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## AST 248 Term Paper

Maximilian Cederholm 116466064

### Topic Question 3

Jerry works behind a desk at NASA. Every morning he makes a pot of coffee, drives to work in his 2003 Ford Victoria, scans his ID into his building, and sits down in an abnormally squeaky office chair to stare at the same patterns of electromagnetic signals on his computer. Or at least he expected to see the same patterns, instead, on this fateful day of November 25th 2027, Jerry's screen was hit with something incredibly abnormal. The use of "instead" here creates a choppy transition that disrupts the flow of the narrative. Consider rephrasing to:

"However, on this fateful day of November 25th, 2027, Jerry's screen was hit with something incredibly abnormal." A set of frequencies with a sort of intelligence behind it. This was no supernova, no pulsar burst, no solar storm. After adjusting the frequencies to match the human visible light spectrum, Jerry saw what it truly was: an image of a creature from another planet, something complex, different, unlike anything on earth. But what did it look like? Well, this date is yet to come, so for now, speculation is the only answer. The phrase "this date is yet to come" is awkward and could be more concise. Consider revising to: "However, since this date is in the future, speculation is the only answer for now."

When it comes to understanding and predicting alien species, there are three questions to cover. The first is foundational, what are the evolutionary requirements to be an intelligent species? This sentence lacks proper punctuation and structure. It should be rephrased as: "The first is foundational: what are the evolutionary requirements for a species to be considered intelligent?" The second is likely the simplest, what are the technological requirements to communicate with humans through images? Similar to the previous issue, this sentence also lacks proper punctuation. Rephrase to: "The second is likely the simplest: what are the technological requirements for communicating with humans through images?" The third is the most diverse, what are the potential habitats for these species and how will that affect their appearance? This sentence also requires punctuation for clarity. Consider rephrasing to: "The third is the most diverse: what are the potential habitats for these species, and how will that affect their appearance?" Before tackling these questions, I present a fourth, significantly complex question which I will not attempt to answer: How would life be different with an inherently different building block for life, such as a cell with a replacement for DNA, or something ulterior from a cell at all. This sentence is overly complex and could be simplified for better readability. Consider revising to: "How would life differ if it had an inherently different building block, such as a cell with a replacement for DNA or something entirely different from a cell?" I will assume life, evolution, and reproduction follow vaguely the same rules as they do on Earth, as I lack the PHD in biochemistry required to follow a proper line of reasoning as to the possibilities of other forms of cells. The phrase "the PHD in biochemistry" should be corrected to "PhD in biochemistry," and the sentence is somewhat convoluted. Rephrase to: "as I lack a PhD in biochemistry, which is necessary to explore the possibilities of other forms of cells."

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Evolution is the baseline to all possibilities for intelligent life. If a lifeform could not reasonably evolve to a state in which technology is accessible, then it is not a candidate for communication. This sentence is overly complex and could be simplified for clarity. Consider rephrasing to: "If a lifeform cannot evolve in a way that allows for technological development, it cannot communicate." An example of this is a bottlenose dolphin, which, despite their comparable intelligence to humans, have no capabilities for technological advancements as they lack fingers. So, we break down the required traits into the following categories: movement, metabolism, senses, communication, fabrication.

Movement is the most basic requirement, one that I suspect is simple to overcome. Movement is convenient for many reasons, it allows for more efficient communication and teamwork between members of the species, it helps with the locating of energy, and provides a greater ability towards safety. This sentence is a run-on and could be broken into smaller sentences for better readability. Consider revising to: "Movement is convenient for many reasons. It allows for more efficient communication and teamwork among species members, helps locate energy, and enhances safety." But the greatest reason movement is necessary is for resource production, a civilization can never build the required technology if it cannot access all of the required resources around the celestial body in which it lives. This sentence is lengthy and could be more concise. Rephrase to: "A civilization cannot build the necessary technology without access to resources on its celestial body." I wouldn't expect this to

be much of an issue, however, as there is a reason we never find highly intelligent trees on Earth. Evolving higher brain functions requires a reason for such evolution, which would generally come from a need to hunt and survive. Fully stationary lifeforms have a requirement for neither, they tend to live near reliable energy sources and reproduce faster than they can be brought to extinction. Higher brain functions can be considered reserved for creatures with a need for hunting, or at the least movement for survival. So, we can consider this requirement obsolete when discussing an intelligent creature.

