1. Use the axes to the right for the following:
   a. Draw and label a line that represents **linear** growth.
   b. Draw and label a line that represents **exponential** growth.

2. List the four most populated countries in the world (in order)
   
   (1) **China**  
   (2) **India**  
   (3) **United States**  
   (4) **Indonesia**

3. Define the term ecological footprint, what types of countries have low and high ecological footprints?
   
   **Amount of biologically productive land and water needed to supply an individual or population with its needed resources, and absorb its wastes.**

4. Write an equation for the rule of 70, and what the rule of 70 is used to calculate:
   
   **Doubling Time = 70/ r where r is the growth rate in percent.**

   Used to calculate the time it takes a population to double in size.

5. Perform the following calculations: (Show all of your work in a logical progression to the final answer.)
   
   a. A city has a population of 50,000 in 2012. If the population of the city grows at an annual rate of 2%, the year in which the population will reach 100,000 is **2047** and the year it will reach 200,000 is **2082**
   
   Show ALL work:
   
   **Doubling Time = 70/2 = 35 years → 2012 + 35 = 2047 → 2047 + 35 = 2082**

   b. A country’s population was 12 million in 1992 and in 2012 it is 24 million. If the population grew at a constant rate, that percent rate of growth was ________.
   
   Show ALL work:

   **Doubling time = 2012-1992 = 20 years → 20 years * r = 70 → r = 70/20 → r = 3.5%**
6. Complete the following table by writing “high” or “low” in each box below.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>More Economically Developed Counties (MEDCs)</th>
<th>Less Economically Developed Countries (LEDCs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>per capita GDP</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>degree of industrialization</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>infant mortality rate</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>per capita fossil fuel use</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>ecological footprint</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>greenhouse gas emissions</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>risk from heart disease</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>risk from infectious diseases</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

7. Identify three examples of renewable resources and three examples of nonrenewable resources.

(1) **Water**
Renewable: (2) **Wind**
(3) **Solar**
Also: Geothermal, Forests

(1) **Coal**
Nonrenewable: (2) **Natural Gas**
(3) **Petroleum**
Also: Nuclear, minerals

8. Define the following:
   a. total fertility rate **an estimate of the average number of children that women in a given population have during their childbearing years.**
   b. replacement level fertility **the average number of children a couple must have to replace themselves. Usually just above 2.**
   c. infant mortality rate **number of babies per 1000 born each year that die before their first birthday**
   d. crude birth rate **number of live births per 1000 people in a population**
   e. crude death rate **number of deaths per 1000 people in a population**

9. Describe the circumstances that will result in a Tragedy of the Commons.

**The depletion or degradation of a potentially renewable resource to which people have free and unlimited and unmanaged access.**
10. Describe an example of a Tragedy of the Commons.

**Depletion of a commercially desirable fish species in the open ocean beyond area controlled by coastal countries.**

11. On the axes to the right, draw a line showing a population that exemplifies logistic growth and label the carrying capacity.

12. Perform the following calculation. Show all of your work:

   In a particular year a population has the following characteristics: the crude birth rate is 45, the crude death rate is 20, the immigration rate is 1%, and the emigration rate is 0.5%. The percent rate of growth for that year is _________.

   Show ALL work:

   \[
   \frac{(45-20)}{10} = 2.5\% + 1\% - 0.5\% = 3\%
   \]

13. Describe an example of a positive feedback loop.

   **Global warming has lots of examples. Increased surface temperatures causes the permafrost in the tundra to melt. The melting permafrost releases methane into the atmosphere. Methane is a greenhouse gas that causes increased surface temperatures.**

14. Use the axes below to draw and label lines representing the birth rate, death rate and total population size during the idealized demographic transition of a country. Include, written directly onto the graph, the names of each phase and TWO explanations for each change in the birth rate and death rate for each phase.
15. On the axes below, draw and completely label four age-structure diagrams that represent slow growth, rapid growth, negative growth, and zero population growth (include labels on the x- and y-axes)

![Age-structure diagrams]

16. Describe an example of a negative feedback loop.

**Warmer temperatures cause more evaporation of water into the atmosphere. Increased water vapor causes more clouds to form. Clouds reflect incoming solar radiation causing the surface temperature to decrease.**

17. Arrange the following types of electromagnetic radiation in order from lowest to highest energy: Ultraviolet, Microwave, Infrared, Gamma, Radio, X-ray, Visible.

   *Radio, Microwave, Infrared, Visible, Ultraviolet*

18. List the following types of visible light in order from shortest to longest wavelength: Green, Orange, Red, Yellow, Blue, Violet.

