympus Mons over an equivalent hot spot on Mars.

35. **The seasonal polar caps on Mars are most likely made up of**
    (a) water and CO_2 ices.
    (b) light-colored dust blown there by intense dust storms and large dust devils.
    (c) volcanic outflow of light-colored lava and dust similar to that produced by Earth-based volcanoes.
    (d) sulfur dioxide and sulfur compounds.

36. **What method was used to land the Mars Pathfinder rover successfully on the Martian surface?**
    (a) It was surrounded by balloons, similar to the airbags in automobiles, and allowed to bounce and roll to a stop, after impact on the planet.
    (b) It was suspended beneath a large gas-filled balloon heated by sunlight allowing it to float in the atmosphere like a hot-air balloon until sunset, when it descended gently to the surface.
    (c) Retro rockets were fired automatically to slow it to a safe landing speed as it neared the surface.
    (d) It was flown down on a parachute similar to a hang glider to a smooth, if rather fast, landing.

Jovian Planets

37. **The probable steps in the process of formation of the large, outer planets were**
    (a) localized accumulation of gas at a defect in the protosun's magnetic field, followed by gravitational accretion of gas and planetesimals.
    (b) accretion of cold planetesimals containing large quantities of hydrogen and helium.
    (c) gravitational condensation of methane and ammonia gas, followed by capture of planetesimals.
    (d) accretion of planetesimals to form a core, followed by gravitational capture of hydrogen and helium gas.

38. **Rank the Jovian planets from least to most massive**
    (a) Uranus, Neptune, Saturn, Jupiter
    (b) Saturn, Uranus, Neptune, Jupiter
    (c) Jupiter, Saturn, Uranus, Neptune
    (d) Uranus, Saturn, Neptune, Jupiter

39. **The Great Red Spot is**
    (a) a large, long-lived, high-pressure storm in Jupiter's atmosphere.
    (b) the colored polar cap of Jupiter.
    (c) clouds of dust-laden gas upwelling above the top of a massive mountain or a volcano on the planet's surface.
    (d) a type of storm in Jupiter's atmosphere that can last for a few months at a time before disappearing.

40. **The rings of Saturn orbit the planet:**
    (a) as a solid body.
    (b) as five separate solid rings.
    (c) as individual particles in circular orbits, each with an orbital period depending on radius.
    (d) they don't orbit, but are static around the planet.

41. **What property is shared by the Earth and Europa, one of Jupiter's large moons?**
    (a) They have both been shown to possess all the necessities for life.
    (b) They both have thick atmospheres of nitrogen and oxygen.
    (c) Both have significant oceans of liquid water.
    (d) They are about the same physical size.

42. **All of the following exist on Saturn's moon Titan *except*:**
    (a) clouds.
    (b) liquid water on the surface.
    (c) rain.
    (d) hydrocarbon lakes.

43. **The first planet discovered which was not known to ancient astronomers was**
    (a) Neptune
    (b) Uranus
    (c) Saturn
    (d) Pluto

44. **Seasonal variations at a particular point on Uranus during a Uranian year would be**
    (a) almost nonexistent, because Uranus moves in an almost perfectly circular orbit, therefore maintaining a constant distance from the Sun.
    (b) moderate, because dense clouds shield it somewhat from climate changes.
    (c) nonexistent, because such variations at any point on the planet would be smoothed out during its long year by the planet's rapid rotation.
    (d) extreme, because its spin axis is nearly in its orbital plane.

45. **Uranus and Neptune are similar in size and atmospheric composition, but Neptune is significantly farther away from the Sun than is Uranus, 30 AU to 19 AU. What conclusion is drawn from the fact that their temperatures are about the same?**
    (a) Neptune's atmosphere must contain a more effective greenhouse gas to retain more solar energy.
    (b) Neptune must have a significant source of internal energy or heat.
    (c) The solar wind is able to penetrate to Neptune's cloud-tops and deposit energy there, while Uranus's magnetic field deflects the solar wind.
    (d) Neptune is distorted, and therefore heat by tidal effects from Jupiter and Saturn.

Extrasolar Planets

46. **Suppose that in the future, a space telescope discovers a series of planets with the following characteristics moving around a star resembling our Sun: spherical, solid surfaces; mean densities about four times that of H_2O; radii about 4000 km; low-density atmospheres. How would these planets be classified in terms of our solar system?**
    (a) Jovian planets
    (b) cometary nuclei
    (c) asteroids
    (d) terrestrial planets

47. **At the present time, how many extra-solar planets have had confirmed discoveries?**
    (a) none
    (b) a few dozen
    (c) hundreds
    (d) millions

48. **What type of search technique has discovered the largest number of planets around the stars other than the Sun?**
    (a) Looking for tiny variations in the star's position in the sky, caused by the gravitational pull of one or more planets orbiting the star.
    (b) Looking for tiny variations in the star's radial velocity by Doppler shifts, caused by the gravitational pull of one or more planets orbiting the star.
    (c) Looking for excess infrared radiation from the star, caused by the presence of planets that are cool and thus emit primarily in the infrared.
    (d) Using space-based telescopes to search for tiny pinpoints of light that follow circular or elliptical paths around the star.

49. **Many of the known extrasolar planets have masses comparable to Jupiter's but orbits smaller than Earth's. What may be an explanation for this combination?**
    (a) The protoplanetary disk was much denser than that of the Sun, and larger planets formed. Collisions between these planets then sent some of them into much smaller orbits.
    (b) Friction with the protoplanetary disk caused planets formed farther from the Sun to lose energy and migrate inward.
    (c) The planets formed separately in the same manner as stars, and were later captured into the orbits in which we now see them.
    (d) The protoplanetary disk was much denser than that of the Sun, allowing large planets to form very close to the star.

50. **The Kepler satellite, which launched sucessfully last week, will find planets via which method?**
    (a) radial velocity method.
    (b) astrometric method.
    (c) transit method.
    (d) pulsar timing method.