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### Astronomy 104, Spring 2023

## Test 2

### Print your name:

# Make sure your scantron has your name and code on it.

## Show a picture ID, and turn in the test paper with the scantron.

# Please circle the correct answers on the test paper.

Answer these questions on the scantron as indicted:

- 1 Answer E
- 2 Answer B
- 3 Answer B

### **4** At what temperature will all molecules disintegrate?

- A: Above ~ 10,000 K.
- B: Above ~ 100 K
- C: Above ~ 273 K
- D: Above ~ 2000 K
- E: Above ~ 1 million K

### 5 What percentage of all stars are doubles?

- A: Almost all.
- B: There are no true double stars. They may seem so only due to perspective.
- C: All.
- D: Half.
- E: Almost none.

### 6 Which one is moving fastest?

- A: X-rays
- B: Visible light
- C: The same
- D: Laser
- E: Radio waves

### 7 Which of the following is wrong?

- A: X-ray photons have more energy than photons of light.
- B: Microwave photons have less energy than photons of light.
- C: The energy of each photon does not depend on how strong the light is.
- D: A blue photon always has more energy than a red photon.
- E: The stronger the light, the more energy each of its photons has.

### 8 How does the Doppler-effect affect the spectrum of a star?

A: An approaching star's light arrive to Earth sooner, which causes its spectral lines broaden.

B: The color of a moving star looks redder/bluer than normal.

C: The star's light is stronger when the star is approaching us, and weaker when it is receding.

D: The spectral lines of an approaching star are shifted from the red end of the spectrum to the blue end.

E: Spectral lines shift (usually a tiny bit) when the star moves towards or away from us.

### 9 When do you see an absorption spectrum?

- A: When planets reflect sunlight.
- B: When cold gas is in front of a light source.
- C: When charged particle hit magnetic fields.
- D: When gas is illuminated from the side.
- E: When hot objects glow.

### 10 How do we measure the mass of stars?

- A: Using Kepler's III law for binary stars.
- B: Using Wien's law, applied to the color of the star.
- C: Using Kepler's II law applied on their planets.

D: We measure how strong a gravitational effect they have on the motion of Earth.

E: We measure the strength of their magnetic field.

### 11 What spectral type is the red giant Betelgeuse?

- A: Hydrogen.
- B: He.
- C: C.
- D: G.
- E: M.

### 12 The spectrum of a hot glowing body is ...

- A: continuous spectrum.
- B: a mixture of an emission and an absorption spectrum.
- C: band spectrum.
- D: absorption spectrum.
- E: emission spectrum.

### 13 The spectral type of a star is related to ...

- A: its surface temperture.
- B: its speed of motion.
- C: its distance.
- D: the temperature in its core.
- E: its chemical composition.

### 14 The spectral type of the Sun is ...

- A: M
- B: B
- C: A
- D: K
- E: G

### **15** Relate the energy of a blue photon to the energy of a red photon.

- A: Blue photons have a hundred times as much energy as red photons.
- B: Blue photons have half the energy of red photons.
- C: Cannot tell: the energy of photons depends on the strength of the light.
- D: Blue photons have twice as much energy as red photons.
- E: Blue photons have a hundred times less energy than red photons.

### 16 Why do we use spacecraft to do X-ray astronomy?

- A: Because the telescope needs to be cooled to liquid helium temperatures (3K).
- B: Because the atmosphere is opaque in X-rays.
- C: Because of interference from medical use of X-rays.
- D: Because X-ray telescopes radiate dangerous amounts of X-rays.
- E: Because spacecraft is closer to the stars.

### <sup>17</sup> What change occurs to molecules in hot matter such as the matter of a star? At what temperature?

- A: Molecules break up into atoms at ~ 2000 to 3000 degrees.
- B: Molecules are fused into very large atoms at ~ 1200 degrees.
- C: Molecules turn into protons and electrons at ~ 2000 degrees.
- D: Molecules pick up extra electrons at ~ 10,000 degrees to become ions.
- E: Molecules break up into atoms at ~ 2 million degrees.

### 18 The equivalent of light at much shorter wavelength is called ...

- A: X-rays.
- B: Radio waves.
- C: Ultraviolet.
- D: Neutrinos.
- E: Charged particle radiation.

### 19 What chemical process changes carbon into oxygen?

- A: Electrolysis.
- B: Burning.
- C: Hydrolysis.
- D: Oxydation.
- E: None.

# 20 Strong ultraviolet radiation comes only from stars of spectral type ..., and why?

- A: All spectral types, because UV production does not depend on temperature.
- B: None, because stars do not radiate in UV.
- C: K & M, because these are hot enough.
- D: All spectral types, because they are all hot.
- E: O & B, because these are hot enough.

### 21 The wavelength of light determines its ...

- A: speed.
- B: ratio of electric / magnetic field strength.
- C: intensity.
- D: polarization.
- E: color.

### 22 What can you tell from the wavelength of a spectral line?

- A: The atmospheric pressure in the source object.
- B: The temperature of the gas that emits the light.
- C: How far is the source from the observer.
- D: Which atom/molecule produced the line.
- E: The strength of gravity of the source object.

### 23 What type of a spectrum does the Sun have?

- A: continuous spectrum.
- B: a mixture of an emission and an absorption spectrum.
- C: absorption spectrum.
- D: band spectrum.
- E: emission spectrum.

# <sup>24</sup> How does the speed of light relate to the speed of radio waves and the speed of sound?

A: Sound and radio waves have the same speed, the speed of light is infinitely fast.

- B: Radio waves are fastest, light is middle, sound is slowest.
- C: They all have the same speed.
- D: Radio waves and sound are slow, light is fast.
- E: Radio waves and light have the same speed, sound is much slower.

