APES OBJECTIVES – UNIT ZERO – INTRODUCTORY UNIT

CHAPTER 1

- Distinguish between ecology and environmental science
- Explain why environmental science is considered an "interdisciplinary" course.
- Define Earth capital and solar capital and describe their roles in a sustainable society.
- Define "ecosystem services"
- Distinguish among **perpetual resources, potentially renewable resources and nonrenewable resources** and give ONE example of each type resource.
- Distinguish between common-property resources and free-access resources. Give examples of these resources.
- Define ecological footprint.
- Distinguish between developing and developed countries. Identify characteristics with each country.
- Identify the components of the formula I = P x A x T . And, explain how these different variables affect IMPACT in developed and less developed countries.
- Describe the role of Garett Hardin
- Describe "The Tragedy of the Commons" and give an example of how this may occur in any society.
- Describe the difference between exponential growth and logistic growth.
- Given graphs, be able to identify as exponential or logistic.
- State the purpose of the "Rule of 70."
- Perform mathematical calculations using the Rule of 70.
- Perform mathematical calculations using scientific notation and dimensional analysis.
- Define pollution.
- Distinguish between point sources and nonpoint sources of pollution. Give examples of each.
- Define GDP and explain it's relevance to environmental science.
- Distinguish between internal and external costs.
- Describe how the principles of supply and demand affect the environment.
- Know the significant contributions of each of the following individuals:
  Rachel Carson, John Muir, Aldo Leopold, E.O. Wilson

CHAPTER 23-25

- Explain what is meant by a worldview.
- State the basic tenets of "planetary management worldview" "stewardship worldview" and "environmental wisdom worldview."
- Relate the three world views in the above objective to the following views: anthropogenic, stewardship, biocentric and ecocentric.
- Distinguish between intrinsic and inherent value.
- Define utilitarian value and give an example
- Describe what is meant by anthropogenic?

- Define the following concepts: full cost pricing, eco-labeling, green tax, subsidy, cap and trade
- Be familiar with the purpose of the following agencies:
  - World Bank
  - WHO
  - EPA
  - OSHA
  - DOE
  - DOT

CHAPTER 2 – CHEMISTRY

- Given an environmental question, be able to DESIGN an experiment including: hypothesis, experimental setup, data collection system, analysis, and conclusions.
- Given experimental data, be able to identify the appropriate hypothesis, independent and dependent variables, controls, constants and conclusions.
- Distinguish between an experimental hypothesis and a NULL hypothesis.
- Perform Chi Square problems to accept or fail to accept a null hypothesis.
- Be able to distinguish among the various types of matter: atoms, elements, ions, and compounds.
- Define atomic number, mass number and isotope
- Given the mass number, be able to calculate the number of protons, neutrons and electrons in a given atom.
- Describe the uses of isotopes in science.
- Distinguish between ionic and covalent bonding AND give ONE example of each.
- Describe the properties of water.
- Distinguish between polar and non polar molecules.
- Describe how the law of conservation of matter and energy work in our environment.
- Identify the four major groups of macromolecules and give a basic function and example of each type.
- Write the balanced equation for the combustion of an organic compound , such as CH_4, methane.
- Define energy
- Distinguish between potential and kinetic energy. Give an example of each.
- Perform calculations for energy efficiency.
- Using the pH scale, determine if a material is acidic, basic or neutral.
- Distinguish between high quality and low quality energy. Give an example of each.
- Define synergy.
- Distinguish between ionizing and non-ionizing energy.
- State the two Laws of Thermodynamics.
- Explain how radioisotopes can be used in nuclear reactions.
- Distinguish between nuclear fission and nuclear fusion.
- Distinguish between open and closed systems in our environment.
- Distinguish between positive and negative feedback systems
- Describe a feed back loop. And, be able to recognize positive and negative loops.

UNIT ZERO – CLASS NOTES

I. BASIC TERMINOLOY

A. ENVIRONMENT – Everything that surrounds us (air, water, energy)

B. ENVIRONMENTAL SCIENCE – An interdisciplinary study of how humans interact with the biotic and abiotic parts of the environment.
These include studies in biology, chemistry, mathematics, geography, economics and political science, bioethics.

