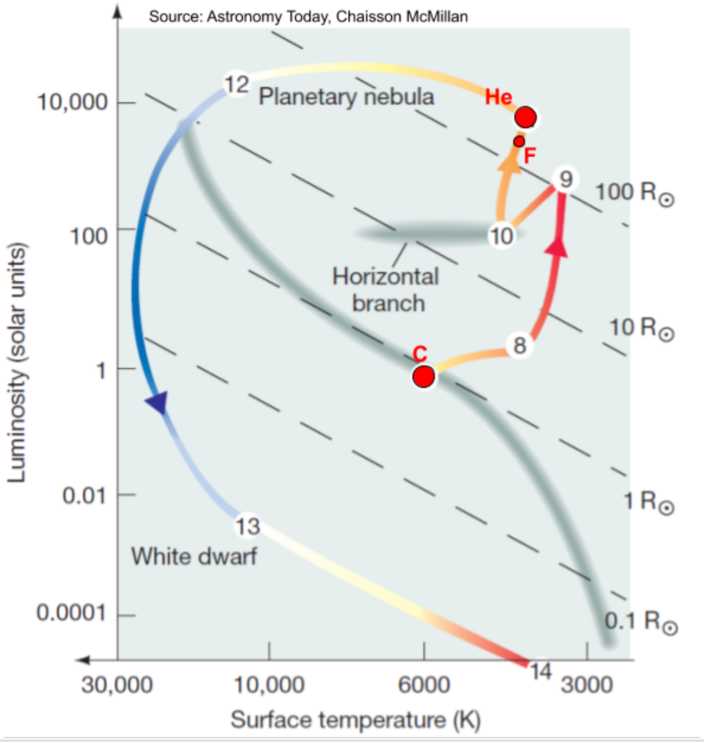
RiverWalker88's Astronomy C SSSS 2020 Test

Answer Key

Disclaimer: I did my best to make sure this answer key was correct. However, there may be errors, which I apologize in advance for.

Question	Part	Correct Answer	Points
		Part A: DSO Identification and Analysis	
1	a	A10, A11, A25	3
	b	Sy 2 Seyfert Galaxy	2
	c	Collision of two galaxies	2
	d	High abundance of interstellar gas and dust due to the collision of galaxies	2
	e	In the tidal tails	2
	f	Infrared	2
2	a	A6, A13, A18	3
	b	Gamma Ray Burst	2
	c	Neutron star merger	2
	d.i	Gravitational Waves	2
	d.ii	GW170817	2
	e	This DSO is 1.7 billion ly away. We could not detect gravitational waves at that distance.	3
3	a	A21, A26, A32	3
	b	**MA**ssive **C**luster **S**urvey	2
	c	It is a very powerful gravitational lens that affects how and where we see other objects.	2
	d.i	14.4 billion ly	2
	d.ii	MACS J1149.5+2223 Lensed Star 1 or Icarus	2
	e	Merger of galaxy clusters.	2
4	a	A4, A19, A30	3
	b	Collision of four different galaxy clusters	2
	c	This is the most energetic event yet observed in the universe.	2
	d	Orange/White: Optical observations, Pink: Baryonic Matter, Blue: Non-Baryonic (or dark) matter	2
	e	The baryonic matter in the cluster was slowed by a drag force, but much of the matter that only interacts gravitationally separated from the baryonic matter. So, the dark matter seperated from the normal matter in this cluster.	3
	f	If hot gas was the most massive component in the clusters, as proposed by alternative theories of gravity, such an effect would not be seen.	3
5	a	A12, A23	2
	b	Supermassive Black Hole	2
	c	the gas cloud is shown as the wispy blue material, while the orange and red disk is showing material being funneled toward the growing black hole through its gravitational pull	2
	d	Great Observatories Origins Deep Survey	2
	e	Some supermassive black holes had formed less than a billion years after the big bang	2
	f	A seed for a direct collapse black hole that is the leading theory for how GOODS-S 29323 was formed	2
6	a	A15, A29	2
	b	Blazar (1 pt for Quasar)	2