   *Red, Orange, Yellow, Green, Blue, Violet*

19. Identify three examples organic compounds and three examples of inorganic compounds.

<table>
<thead>
<tr>
<th>Organic</th>
<th>Inorganic</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) <strong>hydrocarbons</strong></td>
<td>(1) Ammonia</td>
</tr>
<tr>
<td>(2) glucose</td>
<td>(2) Carbon dioxide</td>
</tr>
<tr>
<td>(3) PCBs</td>
<td>(3) Nitric acid</td>
</tr>
</tbody>
</table>

**Organic contains at least two carbons combined with other element.**

20. Using the axes on the right, draw and label three survivorship curves exemplifying early-loss, late loss, and constant-loss species. Give two examples of organisms that exhibit each type of survivorship curve

![Survivorship curves]


   *Rise in sea level will cause flooding, spread of disease outside of normal areas (ex: malaria outside the tropics), and more droughts, wildfires, etc.*
22. List three things you could do to decrease your contribution to global warming.

1. Improve energy efficiency
2. Reduce gasoline use by walking, biking, and carpooling
3. Eat less meat → less methane from cows

23. List four greenhouse gases.

1. **Methane** (CH₄)
2. **Carbon Dioxide** (CO₂)
3. **Water Vapor** (H₂O)
4. **Nitrous oxide** (N₂O)

24. Use the axes to the right for the following:

a. Draw a line representing the Earth’s atmosphere and label each layer of the Earth’s atmosphere and identify where the greenhouse effect occurs and the ozone layer is situated.

25. A man-made product is also known as **anthropogenic**

26. The molecular formula of ozone is **O₃**

27. In the box below, write out a series of chemical equations that illustrate the destruction of the ozone in the ozone layer.

<table>
<thead>
<tr>
<th>Natural:</th>
<th>Depletion:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3O₂ + UV → 2O₃</td>
<td>CFC + UV → Cl</td>
</tr>
<tr>
<td>ClO + O → O₂ + Cl</td>
<td>The Cl can react with thousands of O₃ molecules</td>
</tr>
<tr>
<td>Cl + O₃ → O₂ + ClO</td>
<td></td>
</tr>
</tbody>
</table>

28. The acronym CFC refers to **Chlorofluorocarbon** which is:

**The group of chemicals that were used in refrigerants and aerosol cans that have depleted the ozone layer in the stratosphere. Montreal protocol eliminated their use. They have been replaced with HFCs.**

29. Identify three examples of **biotic** and **abiotic** components of an ecosystem:

<table>
<thead>
<tr>
<th>Biotic:</th>
<th>Abiotic:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Plants</td>
<td>(1) Soil</td>
</tr>
<tr>
<td>(2) Animals</td>
<td>(2) Water</td>
</tr>
<tr>
<td>(3) Bacteria</td>
<td>(3) Rock</td>
</tr>
</tbody>
</table>
30. Complete the following table for these biogeochemical cycles:

<table>
<thead>
<tr>
<th>Trait</th>
<th>Carbon</th>
<th>Sulfur</th>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Importance to life</td>
<td>Building block of major macromolecules and greenhouse gas</td>
<td>Essential nutrient for amino acids, proteins, and enzymes.</td>
<td>Key component in protein and DNA. Needed for plant growth</td>
<td>Needed for plant growth. ATP, bones, Teeth</td>
<td>Essential to all living organisms, universal solvent</td>
</tr>
<tr>
<td>Largest reservoir</td>
<td>Rock</td>
<td>Rock</td>
<td>Atmosphere</td>
<td>Rocks</td>
<td>Ocean</td>
</tr>
<tr>
<td>Methods of transport</td>
<td>Photosynthesis, Respiration, Absorption, Decomposition, fossil fuels</td>
<td>Volcanic eruptions, fossil fuel combustion, decaying vegetation, etc.</td>
<td>Fixation, Nitrification, Denitrification, Assimilation, Ammonification</td>
<td>Weathering and Erosion, Runoff</td>
<td>Precipitation, Runoff, Infiltration, etc.</td>
</tr>
<tr>
<td>Cycle duration (long/short)</td>
<td>Long</td>
<td>Short</td>
<td>Short</td>
<td>Longest</td>
<td>Short</td>
</tr>
</tbody>
</table>

31. Write the balanced chemical equations for photosynthesis and respiration in the boxes to the right.

**Photosynthesis:**

\[
6\text{CO}_2 + 6\text{H}_2\text{O} + \text{sun} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2
\]

**Cellular Respiration:**

\[
\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{energy}
\]

32. The approximate age of the Earth is

**4.5 billion years.**

33. Match the following:
   a. generalist species: **Raccoon**
   b. specialist species: **Giant Panda**
   c. invasive species: **Zebra Mussel**
   d. keystone species: **Sea Otter, Gray Wolves**
   e. indicator species: **Tiger Salamander**

34. Define the term biodiversity.

*Variety of species, genetic information, ecosystems, and functions*

35. Define the term biome.

*Regions of the Earth that are characterized by certain types of life, especially vegetation.*
36. What main factors determine the type of biome an area will have?
Climate (precipitation and temperature) which is based on location → Latitude, proximity to water, elevation, etc.