C. ECOLOGY – The part of biological sciences that study how living organisms interact with each other and their surroundings.

Ecological hierarchy: organisms → communities → ecosystem → biosphere

II. SUSTALINABILITY – The capacity of earth's natural systems and human cultural systems to survive, flourish and adapt to changing conditions into the long-term future.

When we talk "sustainability" – think BEYOND our lifetime – maybe 10 lifetimes.

THERE ARE THREE MAJOR PRINCIPLES OF SUSTAINABILITY

A. DEPENDENCE ON SOLAR ENERGY - SOLAR CAPITAL
The sun is the ULTIMATE source of energy (photosynthesis , wind currents, water recycling)

99% of Earth's energy – can be traced to solar

B. BIODIVERSITY – The variety of genes, organisms, species, and ecosystems which exist and interact. (EARTH CAPITAL)

Genes – "mutations" often provide new biodiversity. Ex. Pesticide resistant crops

Organisms - Complete living thing; interact to increase biodiversity

Species – organisms which can breed and produce viable offspring. (biological concept of a species)

Types of species

- Endemic species – found in only one place; usually require specialized roles. Ex. Would be Golden Toad – costa Rica
- Native Species – species which normally live and thrive in a specific or given area

  Ex. Diamond back rattle snake – Alabama and other parts of southeast

- Nonnative species (invasive , alien, exotic) – species that have intentionally or accidentally been introduced into an area where they are not normally found.

  Ex. Killer bees, kudzu, fire ants, Purple loosestrife – and thousands more!!

- Indicator species – species which show early warnings of problems with a community. Changes in their numbers within a community are critical.
  Ex. Amphibian, birds, butterflies, trout

- Keystone species – Most important for their role; NOT their numbers.

  Classic Example : SEA OTTER → SEA URCHIN → KELP

C. CHEMICAL CYCLING – MOVEMENT OF CHEMICALS NECESSARY FOR LIFE FROM THE ENVIRONMENT → LIVING ORGANISMS – ENVIRONMENT

EX. WATER CYCLE ; CARBON CYCLE , NITROGEN CYCLE

III. KEY COMPONENTS OF SUSTAINABILITY

A. NATURAL CAPITAL = NATURAL RESOURCES + ECOSYSTEM SERVICES

1. NATURAL RESOURCES – materials and energy essential and useful to humans.

- Perpetual (inexhaustible) resources : sun, wind
- Renewable resources : air, water topsoil, plants, animals
- Nonrenewable (depletable) resources:

ENERGY – OIL, COAL

METALLIC – COPPER, ALUMINUM, IRON

NON METALLIC – SALT , SAND

SUSTAINABLE YIELD – THE HIGHEST RATE WE CAN USE A RENEWABLE RESOURCE WITHOUT REDUCING ITS AVAILABILITY.

To help us achieve more sustainable use, we have developed an order relative to Nonrenewable resource use.

REFUSE , REDUCE, REUSE, RECYCLE

2. ECOSYSTEM SERVICES

- WATER AND AIR PURIFICATION
- TOPSOIL RENEWAL
- POLLINATION SERVICES
- PEST CONTROL
- POPULATION CONTROL

B. HUMAN ACTIVITES DEGRADE NATURAL CAPITAL

- DEFORESTATION
- EXCESSIVE USE OF PESTICIDES, FERTILIZERS
- OVERUSE OF RIVERS, LAKES, SOIL, OCEANS

C. SOLUTIONS

- Trade-offs (Compromises); full-cost pricing; what impacts the largest number of people
- Subsidy
- Individual decisions – political/economic and ethical views

IV. ECOLOGICAL FOOTPRINT

- The amount of land and water needed to supply a person or an area with renewable resources and that are needed to absorb and recycle wastes and pollution.

Per capita ecological footprint – average ecological footprint of an individual in a given area or country.