The next is metabolism, which for this discussion, is really just limited to a source of energy. The three options are photosynthesis, chemosynthesis, and ingestion. Photosynthesis is off the table, for a reason described perfectly by synthetic biologist Christina Agapakis, "animals need a lot of energy, and moving at all does not really jive well with photosynthesis." The quote is well-integrated, but the sentence could be more fluid. Consider rephrasing to: "As synthetic biologist Christina Agapakis explains, 'animals need a lot of energy, and moving at all does not really jive well with photosynthesis.' Chemosynthesis may be a little more reasonable depending on luck, as chemical vents or other potential sources can vary in intensity depending on the habitat, but I would like to say that it still remains unlikely. Firstly, we've already decided that active movement is a requirement for an intelligent species, and a chemoautotroph has very little reason to evolve active movement since its energy source is always stagnant. This sentence is overly complex and could be simplified. Consider breaking it into two sentences: "Firstly, we have established that active movement is essential for an intelligent species. A chemoautotroph has little reason to evolve active movement since its energy source is always stagnant." The only possibility for

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one feature it never required for its survival. The phrase "this one feature it never required for its survival" is awkwardly placed and could be clearer. Rephrase to "because it never required this feature for its survival." One thing to note is that an octopus is an R-species, which likely contributes to why communication was never necessary for its survival. The phrase "which likely contributes to why" is wordy and could be simplified. Consider rephrasing to "which likely explains why communication was never necessary for its survival." K-species need to nurse their young and protect them to ensure long term survival, meaning some form of communication must be established and can sometimes lead to pack behavior, seen in many larger mammals. The phrase "can sometimes lead to pack behavior" is vague and could be more assertive. Rephrase to "must be established, often leading to pack behavior, as seen in many larger mammals." The octopus, despite its intelligence, never developed such complex communication potentially because its only interaction with other octopuses is for mating, and it has no need to communicate with its young. The phrase "its only interaction with other octopuses are primarily for mating, and it has no need to communicate with its young." On top of plain communication, it's likely that the species should follow some sort of basic pack behavior, as mentioned earlier. The phrase "some sort of basic pack behavior" is vague and could be more definitive. Rephrase to "it's likely that the species should exhibit basic pack behavior, as mentioned earlier." The organisms need to be able to group and ration at an early stage in order to make way for processes an intelligent species needs to make technological progress, such as jobs and currency. The phrase "make way for processes an intelligent species needs" is awkwardly constructed. Rephrase to "to facilitate the processes necessary for technological progress, such as jobs and currency." Without early evolutionary communication, a civilization could never amass the technology they need to communicate outside their solar system. The phrase "communicate outside their solar system" is somewhat repetitive given the context. Consider rephrasing to "Without early evolutionary communication, a civilization could never develop the technology needed for interstellar communication." Oh — and let's not forget, how could they learn to communicate with other intelligent civilizations if they can't figure out how to communicate with themselves. The phrase "how could they learn to communicate with other intelligent civilizations" is overly casual and could be more formal. Rephrase to "how could they learn to communicate with other intelligent civilizations if they cannot communicate effectively among themselves?" Finally, a species would need some sort of limb dexterity in order to properly fabricate the necessary tools and technology for communication. The phrase "some sort of limb dexterity" is vague and could be more specific. Consider rephrasing to "a species would need a certain level of limb dexterity to fabricate the necessary tools and technology for communication." The aforementioned example was the bottlenose dolphin lacking fingers, however there are multiple conceivable options. Of course, one option is fingers, with an emphasis on the thumb for grabbing and holding. The phrase "Of course, one option is fingers" is informal and could be more academic. Rephrase to "One potential option is the development of fingers, particularly emphasizing the thumb for grasping and holding." It's likely that apes developed such finger dexterity for grip strength while climbing trees, as the height of trees kept them relatively safe and allowed for access to food. The phrase "as the height of trees kept them relatively safe" is somewhat redundant and could be more concise. Consider rephrasing to "as the height of trees provided safety and access to food." Another potential option is a tentacle-like limb system, which we've only seen `html