37. Describe the circumstances that will result in cultural eutrophication.

Nutrients runoff into lake or other water body. Excess nitrogen and phosphorus stimulate algae growth. Excess algae promotes animal life within the lake. Algae and animal life will be decomposed by bacteria which will use dissolved oxygen for decomposition. This makes the lake hypoxic (low oxygen) or anoxic (no oxygen). Without enough oxygen fish and shellfish die. Nutrient sources: agriculture and lawn fertilizers, organophosphate pesticides, phosphate detergents, manure, etc.

38. Explain HOW the increasing concentration of carbon dioxide in the atmosphere leads to ocean acidification. Include a chemical equation in your answer.

Carbon dioxide diffuses into the ocean creating carbonic acid. \( \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \)
Increases in carbonic acid, lowers pH of the ocean. This acidification leads to weakening of shells that are carbonate based. May also result in coral bleaching.

39. Sketch and/or label the following on the map of the world below:

a. the equator
b. the tropic of Cancer and the tropic of Capricorn
c. the Mid-Atlantic Ridge
d. the location of suppressed upwelling characteristic of the occurrence of El Niño
e. the location of India, Ethiopia, Brazil, Peru, Saudi Arabia, Indonesia, Japan, Bangladesh, and Fremont (← from the FRQs 😊)
40. Complete the following table:

<table>
<thead>
<tr>
<th>Type of Biome</th>
<th>Typical Location</th>
<th>Typical Climate</th>
<th>Characteristic adaptations for survival (very general)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical Rain Forest</td>
<td>Tropics</td>
<td>Steady high temps, lots of rain</td>
<td>Plants – Dense canopy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Animals – Chimpanzees, frogs, cheetahs</td>
</tr>
<tr>
<td>Temperate Deciduous Forest</td>
<td>Outside Tropics but not Polar</td>
<td>Defined seasons, moderate rainfall</td>
<td>Plants – Deciduous trees,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Animals – Hawks, deer, foxes, owls</td>
</tr>
<tr>
<td>Taiga (Boreal) Forest</td>
<td>Northern N.A. and Eurasia</td>
<td>Cold temps Lower rainfall</td>
<td>Plants – Conifers, cone-bearing trees</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Animals – Moose, deer, foxes, owls</td>
</tr>
<tr>
<td>Tropical Grasslands</td>
<td>Tropics Africa, S.A., Australia</td>
<td>Steady high temps, clear rain/dry season</td>
<td>Plants – Tall grasses, trees</td>
</tr>
<tr>
<td>(Savanna)</td>
<td></td>
<td></td>
<td>Animals – Lions, giraffes, elephants</td>
</tr>
<tr>
<td>Temperate Grassland</td>
<td>Outside Tropics but not Polar</td>
<td>Defined seasons, moderate rainfall</td>
<td>Plants – Short grass</td>
</tr>
<tr>
<td>(Prairie)</td>
<td></td>
<td></td>
<td>Animals – Prairie dogs, wolves, rabbits</td>
</tr>
<tr>
<td>Tundra (Cold Grassland)</td>
<td>Northern N.A. and Eurasia</td>
<td>Cold, low rainfall</td>
<td>Plants – Grasses, low growing plants, permafrost</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Animals – Polar bears, seals, fox, owl</td>
</tr>
<tr>
<td>Desert</td>
<td>30° Latitude areas</td>
<td>Tropical, hot/dry Temperature, Moderate/dry Polar- cold/dry</td>
<td>Plants – Cacti</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Animals – Lizards, heat tolerant, etc.</td>
</tr>
</tbody>
</table>

41. Name the following:
- NO – Nitrogen oxide
- NO₂⁻ - Nitrite
- NO₂ - Nitrogen dioxide
- N₂ – Nitrogen gas
- NH₄⁺ - Ammonium
- NOₓ - Nitrogen oxides
- NO₃⁻ - Nitrate
- N₂O – Nitrous oxide
- NH₃ - Ammonia
- HNO₃ - Nitric Acid

42. In the box to the right, sketch a house and the surroundings of a house that is designed to make the greatest use of passive solar energy in the northern hemisphere. Include, inside the box, the location of both the winter and summer sun, and labels to indicate the compass direction that the house faces.