A. DEVELOPED COUNTRIES

- Industrialized nations with high average income
- Includes about 20% of world's population
- US, Canada, Japan, Australia, European countries
- Use approximately 80% of Earth's resources

B. Less-developed countries (developing)

- Middle-income (Moderately Developed) – China, India, Brazil, Thailand, Mexico
- Low Income – least developed countries – Congo, Haiti, Nigeria, and Nicaragua
- These countries have 80% of the world's population; use about 20% of the Earth's resources

C. LIVING UNSUSTAINABLY

- AIR POLLUTION
- SOIL EROSION
- DEFORESTATION
- SPECIES EXTINCTION
- AQUIFER DEPLETION
- OVER-FISHING; OVER – HUNTING
- WATER POLLUTION

D. POLLUTION – any agent (chemical or not that can be harmful to health, survival or activities of humans and other organisms,

1. Point source – comes from a single – identifiable source
2. Non Point source – difficult to trace its' origin and manage

E. POLLUTIN CLEANUP

1. POLLUTION CLEANUP – REMOVE POLLUTANTS FROM WATER, AIR SOIL. CHEAPER ON THE FRONT END
2. POLLUTION PREVENTION – REDUCE OR ELIMINATE POLLUTANTS
   a. LEGISLATION – SET LEVELS OF EMMISIONS
   b. MORE EXPENSIVE UP FRONT BUT CHEAPER OVER THE LONG RUN.

F. TRAGEDY OF THE COMMONS

Garrett Hardin (1968)

The overuse of SHARED or OPEN-ACCESS resources based on the fact that if I do not use it – someone else will.

Ways to regulate/reduce the impact of Tragedy of the Commons

- Government regulations
- Convert these area to private ownership

G. AFFLUENCE – OVER CONSUMPTION OF RESOURCES BEYOND THEIR BASIC NEEDS

I = PAT

Impact = Population x Affluence x Technology

V. CASE STUDY: CHINA'S GROWING NUMBER OF AFFLUENT CONSUMERS

- World's largest population ; second largest economy
- Major pollution problems ; few regulations
- Estimated population by 2025 → 1.5 billion

VI. FIVE MAJOR CAUSES OF ENVIRONMENTAL PROBLEMS

A. POPULATION GROWTH

a. Exponential vs logistic growth
b. Rule of 70
   DOUBLING TIME = 70/ annual growth rate (%)

B. UNSUSTAINABLE RESOURCE USE

On average, it requires 27 large tractor-trailer loads of resources per year to support ONE typical American. (high affluence)

C. **POVERTY** - the inability to fulfill your basic need for adequate food, water, shelter, healthcare and education.

- 900 million – live in extreme poverty ; these individuals live on $1.25 a day
- 2.6 Billion live on approximately $2.25 a day
- High overall environmental impact
- Malnutrition
- Limited access to clean water and sanitation facilitites.
- Often severe respiratory diseases – due to burning wood in enclosed spaces
- Approximately, 19,000 children die DAILEY from these causes .

D. **EXCLUDING ENVIRONMENTAL COSTS FROM MARKET PRICES**

Ex. Timber companies pay the cost of clear-cutting forests but do NOT pay for the environmental degradation and loss of wildlife habitat.

It is estimated that gasoline should be about $12.00 / gallon if we take into account it procession and impact on environment.

Subsidies to companies (oil, pharmaceuticals, developers for shopping centers)

E. **INCREASING ISOLATION FROM NATURE**

Today 3 out of 4 people in developed countries live in urban areas. This shift from rural to urban living has isolated us from understanding many of nature's processes.

Nature deficit disorder – loss of contact with natural world; irritability/ aggression/ depression

VII. HISTORY OF ENVIRONMENTAL SCIENCE

A. HUNTER-GATHERERS

- Nomadic lifestyle
- Small groups of tribes
- Consumed few resources
- Moved as they needed to find enough food for survival
- Low overall impact on environment

B. AGRICULTURAL REVOLUTION (10,000 -12,000 YEARS AGO – 1750)

- Move from nomadic lifestyle to settled agricultural communities
- Domestication of wild animals; cultivated wild plants
- Slash-and-burn cultivation
- Dependence on muscle power and crude tools
- Population density is low; little impact on land

C. INDUSTRIAL-MEDICAL REVOLUTION (1800'S – 1950)

- Shift from dependence on renewables (wood) to nonrenewables (coal, gas)
- Movement from small localized production → large-scale manufacturing
- Factory towns grow → noisy, dirty, hazardous conditions
- Increased air, water and water pollution
- Habitat destruction

