

Eco Test: Key

By: Me

Instructions:

The scoring rubric is highly segmented with various points of partial credit given for different portions of the answer. Use your best judgement.

If you have any questions, message me.

Station 1: UNTB

- 1) In the Unified Neutral Theory of Biodiversity, explain what a neutral theory of ecology means. (3pt)

The theory assumes that organisms using the same general resources (saying niche is acceptable) have no competitive advantage over each other (2pt); therefore, the survival of a species is entirely random (1pt).

Saying that natural selection does not take place is worth 1pt.

- 2) The UNTB is based on the theory of island biogeography. Explain this theory and give 3 natural settings in which it could be applied (3pt + 0.5pt per setting)

Island biogeography says that in an isolated environment (0.5pt), the rate of species inflow from immigration or speciation must equal the rate of extinction (2pt).

0.5pt for mentioning any one of the modifiers to richness such as island size, distance from mainland, human influence, etc.

Natural settings (0.5 each for max 3, -0.5 for each one listed over 3 that is wrong): islands, nature preserves, mountains, habitat fragments, isolated lakes (or dammed lakes), or any other setting that sounds right.

- 3) Explain the buffer zone concept of natural preserves (2pt) and describe each of its 3 zones (0.2pt each)

The buffer zone concept says that an ideal natural preserve gradually decreasing human influence as it approaches the center of the natural preserve (2pt)

The outer zone allows low levels of commercial activity and residential development.

The inner zone allows for recreation, research stations, roads, and limited development.

The core preserve has no development with highly restricted access for research or recreation.

- 4) **Conservation Easements** are agreements between landowners and conservation agencies not to develop their land any further (1pt) **(0.75pt for just 'easement')**

- 5) In the time you have remaining, describe the Unified neutral theory of biodiversity, and if you don't know what it is, read about it because it's an interesting perspective on ecology (8pt)

Opt for re-describing neutral theory

An ecosystem has limited resources and thus has a set number of individuals who may use those resources (1pt). When an individual dies, the probability that an individual from any given species replaces it is proportional to the relative frequency of that species (2pt).

This implies that survival of a species is essentially random (1pt) and prone to ecological drift (1pt)

As time goes on, species populations will fluctuate and some species will go extinct by chance (1pt); therefore, the ecosystem needs an influx of species to balance (1pt) its inevitable tendency towards domination by a single species (1pt).

Station 2: Diversity Maths

Ceanothus spinosus	0.5
Arctostaphylos glandulosa	0.36
Dudleya lanceolata	0.03
Romneya coulteri	0.11

1. Calculate the shannon-wiener evenness index (1.5pt)

1.41

2. What does the second column represent? (0.5pt)

Relative abundance; 0.25pt for percent cover or other related terms

3. Which index, simpson or shannon-wiener, puts greater emphasis on rarer species? Why? (1pt)

Shannon-wiener index does (0.5pt) because it uses a logarithmic scale (0.5pt)

4. Explain how the Brillouin index differs from the shannon-wiener index (2pt)

The brillouin index counts the area as a set sample (1pt) whereas the SW index only takes the proportion of area covered into account (1pt).

5. Which of the plants listed has (objectively) the best flowers? (0pt)

Romneya coulteri

Station 3: Selection and Speciation

1. What term best describes speciation from the isolation of a species of insect from the mainland on a small, far off island? (0.5pt)

Peripatric speciation

0.25pt for allopatric speciation

0.01pt for geographic isolation

2. Name the type of selection most likely to occur in each of the following scenarios (0.25pt each)

- a. A pair of similar species undergo exploitative competition

Directional selection (disruptive is wrong because although they move towards 2 peaks, they are separate species)

- b. A species lives by eating either figs or durian and does best when it has the fewest number of individuals competing against it

Negative frequency dependent selection

0.2pt for just frequency dependent selection

3. A penguin undergoes a mutation that turns its arm into a biological analog of a Glock 29 making it far more fit than other individuals. Explain fitness (0.5pt) and name the term that describes the rapid spread of this trait through the population (0.5pt).

Fitness: **relative** (0.15pt) ability to produce offspring (0.15pt) that carry on genetic material (0.2pt)

Selective sweep (0.5pt)

4. A lichen growing high on a mountain near Yellowknife is undergoing outbreeding depression. Explain outbreeding depression (1.5pt) and the most common way species avoid this (0.75pt).

