Exam #2, 2014
Instructor: Michael Brotherton

Instructions

This exam is **closed book and closed notes,** although you may use a calculator (much of the math on the exam may be easy enough to work without a calculator, but if you need to borrow one *please* ask!). Formulas and constants you might want during the exam are given on the last pages. The exam consists of 50 multiple choice questions. Please mark with a number 2 pencil your answers on a blue 5-answer scan sheet (only one answer per question). **Fill in the bubbles for your name!!!** Completely erase any stray marks. In the special code section please fill in "EXAM 1". Please don't cheat and make your best effort. Good luck!

Multiple Choice (50 questions)

1. What is the correct order of planets from the sun, nearest to farthest?
   a) Mercury, Venus, Mars, Earth, Jupiter, Saturn, Neptune, Uranus
   b) Venus, Mercury, Mars, Earth, Jupiter, Saturn, Uranus, Neptune
   c) Mercury, Venus, Earth, Mars, Jupiter, Saturn, Neptune, Uranus
   d) Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
   e) Mars, Venus, Earth, Mercury, Jupiter, Saturn, Uranus, Neptune

2. Which of the following is most distant from the Sun?
   a) Neptune
   b) a comet in the Oort cloud
   c) an asteroid in the asteroid belt
   d) a comet in the Kuiper belt
   e) Mercury

3. What was the frost line of the solar system?
   a) the distance from the Sun where temperatures were low enough for asteroids to form, between the present-day orbits of Venus and Earth
   b) the distance from the Sun where temperatures were low enough for hydrogen and helium to condense, between the present-day orbits of Jupiter and Saturn
   c) the distance from the Sun where temperatures were low enough for rocks to condense, between the present-day orbits of Mercury and Venus
   d) the distance from the Sun where temperatures were low enough for metals to condense, between the Sun and the present-day orbit of Mercury
   e) the distance from the Sun where temperatures were low enough for hydrogen compounds to condense into ices, between the present-day orbits of Mars and Jupiter

4. What mechanism is most responsible for generating the internal heat of Io that drives the volcanic activity?
   a) bombardment
   b) radioactive decay
   c) accretion
   d) tidal forces
   e) differentiation

5. Which world is thought to have a (hidden) water ocean where there could be life?
   a) Io
   b) Titan
   c) Mars
   d) Saturn
   e) Europa

6. Which of the following worlds has the most substantial atmosphere?
   - a) Venus
   - b) Earth
   - c) Mercury
   - d) Mars
   - e) Titan

7. The sky is blue because
   - a) the Sun mainly emits blue light.
   - b) molecules scatter red light more effectively than blue light.
   - c) the atmosphere absorbs mostly blue light.
   - d) the atmosphere transmits mostly blue light.
   - e) molecules scatter blue light more effectively than red light.

8. A rocky leftover planetesimal orbiting the Sun is
   - a) a comet.
   - b) a meteor.
   - c) an asteroid.
   - d) a meteorite.
   - e) possibly any of the above

9. Which of the below is the most significant reason Pluto's status as a planet was changed?
   - a) it was discovered last
   - b) it was discovered by an American
   - c) it isn't round
   - d) its orbit is tilted more than that of the other planets compared to the Ecliptic
   - e) other similar-sized objects were found in the same orbital region

10. Which planet has no known moons?
   - a) Mars
   - b) Neptune
   - c) Uranus
   - d) Venus
   - e) Saturn

11. How does the greenhouse effect work?
   - a) The higher pressure of the thick atmosphere at lower altitudes traps heat in more effectively.
   - b) Greenhouse gases absorb X rays and ultraviolet light from the Sun, which then heat the atmosphere and the surface.
   - c) Ozone transmits visible light, allowing it to heat the surface, but then absorbs most of the infrared heat, trapping the heat near the surface.
   - d) Greenhouse gases absorb infrared light from the Sun, which then heats the atmosphere and the surface.
   - e) Greenhouse gases transmit visible light, allowing it to heat the surface, but then absorb infrared light from Earth, trapping the heat near the surface.