Henry David Thoreau – wrote "Life in the Woods" ; called attention to loss of wild species in eastern Massachusetts at the time

John Muir – troubled by large degree of deforestation; began the preservationist movement – not enacted into law until 1960s

Established the Sierra Club – which is still active to in environmental conservation

Theodore Roosevelt - often referred to as "Golden Age of Conservation"

Established wildlife reserves and more than tripled the size of national forest reserves

Franklin Roosevelt (FDR)

CCC – Civilian Conservation Corps; built large dams, control irrigation; cheap electricity; flood control. (Hoover Dam)

D. ENVIRONMENTAL AGE (1960'S – PRESENT)

- RACHEL CARSON - PUBLISHED SILENT SPRING; FIRST TO ESTABLISH A QUANTITATIVE RELATIONSHIP BETWEEN EFFECTS OF DDT AND MORTALITY RATE OF EAGLES.

- 1970's – EPA established ; Clean Air Act, Endangered Species Act and Clean Water ACT

- 1980's- Superfund established; Love Canal incident

- 1990's- present; emphasis on wind, solar, geothermal

VIII. ENVIRONMENTAL WORLD VIEWS

How you think the world works; what is your role should be on our planet; what you see as "right" or "wrong" environmental behavior.

A. PLANETARY MANAGEMENT MODEL

- Humans are the most important species
- Resources are unlimited as we will always have the ability to develop or find news ones
- Unlimited global economic growth is essential
- Organisms are most important for their utilitarian value

B. STEWARDSHIP WORLDVIEW

- Humans are the most important species; but we have a responsibility to care for the rest of nature
- We will probably not run out of resources, but we should not waste them
- We should encourage environmentally beneficial economic growth

C. ENVIRONMENTAL WISDOM WORLDVIEW

- Nature exists for all species
- All living things have inherent right to exist
- Earth's resources are limited and should not be wasted
- We should encourage earth-sustaining forms of economic growth
- Our success depends on how the earth sustains itself and integrating lessons from nature into the ways we think and act.

AP Environmental Science
Chapter 1 Introduction

1. If a population is growing at a constant rate of 7% a year, it will double in approximately

   A) 5 years B) 10 years
   C) 15 years D) 20 years

2. Select the person who matches the description provided from the list below.

   A. Henry David Thoreau
   B. Garrett Hardin
   C. Rachel Carson
   D. Upton Sinclair
   E. Aldo Leopold

   Author of *Tragedy of the Commons* (1986)

3. Exponential growth

   A) starts out fast and gradually slows down
   B) is characteristic of the human population
   C) is the same as logistic growth
   D) has an S shaped curve

4. An external cost when a consumer purchases a car would be

   A) the extra features that the consumer decides to add to his purchase
   B) the building of an aesthetically pleasing showroom for people to enjoy
   C) the CO_2 and NO_2 that is emitted by the company that manufactured the car
   D) the price of mining the raw materials from which the car is made

5. Which of the following is a non-point source of pollution?

   A) Gas leaks from a tank of methyl isocyanate in Bhopal, India
   B) A smokestack leaks sulfur dioxide, carbon monoxide, and metal dust into the surrounding air
   C) A power plant discharges waste into a sewer system
   D) Forestry operation increase soil erosion and sediment runoff

6. Which of the following is a point source of water pollution?

   A) Inorganic fertilizers
   B) Oil tankers
   C) Acid rain deposition
   D) Pesticides

7. Which of the following is NOT a point source of pollution?

   A) Runoff from streets
   B) Smokestacks
   C) Oil spill
   D) Nuclear meltdown

8. Cost benefit analysis includes all of the following EXCEPT

   A) determining whether the private sector provides adequate public services
   B) assessing the private sector's inefficiencies and their impact upon health and safety
   C) determining external costs to society
   D) quantifying the aspects of a project into monetary units

9. Full-cost pricing

   I. accounts for all internal costs
   II. accounts for all external costs
   III. makes pollution clean-up more profitable than prevention

   A) I only B) I and II only
   C) I and III only D) II and III only

10. External costs

    A) are still paid for by the public except in hidden forms such as higher taxes for health insurance
    B) are usually subsidized by the government to balance out the economy
    C) are paid for by corporations and businesses most of the time to soften the damage to the environment
    D) are usually paid for with forms of capital other than money

11. Why is ground water sometimes considered a nonrenewable resource?

A) It is often contaminated by pollutants.
B) It is part of a continuous cycle.
C) It is removed at a rate faster than it can be replaced.
D) It is not a nonrenewable resource.