Outbreeding depression: when breeding with individuals from further away (0.5pt) that are not as well adapted to the environment in the given area (0.5pt) reduces the fitness of offspring (0.25pt). Occurs mainly in individuals that are highly specialized to their current environment (0.25pt).

Asexual reproduction (0.5pt) because it removes the possibility of receiving genetic material from less adapted populations (0.25pt).

Station 4: Grasslands

1. What are grasslands called in South Africa? (0.1pt)

Veldt

2. Describe the key difference between bunchgrass prairies and typical North American temperate grasslands (0.75pt)

Bunchgrass prairies root from a central base (0.25) while typical grasses use rhizomes (0.25) to spread out in a more broad mat-like area (0.25).

3. Give a brief description of each of the following types of savanna (0.25 each)

- a. Edaphic - Situated on soil that unsuitable for full forest development; soil dependent (0.25)
- b. Derived - Humans (or other animals such as elephants) have damaged original forest cover (0.15). Savanna is now maintained by fire and/or continued disturbance (0.1)
- c. Temperate - Savannas located in temperate climates (yeah, that's actually it) (0.25)

4. Describe temperate grassland soil characteristics (1.5pt)

Temperate grassland soils are rich in humus and decaying organic matter (0.25). They are basic (0.25) and dark in color (0.05). Their soil classification is generally mollisol (0.25). They have well developed soil horizons (0.2) typically including a well developed E horizon with accumulation of leached particles in the B horizon (0.5).

5. Contrast aridification with desertification (1.2pt)

Desertification is removal of plants (generally grasses) and topsoil (0.25) causing the region to transition to a more barren and desert-like area in terms of plants (0.25).

Aridification is the actual drying of the land. Like there is just less rainfall present in the area (0.4) often due to global warming (0.1). It can be a cause of desertification (0.1) but is not the primary cause of desertification (0.1)

6. Draw an approximate curve of stem water potentials for a perennial bunchgrass in California's central valley over the course of a year labelling the highest and lowest points with a reason (2pt)

Yeah, I apologize for the drawing, but something along those lines.

0.5pt for lowest water potential in fall, and 0.5pt for highest in spring



(note that these values for water potential are negative).

Even if they write water potentials as positive values, give 0.25pt for highest in fall and 0.25 for lowest in spring.

Explanation: Summer is the warmest season (0.2) and drought continues through fall (0.1) when anticyclonic pressure from over Nevada pushes hot dry winds through the central valley dramatically lowering water potentials (0.2)

Most rainfall happens in winter-spring (0.2) which is also the coolest time of the year (0.2) and when there is the greatest humidity (0.1).

Station 5: Desserts! (long station)

1. Describe each of the following types of deserts and give an example of each in the US (1.3pt)
 - a. Cold desert - primarily receive precipitation through snow, very cold long winters with short mild summers, stuff like that (0.3pt). The air is too cold to hold moisture which results in low precipitation (0.1). 0.1pt for any icefield in alaska, the great basin (debatable), or north alaskan tundra.
 - b. Semi-arid desert - General description of getting somewhat more rain than other deserts (0.1) with a range of up to 20in per year (0.1). Climate is generally more moderate temperature wise (0.1) with greater vegetation cover (0.1). 0.1 for example such as great basin or high plains.
 - c. Paleodesert - Region that was the desert long ago (0.2). 0.1 for example such as sand hills nebraska or petrified dunes utah.

2. Answer the following
 - a. Define PET (0.5pt) - *potential evapotranspiration (0.1) is the loss through evaporation and transpiration (0.1) that would occur if an ecosystem was given unlimited water (0.3)*
 - b. Define the aridity index (1pt) - *the aridity index measures how dry an area is (0.1). It is defined as precipitation/PET (0.9)*
 - c. Why are many cold deserts not hyperarid by the aridity index definition? (1pt) - *the PET of a true cold desert such as antarctica is rather low (0.3) because temperatures reduce evaporation to near 0 (0.3) and there is little to no plant cover for transpiration to occur (0.3). Thus the aridity index is often rather high because PET is in the denominator (0.1)*