12. Based on our current theory of Earth's formation, the water we drink comes from
   - a) comets that impacted Earth.
   - b) chemical reactions that occurred in Earth's crust after Earth formed.
   - c) ice that condensed in the solar nebula in the region where Earth formed.
   - d) chemical reactions that occurred in Earth's core after Earth formed.
   - e) material left behind during the giant impact that likely formed the Moon.

13. Which moon has the most substantial atmosphere?
    a) Ganymede
    b) Titan
    c) Europa
    d) Triton
    e) Io

14. Which planet could float in a giant bathtub full of water, due to its low density, if such a thing was possible?
    a) Jupiter
    b) Saturn
    c) Earth
    d) Mercury
    e) Mars

15. What is Jupiter's Great Red Spot?
    a) a large mountain peak poking up above the clouds
    b) the place where reddish particles from Io impact Jupiter's surface
    c) a long-lived, high-pressure storm
    d) an indicator that the planet is on sale for Christmas
    e) the place where Jupiter's aurora is most visible

16. What are the main constituents of the jovian planets?
    a) hydrogen and helium
    b) ammonia and methane
    c) ammonia and water
    d) rocky minerals and water, as on Earth
    e) nitrogen and methane

17. Why were the ancient Greeks unable to measure stellar parallax?
    a) stars are too faint.
    b) stars are too far away.
    c) stars are too red.
    d) the Moon is too bright.
    e) they didn't have spectrographs to obtain stellar spectra.

18. Planetary rings are made of
    a) hydrogen and helium gas.
    b) ammonia and methane gas.
    c) solid disks of ice in rigid rotation.
    d) bits of rock and ice up to boulder size in Keplerian orbits.
    e) hydrogen ions trapped in magnetic fields.

19. Which world has no visible craters?
    a) Mercury.
    b) the Moon.
    c) Earth.
    d) Mars.
    e) Uranus.

20. Meteor showers are associated with what phenomenon or objects?
    a) solar wind.
    b) asteroids.
    c) magnetic fields.
    d) auroras.
    e) comets.

21. Which technique below has not been successful in finding exoplanets orbiting stars other than our own sun?
    a) Radar.
    b) Direct Imaging.
    c) Spectroscopic monitoring looking for radial velocity "wobbles."
    d) Monitoring for eclipses.
    e) None of the above. All have been used to detect the presence of exoplanets.

22. How do we think the "hot Jupiters" around other stars were formed?
    a) Many planets were formed around the star but coalesced into a single planet close in.
    b) They formed as gas giants close to the star in the same orbits that they are seen today.
    c) They formed as gas giants beyond the frost line and then migrated inwards.
    d) They formed as dense, rocky planets close to the star in the same orbits that they are seen today.
    e) I'm not saying it was aliens, but...Aliens.

23. Which exoplents would be easiest to find with the astrometric (positional wobble) technique?
    a) Earth-like planets in any orbit.
    b) big planets in face-on orbits around small stars.
    c) small planets in face-on orbits around big stars.
    d) Earth-like planets in edge-on orbits around small stars.
    e) big planets in edge-on orbits around big stars.

24. About how many exoplanets have been *confirmed*?
    a) None
    b) About a dozen
    c) A few hundred
    d) More than a thousand
    e) Millions

25. Which of the below is an uncertainty when using the radial velocity (Doppler wobble) technique to measure masses in binary stars or for exoplanets?
    a) orbital tilt as seen from Earth
    b) temperature of the star or stars involved
    c) dust in Earth's atmosphere
    d) spin speed of the star
    e) glare from brightness of the star or stars involved

26. The center of mass of a binary star system is
    a) at the point halfway in between them.
    b) the point at which the two objects would balance if they were on a see saw.
    c) the average mass of the two stars.
    d) the center of the most massive of the two stars.
    e) the center of the least massive of the two stars.

27. Where does nuclear fusion occur in the Sun?
    a) in its core
    b) just above the visible surface in the hot corona
    c) on the surface
    d) everywhere below the surface
    e) all of the above

28. Since all stars begin their lives with the same basic composition, what characteristic most determines how they will differ?
    a) location where they are formed
    b) luminosity they are formed with
    c) color they are formed with
    d) time they are formed
    e) mass they are formed with

29. If you see a campfire in the distance, how much brighter is it when you cut that distance in half?
   a) the same
   b) twice as bright.
   c) four times as bright.
   d) eight times as bright.
   e) sixteen times as bright.

