**Astronomy Midterm Exam**:

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| 1 | In the Earth’s history there has been only 1 mass extinction  | T F |
| 2 | Protons and Neutrons have nearly identical masses | T F |
| 3 | An electron is made of quarks  | T F |
|  |  |  |
| 4 | There is no such thing as an anti-neutron because a neutron has no charge | T F |
| 5 | Flat rotation curves in galaxies are expected (they would only be expected if you knew about dark matter prior to the first observations) | T F |
| 6 | Silicon burning lasts for just a few minutes in massive stars | T F |
| 7 | DNA is a genetic code that we expect to occur everywhere in the Galaxy | T F |
| 8 | The ozone layer formed about 3 billion years ago (600 million years ago) | T F |
| 9 | Elliptical galaxies are younger than spiral galaxies | T F |
| 10 | The matter density of the Universe is decreasing with time (matter is fixed yet volume of the universe is increasing) | T F |

Part II: Multiple Choice:

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| 11 |  | The Helium content of the Universe |
|  | A | Is about 50% by Mass (no, 25% by Mass) |
|  | B | Was created during the first second (no after 3 minutes) |
|  | C | Occurred from conversion of protons to neutrons by neutrinos (red herring) |
|  | D | **Depends on the proton-to-neutron ratio in the first minute** |
|  | E | Was created after the epoch of recombination (red herring) |
|  |  |  |
| 12 |  | We can not observe the Universe when it was 1000 years old |
|  | A | Because there was no matter then (no, matter is around) |
|  | B | Because there were no photons then (plenty of photons) |
|  | C | The speed of light hadn’t been determined yet (red herring) |
|  | D | The universe was opaque to radiation |
|  | E | The neutrinos have not yet decoupled from the matter (this occurs in the first 2 seconds) |
|  |  |  |
| 13 |  | The existence of free electrons in the early Universe |
|  | A | Is responsible for producing the Microwave background |
|  | B | Interferes with the creation of deuterium |
|  | C | Is due to the decay of free neutrons |
|  | D | Forms a scattering surface for photons |
|  | E | Means the Universe has a net negative charge |
|  |  |  |
| 14 |  | Which of the following is difficult to predict from our standard hot big bang model for cosmology |
|  | A | The measured Helium abundance |
|  | B | **The existence of galaxies (emphasized repeatedly in class)** |
|  | C | The observed redshift of galaxies |
|  | D | The presence of more radiation than matter |
|  | E | None of the above; all can be predicted easily |
|  |  |  |
| 15 |  | Two identical masses are separated by distance D: At a distance of 4D the gravitational force will be |
|  | A | The same; gravity only depends on Mass |
|  | B | Smaller by a factor of 4 |
|  | C | Smaller by a factor of 8 |
|  | D | **Smaller by a factor of 16 ( 1/R2 force law)** |
|  | E | None of the above |

From the distribution of answers it is quite evident that you don’t know what ionization is. Ionization is when an electron is remove from a nucleus, not added to it.

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| 16 |  | Ionization of Hydrogen occurs whenever |
|  | A | Two hydrogen atoms combine to form a molecule (red herring) |
|  | B | Two hydrogen atoms collide – 3 points for this because this can happen but it does not “occur whenever” |
|  | C | A hydrogen atom captures and electron (unphysical process) |
|  | D | A hydrogen atom absorbs a red photon (red photons have insufficient energy to ionize hydrogen – need UV photons) |
|  | E | **None of the above** |
|  |  |  |
| 17 |  | The rate of neutron addition to Iron and other heavy elements during a supernova explosion |
|  | A | Indicates the mass of the pre-supernova star |
|  | B | **Determines the amount of Gold on Earth** |
|  | C | Determines the speed at which the material is ejected |
|  | D | Depends on how much hydrogen has been fused into helium |
|  | E | Determines how much Silicon there is on the Earth |
|  |  |  |
| 18 |  | In our solar system, the observation that the inner planets are denser than the outer planets implies |
|  | A | Only the inner planets could have formed by accretion |
|  | B | There was little nickel or Iron in the outer solar system |
|  | C | There was little hydrogen in the vicinity of the Sun |
|  | D | **The sun was radiating energy prior to the formation of the planets** |
|  | E | All of the above |
|  |  |  |
| 19 |  | Photosynthesis in bacteria evolved in direct response to |
|  | A | the increasing amount of sunlight available as the sun warmed  |
|  | B | the presence of the Ozone layer |
|  | C | **a dwindling food supply** |
|  | D | fluctuating water levels due to periodic ice ages |
|  | E | all of the above are important |
|  |  | All of the other options are red herrings as this was 3-3.5 billion years ago and none of the other things existed then |
| 20 |  | In recent years most all extrasolar planets have been detected by |
|  | A | **The Doppler Wobble Method of radial velocity variations** |
|  | B | measuring excesses of infrared emission around the host star |
|  | C | direct optical imaging from the Space Telescope of nearby stars |
|  | D | measuring the position change of the star caused by the gravitational perturbation of the unseen planet (this is a method but only about 5% of known planets have been detected with it) |
|  | E | evidence of methane in the spectra of the host star itself |
|  |  |  |

Part III: Short Answer Questions (10 points each): **Answer 6 out of 7.**

21. In the early Universe we assume Thermal Equilibrium. What is the simplification that this assumption gives us about the conditions of the early Universe?

See power point on Midterm Results

22. Explain why Carbon can not be created in the very early Universe

See power point on Midterm Results

23. Explain why inflation predicts that the Universe should have a flat geometry.

Initial curvature inflated out due to exponential expansion for a short time period

24.Explain why dark matter may be necessary to facilitate the formation of Galaxies.

Need something to gravitationally clump that is immune to radiation pressure in the early universe

25**.** Explain how the process or neutron capture works to build elements heavier than Iron (e.g. Uranium**)**

Start with iron nucleus – capture neutrons during SN explosion – excess neutrons build until one neutron decays in to a proton – now you have a new element to continue this process. R vs S- process determines the ration of neutrons to protons in heavy nuclei (like Uranium)

26. Explain why the Earth has a dense nickel-iron core while the crust of the earth is composed mostly of silicon and aluminum.

Gravitational separation of heavy and light elements during molten proto-earth

27. Explain why we think that Oceans are necessary to aid in the formation of the first stages of life.

Oceans a) shield bacteria from UV and b) act as a transport medium to facilitate interaction among organic molecules. Oceans are also an environment for thermal vent active bio-chemisty