3. Earth-sci time!
 - a. How does desert pavement form? (0.75pt) - *lighter/smaller particles are blown away (0.3) which leaves behind larger rocks (0.3) forming a coat of rocks and larger chunks of rock over the surface (0.15)*
 - b. Why are deserts common around 30 degrees N/S latitude? (0.5pt) - *descending air masses are warm and dry and found around those latitudes (0.4). They come from hadley cells near the equator and ferrel cells from further towards the poles (0.1)*
 - c. Give the 2 primary reasons deserts are so much warmer than other areas at similar latitudes (1.7pt) - *Deserts have lower humidity (0.25). The lower humidity and lower cloud cover cause more sunlight to hit the ground than in similar latitude regions (0.5). If they say deserts have lower albedo, -0.5pt. If they say deserts have less plants but don't get the rest, 0.1 pt for incomplete explanation of*

humidity. #2: Deserts heat up faster (0.25) because they have lower ability to moderate temperature (0.25) because there is low plant cover (0.2) and less humidity in the air to absorb/release heat throughout the day (0.25)

4. Living stuff

- a. **Xerocoles** are desert animals (0.25pt)
- b. What unique mode of photosynthesis do many species of cacti employ? (0.5pt)
Describe its primary advantages (1pt) - *crassulacean acid metabolism (0.5) or 0.4pt for CAM photosynthesis. It allows the plant to only open its stomata at night (0.25) when it's cooler (0.1) and it loses less water to transpiration (0.35). It also stops photorespiration (0.3).*
- c. Name all the continents where cacti are found (0.25pt) - *North and South America, anything more or less is wrong with no partial credit given*

Station Q: Chaparral

What's that? Chaparral isn't on the biomes list?!?! Sucks for you; it's my favorite biome so deal with it.

1. Name each location in the world where chaparral is found (0.15pt each, -0.15pt for each incorrect guess)

Southern california, Central chile (chile alone is acceptable), south africa, the mediterranean (if they say a more specific region like North africa, that's fine), southwest australia

2. Describe the 3 major fire survival mechanisms of chaparral (1.5pt)

Obligate seeders rely on seeds (0.2) which only sprout after fires (0.3)

Obligate sprouters resprout but do not have seeds which survive fires (0.3). They come back from a deep taproot or knotted basal burl (0.2).

Facultative seeders both produce seeds and resprout from their base after fires (0.5)

3. Give 3 common characteristics of chaparral shrub leaves (0.6pt)

0.2 for each, -0.2 for each guess beyond the first three listed: waxy, hard, small, drought deciduous, flammable (iffy but ok)

4. Describe the type and timing of fires that chaparral is adapted to (1.25pt)

Adapted to high intensity and temperature fires (0.5). Fires generally in summer (0.25) and are usually very large (0.25) with the timing in between fires ranging from 30-150yrs (0.25)

5. Aside from increasing frequency, give the two main ways in which people are changing chaparral fire regimens (2pt)

Climate change (0.1) increases drought frequency (0.15)

Humans start fires outside of natural fire seasons (0.5). Spring fires can kill annuals and seedlings before they set seed (0.5). Fall fires can take advantage of chaparral at its driest (0.25) and is when strong wind systems blow through creating extremely large and hot fires (0.5).

JK, don't actually count this station in score except as a tiebreak.

Station 6: Habitat problem stuff



1. The above image is an example of what? (0.25pt)
Habitat Fragmentation or habitat island or something like that. Do not accept metapopulation.

2. How is the above image similar to a tall mountain? (0.5pt)
The species are isolated (0.25) because they are surrounded by inhospitable environments through which they cannot pass (0.25)

3. Answer the following
 - a. What is the term for the ecotone between city areas and the mountains? (0.25pt)
Wildland-urban interface

 - b. Name 3 major impacts that humans have particularly in this zone (1pt)
0.33 for any of the following (0.34 for the 3rd): increased invasive species prevalence, increased fire frequency, development and habitat destruction, direct human disturbance (recreation, use of resources, etc), pollution (only give points if they are specific - air, trash, runoff, etc; max 1 example of pollution for credit)
There are probably more, and if they make sense, give them credit.

4. Describe a metapopulation (1.5pt)
A group of separated populations (0.25) that have some degree of migratory connectivity (0.25) giving them a limited amount of gene flow (0.25).