* Make sure you understand how the season work! We are closest to the sun on January 3rd! *
Use the information in the diagram on the right to answer the following:

43. The percent change in the per capita global production of protein from poultry between 1980 and 2000 was approximately ___________.
Show work:
\[(25 - 13)/13 \times 100 = 92\%\]

44. The percent change in the per capita global production of protein from farmed fish between 1980 and 2000 was approximately ___________.
Show work:
\[(12 - 2.5)/2.5 \times 100 = 380\%\]

45. The percent change in the per capita global production of protein from beef between 1961 and 2009 was approximately ___________. Show work:
\[(20 - 20)/20 \times 100 = 0\%\]

46. Rachel Carson wrote the book Silent Spring to raise people’s awareness of the harmful effects of the pesticide DDT.

47. The acronym ENSO refers to El Nino Southern Oscillation a phenomenon that occurs in the Pacific Ocean off the coast of Peru.

48. For each of the following events, indicate why they are noteworthy.
   a. Exxon Valdez: Oil Tanker Spill. Took years to clean up.
   b. Chernobyl: Major nuclear power plant explosion in Ukraine.
   c. Deepwater Horizon: Oil spill in Gulf of Mexico. Well was difficult to stop because it was so far down.
   d. Love Canal: Evacuation of people because of hazardous waste. Led to CERCLA (Superfund)
   e. Bhopal: Gas leak at pesticide plant in India.
   g. Montreal Protocol: Conference to get rid of CFCs and restore ozone layer. Successful
49. The acronym BOD refers to Biological Oxygen Demand which is: the amount of dissolved oxygen needed by aerobic bacteria to decompose the organic matter present in a water body.

50. The acronym GMO refers to Genetically Modified Organism which is: Any organism that had its genetic material modified by genetic engineering techniques.

51. Perform the following calculation. Show all of your work.
If the grasses on a 100-hectare area of grassland grow at an average rate of 1 cm/day, the average volume of grass that is added to the grassland each day is ___________ m³. If the density of the grasses that grow in the grassland averages 400 kg/m³, the net primary productivity is approximately ___________ g/m²/day or ___________ g/m²/year.
Show work:

100 hectare x 10,000 m²/hectare = 1x10^6 m² x 0.01 m/day = 10,000 m³/day

10,000 m³/day x 400 kg/m³ x 1000 g/1 kg = 4 x 10^9 g/day / 1 x 10^6 m² = 4000 g/m²/day

4000 g/m²/day x 365 day/year = 1460000 g/m²/year

52. Perform the following calculation. Show all of your work.
A 40 m² solar array is installed on a house where the average insolation is 6 kWh/m²/day if the average total electricity output of the array is 1.2 kWh/hr; the efficiency of the array is ____________.
Show work:

40 m²/day • 6 kWh/m²/day = 240 kWh/day • 1 day/24 hours = 10 kWh/hour

1.2 kWh/hr / 10 kWh/hr = 0.12 = 12%

53. Consider the graph on the right and explain what can be inferred from the data it presents.

The more we educate and empower women, they will be able to make more informed decisions related to family size, and therefore the total fertility rate is lower.

54. Match the ten most populous urban areas in the world with its respective continent:

a. Asia
b. Mexico City

a. Seoul

b. Los Angeles

a. Jakarta

b. Hollywood

c. Sao Paulo

c. Tokyo

d. Europe

d. Osaka/Kobe

e. Australia

e. Tokyo

f. Europe

f. Jakarta

f. Delhi

f. Shanghai

g. Antarctica

a. Moscow

a. Shanghai
55. Define the following…

Watershed:
Land area surrounding a river system that delivers water, sediment, and dissolved substance to this river system.

Clean Air Act:
US federal law designed to control air pollution. Requires the EPA to develop and enforce regulations against the six common outdoor air pollutants that are known to be hazardous to human health. These include: ozone, particulates, sulfur dioxide, nitrogen dioxide, lead, and carbon monoxide.

Clean Water Act:
US federal law that makes the EPA in charge of implementing pollution control programs to ensure water quality standards for surface water. DOES NOT INCLUDE GW, wells, and artificial lakes.

Safe Drinking Water Act:
The EPA sets standards to protect drinking water against animal wastes, chemical wastes, etc. Does not cover private wells. Sets MCLs (maximum contaminant levels) for at least 77 substances.

