2021 Astronomy C Practice Test

Answer Key

I was slightly too lazy to format the answer key in any reasonable manner. You will have to deal with this, I'm afraid.

If you find any errors in this key (or in the exam or image sheet, for that matter), or have a better explanation for one of the questions, feel free to contact me (some info is on the exam), and I can make the fix.

Cover Image Credit: Wolfram Freudling et al.

1	(a)	O
	(b)	H
	(c)	J
	(d)	B
2	(a)	I
	(b)	Any of: A white dwarf accreted matter from a binary companion until it reached the Chandrasekhar limit; two white dwarf stars merged
	(c)	The host galaxy had a very bright spot in the one image, but not in the others.
	(d)	The supernova happened a notable distance from the center of the galaxy, which is where an active galactic nucleus is normally found.
3	(a)	E
	(b)	IV, there only appears to be one nucleus
	(c)	Elliptical, but the stellar mass surface density matches a spiral galaxy (specifically Sbc) better, and is constantly smaller than that of an elliptical.
	(d)	Nucleus
4	(a)	M
	(b)	The filament is constantly adding matter, and thus mass, to this cluster, and more massive objects are better gravitational lenses.
	(c)	It is one of the largest gravitational lenses, so the chance of seeing a lensed AGN in the field is more likely.
	(d)	Velocity, it was moving at a much higher velocity than the other clusters.
5	(a)	4.34
	(b)	sub-Damped Lyman Alpha
	(c)	Energy increases, X-Ray
	(d)	1. Get X-Ray and UV brightness 2. Calculate luminosity 3. Using the inverse-squares law, the apparent brightness of the object, and the calculated luminosity, determine the distance. *Any similar variation of this would work.*

6	(a)	D
	(b)	Hot accretion disk of the black hole (also accept hot gas falling onto the black hole).
	(c)	A galaxy
	(d)	It almost exactly resembled the researchers' model of a direct collapse black hole
7	(a)	F
	(b)	At the age of the universe that DLA0817g is in, we expect galaxies to be merging and interacting all the time, and should therefore be more mangled, and not undisturbed.
	(c)	The faster a galaxy rotates, the broader the lines in its spectrum. By observing these width of these lines, astronomers could determine the rotational velocity of DLS0817g.
	(d)	As the distance from the center of the galaxy increases, the orbits become more regular.
8	(a)	L
	(b)	The component galaxies dominated by old, red stars.
	(c)	According to the virial theorem, high thermal energy would be in equilibrium with high gravitational potential energy. A potential well is an area where a higher mass causes a higher gravitational pull, so matter accumulates in those areas.
	(d)	Less than, matter in a filament travels into a galaxy cluster, which has the higher gravitational pull, so it must be the more massive, and therefore more dense, object.
9	(a)	C
	(b)	FRII (You had to infer this one, I couldn't find it anywhere)
	(c)	The other jet is pointed away from us.
	(d)	Shockwaves from the jet colliding with interstellar medium.
10	(a)	N
	(b)	Any of Relativistic beaming, doppler beaming, doppler boosting, headlight effect
	(c)	Oxygen is the most abundant heavy element in the WHIM
	(d)	It is gravitationally pulled together into the filament structures.
11	(a)	Main Sequence
	(b)	Initial Mass
	(c)	Their intrinsic brightness increases
	(d)	CNO Cycle (half points for nuclear fusion)
12	(a)	Spiral arms are caused by density waves, or higher interstellar density regions. The higher density means more material is nearby to gravitationally collapse. Anything about higher density in spiral arms is acceptable.
	(b)	Hydrogen
	(c)	Dust
	(d)	Ultraviolet (2pts), Young/massive stars (2pts)

13	(a)	The main sequence
	(b)	Two of A, E, F, or D (both have to be correct or no points awarded)
	(c)	A
	(d)	E
14	(a)	In the outermost layers, they are not quite dense enough for unstable free-space neutrons to exist without atomic nuclei.
	(b)	This is a **glitch**, resulting from cracking of the crust caused by strain of decreasing inertial forces. (This sounds really confusing: basically a neutron star is slowing down its rotation very slowly, so the bulge of the star caused by the rotational force will start to shrink a little bit. The crust of a neutron star is very solid, though, so it doesn't want to reshape to the new bulge. Eventually the strain becomes too much, and the crust cracks, resulting in a tiny increase in velocity of the neutron star (a glitch). This stuff in parentheses is way too much for an answer, but should help to clear up with the garbled mess of an answer above means).
	(c)	Starquake, the magnetic field causing the crust of a neutron star crust to crack and release a whole bunch of energy.
	(d)	Galactic Nucleus, GRBs come from neutron star mergers, and there is a higher star density in the nucleus, so it is more likely that two neutron stars would come into contact.
15	(a)	X-Ray, Accretion Disk
	(b)	The lower metallicity star, Stars of very high metallicity are thought to lose much more mass to stellar winds over stars with low metallicity.
16	(a)	Spiral or barred spiral (either for full points)
	(b)	Elliptical
	(c)	Elliptical, it does not contain as much interstellar cool hydrogen, so the 21-cm line (which shows that) will not appear.
	(d)	A normal galaxy's spectrum is mostly made up of a total of stars and gas, which are much more consistent blackbodies than an active galactic nucleus, which is what dominates the spectrum of an AGN
17	(a)	The elliptical galaxy merged with a spiral galaxy
	(b)	A supernova
	(c)	Young stars (UV) extend out much farther in the disk than the interstellar medium (IR) that they should be forming in. You would expect the UV to land near the IR, not extend beyond it.
	(d)	This is caused by the supermassive black hole in the center of our galaxy.
18	(a)	Elliptical
	(b)	It provides the material that feeds the black hole