They are usually more resistant to extinction than completely separated populations (0.25), but extinction vortices and heavily degraded population sink sites can drag the rest of the metapopulation down with them (0.5)

5. Does the image above promote speciation or extinction? Explain your answer as in depth as possible (1.5pt)

If they answer speciation: *It promotes speciation because the populations are geographically isolated (0.25) promoting allopatric speciation (0.25).*

If they answer extinction: *It promotes extinction (0.25) because the populations are isolated from other populations (0.25) leaving little to no inflow of new species and genetic material (0.25). Because the fragments are too small to adequately support this population of species indefinitely (0.25), the number of species will experience an inevitable decline (0.25) as predicted by the theory of island biogeography/UNTB (0.25) without the inflow of new species to counteract this.*

Station 7: Chemicals

1. Rank the following 4 cycles in increasing speed of cycling: carbon, sulfur, water, nitrogen (0.5pt)
Sulfur, nitrogen, carbon, water (only give points if all are correct)
2. How do algal blooms cause fish die-offs? (0.75pt)
Algae can produce toxins (0.25) which bioaccumulate in fish (0.1).
When large quantities of algae grow and subsequently die, bacteria and other decomposers use up huge amounts of oxygen producing deeply anoxic conditions leaving fish to suffocate (0.4)
3. Describe the differences between HFCs and CFCs and what they do (1.4pt)
Hydrofluorocarbons (0.1) are chemicals used to replace CFCs because they don't contain chlorine (0.1). They don't cause ozone depletion (0.1), but they are the most potent global warming agents (0.1) with global warming potentials in the thousands-tens of thousands (0.2)
Chlorofluorocarbons (0.1) are chemicals used as refrigerants and propellants (0.1) that are the primary cause of ozone depletion (0.2). CFCs release chlorine atoms (0.1, -0.1 if they say chlorine gas) which bind to ozone molecules and tear of an oxygen atom (0.2) leaving behind diatomic oxygen (0.1)
4. Acid rain is bad^[Citation Needed]. What are its 2 primary detrimental effects on terrestrial plants? (1.5pt)
Acid rain physically damages the leaves of many plants (0.5).
It also increases the acidity of the soil (0.25) which makes it harder for plants to absorb largely positively charged cation nutrients (0.4) reducing their cation exchange capacity (0.35)
5. Describe each of the following and how they help reduce the effects of agricultural chemical runoff (0.5pt each)
 - a. Contour plowing - *contour plowing creates furrows perpendicular to the slope (0.25) which helps slow runoff and increase plant absorption of the chemicals (0.25)*
 - b. Mitigation banking - *mitigation banking help preserve wetlands (0.25) which are important in the bio/phytoremediation of agroquimicos (0.25)*
 - c. Secondary wastewater treatment - *secondary wastewater treatment uses microbes and other biological agents to break down the chemicals and stuff in wastewater plants (0.5)*

6. In contrast to the Gaia Hypothesis which describes earth as a self-regulating stable system, the Vengeful Earth hypothesis describes earth a system which, once brought out of balance by anthropogenic forces, will only shift more and more towards catastrophic climatic changes. Describe how each of the following support the gaia hypothesis, vengeful earth, or both. (4.25pt)

a. Melting permafrost

It supports the vengeful earth hypothesis (0.25) because melting permafrost unlocks millenia worth of previously frozen vegetation to decomposition (0.5) this decomposition produces huge amounts of methane (0.25) which has 100 times the greenhouse warming potential of CO₂ (0.25)

b. Melting sea ice

It supports the vengeful earth hypothesis (0.25) because melting sea ice reduces ice cover while increasing open ocean cover. This reduces the albedo of the area (0.5) meaning that it absorbs more solar energy (0.25). 0.5pt if they give approximate numbers for albedo: ~0.5 for ice, ~0.05 for open ocean.

c. Oceanic carbon dioxide absorption

It supports both (0.25). When carbon dioxide concentration in the atmosphere increases, more carbon dioxide is absorbed by the oceans helping reduce the warming effects (0.5). On the flip side, when the earth warms and the oceans warm, warm water can't hold as much dissolved gases as cold water (0.5) so it releases CO₂ that it had previously stored (0.25) increasing the warming effects.

Station 8: Trophic levels

1. Which trophic pyramid is most likely to be inverted? Why? (1.5pt)

Numbers pyramid (0.5) because the variable sizes of organisms (0.5) make it very possible for there to be greater numbers of organisms in higher trophic levels. High turnover time which causes inversion in biomass pyramids is not as common in nature as variable size thus numbers pyramids are more likely to be inverted than biomass pyramids and energy pyramids are almost never inverted (0.5)

2. The lengths of foodchains are often limited by the amount of energy available at successive trophic levels. What is the other reason that trophic levels rarely reach past 6 or so in most ecosystems? What is the name of this theory (2pt)?