12. Compared to unsustainable economic growth, environmentally sustainable economic development

A) emphasizes nonrenewable resource types
B) focuses on cleanup in its pollution control efforts
C) emphasizes prevention and precaution as a main guiding principle
D) has high resource throughput

13. Developing countries often have far more severe air pollution problems in their cities than developed countries have in their cities because

A) people in developed countries use clean and efficient public transportation
B) vehicles in developing countries must carry heavier loads
C) vehicles in developing countries are generally older and in poor repair
D) people in developed countries drive less

14. Compared with people in developing countries, people in industrialized countries are more likely to consume

A) potatoes B) milk
C) wheat D) rice

15. Currently, _____ countries make up the majority of the world's population. At the end of the twenty-first century, _____ countries are expected to make up the majority of the world's population.

A) developed; developed
B) developed; developing
C) developing; developing
D) developing; developed

16. Invasive species are often transported to other continents by way of

I. aircrafts
II. ballast water in tankers
III. imported products such as wooden packing crates

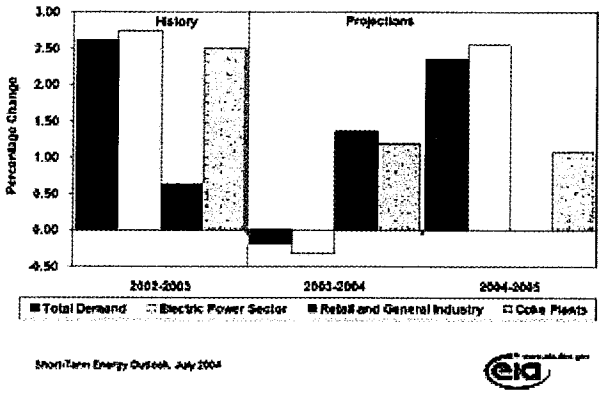
A) I only B) II only
C) I and II only D) I, II, and III

17. Gross domestic product is a measure of

A) the quality of life in a country
B) a country's economic growth
C) the sum of all goods and services produced within a country's borders in a period
D) the average after-taxes income level for the citizens of a given country

Base your answers to questions **18** and **19** on the below chart of US coal demand.

Figure 11. U.S. Coal Demand



18. Which of the following is the trend of total coal demand from 2002 to 2005?

A) Decreasing only
B) Increasing only
C) Increasing, decreasing, increasing
D) Decreasing, increasing, decreasing

19. Which of the following most likely is the basis for the 2003-2004 projection?

A) Tighter clean-air requirements on coal-burning plants
B) Newly released findings on the environmental impacts of coal burning
C) Decreased coal prices
D) Flooding of the US market by foreign coal

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20. Which of the following forms of energy is a non-renewable resource?

A) Solar B) Geothermal
C) Hydroelectric D) Fossil Fuels

21. Which of the following is an example of a renewable resource?

A) Natural gas B) Salt
C) Coal D) Sunlight

22. Which of the following is NOT an example of a renewable resource?

A) Water B) Wind
C) Natural oil D) Fertile soil

23. A group of students studying the ecology of a freshwater stream recorded data in the following categories:

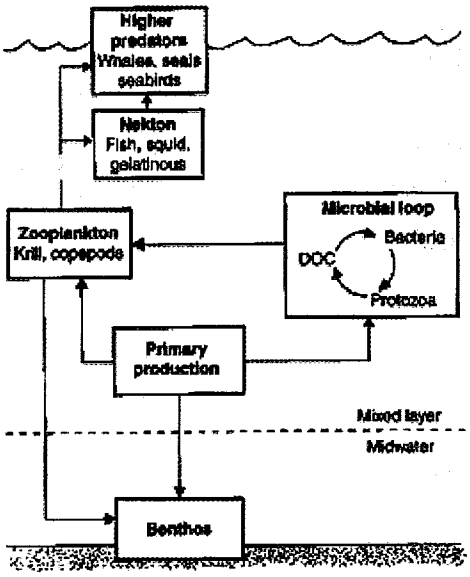
(A) kinds of insects
(B) pH
(C) number of minnows
(D) mineral concentration
(E) types of producers
(F) oxygen content
(G) examples of food chains
(H) water temperature

Which group of data categories contains only biotic factors of the stream?