30. The spectral sequence in order of decreasing temperature is
   a) OBAGFKM.
   b) BAGFKMO.
   c) OBAFGKM.
   d) BAFGKMO.
   e) OFBAGKM.

HR-Diagram that may be useful for the next several questions.
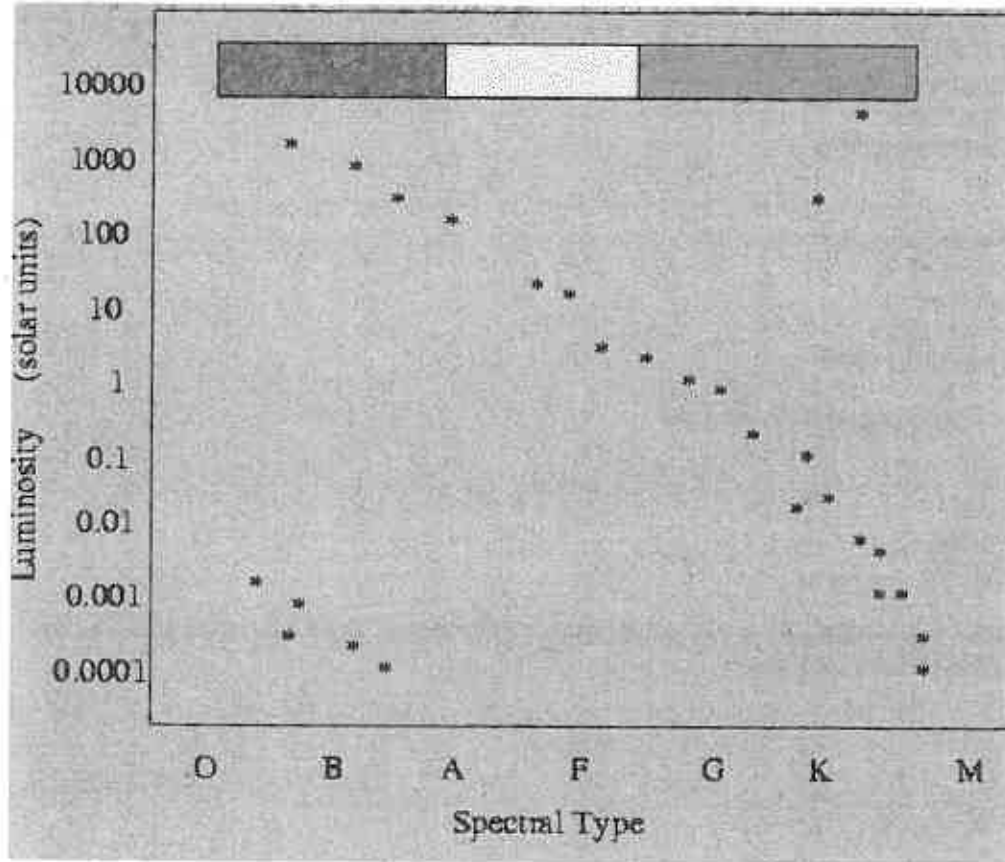
31. On a Hertzsprung-Russell diagram, where on the main sequence would we find the largest stars?
   a) lower right
   b) lower left
   c) upper left
   d) upper right
   e) closer to the center

32. On a Hertzsprung-Russell diagram, where would we find red dwarfs?
   a) lower right
   b) lower left
   c) upper left
   d) upper right
   e) closer to the center

33. On a Hertzsprung-Russell diagram, where would we find the Sun?
    a) lower right
    b) lower left
    c) upper left
    d) upper right
    e) closer to the center

34. On a Hertzsprung-Russell diagram, where would we find the smallest stars?
    a) lower right
    b) lower left
    c) upper left
    d) upper right
    e) closer to the center

35. On a Hertzsprung-Russell diagram, where would we find the bluest main sequence stars?
    a) lower right
    b) lower left
    c) upper left
    d) upper right
    e) closer to the center

