

Name:
ASTRONOMY 1102 – 1
Instructor: Juhan Frank

Second Test –FALL 1999– Friday October 15

Part I – Multiple Choice questions (3 pts/question; total = 60 pts)

Identify the correct answers by placing a check between the brackets []. Check **ALL** correct answers in the questions identified by a *.

*1) Some are wrong; which are correct?

- The spectra of stars have absorption lines.
- The spectra of all stars have emission lines in optical wavelengths.
- The spectrum of a hot solid is a continuous spectrum.
- The color of a star depends on the star's luminosity.
- The color of a star depends on the star's surface temperature.

2) The absolute magnitude of a star is a measure of the star's

- luminosity.
- surface temperature.
- mass.
- apparent brightness.
- density.

3) The apparent magnitude of a star is a measure of the star's

- luminosity.
- surface temperature.
- mass.
- apparent brightness.
- density.

4) Sunspots look darker than the photosphere because

- they are hotter.
- their temperature is lower than 5800 K.
- the magnetic field is weaker in the spots than in the surroundings.
- they are holes in the surface of the sun.
- all the energy is emitted as X-rays.

5) Given G (Universal constant of gravity), the mass of the sun can be measured using

- Stefan-Boltzmann's law.
- Wien's displacement law.
- Kepler's third law as modified by Newton.
- spring scales.
- a spectrograph.

6) The most correct equation representing the overall effect of the pp chain is

- $4\ ^4\text{He}_2 \rightarrow \text{H}$.
- $4\ ^1\text{H}_1 \rightarrow\ ^4\text{He}$.
- $4\ ^1\text{H}_1 \rightarrow\ ^4\text{He} + 2e^+$.
- $4\ ^1\text{H}_1 \rightarrow\ ^4\text{He} + 2e^+ + 2\nu$.
- $^{18}\text{O}_8 \rightarrow 4\ ^4\text{He}$.

- 7) The spectrum of a perfect thermal emitter of surface temperature T looks like
- a blackbody curve with the temperature T without any lines.
 - a pure emission line spectrum.
 - a blackbody curve with the temperature T with absorption lines.
 - a blackbody curve with the temperature T with emission lines.
 - the spectrum of a low density gas at a temperature T .
- 8) The total radiative power per unit surface emitted by a blackbody
- increases linearly with temperature $\propto T$.
 - decreases in inverse proportion to the temperature $\propto 1/T$.
 - increases as the square of the temperature $\propto T^2$.
 - increases as the fourth power of the temperature $\propto T^4$.
 - does not depend on the temperature.
- 9) In the sun, the correct order from the center outward:
- wind, chromosphere, core, convection zone, photosphere, radiation zone, corona.
 - core, convection zone, radiation zone, photosphere, corona, chromosphere, wind.
 - photosphere, chromosphere, corona, wind, core, convection zone, radiation zone.
 - core, convection zone, radiation zone, photosphere, chromosphere, corona, wind.
 - core, radiation zone, convection zone, photosphere, chromosphere, corona, wind.
- 10) The solar energy is carried by blobs of gas rising and falling (similar to boiling) in the
- core.
 - solar wind.
 - chromosphere.
 - convection zone.
 - radiation zone.
- *11) The lower the frequency of electromagnetic radiation,
- the shorter its wavelength.
 - the longer its wavelength.
 - the higher the energy of the photons.
 - the lower the energy of the photons.
 - the slower it moves through space.
- 12) The number of solar neutrinos detected in terrestrial experiments is
- greater than the models predict.
 - consistent with the amount produced in the solar core.
 - less than the number that must be produced by nuclear reactions in the core.
 - almost zero because they have all converted to undetectable types of neutrino.
 - exactly zero since no neutrinos are produced by the pp chain.
- 13) The distance to a star having a parallax of 0.25 arcsec is
- 0.25 pc.
 - 4 LY.
 - 4 ".
 - 2.5 pc.
 - 4 pc.