### 25 How large is the Doppler effect in astronomy in practice?

A: A large shift (say, 10%) in the wavelength of spectral lines.

B: A tiny (say, 0.01%) shift in the wavelength of spectral lines.

C: A large shift in the overall color of a star, say, from blue to red appearence.

D: Both the position of the spectral lines and the overall color of the star changes noticeably.

E: It is impossible to detect the Doppler effect in the spectra of individual stars.

### 26 What can excite a hydrogen atom?

- A: Heating to 1200 K.
- B: Infrared radiation.
- C: UV radiation.
- D: Red light.
- E: A magnetic field.

### 27 Why are double stars important in astronomy?

- A: They provide the only way to tell stellar masses.
- B: It is easier to detect a double star than a single one.
- C: They are the only ones that blow up as supernovae.
- D: They provide the only way to determine the chemical composition of stars.
- E: Double stars have many planets orbiting around them.

### 28 Why does a planetary nebula glow?

- A: It reflects the light of the star in its center.
- B: It is illuminated by surrounding stars.
- C: It fluoresces in the UV of the central white dwarf.
- D: It is illumnated by the Sun.
- E: It is illuminated by the planet whose atmosphere it is.

### 29 What does Stefan-Boltzman's law say?

A: The power radiated by a surface element of a glowing body is proportional to the 4th power of its temperature.

B: The absolute magnitude of a star is independent of its distance.

C: The temperature of a star is inversely proportional to the wavelength of its color.

D: The speed of rotation of a star is inversely proportial to its temperature.

E: Each absorption line is brightest at a particular temperature.

### 30 What type of spectrum does fluorescence produce?

- A: Band spectrum.
- B: Absorption spectrum.
- C: Distorted spectrum.
- D: Emission spectrum.
- E: Continous spectrum.

### **31** Atoms consist of the following constituents:

- A: Electrons and nucleons.
- B: Molecules and electrons.
- C: Quarks, electrons, and gluons.
- D: Electrons, protons and neutrons.
- E: Electrons, and a nucleus.

### 32 How was the speed of light measured for the first time?

- A: Getting a laser reflection from the Moon.
- B: Measuring the delay in the eclipses of Jupiter's moons.
- C: By measuring the slowing down of the time in a spaceship.
- D: By measuring the delay in conversations of astronauts.
- E: By direct measurement in a laboratory experiment.

### 33 What is a double-line binary star?

A: A short-period binary with both stars' spectral lines visible.

B: A star that is visibly broken up into a pair in the telescope and the orbital motion is noticeable.

C: A star that is visibly broken up into a pair in the telescope but the orbital motion is not noticeable.

D: A double star with a strong magnetic field.

E: A doule star system with strong stellar wind.

### 34 What happens to matter at 10,000 degrees?

- A: All substances become solid.
- B: Molecules break up.
- C: Atomic nuclei change into each other.
- D: (At least some) atoms break up.
- E: All atoms become ionized.

### 35 What is plasma?

- A: A viscous liquid.
- B: (At least partially) ionized gas.
- C: Gas that contains no electrons.
- D: Gas that contains no free electrons.
- E: Hot gas with most molecules broken up into atoms.

### 36 What does ionization mean?

- A: The breakup of molecules into atoms.
- B: Electrons moving to a higher orbit in an atom.
- C: Mixing interstellar gas with Fe-containing dust.
- D: Atoms losing (some of) their electrons.
- E: A chemical reaction with an ionizing salt.

### 37 Which one is an example of the Doppler-effect?

- A: Gas illuminated by UV radiation glows in an emission spectrum.
- B: Magnetic fields make spectral lines break up into several lines.
- C: The spectral lines of a moving star are shifted.
- D: The motion of a star makes spectral lines broaden.
- E: The overall color of a moving star changes.

### 38 How long does light take to arrive from the Sun to Earth?

- A: 9 minutes.
- B: 1 light year.
- C: 4.5 billion years.
- D: 4 years.
- E: an hour.

### 39 What does Wien's law say?

A: Thermal glow gets of shorter wavelength when the temperature of the body is increased.

- B: Hotter objects appear redder (I.e. radiate in longer wavelength).
- C: Warmer material absorbs red light stronger.
- D: The wavelength of the light of an approaching body is shifted towards blue.

E: Hotter gas radiates stronger than cold, proportionally to the fourth power of temperture.

### 40 How do we know the chemical composition of stars?

- A: It is calculated based on the amount of energy the star radiates.
- B: From a chemical analysis of interstellar gas blown in into the solar system.
- C: From samples returned by spacecraft.
- D: From the presence of each atom's spectral lines.
- E: From a chemical analysis of cosmic rays.

### 41 The energy of each photon is determined by ...

- A: the speed of the light.
- B: its wavelength only.
- C: both the wavelength and the strength of the light.
- D: the strength of the light only.
- E: nothing at all: it is a universal quantum constant of nature.

### 42 What happens to the spectrum of a star that rotates?

- A: The spectral lines in the red part of the spectrum become brighter.
- B: It is shifted towards red or blue by an even amount.
- C: They are shifted by an amount proportional to their wavelength.
- D: All its spectral lines broaden the same way.
- E: Spectral lines become more prominent.

### 43 Where do 1. low energy, 2. high energy cosmic rays come from?

- A: All: the Solar Wind
- B: Low: deep space, High: the Solar Wind.
- C: Low: the Solar Wind, High: deep space.
- D: All: from Earth, mainly nuclear reactors
- E: All: beyond the Solar System

### 44 A star's color indicates its ...

- A: temperature.
- B: chemical composition.
- C: size.
- D: mass.
- E: distance.

### 45 A hydrogen nucleus ...

- A: consists of one proton and one neutron.
- B: consists of two protons.
- C: is a proton.
- D: is a neutron.
- E: is a proton and an electron.