A) A, B, C, and D B) A, C, G, and H
C) C, E, F, and G D) A, C, E, and G

24. Which of the following is often an indicator species?

A) Bees B) Tigers
C) Shrubs D) Birds



25. Which of the following organisms is likely to be the keystone species?

A) Bacteria
B) Whales
C) Krill
D) Benthos mudworms

Chemistry Review continued

1. + Which statement about atoms and molecules is correct?
   a. the mass number of an element is always less than its atomic number
   b. isotopes are the result of varying numbers of neutrons in atoms of the same number
   c. ionic bonds involve electrons while covalent bonds involve protons
   d. protons and electrons have roughly the same mass.

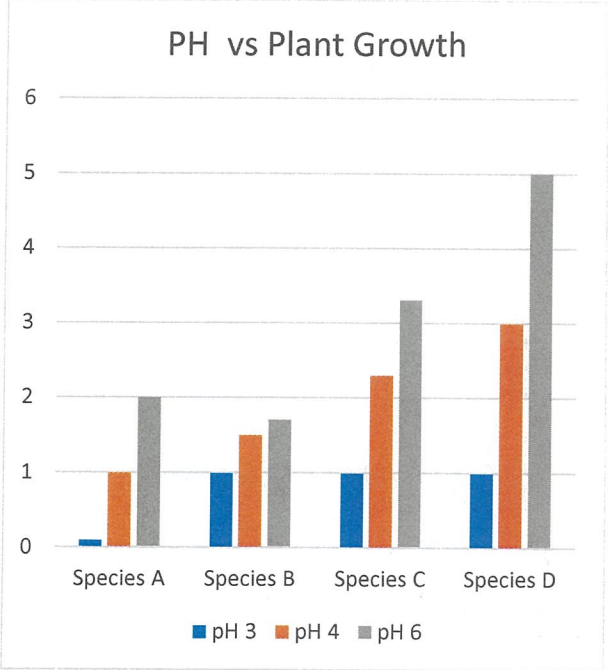
2. Which of the following does NOT demonstrate the law of conservation of matter?
   a. $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$
   b. $NaOH + HCl \rightarrow NaCl + H_2O$
   c. $PbO + C \rightarrow 2\ Pb + CO_2$
   d. $2\ NO_2 + H_2O \rightarrow HNO_3 + HNO_2$

3. Pure water has a pH of 7 because :
   a. Its surface tension equally attracts acids and bases
   b. Its polarity results in a molecule with a positive and negative end
   c. Its capillary action attracts it to the surfaces of solid substances
   d. Its H^+ concentration is equal to its OH^- concentration

4. Which is NOT a type of organic biological molecule?
   a. Lipids
   b. Carbohydrate
   c. Salts
   d. Nucleic acids

5. Which of the below is an example of a high-quality energy source?
   a. Atmospheric oxygen gas that humans need to survive
   b. Recycled components of discarded computers and other electronic devices
   c. Gasoline used to power automobiles
   d. Wood from a fallen tree used to keep a campfire burning on a cold night.

6. A researcher conducts an experiment to test how rain of varying acidity will affect the growth of four different plant species , identified as A, B, C and D. The researcher creates four groups of plants, each with different treatment. Each group contains 10 individuals of each of the four species. One group is watered daily with a solution of pH 3, a second is watered daily with a solution pH 4 and a third is watered daily with a solution of pH 6. At the end of 5 days, the growth of each plant is measured producing the graph below.