El Niño:
Warmer waters off the coast of Peru as a result of weakening Trade winds, which shuts off the upwelling that occurs right along the coast. Causes a large number of climatic changes all over the world.

Baghouse filter
Air pollution control technology that is used to remove particulates out of the gases/air released from commercial processes or power generation.

Electrostatic precipitator:
Applies a high voltage electrostatic charge to capture particulates from industrial processes.

Dioxin:
Known carcinogen that is formed during the combustion of plastic. Also linked to paper bleaching and herbicide manufacturing.

56. Explain three sources of methane that are amplified by human activities.

(1) Cattle Farms
(2) Landfills
(3) Fracking/natural gas + petroleum emissions

Also Rice farming

57. The box to the right contains a crude depiction of a mountain, use attributes of a rain shadow. Include labels for the direction of the pi
58. NO₂ is converted to N₂ and O₂ in a **Catalytic convertor**, which also converts **hydrocarbons** to CO₂ and H₂O.

59. Explain the causes and effects of an urban heat island.

**Impermeable surfaces (roads, buildings, etc.) replace porous natural surfaces**

**Sun can heat roofs and asphalts much hotter than air temps**

**Increased levels of air pollutants**

60. Perform the following calculations: (Show all of your work.)

   a. A rectangular area of forest that measures 10 thousand meters by 300 thousand meters has an area of \(3 \times 10^9\) square kilometers.

   Show work:
   
   \[
   10,000 \text{ m} \times 300,000 \text{ m} = 3 \times 10^9 \text{ m}^2 \times 1 \text{ km}^2/1 \times 10^6 \text{ m}^2 = 3 \times 10^3 \text{ km}^2
   \]

   b. A 60-Watt light bulb that is used for an average of 4 hours each day uses ________ kilowatt-hours of electricity per year.

   Show work:
   
   \[
   60 \text{ W} \times 4 \text{ hr} = 240 \text{ Whr} \times 1 \text{ kw/1000W} = 0.240 \text{ kWh/day} \times 365 \text{ days/year} = 87.6 \text{ kWh/year}
   \]

61. List two characteristics of an r-selected species.

   (1) **Many offspring**   (2) **Generalists/ broad niche**  Also: little to no maternal care

62. List two characteristics of a K-selected species.

   (1) **Few offspring**  (2) **Specialist/narrow niche**  Also: Lots of maternal care

63. What are three characteristics of endangered/extinct species?

   **Niche specialists, few offspring, useful to humans**

64. Identify two examples of endangered species.

   (1) **Piping Plover**  (2) **Orangutan**

65. What are three characteristics of invasive species?

   **Niche generalists, lots of offspring, no natural predators**

66. Identify two examples of invasive species.

   (1) **Phragmites**  (2) **Cane Toad**

67. A company is importing rare tropical hardwood to manufacture furniture, list three laws, regulations, treaties, or acts that the company may have violated.

   (1) **CITES – Treaty on the international trade of Endangered species**

   (2) **Lacey Act – prohibits the interstate transport of wild animals without a permit.**

   (3) **Kyoto Protocol – Agreement to reduce GHG emissions – during the harvesting of the lumber**

68. Whaling is justified in the name of scientific research, by the countries of **Norway and Iceland, and Japan.**
69. Complete the following table:

<table>
<thead>
<tr>
<th>Ecosystem Component</th>
<th>An economically valuable ecosystem service it provides</th>
</tr>
</thead>
<tbody>
<tr>
<td>honey bee</td>
<td>Pollination - orchards</td>
</tr>
<tr>
<td>water cycle</td>
<td>Purification, transports nutrients</td>
</tr>
<tr>
<td>forest</td>
<td>Purification of air and soil, erosion prevention</td>
</tr>
<tr>
<td>bat</td>
<td>Keeps mosquitos at bay, pollinate plants, disperse seeds</td>
</tr>
<tr>
<td>bacteria</td>
<td>Breakdown wastes (landfill) and potentially other toxings</td>
</tr>
<tr>
<td>coral reef</td>
<td>Storm protection/habitat for fish</td>
</tr>
<tr>
<td>wetland</td>
<td>Water filtration/ storm protection/flood control</td>
</tr>
</tbody>
</table>

70. Two islands, different distances from the mainland have different rates of extinction, this is explained by the theory of island **biogeography**.

71. **Dredging** is an ecologically damaging fishing technique typically used to harvest scallops, crabs, and shrimp from the sea floor.

72. **71%** of the Earth is covered with water. Of all the water on Earth **97%** of it is saltwater, **69%** is frozen, and **1%** is available and relatively accessible.