- 14) All stars found on the Main Sequence are
- burning H to He.
 - burning H to He by the pp chain.
 - burning H to He by the CNO cycle.
 - burning H to He at the same rate as the sun.
 - burning H to He at higher rates than the sun.
- 15) A yellow G2 supergiant has
- a higher luminosity, larger radius and higher surface temperature than the sun.
 - a higher luminosity, smaller radius and higher surface temperature than the sun.
 - a lower luminosity, the same radius and lower surface temperature than the sun.
 - a higher luminosity, larger radius and the same surface temperature as the sun.
 - a higher luminosity, larger radius and lower surface temperature than the sun.
- 16) Jupiter is approximately 5 AU from the sun. The solar flux measured on Jupiter is
- 25 times the solar constant.
 - 5 times the solar constant.
 - equal to the solar constant.
 - $\frac{1}{5}$ of the solar constant.
 - $\frac{1}{25}$ of the solar constant.
- 17) A B3V star appears white blue because it
- only emits white blue light.
 - emits electromagnetic radiation of all wavelengths but more blue than red.
 - emits no red light.
 - emits more blue light than UV.
 - absorbs almost all red light, so more blue is left over.
- 18) The Earth's atmosphere is transparent in the following "windows"
- optical and radio.
 - optical and X-rays.
 - far infrared and short wavelength UV.
 - X-rays and radio.
 - optical and far infrared.
- *19) The largest and the smallest of the stars having the following spectral types
- O3V.
 - M6III.
 - A2V.
 - M5V.
 - K2I.
- *20) The coolest and the hottest of the stars having the following spectral types
- O3V.
 - M6III.
 - A2V.
 - M5V.
 - K2I.

Part II – Problems (10 pts/problem; total = 40 pts) **NO CALCULATORS!**

Problem 1: More Powers of Ten: The total mass of hydrogen available for fusion into Helium in the sun is approximately 2×10^{29} kg. The current rate of burning is approximately 600 billion kg/s. One year is equivalent to 31.5 million seconds.

Estimate the lifetime of the sun in years.

The lifetime in seconds is:

$$t_{\text{Life}} = \frac{2 \times 10^{29} \text{kg}}{6 \times 10^2 \times 10^9 \text{kg/s}} = \frac{2}{6} 10^{29-11} \text{s} = \frac{1}{3} 10^{18} \text{s}$$

Converting to years:

$$t_{\text{Life}} = \frac{10^{18} \text{s}}{3 \times 3.15 \times 10^7 \text{s/yr}} = \frac{10^{18} \text{yr}}{10^8} = 10^{10} \text{yr}$$

Problem 2: Two stars in a certain CCD exposure taken by the Hubble Space Telescope are of very different brightnesses: star A has a magnitude 7, while star B has a magnitude of 22.

a) Which of the two stars is brighter?

The star with the SMALLEST apparent magnitude appears brightest: Star A.

b) What is the ratio of fluxes of the brighter star to the fainter star?

The difference in magnitudes is $22 - 7 = 15$. Every 5 magnitudes is equivalent to a flux FACTOR of 100. So 15 magnitudes corresponds to $100 \times 100 \times 100 = 10^6$.

Problem 3: A distant galaxy shows an emission line whose rest wavelength is 400 nm shifted to 480 nm. Is this a blueshift or a redshift? Is this galaxy moving toward us or away from us? At what speed is it moving?

Since $\lambda_{\text{obs}} > \lambda_{\text{rest}}$ this is a shift to LONGER wavelengths or a REDSHIFT. So the galaxy is moving away from us. The shift is $\Delta\lambda = \lambda_{\text{obs}} - \lambda_{\text{rest}} = 80 \text{ nm}$. The Doppler formula then gives us the speed as

$$\frac{v}{c} = \frac{\Delta\lambda}{\lambda_{\text{rest}}} = \frac{80}{400} = 0.2$$

So the speed is $0.2c$ or $60,000 \text{ km/s}$.

Problem 4: The diagram below shows a hot O3V star, which emits by definition “an O3V spectrum”, and a cloud of gaseous Hydrogen and Oxygen at a lower temperature than the star. Several lines of sight are drawn with the “eye” indicating the point of view, and labelled with numbers. Write in the space provided the type of spectrum you should see from each of the chosen vantage points. If emission or absorption lines are seen identify which elements produce them, so for example, you could say “an O3V spectrum with additional H and O absorption lines”, or “an O3V spectrum”, or “an emission spectrum of ...such and such element...”.

See Figure

- 1.- *Emission spectrum of H and O.*
- 2.- *O3V spectrum.*
- 3.- *Emission spectrum of H and O.*
- 4.- *Emission spectrum of H and O.*
- 5.- *O3V spectrum with additional H and O absorption lines.*
- 6.- *Same as 5.*