Which species appears to be least sensitive to the pH of rainfall across the range of exposure?

a. Species A
b. Species B
c. Species C
d. Species D

7. The warming of the oceans causing less carbon dioxide to be soluble in them, and at the same time leaving more carbon dioxide in the atmosphere causing an increased warming of the atmosphere ,is an example of a

a. Model of a system showing a paradigm shift
b. Negative feedback system
c. Positive feedback system
d. Synergistic reaction

8. Sarah is currently spending $100 per month on electricity. She pays $0.20 per kWh (kilowatt hour). Her space heater is responsible for 10% of her electricity consumption. How many kilo-watt hours (kWh) does her space heater use in a month? Assume a month is 30 days.
   a. 0.07 kWh
   b. 2 kWh
   c. 20 kWh
   d. 50 kWh

9. The National Hurricane Center studies the origins and intensities of hurricanes over the Atlantic and Pacific oceans and it attempts t forecast their tracks, predict where they will make landfall and assess what damage will result. This system analysis involves
   a. Changes within a closed system
   b. Inputs and outputs within a closed system
   c. Inputs from a closed system and outputs in an open system
   d. Inputs, outputs and changes within an open system

10. During radioactive decay
    I. There is a release of material from the nucleus of unstable isotopes
    II. There is a change in the half-life of an element
    III. An element is changed into a different element

a. I only
b. II only
c. I and II
d. I and III

11. The mass number of the element selenium is 80 and the atomic number is 34. How many neutrons does selenium have?
    a. 114
    b. 80
    c. 46
    d. 34

12. Which list contains only organic material?
    a. Proteins, lipids, salts
    b. Dead trees, decomposing leaves, earthworms
    c. Cellulose, ethanol, calcium chloride
    d. NH_3 , NaOH, NO_3^{-1}

13. If the average adult woman consumes approximately 2,000 kcal per day, how long would she need t run in order to utilize 25% of her caloric intake, given that the energy requirement for running is 42,000 J per minute? (Recall 1 kcal = 4284 joules)
    a. 200 minutes
    b. 50 minutes
    c. 5 minutes
    d. 1.0 minute

14. Which of the below organic molecules is incorrectly paired with its function or role?
    a. Methane – component of natural gas
    b. DDT – chlorinated hydrocarbon – insecticide
    c. Chromosome – energy storage
    d. Starch – complex carbohydrate for energy storage.

15. Entropy is
    a. The amount of heat in a system
    b. The lowest level of energy quality
    c. The ease with which an energy source can be used for work
    d. The randomness of a system

Questions 16-20 refer to the description of an experiment below.

Ecologists designed an experiment to determine whether nitrates or phosphates are more limiting to algae growth. A lake in Canada (Lake 226) was divided into two equal sized sections by a vinyl curtain. Each sub-basin of the lake was then fertilized, one with nitrates and carbon and the other with phosphates, nitrates and carbon. The amount of phytoplankton (algae) in the lake was then measured in each side, with the side of the lake with phosphates added showing a greater rate of phytoplankton growth.

16. Frequently studies in nature are difficult to set up and may lack some aspects of more traditional laboratory based experiments. What element of this experiment could be considered to be lacking?
    a. An independent variable
    b. Constants
    c. Control
    d. Repeated trails
    e. A dependent variable
17. Which of the below is the independent variable in this experiment?
    a. The location of the lakes
    b. The two lakes separated by a vinyl curtain
    c. The amount of phytoplankton growth
    d. The depth of the lakes
    e. The phosphate added to one side of the lake
18. Identify the constants in this experiment
    a. The depth of the lakes
    b. The nitrates and carbon added to both lakes
    c. The amount of phosphate added
    d. The amount of phytoplankton growth
    e. The species of fish in both lakes compared to other lakes
19. Which of the below would be a valid hypothesis for this experiment?
    a. The amount of phytoplankton growth will vary with the depth of the lake
    b. If more phosphate is added to one side of the lake, then there will be more phytoplankton growth on that side
    c. If one side of the lake receives more sunlight, then that side will have more phytoplankton growth
    d. Phytoplankton grows faster with more nutrients added
20. Which concept below best describes the process being studied in this experiment?
    a. The greenhouse effect
    b. Cultural eutrophication
    c. Red tide events
    d. Denitrification in response to fertilizers

1. Scientists are interested in how the severity of acid deposition affects the soil of the red spruce forests. They design a laboratory experiment in which rainwater of different pH values is used to water soil samples taken from red spruce forests. The soil samples are the same size and contain the same ratios of sand, silt and clay. The same amount of water s sprayed on the soil samples every day for a week.