73. Arrange the following particles in order of smallest to largest: clay, sand, silt

(1) clay (2) silt (3) sand

74. What are the 3 most commonly produced grains?

(1) **Corn** (2) **wheat** (3) **rice**

75. List four innovations that characterized the Green revolution.

(1) **Irrigation** (2) **Synthetic pesticides** (3) **GMO and artificial selection** (4) **Synthetic fertilizer**

76. What was the Green Revolution and why is it important?

**Popular term for the introduction of scientifically bredor selected varieties of grain that with adequate inputs of fertilizer and water can greatly improved crop yield.**

77. Use the axes below to draw and label an illustration of the pesticide treadmill, make sure to label predator, pest and application of pesticide.

![Diagram of pesticide treadmill]
78. Explain out the process of the pesticide treadmill and the creation of superbugs.

As a pesticide is applied, organisms in a species that is adapted to survive the pesticide will pass this trait to its offspring. Therefore, over time, the population will become resistant to the pesticide. Therefore, a new pesticide needs to be applied.

79. Explain how the biomagnification of DDT led to the (near) demise of the Bald Eagle population in the US.

DDT is fat soluble and therefore accumulates in the tissue of smaller organisms. As you go up the food chain the amount of DDT in the creature gets much bigger. DDT in Bald Eagle was causing the egg shells to thin. When adult bird sat on them to incubate, they would crack.

80. List three things you could do to conserve water.

(1) Be a vegetarian
(2) Use greywater
(3) Low flow appliances, such as toilets and shower heads.

81. Perform the following calculations: (Show all of your work.)

a. A family of 5 replaces a 6-gallon/minute showerhead with a new 2-gallon/minute low-flow showerhead. If every member of the family takes one 10-minute shower per day, the family will save 73,000 gallons of water in one year.

Show work:

\[
6 \text{ gal/min} \times 5 \text{ members/family} \times 10 \text{ min/day} = 300 \text{ gal/day}
\]

\[
2 \text{ gal/min} \times 5 \text{ members/family} \times 10 \text{ min/day} = 100 \text{ gal/day}
\]

\[
= 300 \text{ gal/day} - 100 \text{ gal/day} = 200 \text{ gal/day} \times 365 \text{ day/year} = 73,000 \text{ gal/year}
\]

b. A family has a rectangular swimming pool that measures 15 feet by 20 feet. If water evaporates from the pool at a rate of 50 gallons per square foot per year and a pool cover will reduce evaporation by 90 percent, the family can save 13,500 gallons of water per year by using a pool cover.

Show work:

\[
A = 15 \text{ ft} \times 20 \text{ ft} = 300 \text{ ft}^2 \times 50 \text{ gal/ft}^2 = 15,000 \text{ gal} \times .90 = 13,500 \text{ gal}
\]

82. Define the following:

pH:

A measure of the H\(^+\) concentration. Used to determine the acidity of a solution. The lower the number the more acidic. (7 = neutral).
Turbidity:
A measure of water clarity. The amount of suspended particles like soil, algae, plankton, etc. can cloud the water.

Water hardness:
The measure of the amount of calcium and magnesium in the water, which come from the weathering of rocks.

Biological oxygen demand:
The amount of dissolved oxygen needed by decomposers, such as bacteria, to break down the organics in a water body.

Organic waste:
Biodegradable wastes that can be broken down in a reasonable amount of time into its base compounds by microorganisms and other living things.

Cholera:
A bacterial disease cause severe diarrhea and dehydration, usually spread in water. Common in developing countries or areas of poor sanitation.

Giardia:
An intestinal infection caused by the protozoan giardia, found in areas with poor sanitation and unsafe drinking water. Causes extreme diarrhea and weight loss.

83. Label the following diagram of a sewage treatment plant and list the items removed at each step.

84. In the box to the right, list the ranks of coal in order from highest to lowest energy content. (indicate the direction in the box.)

Peat (Precursor to Coal) → Lignite → Bituminous → Anthracite
85. List three air pollutants that are emitted during the burning of coal.

(1) Sulfur Dioxide   (2) Nitrogen Oxides   (3) Mercury

Also: Carbon dioxide although its status as an air pollutant is up in the air right now.

86. List five products that are derived primarily from crude oil:

Asphalt, gasoline, Diesel Oil, Jet/aviation fuel, Heating oil

87. The acronym OPEC refers to Organization of Petroleum Exporting Countries which is important because:

It’s made up of 13 countries that have 60% of the world’s proven crude oil and are therefore likely to run the world’s oil supply for decades. Official purpose is to coordinate and unify petroleum policies, create stable markets, etc.