	(c)	Material from the jet is shooting into the interstellar medium, which slows it down through drag forces. More material is slamming into the slower material, causing immense friction and heating the gas.	
	(d)	synchrotron	
19	(a)	Their physical size is smaller, so it takes light less time to travel across them, so we can see shorter-timescale variations.	
	(b)	One bump corresponds to the synchrotron emission of the blazar, the other one shows inverse-compton scattering caused by the jet. (This isn't needed in the answer, but for clarity, inverse-compton scattering is basically where a particle travelling at a significant fraction of the speed of light comes into contact with a photon and transfers a bunch of energy into the photon, boosting its wavelength way down).	
	(c)	the second bump, the broad-line region corresponds to the accretion disk around the black hole where material is spinning at extremely high velocities.	
20	(a)	Point of view	
	(b)	The unified model would imply that galaxies would all be the same, but from different angles. The fact that different galactic features tend to favor one of the nuclei more implies that the nuclei are not the same, as they affect the galaxy differently (or the host affects the nucleus differently).	
	(c)	The accretion disk around the supermassive black hole	
21	(a)	i.	Silicon
		ii.	As time goes on, we could look at the light curve and see if it matches the light curve of a Type Ia Supernova
		iii.	1.26×10^{8} pc
	(b)	i.	85.46 arcseconds
		ii.	It covers a range of 21.088cm to 21.124cm
		iii.	1.995×10^{16} s
	(c)	i.	$2.346 \times 10^{11}\ M_{\odot}$
		ii.	2.125×10^{-22} kg/m^3
		iii.	$5.934 \times 10^{-2}\ L_{\odot}/M_{\odot}$
22	(a)	5160 K	
	(b)	0.763 $R_{\odot}$	
	(c)	0.753 $M_{\odot}$	
	(d)	250.1pc	
	(e)	2.032×10^{10} yr	

23	(a)	i.	Two of the points are for correctly stating **radio-loud**, the rest were for calculating the ratio of radio flux density to optical flux density (12.251) and stating that it was >10.
		ii.	0.1199 arcseconds
	(b)	i.	4.908×10^{-3} nm, Seen in X-Ray
		ii.	5.909×10^{8} K
		iii.	4.365×10^{67} W
	(c)	i.	2.742×10^{12} m
		ii.	2 points for stating **within**, remaining points for justifying answer using Schwarzschild radius, solved numerically (5.484×10^{12} m) or symbolically ($R_S = 2r$) for full points.
24	(a)		Use the WCS menu to change your coordinate system to "galactic". Then hover over the approximate center of the object and use the green coordinates in the corner. **297.97, -67.76** (accept a decent range of values)
	(b)		The reservoir of hot gas
	(c)		Surround the cluster with a region, and use Analysis > Energy Spectrum. Values between **1000ev-1600ev**
	(d)		Using Analysis > Light Curve (Do NOT use the light curve under the NSO analysis heading, use the other one). Pick the highest and lowest counts values, and subtract them. I get 409-333 = **76**. Anything between 60 and 95 will work, I think.
	(e)		Take your maximum value from the above part (409 for me), and divide it by the area of your region (found using Analysis > Counts in Regions). There's a lot of variability that can be introduced by how you sized your region, so you should account for that. I get 409/25431 arcseconds**2 = 16.1×10^{-2} photons/arcsecond^2
	(f)		Late, as the gas is not very separated, so has therefore been interacting through drag forces.
	(g)		Use what you know here as evidence (think about the Bullet Cluster). The central gas looks like it's interacting with drag forces, so we can expect that a majority of the mass in dark matter has passed through and will be on either side of the hot gas. The galaxies would also be in the same place, as they wouldn't hang back with the hot gas.