They can be limited by fluctuations in population (0.5) which become amplified as they move up the food chain (0.5). This instability can cause random shifts which push the population into extinction (0.5). This is called the dynamic stability hypothesis (0.5)

3. The lotka volterra equations are used to model changes in predator and prey populations over time. The lotka volterra equation for a predator species is $dP/dt = cnP - qP$ where P is predator population.

- a. What do c, x, and q represent? (1.25pt)

It doesn't matter if they switch c and x

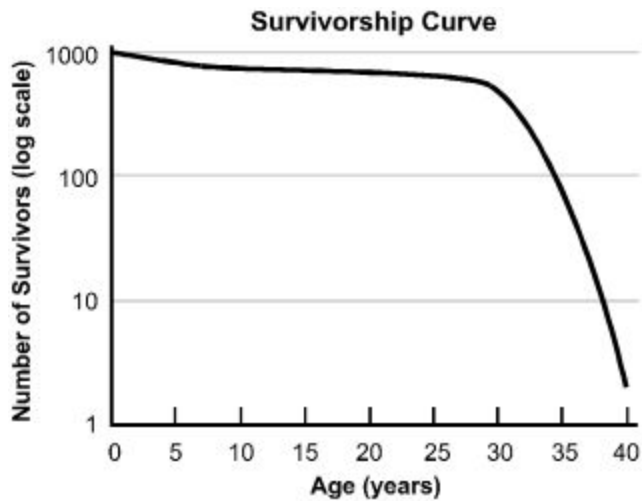
C: efficiency at converting prey into offspring (0.5)

X: prey population (0.5)

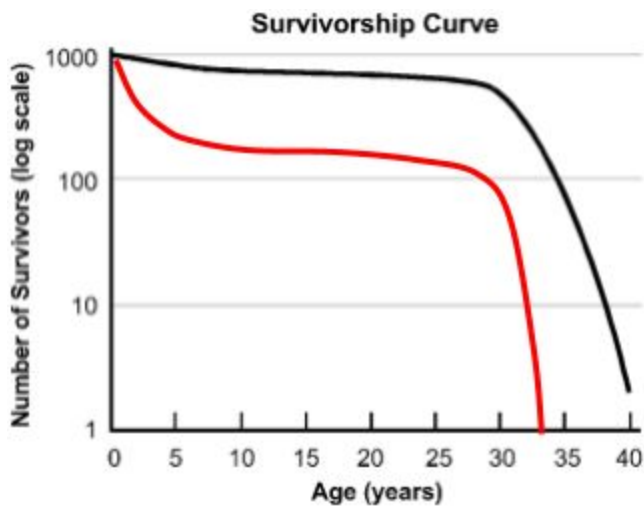
Q: mortality rate (0.25)

- b. The lotka volterra equation for a given prey species is $dX/dt = rX - zX$ where X (prey population) is initially 100 and r and z are constants. What is the percent change in prey population in 3 years (where time is measure in years) in terms of r and z? (1pt)

$$e^{3(r-z)}$$



4. The above image is a survivorship curve of the endangered Pacific Northwest tree octopus (*Octopus paxarbolis*). The animal reaches maturity around 15 years of age. How would this curve change in response to the introduction of a predatory sasquatch? Draw the new curve and explain the major changes in the shape of the graph. (2pt)

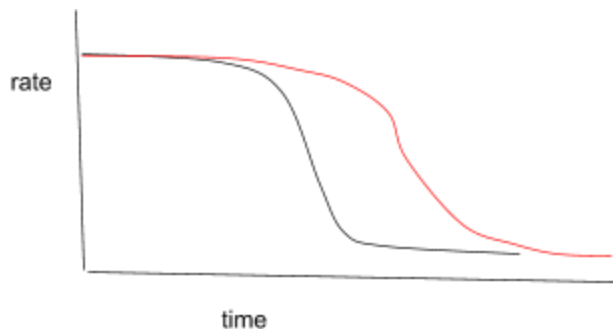


Or something like that (1pt)

The first drop is because young individuals are more vulnerable to predation (0.5), and the second is because older individuals are more vulnerable to predation (0.5).