88. Fracking is a common name for Hydraulic Fracturing and it is a concern because…

The forcing open of fissures with water and sand is leading to contaminated drinking water, earthquakes, and the release of methane, which is a greenhouse gas.

89. The acronym ANWR refers to Arctic National Wilderness Refuge, which is important because:

It was established in 1960 to preserve duty, to ensure a place for hunter and gathering, protect water quality. Contains largest designated wilderness area in the US. Contains oil reserves that people would like to make available.

90. The Keystone Pipeline refers to the pipeline connecting the US to Canada in order to access the tar/oil sands, which is important because: it raises concern over habitat destruction, possible leaks, and is built on the permafrost which is melting due to climate change.

91. Perform the following calculations: (Show all of your work in a logical progression to the final answer.)
   
a. A family has a total of 1500 Watts of light bulbs throughout their house, if they replace them all with LED light bulbs, which use 90% less energy, the family will now use 150 Watts of electricity.
   Show work:

   \[1500 \text{ W} \times 0.10 = 150 \text{ W}\]

b. A space heater operates at 1500 Watts, if it is used for 10 hours each day for one week and the cost of electricity is 20 cents per kilowatt-hour, it will cost $21.00 to operate the heater for the week.
   Show work:

   \[1500 \text{ W} \times 10 \text{ hours} \times 1 \text{ kW}/1000 \text{ KW} \times 0.20 = $3.00 / \text{ day} \times 7 \text{ days} = 21.00\]
92. The acronym CAFE refers to Corporate Average Fuel Economy, which is important because:

They are regulations in the US which are intended to improve the average mpg of cars and light trucks produced for sal

93. List four things you could do to conserve energy.
   1. Use energy start light bulbs and appliances
   2. Switch to LED lights bulbs
   3. Walk, bike, carpool
   4. Double-paned windows

94. Complete the following chart.

<table>
<thead>
<tr>
<th>Mining Technique</th>
<th>Description</th>
<th>Environmental consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open-Pit mining</td>
<td>Removing minerals by digging a large hole.</td>
<td>Land above cleared = habitat destruction, runoff of sediment, acid mine drainage</td>
</tr>
<tr>
<td>Subsurface mining</td>
<td>Extraction of a metal or other resource that is deeper underground. Ex: coal</td>
<td>Cave-ins, explosions, fires, black lung, subsidence</td>
</tr>
<tr>
<td>Strip mining</td>
<td>Utilizes bulldozers, shovels, to remove large chunks of the surface in large strips.</td>
<td>Promotes erosion, acid mine drainage</td>
</tr>
<tr>
<td>Mountaintop removal</td>
<td>Dynamite is used to remove the tops of mountains to expose the coal underneath.</td>
<td>Waste rock and dirt destroys forest, buries streams. Toxic mining materials like arsenic and mercury an overflow from dam structures.</td>
</tr>
<tr>
<td>Ocean Drilling</td>
<td>The harvest of natural gas and oil require drilling deep into the subterranean rocks</td>
<td>Possible spills, explosions</td>
</tr>
</tbody>
</table>

95. Silicon is the active element in most photovoltaic cells.

96. Explain what happened at Three Mile Island, and why it is significant.

Three mile island is the United States’ worst and only nuclear event. The reactor partially melted down but only minimal radiation escaped the contaminant unit.

97. Explain how thermal pollution is produced by power plants.

In most power plants, large amounts of heat is produced to turn water to steam, which turns a turbine, which is connected to a generator. This steam is condensed and recycled using cooler water. These heated water is returned to a nearby river or stream which can cause thermal shock to organisms living in the lake.
98. Explain what happened at Fukushima Daiichi and why it is significant.

**Occurred in 2011 when a tsunami hit the nuclear power plant. Meltdowns occurred in 3 out of the 6 reactors. No fatalities or radiation sickness was reported.**

99. Perform the following calculation. Show all of your work. A radioactive cloud may contain Iodine-131, which has a half-life of 8 days. If the waste must decay to a concentration of less than 0.1% to be considered safe, it will take approximately **80 days** days to reach safe levels.