with octopuses underwater. Octopuses developed their tentacles as it made them more formidable predators, allowing them to catch prey from afar and hold them with the suction cups. In theory, either limb system could be present in either habitat, but it's not very surprising that there are significantly more fingers on land and tentacles in water than the opposite. This sentence is somewhat awkward and could be rephrased for clarity. It is not surprising that there are significantly more fingers on land and tentacles in water than vice versa. An ancestor to whales used to live on land as a four-legged animal, but every subsequent species of that parent species which lived in the water ended up evolving into flippers over fingers simply for the advantage of movement. Due to the significant buoyancy produced by water, there really is no reason to require fingers in the way that apes needed it. This phrase is convoluted and could be simplified. There is no necessity for fingers as apes required them, and due to the force of gravity in really any gas medium, tentacles seem like an overall weak candidate for a land animal. Our final evolutionary parameters are therefore: Must be intelligent, capable of intended movement, accurately perceptive of surroundings, able to and actively interested in communication within the species, and have dexterous limbs such as fingers for land animals and tentacles for sea animals. The advancement and accessibility of technology is the next hurdle. A species capable of producing modern technology does nothing if the resources aren't available for use, or are unusable due to the habitat. This sentence is a bit lengthy and could be broken up for better readability. A species capable of producing modern technology is ineffective if the resources are unavailable or unusable due to their habitat. For this section, we break down the technological requirements into

two sections: the availability of natural resources and the potential of said resources due to habitat. The largest technological requirement for a natural resource isn't an element like iron or silicon (however both are worthy candidates), it's certainly energy. The use of "it's" here is informal; "it is" would be more appropriate in an academic context. It is certainly energy. If we look back in human history, there are recognizable ages such as the Bronze or Iron age where we had a widespread advancement in technology that governed the tools and inventions of the time. But progress was slow then, and in the grand scheme of things, the heavy reliance on tools made from these materials may not have been necessary. This phrase is vague and could be more precise. the reliance on tools made from these materials may not have been as critical as once thought. It's likely that without bronze, another contender for tools may have been discovered, as is probably true with most early inventions. But when it comes to the inventions in the industrial revolution, when progress really started accelerating for humanity, The repetition of "when" makes this phrase awkward. which marked the acceleration of progress for humanity, energy sources were at the forefront of it all. From burning coal and oil

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to fusing hydrogen nuclei, the search for energy never ends, but it certainly starts somewhere. For humans, I will consider the first of these to be the steam engine, running on organic compounds found primarily in coal, but potentially oil, wood, methane, and all of those traditional fossil fuels. Such fuels are appealing to early civilizations because they are high in abundance, efficient enough, and early civilizations are less worried about long term sustainability.

These fuels are abundant on earth, but how abundant could they be in other locations? Before I elaborate on this further I need to define exactly what these locations are. This sentence is somewhat abrupt and could be more smoothly integrated into the previous sentence. Consider rephrasing to: "Before elaborating on this further, it is important to define exactly what these locations are." In the following paragraphs I will utilize three planet types: The runaway greenhouse habitat, the earth-like habitat, and the ice-ocean habitat. These are the three with potential for life, each describing a different section of the habitable zone. To analyze the formation of these resources in these different habitats, we first need to understand their formation on earth. Coal, oils, and natural gas form when organisms get trapped in positions where decomposers cannot return them to the ecosystem. This is most often in muddy swamps, where organisms will die and fail to be decomposed. The carbon will then be compressed over time, piled over with dirt, stones, or even lakes or oceans. On earth, this is primarily due to the high abundance of plants in swamps, which can easily pile up massive amounts of coal under prehistoric swampy regions. Oceans do not have such luck, as organisms that die there are significantly fewer and more likely to be decomposed anyway.

That rules out the existence of coal in icy oceans, but seems perfectly fine in the other two. This sentence is somewhat choppy and could be better connected to the previous context. Consider rephrasing to: "This rules out the existence of coal in icy oceans, while the other two habitats remain viable for coal formation." The runaway greenhouse habitat is implied to have once been habitable for life on the surface, so underground coal is a possibility if plant life managed to flourish once. However, it would be significantly less abundant than an earth like planet with the optimal amount of time in the safe part of the habitable zone, as coal takes ages to compress and form properly.