	c	Sculptor Wall	2
	d	OVII absorption lines	2
	e	Warm-Hot Intergalactic Medium (or just WHIM is fine)	2
7	a	A7, A27	2
	b	Laser Interferometer Gravitational-Wave Observatory (1 pt for LIGO)	2
	c	Black hole merger	2
	d	5.373E+47 J	5
	e	Black holes have a gravitational field within their schwartzchild radius so strong that light cannot escape, so we can detect no light coming from them.	3
8	a	A5, A16, A22, A24	4
	b	The supermassive black hole at the center.	2
	c	Radio	2
	d	accretion disk of the supermassive black hole	2
	e	Relativistic mass	2
	f	The jet is thought to be produced by strong electromagnetic forces created by matter swirling toward the supermassive black hole. These forces pull gas and magnetic fields away from the black hole along its axis of rotation in a narrow jet. Inside the jet, shock waves produce high-energy electrons that spiral around the magnetic field	2
	g	M87 may have gravitationally pulled globular clusters from the surrounding small galaxies.	2
	h	The surrounding small galaxies all seem to lack in globular clusters.	2
		Part B: Conceptual Astronomy	
9	--	B	1
10	--	A	1
11	--	O - BC6, B - BC3, A - BC4, F - BC7, G - BC5, K - BC2, M - BC1 (0.5 pt per)	3.5
12	--	O - Blue, B - Blue, A - Blue-white, F - White, G - Yellow-White, K - Orange, M - Red (0.5 pt per)	3.5
13	a	 Source: Astronomy Today, Chaisson McMillan	2
	b		2
	c		2

14	--	Giant stars are very large, and therefore very luminous. So, we will be able to see them at much higher distances that stars that are smaller and less luminous.	3
15	--	Lowest: iv, iii, ii, i :Highest (0.5 per correct rank)	2
16	a	Shock waves can cause a buildup of matter in one area, so that area gets dense enough to collapse into a protostar.	2
	b	An O or B type star quickly forms and dies, resulting in a supernova, which causes shock waves that result in an increase in star formation.	3
17	a.i	Four Protons and two electrons	2
	a.ii	Two protons collide with enough energy to form a heavy hydrogen nucleus (releasing a positron), which then fuses with another proton to form a light helium nucleus.	3
	a.iii	The positron released to form heavy hydrogen collides with an electron and the fusion of light helium also releases a gamma ray.	3
	a.iv	The solar interior is opaque to gamma rays, so the gamma rays are constantly being absorbed and re-emitted. They lose energy as they go outward into cooler parts of the sun, and have degraded to visible light when they exit into space.	2
	b.i	Carbon-Nitrogen-Oxygen	2
	b.ii	The carbon acts as a catalyst to fuse the protons together to make helium. It comes back unchanged.	3
	b.iii	Oxygen-15	2
	b.iv	Gamma Rays and Neutrinos	2
	c	Proton-Proton Chain	2
	d	1.3 solar masses	2
	e	Main-Sequence Stars	2
18	a	Three helium nuclei are fused into carbon by first fusing two helium into highly unstable Be-8, and then fusing another helium with Be-8 to form carbon	3
	b	Red giant stars	2
19	a	A superwind triggered by pulsations of the star that quickly rips off the envelope of the star, leaving behind a core and a cloud of material--a planetary nebula	3
	b	Less than 8 solar masses	2
20	--	A neutron star is not undergoing fusion or in hydrostatic equilibrium, so isn't actually a star.	2
21	--	BC8	1
22	--	The chromosphere has a very low density in comparison to the rest of the sun, so it is transparent to the light passing through it.	2
23	--	1. A cloud of cool molecular gas becomes unstable. 2. The cloud begins to fragment 3. Due to energy loss, a fragment of the cloud begins to collapse. 4. The cloud continues contracting, forming a protostar	3
24	a	Matter between stars, composed of gas and dust	2
	b	Dust, it has much larger and more complex molecules than gas	2
	c	We will observe the star to be dimmer due to extinction and the star to be redder due to reddening	2
	d	The density of interstellar medium varies a lot, but averages about 10^6 particles/m^3	2
	e	Elongated, rodlike particles of dust form into complex structures	2
	f	The rodlike particles of dust cause light in space to be polarized, so we can observe polarization. We are unable to know composition as well because we cannot easily measure the spectrum of interstellar dust	3
25	a	Flux density can be identified as the amount of the radiative field going normal through a given unit surface.	2