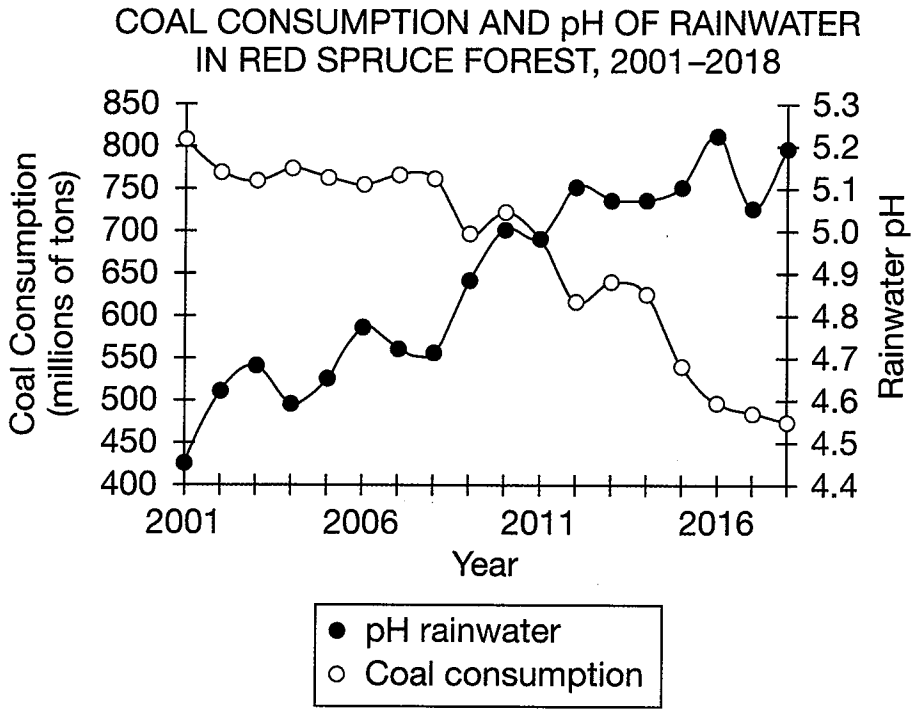
a. **Describe** **<u>one</u>** effect that acid rain (deposition) could have on trees in a forest ecosystem, other than death.

b. Throughout the experiment, the scientists meausred the concentration of toxic forms of aluminum in the soil sample.

   i. **Identify** a dependent variable for the experiment
   ii. **Identify** TWO constants in the experimental design.
   iii. **Describe** the likely scientific question investigated in the experiment

In 2018 researchers found that many of the red spruce forests had started to recover from the damage caused by acid deposition. Based on the research, a group of scientists hypothesized that coal-fired plower plants were a likely source of pollutants that lead to acid deposition in the red spruce forest.

c. To test their hypothesis, they researched the consumption of coal by electric utility companies in the United States and the pH of rainwater from a red spruce forest in Vermont between 2001 and 2018.



i. Based on the data in the graph , **describe** the trend in pH rainwater from 2001 to 2018.
ii. Based on the data in the graph, **identify** the year with the highest coal consumption.
iii. One of the major gases released from coal power plants would be sulfur dioxide, SO_2. **Describe** how this gas, SO_2 contributes to the formation of acid rain.

d. **Explain** how the data in the graph support the hypothesis that the combustion of coal in coal-fired power plants could be correlated to the damage in the red spruce forests.

e. **Explain** how the data in the graph support the hypothesis that the combustion of coal in coal-fired power plants could be correlated to the damage in the red spruce forests.

f. The Clean Air Act enacted in the 1970's has made great strides in improving air quality by holding companies responsible for excessive pollution. Some feel that the Clean Air Act has a negative economic impact while others believe the economic impact is overall positive. **Make a claim** of what you think best describes the economic impact of this legislation and **justify** your response.