We may, however, give these civilizations the benefit of the doubt and assess the possibility of majorly skipping over fossil fuels as a primary energy source. Perhaps electronic discoveries can be pursued first, allowing for generators powered by sustainable energy such as hydroelectrics, windmills, and geothermal energy. A civilization on a planet with a runaway greenhouse effect could potentially use

```html the immense heat on the surface in a similar way to how we currently use geothermal energy for steam power, however they'd be cautious not to lose whatever water they have access to. The use of "however" here creates a run-on sentence, as it improperly connects two independent clauses without proper punctuation. Consider breaking this into two sentences: "The immense heat on the surface can be utilized in a similar way to how we currently use geothermal energy for steam power. However, they'd be cautious not to lose whatever water they have access to." An ocean civilization would be able to use convection currents caused by the warm chemical vents to power mills at the bottom of the ocean, acting as another alternative energy source. While energy is definitely the most important resource, there are some others worth introducing to this discussion. Metals like iron, copper, and aluminum require high abundance to be utilized effectively. Especially copper, with

a low resistivity, making it the most effective metal for transporting electrical energy. This sentence is a fragment and lacks a main clause. Revise to: "Especially copper is important due to its low resistivity, making it the most effective metal for transporting electrical energy." Another element with an important place in civilizations is silicon, which is vital for semiconductors used in all electronic devices. If a planet happens to lack silicon, it would be significantly more difficult to advance technology to the standards humanity has today. However, on this front, it seems rare to lack elements common in rock with a solar system that has abundance of high elements, simply because of the composition of the rocks throughout the early solar system. I think it is fair to say that a planet with the necessary organic molecules for life will also have the required metals and resources for technological advancements, apart from the sources of energy. However, access to certain materials does not equate to **its** The pronoun "its" is incorrectly used here; "materials" is plural, so the correct pronoun should be "their." Change "its use" to "their use." In a runaway greenhouse environment, are fossil fuels helpful if water cannot be spared for energy? At the bottom of a frozen ocean, are fossil fuels helpful if there is too little oxygen to stoke the fire? These issues must be tackled by the civilizations prior to any progress that may occur. Perhaps water reserving technology on a heated planet has become so efficient that the water can be spared for energy, **so long that every drop is reused.** The phrase "so long that" is awkward and not commonly used in this context. Consider revising to: "so long as every drop is reused." For the ocean habitat, unfortunately, there seems to be no saving it. I have yet to mention the water pressure at such depths, but building nearly anything would be nearly impossible due to structural integrity. Mining materials seems cumbersome at such depths, and experimentation is largely quelled underneath the water. A civilization down there could not learn about combustion, electrical currents, or vaporization without intensive watertight structures intended for testing experiments outside of water. Yet just doing that requires first the recognition that water is simply a medium, not the world. ^ ^ ^ ^ html

With this, we may craft our first concept species, one from the depths of an **icey** "Icey" is a misspelling; the correct spelling is "icy." Replace "icey" with "icy." ocean similar to Europa. The celestial body **this species lives on is an icy moon** This phrase is awkwardly constructed. It would be clearer to say "on which this species lives." Rephrase to "on which this species lives." is an icy moon orbiting a gas giant subject to major tidal heating at the bottom of the oceans. Nutrients from the surface seep into the waters incredibly slowly, beginning a lengthy nutrient cycle. Organic compounds slowly move around and begin forming the required structures at rates significantly slower than anything on **earth** "Earth" should be capitalized as it is a proper noun. Capitalize "earth" to "Earth." Eventually, near the high energy chemical vents at the bottom of the oceans, reproduction begins at a cellular level. These processes take unfathomable amounts of time due to the slowed nature of the cold waters, but eventually ecosystems form. Autotrophs feeding on the chemicals and heat energy of chemical vents form the base of the ecosystem, with food chains climbing upwards. Habitats survive solely around these vents, as there are no photosynthetic organisms this far from the sun.

All organisms here are small and **save however much energy they can** This phrase is awkward and unclear. "Save" is not the correct verb here. Rephrase to "conserve as much energy as possible." Large organisms require more energy, so larger genes tend to die off. For this reason, many animals end up small and **stick in groups rather than relying on solidarity** The phrase "stick in groups" is informal and could be more precise. Rephrase to "form groups rather than rely on solitude." This includes our intelligent organisms at hand, **we may call them the Europeans** This clause is awkwardly placed and disrupts the flow of the sentence. Rephrase to "which we may call the Europeans." (not to be confused with Europeans, a different kind of alien). Europeans are octopus-like creatures with interesting looking faces. These beings have two sound receptors on their faces (potentially where human eyes are) and one sound producer right beneath. The sound receptors are incredibly advanced, being intended for **echo location** "Echolocation" should be written as one word. Change "echo location" to "echolocation." as a primary sense. A powerful enough mind could use the pressure waves to describe a full image of the surroundings. The existence of two sound receptors is for triangulation; if a sound comes from somewhere external, the highly sensitive receptors could triangulate a distance in a similar way to how human eyes can calculate depth. Europeans communicate primarily with clicks intended for echolocation, and can easily identify another member of **its species** The pronoun "its" should be "their" to maintain plural agreement with "members." Change "its species" to "their species." through the echolocation. Europeans can also distinguish between a common echolocation frequency and a conversational frequency to avoid confusion, which is evolutionarily backed by **less effective communicators being seperated from packs and killed** "Separated" is a misspelling; the correct spelling is "separated." Correct "seperated" to "separated." Along with the sound receptors, the tentacles have infrared detectors as infrared light would be the only present photons from chemical vents and potentially