	b	Jansky (Jy)	2
26	--	This one is fairly open-ended, so not all answers are listed here. One example is: gravity causes objects to accelerate toward each other, and Newton's first law states that an object's motion stays constant unless affected by an outside force.	2
27	--	Irregular, Elliptical, Spiral	2
28	--	Not all quasars are strong radio emitters.	2
29	--	Any three of these five work: 1. Rapid variablilty in radio, infrared, and visual wavelengths. 2. Extremely weak or no emission lines. 3. Nonthermal continuous radiation with most of the energy emitted in infrared. 4. Strong and rapidly varying polarization. 5. Generally a starlike appearance; structure is rarely visible.	3
30	a	Active galaxy with emission from a very small region within the nucleus of an otherwise normal-looking spiral galaxy.	2
	b	We believe that much of the high energy radiation of Seyfert Galaxies is absorbed by dust in or near the nucleus and re-emitted as infrared.	2
31	a	The cosmological constant is homogeneous energy density that causes the expansion of the universe to accelerate	2
	b	Originally, the cosmological constant proposed by Einstein was a repulsive force that he added to his equations so that the universe didn't expand in his equations, because at the time, the expansion of the universe had not yet been discovered.	3
32	--	A black hole is formed	2
33	a	The universality of physical laws: The physical laws we observe on Earth apply to everywhere in the cosmos	3
	b	The cosmos is homogeneous: All matter in the cosmos is distrubuted evenly	3
	c	The universe is isotrophic: Space has the same properties in all directions, no one place can be distinguished from another by experimentation or observation.	3
34	--	Olber's paradox states that in an infinite, unchanging universe (as the universe was viewed in the early 20th century), when looking up at the night sky, you would eventually encounter a star, so earth would always be assulted by starlight. Because we are not, and night is dark, one or both of the assumptions must be wrong.	3
35	a	The Epoch of Recombination	2
	b	B	1
	c	The CMB will be slightly redshifted in the direction opposite our direction of motion, and slightly blueshifted in the direction of our motion, so we could use the redshift to determine the velocity of our galaxy	3
36	a	Normal, Atomic Matter	2
	b	Filaments of hot, diffuse gas; highly ionized baryons; sparse, warm-to-hot plasma that exists in the spaces between galaxies	2
	c	Hard to observe in X-Rays because of its low density, relatively low temperature (for X-Rays), and the poor spectral resolution of most instruments.	3
37	a	Karl G. Jansky Very Large Array (1 pt for Very Large Array)	2
	b	Interferometers	2
	c	Interferometers achieve high-resolution observations by mixing signals from a cluster of comparatively small telescopes rather than a single very expensive monolithic telescope	2
	d	The farther apart the telescopes are placed, the higher resolution the image, but the lower the area covered in the image. Configuration A has the highest resolution image, Configuration D has the highest area image.	3
	e.i	Change in energy state of hydrogen atoms	2
	e.ii	Emission in this band allows astronomers to map the interstellar hydrogen in a galaxy.	2

38	a	Expansion of the universe causes light waves to stretch in wavelength as well.	2
	b	The wavelength has lengthened by a factor of z+1, so the universe would have expanded with a factor of z+1	2
Part C: Conceptual & Calculation			
39	a	5.283e38 N. Use g = GM/r^2 to find the gravitational acceleration, then multiply by M (F = mg) to get F	6
	b	Hydrostatic equilibrium	2
	c	7.62e8 years, Use T = 10^10 (M)^2.5, M in solar masses	5
40	a	219.1 K	6
	b	Neither	2
41	a	21406 K velocity=sqrt((boltzmann constant * temperature)/mass)	6
	b	6.17e26 W	6
	c	Recurrent Nova	2
	d	100 times closer	5
	e	14560 km/s	5
	f	Type Ia Supernova	2
	g	3.188e20 seconds	6
	h	6.8e29 kg	6
42	a	2.666e31 W	5
	b	193.3 nm	5
	c	Spectral type: B5, Luminosity Class: V	2
	d	24.063 solar masses	5
	e	3.521e6 years	5
43	a	7.057e55 J	5
	b	1.7e18 kg/s	5
	c	8.615 J	5
	d	Density of galaxies, quantity of galaxies, age	3
	e	30.83% dark matter	6
44	a	4.2e-12 J	2
	b	9.286e37 reactions per second	5
45	a	2.42e8 m/s	5
	b	3916 m	5
	c	The Schwartzchild radius is the radius where the escape velocity is equal to the speed of light.	2
	d	If the mass increases, the radius will decrease and the Schwartzchild radius will increase.	2
46	a	0.0103 AU	5
	b	21 times per year	5
	c	69.11 m	6
47	a	2.73e20N	5
	b	2.7e-16 m/s^2	5
	c	Galactic Cannibalism	2