Station 9: Energy and Demographics

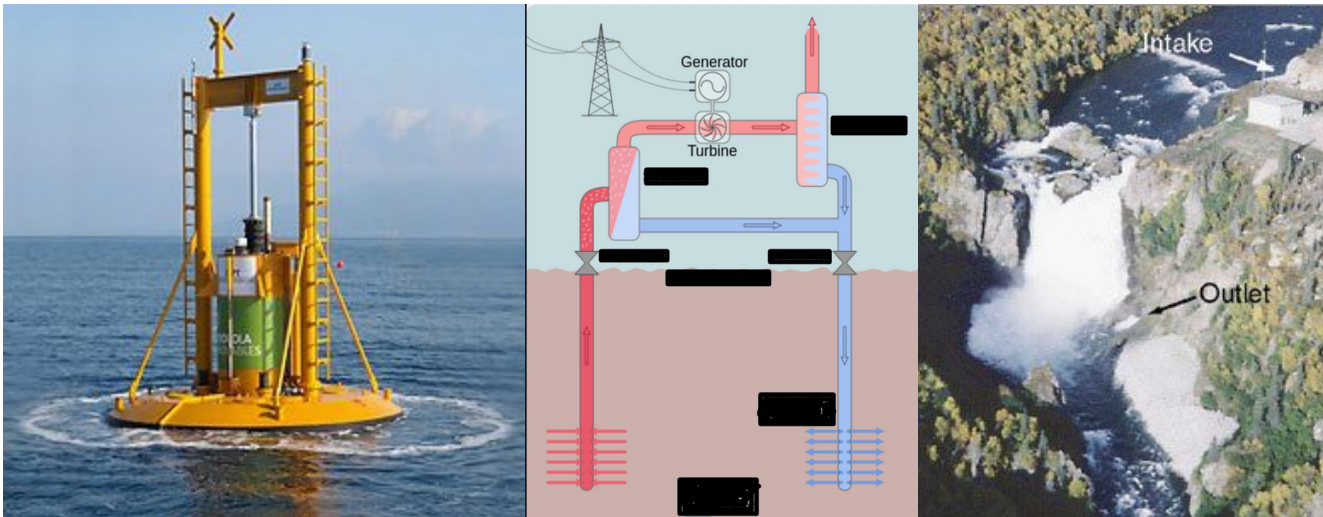
1. Draw a graph of birth rate and death rate over time during a demographic transition (0.5pt)



0.5 for a graph something like that where black is death rate and red is birth rate

2. Define replacement fertility and give its approximate value for the US (0.5pt)
The number of children that need to be born per woman to replace the current individuals present in the us -or- to keep the population constant (0.4)
The value is about 2.1, but any value 2.01-2.3 is acceptable (0.1)

3. Name the types of renewable energy depicted below (1pt)



Left: wave power (0.1), wave power buoy (0.15), or wave power point absorber buoy (0.25) are acceptable

Center: geothermal power (0.05) or flash steam geothermal power (0.25)

Right: hydroelectric power (0.05), run of the river hydropower (0.25), microhydropower (0.25), or diversion hydropower (0.2). Any combination of 2 modifiers is 0.4 and if all 3 are mentioned it's 0.5pt

4. What country has the most oil? (0.25)

Venezuela

5. Explain how each of the following renewable energy sources damage the environment (1.5pt)

a. Solar

The use of solar takes up large amounts of land (0.2). Silicon cells are very energy intensive to make (0.1) and thin film cells contain many toxins (0.2). Concentrated solar power can waste water (0.15) and the intense heating can kill birds and other animals (0.1)

b. Hydro

Hydropower reservoirs can drown large areas of land (0.15) which can (especially in the tropics) cause large amounts of decomposition and methane emissions (0.2). Evaporation (especially in desert areas such as the colorado) can cause serious decreases in water available for nature (0.1). Dams can block the migration of fish and other anadromous/catadromous organisms (0.15). Dams from hydropower inhibit sediment flow downstream destroying beaches, islands, sandbars, deltas, and other riparian landforms (0.15).

6. Answer the following about biofuels

a. Bioethanol is produced by what process? (0.25pt)

Fermentation

b. Explain the primary differences between bioethanol and biodiesel (1.5pt)

Bioethanol is a 2 carbon molecule (0.1) with lower energy density (0.1). It has a high octane rating (0.2) and is produced through the fermentation (0.1) of starch/sugar based feedstocks (0.2). It is more commonly used (0.05).