```html other organisms. These infrared detectors are used to detect hunting grounds where prey lives, as sound cannot easily locate the chemical vents in which ecosystems surround themselves in. Other senses are likely present, such as touch, taste, and smell, but the primary ones were already listed. This sentence is somewhat redundant because it repeats the idea of senses being present without adding new information. Consider rephrasing to: "While other senses such as touch, taste, and smell may also be present, the primary senses have already been identified." These organisms live off of schools of underwater organisms, working together to herd the little organisms into the nets woven between each tentacle. These organisms have widespread communication, spanning groups, cultures, and connections across the entire moon. Trade has occurred, however inventions are slow and far between due to the harsh conditions. The use of "however" is somewhat awkward here and creates a choppy transition. Consider revising to: "However, due to the harsh conditions, inventions are slow and far between." Thankfully, despite the slow nature of just about everything on this moon, the fact that it's already outside of the sun's habitable zone acts a little like a good thing. With a planet inside a habitable zone, it's unfortunately only a matter of time before the sun becomes too luminous for the planet and the habitable zone expands too far. This sentence is lengthy and convoluted, making it difficult to follow. Consider breaking it into two sentences: "A planet within a habitable zone faces the unfortunate reality of the sun becoming too luminous over time. This causes the habitable zone to expand too far." But with an icy moon on an ice giant, there are no such limitations and life can develop for far longer periods of time, as long as it started in the first place. So after ages of civilization, these beings find intuitive ways to do inconceivable things for their situations, such as building waterless rooms, suits allowing for water in a zone with none, experiments with copper and energy, all until a solution is found to utilize electrical energy for progress. The phrase "all until a solution is found" is awkward and could be more concise. Consider rephrasing to: "until they find a solution to utilize electrical energy for progress." Once energy is going, journeys begin away from the bottom, learning to endure the cold, lack of food, change in pressures, until one day the giant ice sheet is met. The Europeans find a way to break through while stimulating the required pressures for their bodies. They get above the ice and... see nothing. Sound cannot travel through space, only light. They learn to translate the cosmic photons to infrared or some sort of sound for the Europeans to understand. Eventually, after all this unlikelihood, suffering, and slow burn to success, the Europeans can send out an infrared picture of themselves to arrive at Jerry's office on November 25th 2027. I expected to explore more about runaway greenhouse habitats and earth-like habitats, but I'm content with the detail of the previous works. The phrase "I'm content with the detail of the previous works" is somewhat informal and could be more academic. Consider revising to: "I find myself satisfied with the depth of the previous works." My concept for the runaway greenhouse, however, was an underground civilization similar to that of a mole, with claws intended for digging but potentially repurposed for ulterior purposes in the grand scheme of the civilization — so many possibilities, I love it. The phrase "so many possibilities, I love it" is informal and lacks academic tone. Consider rephrasing to: "which presents numerous possibilities for exploration." ```html

Sources

National Geographic “Will we ever photosynthesize like plants” (Missing punctuation at the end of the title)
“Will we ever photosynthesize like plants?”

Smithsonian “Octopuses and Squids” (Missing punctuation at the end of the title) “Octopuses and Squids?”

US Energy and Information Administration “Coal Explained” (Missing punctuation at the end of the title) “Coal Explained?”

US Energy and Information Administration “Natural Gas Explained” (Missing punctuation at the end of the title)
“Natural Gas Explained?”

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