Show work:

\[
\begin{align*}
100/2 & \rightarrow 50/2 \rightarrow 25/2 \rightarrow 12.5/2 \rightarrow 6.25/2 \rightarrow 3.13/2 \rightarrow 1.56/2 \rightarrow 0.78/2 \rightarrow 0.39/2 \rightarrow 0.195/2 \rightarrow 0.0975 \\
10 \text{ half lives} \times 8 \text{ days/half live} & = 80 \text{ days}
\end{align*}
\]

100. Perform the following calculation. (Show all of your work in a logical progression to the final answer.)

A family has a 75 m$^2$ solar array on their house, which has an efficiency of 10%. If the average insolation on their array is 6 kWh/m$^2$/day and their average cost of electricity is 20 cents per kilowatt-hour, the family has the capacity to produce **$9.0/\text{day}$** worth of electricity daily, and **$3,285$** annually, from the sun.

Show work:

\[
75 \text{ m}^2 \times 6 \text{ kWh/m}^2/\text{day} \times 0.10 \times \$0.20/\text{kWh} = \$9.0/\text{day} \times 365 \text{ days/year} = \$3,285
\]

101. For each of the following substances, draw an arrow that points to an unambiguous location along the line, below, representing pH:

- orange juice
- normal rain
- ammonia
- lime (calcium carbonate)
- sulfuric acid
- acid rain
- human blood

102. Explain what evapotranspiration is and why it is significant.

**The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants. Responsible for 15% of atmospheric water.**

103. What is different about growing plants hydroponically?

**Grow the plants in substrate that contains added nutrients, but without soil.**

104. In the box, write a series of chemical reactions that leads to the formation of tropospheric ozone in photochemical smog.

\[
\text{NO}_x + \text{VOC} + \text{sunlight} \rightarrow \text{O}_3
\]
105. The acronym POP refers to **Persistant Organic Pollutant** which is: an organic compound that is resistant to environmental degradation. They biomagnify as well. They are regulated by the **Stockholm convention**.

106. Explain what a watershed is and why it is significant.

The land area that delivers water, sediment, and dissolved substances to the river system. Whatever happens in a watershed affects everything in the watershed.

107. List two environmental benefits of wetlands.

1) **Flood control**
2) **Natural Filter**

Also: Good habitat for migratory birds and other organisms.

108. Explain how electricity is produced by a dam.

A dam is built to block a river from flowing, creating a reservoir. Water from the reservoir is brought through a gate in the dam. As it moves through the dam it turns a turbine, which is connected to a **generator**.

109. List four characteristics that will result in waste being classified as “hazardous”

1) **Poisonous**  2) **Chemically Reactive**  3) **Corrosive**  4) **Flammable**

110. What is a wet scrubber and how does it work?

A device used to remove suspended dust particles. The polluted gases come in contact with a liquid, capturing the particles in liquid droplets, which must be treated after the process.

111. In the box below, write a series of chemical reactions that leads to the formation of acid rain.

\[
\begin{align*}
    H_2O + SO_3 &\rightarrow H_2SO_4 \\
    H_2O + NO_2 &\rightarrow HNO_3
\end{align*}
\]

112. If the cost of gas is $3.50 per gallon and the average gas mileage of a car is 25 mpg, the cost of driving the car per mile is **$0.14 $/mi**, or **14 ¢/mi**.

Show work:

\[
$3.50/gal \cdot 1\text{ gal/25 miles} = $0.14
\]

113. The acronym NIMBY refers to **Not In My Back Yard** which is: opposition by residents to a proposal for a new development because it has a high perceived risk. Rather not have it close by even if it will benefit society.
114. Identify significant sources of the following air pollutants:

Formaldehyde: **Building and insulation materials**

Radon: **Naturally occurring in the rocks. Heavy so accumulates in the basement.**

Mercury: **Neurotoxin found in rocks such as coal. Coal combustion provides the largest amoun.**

Carbon monoxide: **Motor vehicle exhaust and fossil fuel combustion.**

Nitrous oxide: **Automobile engines and coal power plants**

115. List three specific health effects of lead on humans.

**Neurotoxin – can also palsy, paralysis, blindness, mental retardation**

116. Label the four major zones of life in the appropriate areas on the diagram representing a temperate lake in the box to the right.

![Diagram of Three Zones of a Pond or Lake]

117. List three disinfectants that are commonly used to make drinking water safe during in the water treatment process.

1) **Chlorine**

2) **Ozone**

3) **UV**
118. On the circle to the right, draw out 0, 30, 60 and 90 degree latitude lines. Draw and label the Polar Hadley and Ferrell cells, with the proper circulation pattern for each (clockwise or counterclockwise)

119. In the box below, write the chemical equation for the formation of carbonic acid from the reaction of water with carbon dioxide.

\[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \]

The reaction goes both ways.

120. Identify two places in the environment where the above reaction occurs naturally.

1) **In the ocean/lakes, etc.**
2) **In the blood**