36. On a Hertzsprung-Russell diagram, where would we find the least massive stars?
    a) lower right
    b) lower left
    c) upper left
    d) upper right
    e) closer to the center

37. About what temperature are O stars?
    a) 3K
    b) 30K
    c) 300K
    d) 3,000K
    e) 30,000K

38. For every star formed with a mass greater than 10 solar masses, about how many stars are there with masses less than half a solar mass?
    a) 1
    b) 2
    c) 10
    d) 20
    e) 200

39. Which two forces are balanced in what we call hydrostatic equilibrium?
    a) gravitational potential energy and kinetic energy
    b) light and gravity
    c) the electromagnetic force and gravity
    d) outward pressure and gravity
    e) outward pressure and heat

40. What makes up the interstellar medium?
    a) O and B stars
    b) K and M stars
    c) open clusters
    d) gas and dust
    e) bits of Groot's bark

41. Which of the following is closest in size (radius) to a white dwarf?
  a) Earth
  b) a small city
  c) the Sun
  d) a football stadium
  e) Jupiter

42. In nuclear fusion, how many hydrogen atoms does it take to make one helium atom?
  a) 1
  b) 2
  c) 3
  d) 4
  e) it varies

43. A red dwarf is expected to live about how long on the main sequence?
  a) 1 million years
  b) 10 million years
  c) 100 million years
  d) 10 billion years
  e) 100 billion years

44. Which is the identifier of a red giant star?
  a) M2 V
  b) B2 I
  c) M2 III
  d) F2 IV
  e) G2 V

45. By mass, what is the Sun made of?
  a) 50 percent hydrogen, 25 percent helium, 25 percent other elements
  b) 98 percent hydrogen, 2 percent helium and other elements
  c) 70 percent helium, 28 percent hydrogen, 2 percent other elements
  d) 70 percent hydrogen, 28 percent helium, 2 percent other elements
  e) 100 percent hydrogen and helium

46. How much larger than the sun can a star be? Comparing the diameters, super giant stars like Betelguese are about
  a) 10x larger
  b) 100x larger
  c) 1000x larger
  d) 10,000x larger
  e) 100,000x larger

47. What is the largest mass a newborn star can have?
  a. about the mass of our Sun
  b. about 10 times the mass of our Sun
  c. about 100 times the mass of our Sun
  d. about 1000 times mass of the our Sun
  e. there is no upper limit

48. By spectral class, which is the least common type of main sequence star made in a star forming region?
  a) A
  b) B
  c) G
  d) O
  e) M

49. What makes a brown dwarf fundamentally different from a red dwarf?

a) the elemental composition.

b) the lack of nuclear fusion.

c) the presence of molecules rather than atoms in its atmosphere.

d) age.

e) all of the above.

50. Let's ride off into the sunset, which are red because...

a) sunlight must pass through more atmosphere then, and the atmosphere scatters more light at red wavelengths than bluer wavelengths.

b) the cooler atmosphere in the evening absorbs more blue light.

c) sunlight must pass through more atmosphere then, and the atmosphere scatters even more light at bluer wavelengths, transmitting mostly red light.

d) the Sun emits more red light when it's setting.

e) magnetic fields.

Potentially Useful Relationships/Formulas/Figures

$$\frac{\text{Angular diameter}}{206265 \text{ arcsec}} = \frac{\text{linear diameter}}{\text{distance}}$$

Kepler's third law: P^2 is proportional to a^3; specifically $a^3 = (GM/4\pi^2)P^2$

c = speed of light = 3×10^8 m/s; 1 AU$=1.5 \times 10^{11}$ m

Photon Energy: $E = hc/\lambda$, where Planck's Constant is $h = 6.63 \times 10^{34}$ J s

Classical Doppler shift: $V/c = \Delta\lambda/\lambda_0$, where λ is wavelength

Wien's Law: $\lambda max = 3000000/T$ (λ in nm, T in degrees Kelvin)

Steffan-Boltzmann Law: $E = \sigma T^4$, where $\sigma = 5.7 \times 10^8$ J/m^2 deg^4

200 ITEM ANSWER SHEET — Scantron form (Apperson #204040, RR 10/12 A1841 05/13)