Biodiesel is a collection of fatty acid methyl esters (FAME) (0.15) produced from feedstocks of fats and oils (0.2). It has a high cetane rating (so a low octane rating) (0.1) and is produced through transesterification (0.1). It has higher energy density (0.1) and is rarely used in high concentrations (0.1)

I guess also accept stuff about engine corrosion, cloud point, lubrication, etc for like 0.1 each.

c. Compare the emissions of bioethanol to that of standard gasoline (0.75pt)

Bioethanol produces lower CO₂ emissions (0.25) and higher NO_x (nitrous oxides) emissions (0.35) and lower emissions of SO₂ (sulfur dioxide) (0.15).

7. Answer each of the following

a. Advantages of vertical axis wind turbines (0.65pt)

VAWTs are cheaper to install (0.1) because the gearbox and power generator can all be placed at ground level (0.2). VAWTs can accept wind from any direction (0.25). VAWT produce higher torque (0.1).

b. Describe passive solar and what trombe walls are (1pt)

Passive solar power uses the simple heat of the sun without converting it into electricity or any other intermediate (0.25).

Trombe walls are darkly colored walls with a small air gap to a clear glass pane in front of the them that are located on the sun-facing side of a home (0.25). In cold weather, the trombe wall heats up the air in the pocket and a gap is opened at the top of the pocket to bring that air into the house (0.25). In warm weather, the trombe heats air in the pocket causing it to rise. A gap at the bottom leading to the house is opened along with one at the top of the pocket leading outside and a cap on the shady side of the house (opposite the trombe wall). The warm rising air from the trombe wall pulls air out of the house thereby pulling in air from the shady side (0.25pt)

c. Name the major advantage and disadvantage of cadmium telluride photovoltaic cells (0.75pt)

The major advantage is that they are much cheaper and easier to make than traditional solar cells (0.25pt)

The major disadvantage is that they contain cadmium which is rather toxic and disposal is difficult (0.5pt)

Station 10: Random stuff that comes to mind at 2am

1. Explain Dollo's law (0.5pt)

Evolution can never reverse itself (0.4) which is generally true, but there are many counterexamples (0.1)

2. What is specific metabolic rate? If a 4kg cat has a specific metabolic rate of 10, what is the approximate specific metabolic rate of a 40kg deer? (1pt)

Specific metabolic rate is the metabolic rate divided by the body mass of an organism (0.25)

56.2 approximately (0.75). It's proportional to the $\frac{3}{4}$ power of body mass. 0.01pt for saying 100.

3. Identify each of the invasive species below by either common or scientific name (Sorry to all who have not done Invasive. Y'all have led sad lives.) (1.5pt)



Top left: silver carp or *Hypophthalmichthys molitrix* (0.3), 0.15pt for just asian carp

Top right: air potato or *dioscorea bulbifera* (0.5), -0.01 for kudzu

Bottom right: european honeybee or *apis mellifera* (0.25), 0.3pt for *apis mellifera* ssp. *mellifera*, 0.2pt for african honeybee or *apis mellifera* ssp. *scutellata*

Bottom left: brown tree snake or boiga irregularis (0.4)

4. The California raccoon feeds primarily on acorns in its natural state. However, with the introduction of many easy garbage cans to prey upon, some raccoons now survive on discarded cans of Arizona Tea. What type of speciation does this promote? (0.25pt)

Sympatric speciation

5. A population of peppered moths has established itself on some magnolia trees in LA. When an area is polluted, some trees darken and subsequently have greater concentrations of dark colored moths. When an area is near a high school, some trees are covered in bright blue graphitti, but no blue moths are found. Why is this? (0.75pt)

Evolution can only act upon alleles/characteristics already present in a population (0.5). Because there is no blue moth to begin with, nature cannot simply choose for a blue moth to appear (0.25)

6. The agribusiness firm KimBer buys some land in Alaska which, until the implementation of Scott Pruitt's environmental regulations, had been covered by glaciers. They plant their rice chex plantation and notice that chex plants growing on areas which previously had lichen fared poorly. What model of succession does this support? (0.75pt)

Autogenic (0.5) inhibition (0.25) model of succession

7. An oily alum with a grudge against Troy threatens to sneak some Formosan subterranean termites into Troy's build room unless he is paid a ransom of 3 national trophies. This is an example of what? (0.25pt)

Bioterrorism